iCare Story (2)

RUNNING HEAD: Testing *iCare*™*v.1.0*

Testing *iCare*™*v.1.0:* An EHR Learning Tool

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ABSTRACT

Purpose: An electronic health record application, *iCare, v.1.0,* was developed and tested that allows data input and retrieval while tracking student performance over time. Methods: The development and usability testing of *iCare v.1.0* followed a rapid prototyping software development and testing model. Once the functionality was tested by engineers, the usability and feasibility testing began with a convenience sample of focus group members including undergraduate and graduate students and faculty. Approximately 5 subjects participated in each focus group (n=15). Three focus groups were conducted in 2008. Nielsen's usability heuristics and methods of evaluation were used to analyze data captured on the interview schedule after each focus group. Results: Overall, users wanted a full featured electronic health record with features that coached or guided users. The earliest versions of *iCare, v.1.0* did not provide help features and prompts to guide students but were later added. Future versions will incorporate a full featured help section. Conclusion: The interface and design of *iCare, v.1.0* is easy to use and similar to professional electronic health record applications. As a result of this usability study, future development and testing will include more robust help features along with advanced reporting for faculty use.

KEYWORDS: electronic health record; usability testing; learning tool; EHR;

TESTING ICARE™ *V.1.0*: AN EHR LEARNING TOOL

A precedent for quick action toward electronic health records (EHR) was established during a State of the Union address in 2004 when President Bush introduced the goal of universal adoption of EHRs by 2014. After taking office in 2009, President Obama promised 50 billion dollars of federal monies over five years to improve health including access to EHRs to reduce medical errors and costs while improving the health of Americans.[1] The health care industry is diligently working toward this goal, which has implications for the education of health care providers.

The Technology Informatics Guiding Education Reform, better known as the TIGER initiative, represents over 120 organizations who are working together to integrate nursing informatics, including EHRs into nursing education.[2] One goal of TIGER is to promote health information technology competencies across all levels of training as published in the Nursing Scope of Practice for Nursing Informatics.[3] In 2008, the American Association of Colleges of Nursing and the National League for Nursing both published position statements encouraging nursing programs to incorporate nursing informatics competencies, with a focus on EHRs in their curricula.[4,5] Meeting these competencies is a challenge because to date, there are no universal or interoperable applications. Even the components that define an EHR are debatable.[6] Further, current EHR applications have exorbitant price tags because they must have state-of-the-art security features that protect patient data. These expensive security features are not necessary in EHR applications used for training purposes because data housed in them are fictitious and not associated with actual patient data.

To meet the competencies as promoted by the TIGER initiative and all of its represented organizations, the University of Tennessee Knoxville, College of Nursing and

the College of Information and Industrial Engineering developed and tested a prototype EHR application, *iCare™v.1.0,* that allows students to input data, retrieve pertinent health data, such as lab values and vital signs, while accessing evidence-based health information through a portal to system libraries. *iCare™v.1.0* is a learning tool that combines the expertise of information engineers and nurses in a clinical tool with state-of-the-art information systems tools. Further, this tool is unique because it was specifically designed as a learning tool, not an EHR to store actual data. *iCare™v.1.0* can generate reports that track student performance over extended periods of time and allows multiple users to document and retrieve data simultaneously on one particular patient, unlike EHRs used in the clinical setting. To ensure *iCare™v.1.0* met the needs of students and faculty, usability testing occurred while it was developed using a rapid prototyping process of design and Nielsen's heuristic methods of evaluation. Faculty and students evaluated the application at various points during its modification (*iterative process*). The goal of this research project was to;

1. Develop an electronic health record application to use with nursing students during simulated lab learning situations.
2. Evaluate the usability of the electronic health record application in three stages while being developed.

BACKGROUND

There are many reasons to teach nursing students how to use EHRs. The Institute of Medicine recommends integrating EHRs into nursing education to establish a framework for evidence-based nursing.[7] The American Organization of Nurse Executives developed basic computer and informatics competencies for nurse leaders that include using EHRs to document, retrieve, monitor, and create patient care plans.[8] Surprisingly, there are currently few RNs who

use EHRs in their facilities. DesRoches[6] and her colleagues revealed that approximately 20% of RNs in the U.S. work in facilities that have adopted minimally functioning EHRs. While the prevalence of EHR use by nurses seems low, this percentage will grow exponentially over the next five years if President Obama's goal of an EHR for every American is met by 2014.

Adopting EHRs into nursing practice can be a challenge. Some nurses perceive an increase in workload with EHRs. According to Moody[9] and colleagues, only 36% of nurses reported a decrease in workload after the adoption of EHRs. However, most nurses, (75%), believed that EHRs improved patient care and those nurses who received extensive EHR training, (80%), were the most favorable about the benefits of EHRs. Clearly, nurse educators have an opportunity to influence a nurse's perceptions about EHRs by adequately training them during their studies. Consequently, patient outcomes may be improved when nurses feel adequately trained to use EHRs for data retrieval, entry, and to base practice on evidence generated by stored data.

One reason that nurses are not adequately prepared to interact with health information technology, such as the EHR, is due to the knowledge deficits of nurse educators. In fact, in a survey of administrators from 266 baccalaureate or higher nursing programs, they ranked about 50% of their faculty as beginner or advanced beginner users of nursing informatics.[10] Without nursing informatics knowledge by educators, the needs of incoming nurses will not be met.[11] Nurse educators at the University of Kansas did just that. They partnered with other universities and Cerner® resulting in the Simulated E-hEalth Delivery System (SEEDS) project.[12] By coupling an EHR system created for learning with simulated learning experiences, students were able to enhance critical thinking and problem solving in the clinical setting, demonstrate proficiency in EHR data retrieval and documentation, and develop beginning healthcare

informatics competencies. [12] Thus, this enables the University of Kansas to meet the informatics criteria for nursing programs as outlined by the NLN and the Commission on Collegiate Nursing Education, (CCNE), an affiliate of AACN, which are the accrediting bodies of nursing programs.

Unfortunately, few other nursing programs have taken such rigorous steps toward preparing nurses and meeting beginning level informatics competencies. [13] The topic of e-health and informatics competencies for practicing nurses is just beginning to surface in the nursing literature[14] and even fewer articles exist that discuss the ways informatics competencies, such as EHRs, are included in nursing education. However, technology in nursing education is common on conference circuits today and there are a growing number of interest groups and listservs discussing informatics competencies. In fact, new ideas and solutions are surfacing about ways to integrate informatics competencies, such as EHR data entry and retrieval with simulation to create meaningful learning experiences.

Undoubtedly, nurse educators must incorporate the use of EHRs into curricula to prepare students for their nursing roles in the 21st century. Nursing programs are currently meeting this educational need in several ways. Some have adopted EHR tools by forming partnerships with existing EHR companies such as McKesson® and Cerner®.[15] Others have access, albeit limited access, to EHRs during clinical experiences in healthcare facilities. Still other nursing programs seek EHR products that can be integrated into simulation scenarios or be used as a stand alone learning tool. Nursing programs in the U.S. are not alone. Schools in Canada are also seeking ways to prepare nurses as more healthcare facilities are adopting EHRs. Canada's Academic Learning Advisory Group, similar to the U.S. TIGER initiative, has a goal to develop strategies to integrate EHRs into health discipline curricula. [16] This indicates there is great need for further discussion and novel ways to incorporate learning opportunities and teaching strategies with

EHRs for the purpose of improving patient outcomes. In an attempt to answer this call for action, this team of researchers developed *iCare™v.1.0* and conducted usability testing through focus groups of faculty and students to create a user friendly EHR learning tool.

METHODS

Prior to building the program, the research team including 2 registered nurses (RNs) and 2 information systems engineers, one with extensive experience in health care informatics, reviewed a variety of EHR applications designed for teaching and learning. Each product offered a unique teaching/learning approach and ranged in pricing but none met the needs of the University to find an affordable product that could be fully integrated with simulation scenarios. Based on the experience of the research team and the review of products, it was determined that a robust yet affordable product could be developed to teach students data entry and retrieval, how to access evidence-based practice guidelines, and generate student reports for educators.

A storyboard prototype was built with a Microsoft Excel spreadsheet using the tabs of the Excel worksheets as a navigation tool. Nursing flow sheets were gathered from local health care facilities to compare and contrast checklists and data entry formats. Data from case studies helped guide the interface, design, and presentation of health data that would be reviewed by student nurses in a newly designed electronic health record system to supplement simulation learning. The aforementioned review of products and the organization of data from nursing case studies in the Excel worksheets served as a method of communication between team members. The prototype *iCare™v.1.0* was built with Microsoft Visual C# .NET and interfaces with a XML file that presents data from a relational database. The design of the database uses Health Level 7 standards, which are the accepted messaging standards for clinical data. The functionality of *iCare™v.1.0* was continuously tested by the development team of engineers and the usability

and feasibility testing occurred with focus groups of undergraduate and graduate students and faculty following Nielsen's usability evaluation model.

The Nielsen evaluation model identifies user (usability) problems and devises solutions that are incorporated into the next sequence of program development. These problems may be varied in nature: engineering, design, interface, and interaction. A focus group of users evaluates the product because no one user can identify all of the problems, yet when users work together in focus groups, they often reveal problems not discovered when evaluating the program alone. Products are evaluated on five components as described in Table 1. A focus group following Nielsen's model allows users to discover mistakes and recover without assistance because this provides more data than simply helping the user. Data collectors, however, intervene and assist users only after it is determined that they can no longer proceed. While observing, data collectors record user behaviors, actions, and comments.

Once IRB approval was obtained for this study, a convenience sample of faculty and students from a university in the southeastern region of the U.S. were recruited to participate in one of three focus groups evaluating the usability of *iCare*™*v.1.0*. This research used a rolling recruitment technique because data collection occurred over a 4-month period. Eligibility criteria included faculty who teach in the undergraduate and graduate program because *iCare*™*v.1.0* was designed for both student populations. Students from the same programs and over 18 years of age were eligible. Faculty not involved in simulation or clinical lab learning were excluded. Each focus group included faculty and students representing either the undergraduate or graduate student body. Testing occurred during 3 focus groups and the demographic description for each focus group is described in Table 2. Lunch was provided for participants because focus groups occurred during the lunch hour in meetings rooms to accommodate 10 people.

INSTRUMENTS

The script and interview schedule for each focus group was based on the functionality, usability, and content that had been developed prior to each focus group. The interview schedule for the first group concentrated on ease of use, general appearance, and navigation. First, participants in focus group one were asked to locate information about patients in the EHR. For example: 1) What is Mrs. Hughes major complaint? 2) What is Mrs. Hughes level of pain? 3) What diagnostic procedures have been performed on Mrs. Hughes? Next, participants in focus group one were asked to report on the ease of use. For example: 1) How would you improve the organization of the information? 2) What information would you expect to add to the documentation? 3) What could be added to better help you learn (or teach) from this program?

The second focus group interview schedule identified flaws in the design and content areas and determined how users would input and retrieve data. Example questions included: 1) What information do you want to locate for Mrs. Hughes? 2) Was that information where you expected to find it? 3) Go to the Nurses Notes tab and insert a fictitious cardiac assessment. Was this task confusing and how would you improve it?

The third and final focus group interview schedule identified any omissions in the EHR and more efficient ways to present data. Sample questions during this focus group included: 1) Locate Mrs. Hughes latest vital signs. Where you able to retrieve them quickly? 2) Have there been changes in Mrs. Hughes level of consciousness during this hospital stay? 3) What information do you need to provide care to Mrs. Hughes that you cannot find? 4) How would you change the information presented about Mrs. Hughes?

PROCEDURES

A mutually agreed upon time and place for a meeting between the researcher and the participant occurred to discuss the study and obtain consent. All questions regarding the study were answered prior to obtaining a signature on the consent form. All participants were notified of scheduled focus groups via email and in the body of the email, participants were asked to respond to ensure that each received notification. Focus groups were scheduled during weekdays that corresponded with student class schedules requiring no one to travel to campus unnecessarily. Focus groups were also scheduled during lunch breaks so that students and faculty could attend the focus groups between classes.

Three focus groups were conducted between May and September 2008. During each of the one hour focus groups, participants reviewed *iCare™v.1.0* on a university owned laptop and responded to interview questions. All participants responded to each question; if they had no response, then they stated, "no response at this time". Researchers moderated each group and used the interview schedule to elicit feedback from subjects. During the focus group, the research team did not guide or coach subjects in finding information so that design flaws could be identified. A research assistant recorded all comments and feedback on the interview schedule. Each focus group was audio-taped to ensure that all data were captured. Audio-taped focus group data were transcribed verbatim and the tapes were destroyed once all data were included on the heuristic evaluation tool described later in the analysis section.

During the first focus group (May, 2008) subjects evaluated the interface, design (look and feel) and functionality of the application by examining *iCare™v.1.0*. The second focus group (June, 2008) incorporated modifications from the first focus group and evaluated the functionality of *iCare™v.1.0* including the addition of a health assessment documentation function. Participants in the third and final focus group (August, 2008) evaluated all features and

functionality of the completed EHR application, which incorporated all revisions and modifications from the first two focus groups.

ANALYSIS

Nielsen's[17] usability heuristics and methods of evaluation were used to analyze data captured on the interview schedule after each focus group. Each item identified during the focus group was evaluated to determine if the item reflected a user's personal preference or a usability flaw. Items on the interview schedule that were classified as a usability issue were scored and ranked according to the importance of correcting the function and the feasibility of modifying the application. Those items ranking highest were modified and re-evaluated by the participants in the follow-up focus group. See sample evaluation tool Table 3.

RESULTS

To familiarize focus group 1 (FG1) participants with *iCare™v.1.0,* the interview questions required participants to find clinical data about a fictitious patient. All participants were able to retrieve data but each participant also identified omitted features or required content areas. For example, one participant noted that the "pain scales need ranges", while another participant found a navigation error; "If you open up a tab you are forced to use that tab. You cannot get out of it without clicking on something else." Overwhelmingly, students and faculty reported that *iCare™v.1.0* was easy to use and required little effort to become familiar with the layout. Two of the four participants reported that the design of the program was "nice", while the third reported it was "attractive" and the fourth said, "I liked the ease of reading." Interestingly, FG1 participants concentrated on the content in the EHR rather than the layout and design. The facilitator of FG1 had to frequently repeat questions about layout, design, and functionality to

keep the participants on track. All feedback was scored and ranked and those content issues scoring 15 or greater were modified for the second focus group (FG2).

Results from FG2 focused on content, design flaws, and features for data entry and retrieval. Participants in FG2 needed little introduction to *iCare™v.1.0* because data were populated for several patients and participants were allowed to freely navigate and explore to locate information. Details about content were the first usability issues identified. For example, the height and weight of a patient needed to be available in both metric and English units and for the EHR to automatically calculate the conversion. A key finding in this focus group related to the assessment screens. Participants identified the need to chart "by exception" instead of requiring a full head to toe assessment. During this focus group, it was also noted that students needed guides or access to help for many of the features, acronyms, and assessment options. One participant suggested adding a feature whereby a user could *hover* or *mouseover* words to reveal a definition or helpful hints. Faculty who participated in FG2 identified key reporting features to add to the program that would enable an instructor to evaluate student performance. For example, faculty suggested adding an instructor dashboard that allowed an instructor to retrieve student reports about information accessed and data entry by the students. Faculty also requested options to easily modify and add patient data to simulate a hospital length of stay for any case scenario. Focus group two generated the greatest product scores on the heuristic evaluation when compared to the other two focus groups. Due to the complexity of the modifications based on the focus group evaluation, the research team required more time to revise *iCare™v.1.0* so the third and final focus group occurred approximately two months later.

Participants in FG3 evaluated all aspects of *iCare™v.1.0* including the design, usability, content, and functionality. As a result of the comprehensive review and evaluation performed by

the participants in FG2, there were minimal usability and design issues identified during FG3. Usability issues included more detail about assessment data such as the following; 1) "the abnormal lab values need to appear in red", 2) need abbreviation of RUE, RLE, LUE, and LLE, 3) Need "Alert" tab under level of consciousness- neurological exam. Because the usability issues identified by participants were easy to resolve the product scores on the evaluation tool were high and all issues were addressed.

DISCUSSION

iCare™v.1.0, an EHR learning tool, was built and tested using Nielsen's heuristics and rapid prototyping methods that supports an iterative process of development and testing. The program was developed in phases, which included focus group testing with the intended audience. At each phase of development, a focus group of both faculty and students evaluated aspects of *iCare™v.1.0.* This technique of rapid prototyping program development coupled with focus group evaluation is commonly used in software and development.[18] Some developers engage in focus group evaluation after the product is developed. [19,20] but this technique can lead to costly modifications and revisions after the application is developed. By incorporating focus group evaluation, individual interviews, user surveys, prototype walk-throughs, or usability audits, during software development, researchers and evaluators learn user behaviors, preferences, and needs at an earlier stage allowing those features to be incorporated while the application is developed.[21] This technique may prolong the development phase but saves costly revisions in the final stages.

Jakob Nielsen[17], well known for his evaluation techniques of websites and applications, recommends alternating user testing with development to identify usability problems that might be overlooked. In fact, Nielson has identified 10 usability principles or heuristics to frame

evaluations and he advocates focus group testing because no single user can identify all usability problems. Nielsen's heuristics and specific techniques were used in this study and while the development and testing took over a year to complete, this process yielded a full featured EHR learning tool for nursing students. Future versions of *iCare*™ will include more robust instructor features such as a test mode whereby helpful hints and definitions can be suspended for testing purposes. Future versions will also incorporate specialty populations such as children including newborns, laboring women and those with mental health disorders.

CONCLUSION

Advancing healthcare technologies demand nurses' to be competent in technology skills that improve patient care. While healthcare facilities offer specific technology training, it is neither feasible nor desirable for healthcare facilities to assume training in its entirety. Without a baseline understanding of technologies and their role in healthcare, it is nearly impossible to gain rapid proficiency in facilities that use advanced technologies such as EHRs to deliver care. For this reason, it is essential to integrate the use of healthcare technologies into nursing programs. Without these vital technology skills, nurses are neither marketable nor prepared for their future roles. While this seems a daunting task when considering the already packed curricula, it does merit further consideration and creative ways to integrate healthcare technologies, similar to the way technologies are integrated in healthcare delivery.

The most recent teaching practices in nursing integrate simulation into student experiences. Some nursing programs are offering full featured simulation including pre-clinical planning, post conferences or debriefing sessions. Few have access to EHRs for simulation lab experiences. *iCare*™*v.1.0* was developed and tested to fulfill this gap in practices. It was designed by nurse educators and engineers to simulate EHRs in hospital settings but it is not

intended to be a full featured EHR with security features to protect patient data. Instead, it is a learning tool to store case studies and student data. By integrating this tool with simulation experiences, students learn the fundamentals of EHRs, including navigation, data entry and data retrieval. Further, *iCare*™*v.1.0,* includes portals to health care databases so that student's can access evidence based guidelines and research to support practice. See Figure 1 for sample screenshots of *iCare*™*v.1.0.*

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TABLE 1: NIELSEN'S USABILITY COMPONENTS

Component	*Description*
Learnability	How easily can the user learn the product? If the user returns to the product, how long will it take to reorient/relearn the product?
Efficiency	How quickly can the user learn the product?
Memorability	Once the user returns to the product, how long will it take to reorient or relearn the product?
Errors	How many errors does the user make?
Satisfaction	How pleasant or unpleasant is the design and functionality and does the product deliver what the user expects?

TABLE 2: SAMPLE DESCRIPTION

	FG 1	*FG 2*	*FG 3*	**Total**
Faculty	1 ♀	1 ♀	1 ♀	3
Graduate Students	1 ♂ 2 ♀	1 ♀		3
Undergraduate Students		2 ♀	1 ♂ 2 ♀	5
Total	4	4	4	12

TABLE 3: EVALUATION TOOL

FOCUS GROUP 1-3		IMPORTANCE	EASE of ACHIEVEMENT	PRODUCT
iCare™: An Electronic Health Record System		Low ..... High	Difficult .....Easy	
Content Issues	Preference or Flaw?	1 2 3 4 5	1 2 3 4 5	
Patient allergies on every screen	Flaw	☐ ☐ ☐ ☐ ☒	☐ ☐ ☒ ☐ ☐	15
Diagnosis vs Chief Complaint	Flaw	☐ ☐ ☐ ☐ ☒	☐ ☐ ☐ ☒ ☐	20
Document 2 different pupil sizes	Flaw	☐ ☐ ☐ ☐ ☒	☐ ☐ ☐ ☒ ☐	20
Need picture of pupil size	Preference	☐ ☐ ☐ ☒ ☐	☐ ☐ ☐ ☒ ☐	16
Need descriptions of MRN, FIN ...	Flaw	☐ ☐ ☒ ☐ ☐	☐ ☐ ☒ ☐ ☐	9

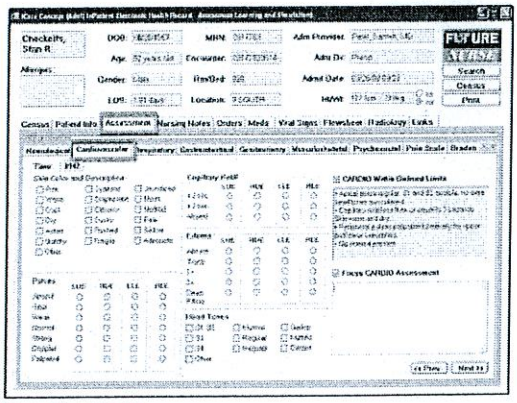
Figure 1: *iCare™v.1.0* highlighted features

iCare
Student Electronic Health Record Tool

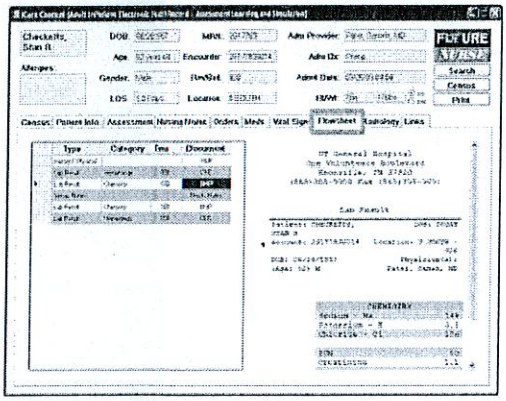
iCare is educational software designed to integrate electronic health records (EHR) into simulated learning. iCare uses designs similar to popular electronic health records found in health care facilities. This allows students to learn aspects of health information technology before graduating—not on the job. Students can record data such as physical assessments, vital signs, medication administration, and input and output. Students can also retrieve pertinent information such as orders and diagnostic results for integrated case scenarios.

Highlighted Features

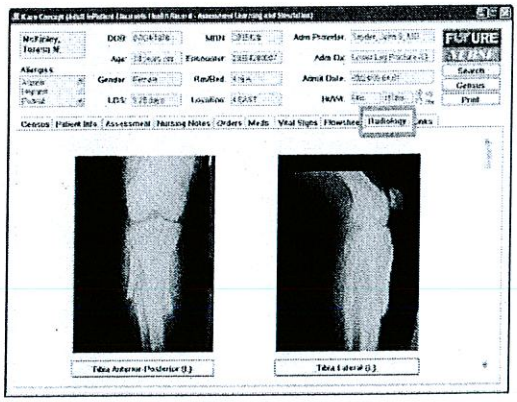
- Simulated patient search functions
- Pre-configured case studies
- Dynamic date/time stamps
- Integrated evidence-based libraries links
- User-friendly interfaces
- Point-n-click, step-by-step health Assessment features with Knowledge-based rules
- Simple "mouse-over" for help and tips
- Data entry and data output reports
- Student evaluation reports
- List of orders



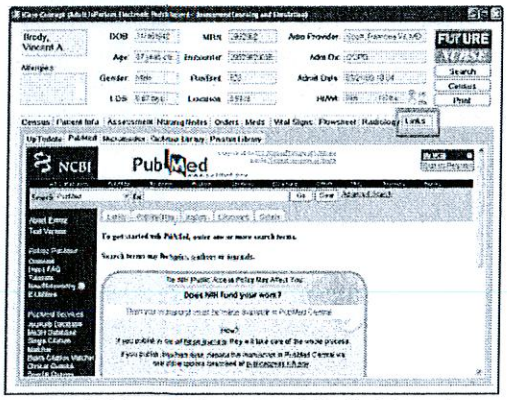
Easy Data Entry



Patient Data and Integrated Lab Reports



Embedded Radiology Transcribed Reports



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