Advocating for greater usability in clinical technologies: The role of the practicing nurse

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KEY POINTS
- Intensive care nurses use multiple technologies to perform an array of patient care tasks. For technologies to be useful they must have utility and be highly useable.

- Electronic health records mediate many of nurses tasks and usability problems with these records can have unintended consequences that harm patients and can cause additional workload for nurses and other clinicians.

- By advocating for strong usability testing methods by vendors and identifying usability problems, nurses can play a critical role in decreasing the technology associated workload and improving the technology’s usefulness.

**SYNOPSIS**

Healthcare, and especially intensive care units, rely on multiple types of technology in order to promote the best patient outcomes. Unfortunately, too often these technologies are poorly designed causing errors, additional workload and unnecessary frustration. The purpose of this paper is to: 1) Empower nurses with the needed usability and usability testing vocabulary in order to identify and articulate clinical technology usability problems and 2) Provide ideas on ways to nurses can advocate to impact positive change related to technology usability at within a healthcare organization.
Introduction and Background

Technology in healthcare is now ubiquitous. Intensive care units (ICUs) in particular, are a virtual sea of technology, often adding complexity to the environment where critically ill patients receive life-saving care. Nurses are often at the center of this complexity using technologies in their role of provider of hands-on care on behalf of the health care team. In addition to hands-on care, ICU nurses rely on clinical technologies to support one of their most important responsibilities: vigilance. That is, as the clinician that spends the most time observing and assessing patients, nurses play the primary role in detecting and responding to moment to moment clinical changes in critically ill patients in order to detect and respond rapidly to signs of patient deterioration.

There are multiple technologies to support the delivery of patient care in ICUs including: lifesaving technologies, technologies that monitor patients ever changing clinical conditions, technologies to retrieve patient medications and technologies to directly deliver medications directly into the body. In addition, health records are also now technologies (electronic health records or EHRs) that are designed to both retrieve patient information, communicate the patient’s condition to the entire team, provide a safe mechanism to order and administer medications and document interventions.

EHRs likely represents a major source of increased complexity both in and outside ICUs, for a majority of practicing nurses. In an effort to make care safer, Federal law was enacted in 2009 that gave strong incentives to EHR adoption. By 2015, 83.8 percent of non-federal acute care hospitals in the United States had adopted an EHR. EHRs are used by both large and small hospitals and in 2016, hospitals with less than 200 beds accounted for 78% of EHR purchases. Even hospitals with existing comprehensive EHRs were impacted by the federal law, as a large number of hospitals changed to federally compliant new systems. Other reasons prompting EHR change over the last several years include: the formation of new strategic partnerships, instability in the smaller EHR vendor market, and changing organizational needs. This means that the majority of nurses employed at hospitals not only currently work with an EHR, but that they likely lived through a major EHR implementation.
The process of using EHRs and other technologies to make care safer has also added additional workload. What in the past may have been opening a paper chart and writing a structured note using free text, now has involved multi-step computer log in, identifying the relevant patients EHR from a list, scanning a list of electronic tabs to find the right section and series of mouse scrolling and searching for appropriate check boxes and data entry fields. In addition, many EHRs also provide a newer type of technology: clinical decision support (CDS). CDS provides real time computer generated information about the patient within the EHR that assist nurses in making decisions and adhering to evidence based guidelines. Although CDS supports decision making and evidence based practice it often adds additional steps and may even temporarily stop workflow. Given the wide range of technologies that ICU nurses must use, it is not surprising that technologies with different functions are often designed by different vendors. This generally means that the interface, steps to uses, audible alarms etc. differ from technology to technology further adding to the complexity of technology use in ICUs.

These technologies are integral to providing healthcare in our Digital Age and has led to many positive outcomes related to patient safety. Unfortunately technology does not prevent all patient harm and can even facilitate nursing errors. There is evidence of serious unintended consequences from health information technologies. These problems are serious and include: alert fatigue, administration of multiple does of the same medication, wrong medication difficulty determining which medications are due, and omission of scheduled medication administration.

Given the complexity, major system changes, additional workload and unintended consequences, healthcare providers are increasingly frustrated with technologies they find difficult to use. Excessive clicks needed to access information, confusing alerts, too many alerts, false positive alarms etc. are often routine parts of a clinician’s day. What may seem like a simple problem or a small extra step is now compounded by the number of tasks now mediated by computer and other technologies. With medical errors estimated to be the third leading cause of death and burnout a problem in retaining well trained staff, it is imperative that nurses and other clinicians are engaged and empowered to influence the
design and purchase of technologies that are highly usable and make it easier to provide safe and high quality care.

Objective

The purpose of this paper is to: 1) Provide the needed usability, design and testing vocabulary in order to identify and articulate clinical technology usability problems and 2) Provide ideas on ways to advocate and impact positive change related to technology usability at within a healthcare organization.

What makes a Technology Usable and Useful?

A technology needs must have usability and utility in order to be considered useful. In the contest of technology usefulness, utility refers to whether the technology fits a need of a user (people who potentially will or currently are using the system not the designers or programmers) whether it does what it was designed to do. Usability refers to a quality attribute that assesses how easy user interfaces are to use. It has been formally defined by the International Standards Organization as: “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.” Nieslen (1993), a leader in the field of usability engineering, broadened and clarified the term further by defining 5 key components of usability: 1) efficient to use; 2) easy to learn; 3) easy to remember; 4)low error rate and easy error recovery and 5) subjectively pleasing. See Table 1.

Table 1: Attributes of Technology Usefulness

<table>
<thead>
<tr>
<th>Concept</th>
<th>Attribute</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Utility</td>
<td></td>
<td>Technologies that meet a user’s need by correctly doing what it was designed to do.</td>
</tr>
<tr>
<td>Useable</td>
<td>Efficient</td>
<td>Once the user has learned the system, the systems allows the user to perform at a high productivity level.</td>
</tr>
<tr>
<td>Learnable</td>
<td>Technologies that are so easy to learn that a user can quickly perform the tasks the first time they interact with it.</td>
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<tr>
<td>--------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Memorable</td>
<td>Technologies that are so easy to remember that a user can quickly recall how to perform tasks after a period of non-use.</td>
<td></td>
</tr>
<tr>
<td>Errors</td>
<td>The low errors rates prevention of catastrophic errors, and easy recovery from errors.</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>The technology is subjectively satisfying to the user.</td>
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</table>
Overview of Usability Assessment Methods

We categorize assessment of a technology usability in healthcare into four major types conducted by vendors and researchers: 1) inspection methods; 2) formal usability testing; 3) summative testing and 4) field studies.

Inspection Method

After a preliminary design or functioning prototype (a model that is used to design the full system from), experts (both human factors, engineers and clinical) should perform some kind of systematic inspection of the prototype to uncover usability problems. One such example of this is called heuristic evaluation that systematically evaluates the technology with known human computer interface design principles. This evaluation usually focuses on 10 major factors:

- **Visibility of system status**: The systems should include some kind of display that keeps users aware of what the system is doing. This is especially important when the system is searching for information and work in the system is temporarily paused.
- **Match between system and the real world**: The system should use words, phrases and concepts that are familiar to the intended users.
- **User control and freedom**: The systems should have ways that the user can exit, undo and redo.
- **Consistency and standards**: There should be consistency in words, colors and icons throughout the system and when possible use conventions common outside the system (e.g. red= stop).
- **Error prevention**: Designs should prevent users from making errors from occurring (e.g. limit systolic blood pressure data fields to three characters).
- **Recognition rather than recall**: Designs should minimize the user's memory load by making instructions, actions, and options easily visible. This way the user can recognize the way to use the system without taxing the user’s memory load to recall their training.
• **Flexibility and efficiency of use**: Designs that allow different efficient means (e.g. shortcuts) expert users can use to accomplish frequent tasks.

• **Aesthetic and minimalist design**: Designs should not include extra information as every piece of additional information diminishes the visibility of essential information.

• **Help users recognize, diagnose, and recover from errors**: Design should include error messages that indicate the problem and potential solutions in plain language that are clearly visible.

• **Help and documentation**: Although the goal is that a system can be used without support, it is sometimes necessary to have easily accessible help documentation within the system.

Another inspection method is called cognitive walkthrough. Cognitive walkthrough is another common systematic procedure that focuses on how well the interface can be used without training. Other methods combine the two approaches or focus on inspection of specific features. Whatever the inspection method used, it is important for key members of the purchasing organization to know if some kind of systematic inspection was used before the technology is tested with potential users.

**Formal Usability Testing**

Usability testing refers to the evaluation of a technology or software system that involves tests by design and usability experts with a representative group of potential users of the technology as they perform tasks using the system. Rather than conduct tests with large groups of users, repeated cycles with small numbers of testers (8-10) is often considered best practice for usability testing during the creation and refinement process (often referred to as formative testing). The process of iteratively designing and, called user centered design, allows the vendors identify problems and obtain feedback that can be iteratively incorporated into the design. Using this method, vendors have the opportunity to substantially improve the usability and may be implementing a design that has been improved several times before implementation.

One common method is called the “think aloud” method. Think alouds are simple and inexpensive method whereby a test user narratives what they are doing and why they are doing it while
interacting with the system to perform given tasks. The moderator of the test does very little speaking or question asking. Rather, the moderator encourages the test user to have a running dialogue of their thought processes so they can understand what motivated a test users actions that could be moving them toward an unintended decision (e.g. “I see this little book symbol…not sure what it means, maybe it means there is important information…since most of my days are busy and this does not look important, I don’t think I’m going to click it”).

Analysis of think alouds often involves a video recording that synchronizes the test users’s words with what they are seeing and interacting with on the screens to pinpoint areas of the interface that were not used correctly or confused test users in order to redesign. Think alouds should be Best practices for conducted with clinical scenarios and some degree simulation of clinical care. This can be low fidelity such as a computer lab when test users are given a clinical scenario and asked to make decision in the way they would in clinical practice, to high fidelity that also can include: physical environment that emulates a clinical setting, clinical noises and distractions and actors to portray patients and other members of the health care team.

Another method used less commonly, but valuable to the design of clinical decision support is called cognitive interviewing. This method involves asking test users questions about how they interpret clinical alert messages. Clinician interpretations may not be apparent in a think aloud interview and it is very important to solicit test user’s interpretations. For example it is possible that what the designers intended to be a “call to action” for a nurse, might be interpreted by a nurse as “something they can’t really do anything about.”

There are a variety of other usability testing methods available to vendors and easy to access evidence based toolkits during the design and refinement process. Unfortunately, a study of EHR vendors revealed that formal usability testing, user-centered design approaches, and employment of usability experts are rare. In addition, some vendors may only test their system with non-clinician staff. Therefore it is critical for hospital administrators and nurses involved in the technology selection
process to be assertive on this particular issue to know how many and the clinical background was of test users. Systems that have not been tested on representative clinicians should be viewed very negatively.

**Summative Testing**

Summative testing (also referred to as validation testing) is done closer to the end of the design cycle once the majority of errors and usability problems have been detected. This may be done in larger groups of potential users to allow for validation of the technology with statistical analysis. This round of testing may be done by the vendor or by objective researchers. The aims of this round of testing evaluates effectiveness, but may also include usability questionnaires (such as the System Usability Scale) and possible cognitive workload (such as National Aeronautics and Space Administration Task Load Index [NASA TLX]).

**Field Studies**

Qualitative methods or field studies conducted by experts in these methods and healthcare workflow or researchers are also important to determine usability. Conducted after the technology implementation, these structured (have a specific set of variables to examine) and unstructured (overserves take notes on anything they think would have the redesign process) observation methods of practice (e.g. shadowing nurses as they work) are useful to uncover usability problems that were not deducted during laboratory test conditions.

**Remote Testing**

Testing usability can also be conducted by vendors or researchers with nurses and other clinicians using screen sharing software. Although this method is not featured prominently in the published literature, there are some vendors that rely on this method to improve usability. Vendor remote testing can be a valuable way for organizations to demonstrate clinician identified usability problems to an EHR vendor and could be very helpful for organizations with small information technology departments.

Assessing and Advocating for Usability within Healthcare Organizations: What can practicing nurses do?
Although vendor and research usability testing may sound costly and time consuming, Nielsen (1993) notes that many methods are simple and inexpensive and dubbed them “discount usability engineering.” Some of these methods that can be incorporated by non-engineers. Practicing nurses, can play a valuable role at several points in the process including the selection process, after system upgrades, after new features are added and long after implementation.

In the previous section we highlighted definitions and terms that allow nurses to articulate what specific usability attributes, potential causes and vendor and researcher and usability testing methods. In the following section, we describe several feasible ways nurses can participate, provide data and advocate for usability improvements at the following times: before the initial go-live (that moment in time when the system is used during actual care delivery), during build (the vendor’s process of compiling parts of the software program that are specific for the organization) and go-live and in the months and years post–technology implementation.

Definitions and terms that allow nurses to articulate specific usability attributes and usability testing methods are discussed previously. This section describes several feasible ways nurses can participate in, provide data for, and advocate for usability improvements at the following times: before the initial go-live (that moment in time when the system is used during actual care delivery), during build (the vendor’s process of compiling parts of the software program that are specific for the organization) and go-live, and in the months and years post–technology implementation.

Before Go-live

Many hospitals identify end-users early in the process for review of the software, dialogue with the vendors, and site visits to hospitals using the software under consideration. When that happens, it is time
for nurses to volunteer, ask questions, and provide expert input! Many decisions are made prior to purchase as the project is defined and cost estimates are fine tuned. Some of the key roles of the nurses involved with the purchasing decision are shown in Table 2:

Table 2: Questions to ask about technology to identify usability problems

<table>
<thead>
<tr>
<th>Concept</th>
<th>Attribute</th>
<th>Potential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility</td>
<td></td>
<td>Does the technology do what the nurse needs it to do? Can tasks performed by nurses be more efficient and safe using the designed technology?</td>
</tr>
<tr>
<td>Useable</td>
<td>Efficient</td>
<td>Are there unneeded steps in the technology that if removed would not reduce the utility or safety?</td>
</tr>
<tr>
<td></td>
<td>Learnable</td>
<td>Can a clinician learn to use the technology quickly? Are large technical manuals needed as reference?</td>
</tr>
<tr>
<td></td>
<td>Memorable</td>
<td>How likely is it that a clinician could recall how to use the technology after a period of non-use?</td>
</tr>
<tr>
<td>Errors</td>
<td></td>
<td>What type of inspection methods (e.g. Heuristic review) and usability tests did the vendor use to uncover potential errors?</td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td>Will clinicians enjoy using the technology? Will clinicians perceive the technology valuable to providing safe and high quality care? What process does the vendor use to respond to usability problems that are identified post go-live?</td>
</tr>
<tr>
<td>Effective</td>
<td></td>
<td>Has summative testing to determine efficacy and usability been conducted? Were summative tests conducted by the vendor or by objective researchers?</td>
</tr>
</tbody>
</table>
Have barriers to care delivery that could occur with a particular system given current workflows or patient populations been identified?

Vendor Testing process

Determine usability methods that the vendor used when developing the EHR including: tests performed, types of experts, involvement of users (should be all types of workers that will use the EHR) during the design process, EHR tasks evaluated and number of subjects.

**Build and Go-live**

Once the purchase has been made, an extensive project plan will be completed. Often systems come with best practice content that has been built to serve as a template for implementation. That pre-build content can be used as a base to design the electronic record, but additional work with hospital subject-matter experts is necessary to ensure that the needs of particular patient populations are addressed and that unique workflows are identified in each care setting. For instance, the documentation for patients in a critical care unit where adult neurosurgery patients receive care may be significantly different than one where adult and pediatric cardiac patients are treated. Nurses who obtain all laboratory specimens for their patients would have a different workflow than nurses who use a phlebotomy service to obtain specimens. Hospitals and software companies use a variety of techniques to build this customized content. There may be clinical informatics nurse specialists in the organization along with computer analysts who get specialized training in the build. If so, this could be a new career opportunity for practicing nurses who want to focus in the area of informatics. In other instances, outside experts do the build. Either way, the team involved in the build will need clinical input to understand workflows, special populations, roles and duties of each member of the care team. Many organizations identify super users for this step in the process and provide them with early training so they can help guide the build and
Training and Go-live

Prior to implementation of an EHR, nurses are offered training on the system. This training should be designed to allow practice in the specific workflows that will be important when the system is actually used to document patient care. Taking full advantage of all training and practice is a must. Often, several guided training opportunities are available as well as “learn at your own pace” practice sessions. It is essential to allow sufficient time for nurses to become familiar and proficient on the parts of the system before the go-live date. Almost as important, other members of the care team may need to be encouraged to complete the training in advance of go-live. This is critical to nursing practice, because physicians who do not receive training and cannot enter orders when EHRs go live will have a negative impact on practice.

For go-live, some hospitals choose a system-wide approach for implementation and others turn the system on 1 unit or department at a time. Both methods have benefits and challenges. Starting 1 unit or department at a time may seem to be the easiest implementation approach, but because patients are treated across a broad continuum of care and staff function in multiple practice areas, using 2 systems of documentation during a transition period within an organization can be challenging for administrators. For example, laboratory, pharmacy, dietary, and radiology departments often must be an all-or-nothing implementation. Because these departments cross all areas of practice, many hospitals choose an enterprise-wide implementation over the more gradual department-by-department or unit-by-unit roll-out.
Testing in controlled clinical conditions within a healthcare organization

This type of testing can be done within health care organizations during the implementation of EHRs or for new features. A virtual test environment is created with scenarios meant to mimic real patient care at the institution. Generally, a team of clinician users are identified to walk through these scenarios and enter data simulating a patient flow through the hospital or clinic. Various disciplines participate to identify parts of the system that are not working correctly or missing pieces essential to the delivery of care in the particular care process being tested.

This type of testing can be very labor intensive for an organization because experts in every area of the hospital are needed simultaneously to test these situations. The clinical informatics team solicits volunteers to do testing. Nurses can contact the clinical informatics team to express their interest in testing a new system. Although nurses that consider themselves “tech savvy” may be the first to volunteer, it is very helpful to have testers that consider themselves “tech challenged” to identify a wider array of potential problems.

Nurse Practice Councils and Other Committees

Practice Councils, working with clinical informatics specialists, can develop new workflows, new alerts and reminders, and new care planning content to constantly improve care at the bedside. Ask questions and identify who in the organization is able to make changes in the system. Dialogue with those people, often clinical informatics nurses, will help them understand specific clinical practice and address ways that the technology can be used effectively to support that practice. Usability issues can be addressed more rapidly with this type of partnership allowing clinical nurses to realize the full potential of the available technology.

In addition, healthcare systems often have a committee structure where requested changes are vetted to determine if the change is possible and if it will have a positive impact. Additions and future upgrade options often surface in these committees and priorities are set based on their recommendations.
This committee structure can be quite complex in large organizations with multiple hospitals and clinics, but nurses who communicate to leadership about their desire to be involved in these committees can have a seat at the table when priorities for change are determined.

**Concluding Remarks**

Technologies are, and will be for the foreseeable future, central to the work of intensive care nurses. These technologies must be highly useable to ensure high quality and safe care delivery without unnecessary increases in workload. Importantly when nurses, the frontline users of many patient care technologies, have a hunch something is not working quite right with a technology or the technology could be made easier, they can play an important role leading to system improvement. Change is possible with an increasing number of practicing nurses who are educated about what usability is how to assess usability vendors’ practices, evidence based design principles and are empowered to advocate for changes.
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