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Nurses' perceptions of a novel health information technology: A qualitative study in the pediatric intensive care unit

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Abstract

The purpose of this study was to evaluate the use of a novel health information technology (HIT), a large customizable interactive monitor (LCIM), implemented in a pediatric intensive care unit (PICU). Specifically, we explored nurses' perceptions of this novel HIT application and its perceived effect on family engagement. We used a qualitative research design to collect and analyze data from 55 PICU nurses in seven focus groups. A trained moderator followed a semi-structured discussion guide with questions related to perceptions, attitudes, and care team interactions with the LCIM. Groups were audio-recorded, transcribed, and coded using content analysis procedure. Six major themes emerged from the nurse focus groups, which include familiarity and use routines, positive perceptions with the LCIM, negative perceptions with the LCIM, privacy, training, and suggestions for improvement. Insights into nurses' perceptions of the LCIM has the potential to improve family-centered care.

Keywords

Nursing informatics; Family engagement; Pediatrics; Health information technology; Patient Facing technologies

1. INTRODUCTION

Health information technology (HIT) has become an essential part of healthcare systems in hospitals (Blumenthal & Squires, 2015). In addition to health care providers' mandated use of electronic health records, the use of non-mandated, novel and more interactive HITs continue to grow. Research points to increased focus on the role of novel HITs in promoting patient-centered, high quality care as well as patient and family engagement (Finkelstein et al., 2012; Prey et al., 2013). Some of these novel and interactive HITs are electronic white

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boards (Tang, Carpendale, & Scott, 2010; Wong, Caesar, Bandali, Agnew, & Abrams, 2009), tablets (Vawdrey et al., 2011) , patient portals (North et al., 2011), patient facing technologies (Wilcox et al., 2013), and mobile health applications (Pandey et al., 2013; Vardoulakis et al., 2012). Studies suggest that these type of technologies might improve health care quality (Buntin et al., 2011), patient safety (Middleton et al., 2013), patient engagement (White & Danis, 2013), patient-centered care (Zhang et al., 2015) and medication management (Holden et al., 2011); however, additional research will be necessary to understand these benefits and the effective use of these technologies by end users.

Previous research suggests that the *field of dreams fallacy* may apply to use of health information technologies, in other words, simply implementing a technology does not guarantee its use (Choi & Chung, 2013; Holden & Karsh, 2010). The Technology Acceptance Model indicates that regardless of the purported quality of the technology or the fact that a given HIT was installed, ultimately, it is the perceptions of those intended to use the technology that determine both its use and whether potential benefits are realized (Holden, 2010). While users may express wants or desires about a given technology, the degree to which their needs are met by the HIT and perception for improving care influences the actual use of the device (Holden & Karsh, 2010).

Several studies focused on doctors' acceptance and perceptions of electronic health records (EHRs) in both inpatient and outpatient settings (Lanham et al., 2014; Makam et al., 2013), however relatively few studies explores nurses' HIT perceptions or acceptance (Carrington, 2015). A recent literature review identified only 13 articles exploring nurses' acceptance, perception or use of newly implemented HITs (Strudwick, 2015). Some of those studies assessed perceived usefulness and perceived ease of use based on the technology acceptance model on various newly implemented HIT, such as bar-coded medication administration systems (Holden et al., 2012; Marini, Hasman, & Huijer, 2009), PDAs (Zhang, Cocosila, & Archer, 2010), medication administration system (Kuo, Liu, & Ma, 2013), EHRs/clinical information systems (Carayon et al., 2011), and hospital information systems (Ketikidis et al., 2012). Some other studies explored nurses' perception regarding the impact of such technologies on the quality of care (Karsh et al., 2009). Those studies reported variation in nurses' HIT acceptance and multiple predictors of acceptance, including the HITs perceived usefulness and ease of use (Strudwick, 2015). It is critical to explore and understand the perceptions of nurses on any newly implemented HIT, since nurses are critical users and have pivotal roles in health care delivery.

This qualitative study examines nurses' perceptions of a commercially available, novel HIT application, the large customizable interactive monitor (LCIM), implemented in a pediatric intensive care unit (PICU). The LCIM is a wall-mounted flat panel touch screen that displays EHR data including vital signs, laboratory results, medications and interventions for the use of providers and families in the room. This study took place in the first PICU to implement this technology in the U.S. To our knowledge, nurses' perceptions of this HIT have not been studied before. The purpose of this qualitative study, which is a part of a larger mixed-methods study, was to understand nurses' positive and negative perceptions of this

novel HIT application as well as its perceived contribution to family engagement in the PICU.

2. METHODS

2.1 Overview

We used a qualitative research design to collect and analyze focus group data from nurses. Focus groups were conducted from September to December, 2015. This study was approved by the hospital's institutional review board. Verbal consent was obtained from participants prior to starting the focus groups.

2.2 Setting

The study was conducted in a freestanding Midwestern children's hospital PICU, a 72-bed unit with approximately 3000 admissions per year. The three-floor PICU delivers highly specialized care for critically ill children and newborns. The first floor admits children with complex heart conditions. Children on this unit receive services related to monitoring of assist devices, extracorporeal membrane oxygenation, post-heart surgery and post-organ transplant. The second floor is a surgical-medical unit providing care to children with body trauma, transplants and innovative surgical procedures. The third floor is a medical-surgical unit with patients that require intensive level medical management, such as sepsis, burns and oncologic disorders. Wall mounted LCIMs were installed in each PICU patient room at the time of the implementation of a new commercial EHR.

2.3 Technology

The EHR system, Epic Version 10 by Epic Systems Corporation, was implemented in November of 2012. EHR settings include all inpatient environments, the emergency department, the operating room environment (as well as anesthesia services), and health system associated primary and subspecialty ambulatory care settings. PICU leaders chose to additionally install the LCIM in each PICU patient room. This LCIM installation was the first in a PICU setting in the U.S. The LCIM is an interactive "view only" technology with no ability to enter data. The LCIM technology utilized the Epic Monitor (v 2010, Epic Systems Corporation, Verona, WI). The organization ensured that the LCIM operated in compliance with HIPAA regulations.

The LCIM is a supplementary software tool that works with the Epic EHR and allows the creation of customized review widgets for display of a patient's chart. The main use of the tool is to display information about one patient on a large touch-screen monitor within the patient's room. The customizable nature of the software has the potential to display data whether as a "tracking board" or in an overview of a patient care unit, including vital signs, laboratory results, medications, patient problem list and interventions. In contrast to traditional HIT intended for providers that requires a secure login to access patient information, the LCIM is available in each private patient room for viewing and use by providers as well as patients/families without any login required.

2.4 Recruitment Process and Participants

A convenience sample of PICU nurses was obtained during regularly scheduled monthly staff meetings. Announcements about the research study were posted in the units with the contact information of the research coordinator. The research coordinator met with nurse managers to announce the study and encourage participation during the sessions. Seven focus groups involved a total of 55 nurses. Their mean tenure in nursing was 9 years (median 7 years, range 1-35 years), and mean tenure as a PICU nurse was 6 years (median 6 years, range 1-29).

2.5 Focus Groups

Focus groups were conducted during regular monthly staff meetings to determine the perceptions of PICU nurses regarding the LCIM. There were several reasons we conducted focus group rather than individual interviews. Chiefly, there are restrictions from the hospital management on how nurses can be compensated for participation in research and nurses would need to stay after regular work hours to participate in an individual interview. Thus, we attended the regular monthly staff meetings so that no additional effort was required from the nurses in order to participate. In addition, we viewed the group environment as a strength for discussion of this topic, since individuals can respond to and build on others' comments. A member of the research team led the group discussions following a semi-structured guide. The focus group guide was developed by the research team based on specific study objectives and following the study framework, the Technology Acceptance Model. The focus group guide included questions regarding nurses' use routines, how and when they use the LCIM, training and familiarity as well as perceived usefulness and ease of use (Table 1). Discussions were audio-recorded and professionally transcribed, and a second member of the research team additionally took observational notes throughout the groups. Participants were free to answer only those questions to which they were comfortable responding. Each session lasted approximately 30 minutes.

Focus groups continued until saturation was reached, and no new information was shared (Morse & Field, 1995). Two coders independently read and analyzed all the transcripts (in total 7 transcripts). Coding began with creating an initial codebook, which was modified as new codes emerged. The team met to discuss any new codes and to reach consensus, which formed the final codebook. The entire data set was coded by two team members (O.A. and L.A.). Discrepancies were resolved through discussion until consensus was achieved. Coding and analysis was completed using NVivo 10 software.

3. Results

Six major themes emerged from the analysis: 1) familiarity and use routines, 2) positive experiences, 3) negative experiences, 4) privacy, 5) training, and 6) suggestions for improvement. Each theme is described below.

3.1. Familiarity and Use Routines

The topic of familiarity was interpreted differently by different nurses. Some nurses were less familiar with the LCIM and how to use it, *"…If families ask to look at something quick,*

and it's easier to just click, you know, pull it up in there. Otherwise I just tend to log into Epic." For those who did not use the LCIM, it was easier for nurses to look at the computer rather than at the LCIM because it was already part of their workflow. Others incorporated the LCIM as part of their routine workflow depending on how much families or attending physicians used the LCIM, "*Just when I'm using them it all depends on how comfortable the attending is with using it or if they usually use it during rounds, that's when I would use it. Or, if families are already looking at it, that's when I kind of play with it a little bit more with them."* Furthermore, several nurses stated that they do not know all the features of LCIM, so they want to learn more about the LCIM. Several nurses stated the LCIM was designed for physicians and not for nurses.

We also identified several use patterns and purpose of use from this data. Table 2 lists the different ways nurses used the LCIM. The nurses who used the system more frequently viewed lab results, fluid intake and output chart, medications, and the problem list. The ability to view x-rays was used once it was added as a feature of the LCIM (partway through the study).

Some nurses emphasized that showing families how to use the LCIM was a critical element to engaging families in their child's care. However, they noted that it was necessary for themselves to have those skills first, as demonstrated by this comment, *"Well I think if we knew how to use them we could even show families what they're looking at. You know a lot of times they will be like, 'What is this?' and I go, 'That's what you see that's what it is, I don't know how to do anything else because I'm not going to break it.'"*

3.2. Positive Perceptions of the LCIM

Nurses spoke about positive perceptions and experiences with the LCIM including family-provider interactions, data display and functions, and physical properties/overall beliefs (Table 3). Nurses stated that the system has potential to assist them with explaining the context of data to families and can be used to educate/teach families, such as, *"Visual information helps families understand the data better and facilitates the communication."* Nurses saw the LCIM used as a guiding tool that can help them break information down for families, particularly for complex patients. Also, it was easier for nurses to show trends over time on the LCIM because it graphs the data, *"you know I used it last week to show them you know where the kids white count was going up, what that meant, and they could actually like physically see it and not a number, they can see the pretty blue graphs, it was kind of cool."*

Families with children with chronic conditions benefit from the LCIM because they have continuous access to their child's medical information. As one nurse described, *"I'm mostly focused with our oncology patients whose families are relatively well-versed in what certain values mean. So, they're expecting and waiting for those lab results, and when they pop up I can help show them what might be just, you know, an extraneous circumstance of lab vs a trend or something like that."* Nurses thought families feel more involved and in control when information is transparent and they can see what is going up or down, if something is getting better or worse, "*They like to follow their children's progress because it has been a*

long road for them." Finally, some nurses cited that the LCIM was very helpful in accessing quick information, especially in emergency situations.

3.3. Negative Perceptions of the LCIM

Nurses shared their negative perceptions and experiences with LCIM based on family-provider interaction, data/content related, and technical features/usability issues (Table 4). The impact of different timeframes was frequently mentioned by nurses, who noted the intake and output chart on the LCIM (midnight to midnight) was different from that within the main EHR system (7 am to 7 am). This created confusion and contradicted the mental model of some providers. A comment typical of nurses in this group was, *"The monitors go twelve to twelve, somebody said that the other day and I was like because we were having an I and O [input and output] issue with a friend. Which caused issues in rounds because, one person was looking at the computer, and one person was looking at the monitor, so they were off and they were like why is one this and one that"*. Other system issues included the LCIM not working, freezing or crashing.

Additionally, nurses had mixed responses to perceived negative comments by family members. Parents asked nurses about information from the LCIM and what it meant. In particular, red values (which are not within the normal range) on the monitor created additional/unnecessary anxiety and worry for families. Some family members became too concerned with specific values, *"But, I would say sometimes it is a little distracting because they're red, even if it's one off. So, it might be a sodium of one off and then you have to, you know, explain all those things."* Nurses observed that too much information on the LCIM can be challenging for parents, since some parents expressed frustration when they do not understand all of the information.

3.4. Privacy

Despite the fact that the LCIMs were approved by the Corporate Compliance Officer and were NOT identified as a violation during Joint Commission surveys, some nurses were concerned with privacy issues. Common concerns identified included children's names being displayed on the LCIM and whether this was in compliance with HIPAA privacy rules, *"Having the full name so big when we have a lot of confidential patients that you can't do anything about that name being there and their birthdate.."* Some nurses responded negatively for having all the data available to anybody coming into the room, *"The other thing to is you know you have visitors coming in the room and who, you know who's to say they want Aunt Sue to know all that information when she's visiting. You know we have to get permission to give any information out so, yes it's kind of right there for anybody."* A few nurses also reported problem list on the screen can show a psychological diagnosis and psych meds which may make patient/family feel uncomfortable when visitors come in the patient room.

3.5. Training

Nurses commented about their training experience in regards to the LCIM. Nurses did not get institutionally-led formal training on how to use the LCIM. Some were not bothered by the lack of training, but commented on how formal training should have been provided,

"With them not being utilized, it's kind of one extra thing that we'll say, you know, we'll get the training on and then…if it's never put into practice, it won't get used and the training won't stick." Some nurses cited that the LCIM was relatively simple and intuitive to figure out how to use. However, nurses noted that more time was needed to learn and use additional features of the system. It was recommended that training would be useful for new hires and they wanted one-on-one training, *"I think the best way would be to have someone come on the unit, come into my patient's room and play with me. Show me what I can access."*

3.6. Suggestions for Improvement

Different suggestions were made by the nurses for improvement to the LCIM (Table 5). One nurse mentioned several suggestions in one answer, *"If there were a board like that, that's interactive and you can flip through each patient as we're doing our post round's huddle to discuss patient flow, if there were a way to look at each patient's profile, have that discussion, if you can free-text in because they like to write down, you know, getting blood, need to follow up, write transcript or whatever, if there were one of those boards in there, live and interactive that fed to the electronic medical record, then everybody would be updated all at once about."*

4. Discussion

There is increased attention from health care system leaders and hospitals on the implementation and use of novel, next generation HIT systems like the LCIM to help transform medicine. Nurses are one of the main users of various HITs in health care settings and have a pivotal role in health care delivery. Therefore, it is especially important to explore and understand nurses' perceptions of novel technologies in health care settings. The present study is the first to investigate nurses' perceptions of the novel LCIM in a PICU setting, and the data suggest a number of novel findings.

First, all nurses agreed that there was a lack of institutional training, which may explain the finding that some nurses said they were unfamiliar with the LCIM. The LCIMs were installed at the time of the implementation of the EHR, and the hospital IT team confirmed the nurses' perception that no training was provided. Effective technology implementation includes formal training (Karsh, 2004, Duke, Frankel, & Reis, 2013). It has been also reported that lack of training impacts actual use in a negative way (Fossum, Ehnfors, Fruhling, & Ehrenberg, 2011; Middleton et al., 2013). Despite this, several nurses reported learning the LCIM's content by exploring the system on their own or from other providers who knew how to use the system. An interesting finding in this study was that some families helped nurses learn the system as well. Regardless of these reports of successful use, organizations implementing technologies like the LCIM would be well served by employing proven implementation principles including training, pilot testing, formal communication and feedback processes, and end user participation (Karsh, 2004).

Second, nurses reported variation in use patterns based on their familiarity level with the system. The Technology Acceptance Models predicts this finding; users are more likely to use technologies that are perceived as easy to use or useful to their tasks. The LCIM can be perceived as easy to use in that in requires no login or password, allowing timely access to

data. Additionally, the fact that the LCIMs are mounted within the patient room often in close proximity to the patient may make it an easier source of data than the traditional computer-based EHR. The LCIM can be perceived as useful to nurses' tasks in that they can quickly access specific data such as labs, inputs and outputs, problem list, etc. In addition, our data suggest that the LCIM contributes to nurse-family communication and family engagement, a task that is crucial to quality patient/family care (Carman et al., 2013; Pelletier & Stichler, 2013; Söderström, Benzein, & Saveman, 2003). For example, some nurses used the LCIM as a tool to communicate and inform parents about specific lab values. The ability to easily achieve such useful tasks as information sharing with parents illustrates the potential of the LCIM to enhance care.

Third, nurses identified several positive features and perceptions of the LCIM. The nurses' perceptions regarding the impact of family interactions with the LCIM are promising practices for family engagement. There has been significant attention given to research on the impact of HIT to improve patient and family-centered care in health care (Prey et al., 2013; Street Jr et al., 2014). The use of the LCIM by nurses as a communication and parent education tool may contribute to the ultimate goal of creating a more patient and family-centered healthcare system. This may be even more important in ICU settings, which can be perceived as overwhelming and even traumatizing (Azoulay et al., 2005; Söderström et al., 2003). The fact that nurses reported that families initiated questions in response to viewing the LCIM suggests its potential as a catalyst for communication. This positive impact can lead to improving family-nurse communication that should be explored in future studies.

Furthermore, the data showed other positive features of the LCIM for nurses, such as providing nice visuals, being easy to use, having clear information and a snapshot view. These technical features have been reported as important factors influencing actual use and perceived usefulness of the technology (Strudwick, 2015). In addition, it was interesting to hear comments about the potential positive effects of this technology on trust and transparency. Some nurses believe that having all information available for parents increase their trust in providers.

We also identified several negative perceptions of the nurses regarding the LCIM. As with many complex technologies, there were technical issues including the screen freezing, displaying information parameters in a different way from the main EHR, and concerns about the light from the bright screen during the night. However, the main concerns were about information overload and additional anxiety of parents because of misinterpretation of the data. Information overload has been discussed in previous papers, questioning the amount and detail of medical data that should be given to patients or families during a hospital stay (Beasley et al., 2011). Nurses observed that some families focused too much on red values (i.e., out of normal range) and had additional anxiety regarding the data. Thus, some nurses felt overwhelmed or even irritated themselves with families who were alarmed by the red numbers and asked many questions based on that information. On the positive side, families asking questions can improve care and communication. Additionally, privacy surfaced as a main concern due to the no log in requirement. Nurses' reactions were mixed on names being displayed and the readability of medical information from anyone passing

by the patient room. Nevertheless, several nurses stated that the individual data values were too small to be reviewed from any distance without entering the patient room.

Finally, nurses suggested several improvements to the LCIM ranging from a way to darken the screen while patients slept to formal training of the nurses. The perceived need for improvements suggest that many of the nurses see unrealized potential of the technology that can be met through both organization changes and enhancements of the technology by the vendor. One additional perceived improvement was the ability to view x-rays directly on the monitor. Since the time of data collection, this functionality has been introduced. Anecdotal reports suggest increased use of the LCIM by nurses and families to view images (MS).

This study had both strengths and weaknesses. Study strengths included a high sample size (55 nurses) for a qualitative study and a focus on a less studied area of nursing and pediatrics HIT (Lehmann et al., 2015). Weaknesses included studying a single site that may limit generalizability of the findings. However, because the setting was a 72-bed ICU that had a dedicated cardiac, surgical and medical floors, the broad range of patient populations in this single ICU may result in findings that would apply to other organ center specific ICUs, even perhaps in the adult setting.

5. Conclusion

This study contributes to an understanding of nurses' perceptions of a novel, next generation HIT systems in pediatric critical care. It yielded important findings about the potential impact of this technology on family engagement, lending insight into future design, implementation, understanding HIT perceptions and use research on similar technologies. It also highlighted a major point to understand the importance of training on and orientation for this type of novel technology regarding its goal, purpose of implementation, functions and potential contribution to patient care. Future longitudinal studies should examine the impact of this type of novel HIT on care improvement as well as family/patient engagement.

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Biography

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Table 1.

Sample interview questions

How and when do you use the LCIMs? If not, why not?
How do you use the LCIM when you are with parents?
When you are using the LCIM in an interaction with the family, what kind of information are you looking at?
Do you think families benefit from using the LCIM?
What do you think prevents you from using the LCIM?
Did you have any training on the LCIM?
Do you think that new nurses should get any kind of formal training?
Is there any information that you want added to the LCIM that would be useful for you/families?
Do you have any concerns about the LCIMs?
Within thinking about a specific interaction with a family, what would you say are the advantages and disadvantages of being able to use the LCIM?
Who do you think the technology was designed for?
Do you think the LCIM can improve care for patients?

Table 2.

Nurses' LCIM Use Routines (when and how they use it)

Theme	Situations of the use
Source of Information	- To quickly check if an order was given or not given - To access specific labs, inputs and outputs, vitals, chest x-ray, assessments - To know the patient's name, problem list and diagnosis information
Interaction with families	- To access lab results with chronic children's families, parents, (e.g., oncology patients) - To look at the medication list with parents - To view imaging (e.g., chest x-rays) with parents - To answer a question from parents when they notice a red lab value (out of normal range)

Table 3.

Reported positive perceptions

Family interaction
The LCIM allows nurses to show data to families to help them understand their childmation, what is going up
Families like accessing labs through the LCIM
Families have a sense of control or more involvement with their child's care when using the LCIM (parents can see everything)
Families follow up updated lab results through LCIM
Nurses use the LCIM as a tool to guide them and help explain information to families
The LCIM raises awareness to parents when they see red numbers or values they do not understand
Families use the LCIM for medication reconciliation and timings
Data display/Functions/Overall Beliefs
The LCIM provides a visual to pull graphs, images and see tangible values
The LCIM is easy to use, interactive, and self-explanatory
The LCIM has nice colors
Information is clear on the LCIM
The LCIM allows you to see information in a quick manner (especially helpful in emergency situations)
The LCIM is always available in the room and nurse can pull up information to tell parents
The LCIM shows transparency, parents feel comfortable and know that nurses are not hiding anything
There are varying levels of parents- some trust what the nurses say and some want to know/see exact numbers from the LCIM

Table 4.

Negative perceptions of the LCIM

The red numbers (indicating out of normal range) on the LCIM create anxiety and worry for parents who do not understand these values
The LCIM prompts more questions from families to nurses, it looks scarier than knowing the real information
Information overload with the amount of data displayed on the LCIM
The LCIM has too much space with information that nobody ever uses
The Is and Os on the computer go from seven to seven, from midnight to midnight on the LCIM (creates confusion)
The LCIM freezes often
LCIMs in the patient room are so bright at night that the older kids have a hard time sleeping
Where they are located affects how they are used (No standard location)

Table 5.

Suggestions for Improvement

• Adding due dates for some tasks on the LCIM would be helpful such as dress changes
• The LCIM should have the function of a white board: daily goals and plan for the day (Make it consistent with Epic)
• There are useless and unused widgets/parts on the LCIM, which can be used in a better way with more useful widgets
• Highlight new lab values versus old lab values
• Highlight or place arrows for a little above normal values instead of having everything in red if it's a little elevated (values that are not worrisome)
• The Is and Os should be shown 7am-to 7 pm
• Upcoming activities such as when the next x-ray or labs should be scheduled
• Personalized items for the child so the nurse on the next shift knows something about the child (i.e. favorite animal is a bunny)
• Fun activities for children
• Make it similar to the handoff tool in Epic (pull up handoff screen and do it in the patient's room when nurses can check all of their information)
• General hospital resource information (i.e. café hours, phone numbers)
• Checklist of education that needs to be done before patient can be discharged
• creen saver or sleep mode should be added, so it is not necessary for that to be on 24/7
• Privacy: Only have initials up on the screen instead of the full name
• Effective training for nurses regarding LCIM