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Enhancing Clinical Nurse Workflow through Redesign of Networked Wireless Laptop Computers

This is the Published version of the following publication

Enhancing Clinical Nurse Workflow through Redesign of Networked Wireless Laptop Computers

Liza Heslop[1], Gitesh K Raikundalia[2]

[1]*School of Nursing and Midwifery, Centre for Applied Informatics, Victoria University, Australia*
[2]*School of Engineering and Science, Victoria University, Australia*

Abstract

Nurses spend a substantial amount of their time documenting observations and care processes, leaving less time for patient-centred activities. This paper covers our study of the application of mobile-wireless laptop computers to clinical workflow within the nursing unit. An observational study design was used to explore ergonomic and functionality issues of networked wireless computers and to determine the practical utility of the networked wireless computer for clinical workflow processes. A small group of nurses were observed over a six-month period in using two laptops affixed to trolleys for access in wards and at beds. Four main purposes for the laptops were discovered: ward rounds, diagnostic information, team meetings and education. This paper covers various findings related to each of these purposes. Additionally, findings for ergonomics and functional design related to the laptops are described. For instance, the inclination towards a traditional mouse as opposed to a touch-pad mouse. We also discuss the application of our findings to future use of mobile-wireless laptop computers in the unit setting.

Keywords: Mobile-Wireless Laptops; Workstations on Wheels; Nursing informatics; Observational Study

1 Introduction

In a hospital unit care environment, nurses spend a substantial amount of their time documenting observations and care processes, which leaves less time for direct patient-focused activities [1]. Harrington and Kovner [2] found, for example, that for every hour of nursing care provided to a patient in the emergency department, one hour of paperwork was performed. In 2007, the Maryland Nursing Workforce Commission Documentation Work Group [3] reported that 81% of nurses thought time spent on documentation significantly reduced the time spent with patients.

In most unit-based care environments nurses expend time entering information electronically at fixed centrally-based workstations which are some distance from the point of care or the patient's bedside [4]. This work scenario has promoted beginning research to discover and assess the scope of wireless technology for the clinical workflow of professional nursing unit based practices in the hospital care en-

vironment, for example [15]. Devices with potential for mobile wireless connection to hospital electronic information networks include laptop/notebook computers, ultra compact notebook computers (also known as netbooks), personal digital assistants (PDAs), robots, telehealth apparatus, pagers, cordless telephones and advanced mobile phones.

1.1 Study Aims

This paper reports a study, which formed part of a larger project. The larger project objectives were to implement and evaluate the potential of mobile-wireless laptop computers and portable devices as an ongoing process to support clinical decision making and documentation by enabling access to existing information and the ability to input new information at the point of care [4].

This study's objectives were to:

1. highlight ways in which the mobile-wireless laptop computers were used by nurses in practice, and

2. detect and describe ergonomic and functional design issues experienced by nurses using mobile-wireless laptop computers at the point of care.

1.2 Current use of Portable Computing in Unit Health Care Settings: a Literature Review

The use of portable computing has been shown to enable clinicians to readily communicate and exchange information, such as improved access to patient data [5–8]. Evaluation and implementation studies show that portable devices enhance clinicians' use of patient management and clinical systems by providing decision-support and clinical information exchange at the point of care [4, 9–11].

In our previous research, we identified the unique characteristics of the unit setting as having the following ramifications for mobile-wireless implementation [4]:

- Staff compete for a small number of fixed workstations

- The workforce is mobile

- Equipment is electronically sensitive

- Needs vary according to the role (for example, nurse or doctor)

- High level of reliability and security required

- Different levels of security and access are required

- Information workflow is complex

- Complex professional bureaucracy

The focus of much research on clinician experience with portable computing devices has been on investigating the use and application of hand-held Personal Digital Assistants (PDAs) by doctors. Wilcox & La Tella [12] report that PDA usage is growing in popularity among health care professionals. Aaron et al [13] reported that more than half of doctors under 35 in the United States use PDAs for tasks including accessing drug reference databases (80%), personal scheduling (67%) and medical calculations (61%). Garritty & Emam's systematic review [14] of PDA usage in health care settings indicated physicians were the highest users.

Very few studies were available that investigated wireless laptop computers for enhancing multidisciplinary workflow processes in unit settings. Two reports of the use of workstations on wheels (WOWs) are found in [15] and [16].

Parker & Baldwin [15] discuss a study at Alegent Lakeside Hospital, USA. This hospital used WOWs with their barcode medication administration and documentation system. Problems with this approach, such as lack of satisfaction for nurses, were addressed by introducing a new device called Motion C5. A pilot study of Motion C5 was conducted. It was found that the use of this device "enabled nurses to increase documentation at the point of care, which improved accuracy of clinical documentation and reduced duplications" [15, p. 14]. Therefore, this study reveals an improvement on WOWs.

An expert commentary [16] promotes the use of WOWs in hospitals but makes it clear that their effectiveness and acceptance are conditional on various factors. WOWs are the principal mobile device at the point of care but selection of WOWs should not be driven from an ICT or hardware perspective. Instead effectiveness and acceptance of WOWs needs efforts to be directed at factors such as strong promotion of new care models to relevant stakeholders, training in devices, clinical and clinician leadership in various areas, and provision of required quantities of devices to fully support clinicians.

Key directions for development in Mobile Information Communication Technology (MICT) implementation studies suggest that substantive research should elaborate the fit between user and task [17–19].

2 Methods

2.1 Description of the Case Site or Unit Setting and Existing IT Infrastructure and Capability in the Unit Setting

The study was conducted in a unit setting of a major teaching, research and referral health service in Australia. Computer terminal usage on the unit seemed to be managed in a laissez-faire manner. Nurses on the unit setting were not allocated a personal workstation. Terminals were accessed by staff for varying requirements. Access included information gathering and input. Computer access was required for:

- accessing pathology results

- tracking in-patient admissions, communication between staff with nurses creating a handover sheet between shifts

- stock order with the unit clerk (ordering stores via computer)

- e-mail
- invoicing for cross charging of services
- accessing intranet for policies
- compiling staff rosters
- staff and patient allocation, connecting pagers and phones to allocated staff, accessing bed status information
- word processing for procedures, protocol, standing orders, memoranda, drug, stock, equipment and linen orders

Medical and allied health personnel competed for access to the computers. There were constant queues at the terminals for patient administrative work and frustration levels ran high. Because access to computer terminals was a problem, the full range of existing applications available to clinical and administrative staff were not used to their full advantage.

2.2 Design

An observational study design was chosen to explore ergonomic and functionality issues the networked wireless computer (the interaction between task, technology and the user) and to reveal the practical utility of the networked wireless computer for clinical workflow processes. Structured observation of a small group of nurses working in a unit setting was conducted in the Victorian public health care sector over a six-month period concluding in 2006. As part of the larger project previously mentioned, the research team engaged with clinicians to establish the wireless infrastructure and devices and to make process improvements and practical adaptations to the technology in order to improve uptake of the mobile devices and access to information at the bedside. The observation study reported here allowed for detailed observation of nurses' use of technology within the context of their interprofessional practice and to identify design and ergonomic issues associated with the networked wireless laptops. The infrastructure supporting the networked wireless computers were in early stages of deployment and structured observation was an ideal method to support the larger implementation project. The virtues of the observation to view design issues in the direct context of the work environment are well known [20].

Observations critical to the research objectives were recorded weekly in a journal and the content was identified (reflection by the research team) at the end of each month. This approach allowed the research team to focus on specific design issues and to observe and then describe how the technology was used by nursing staff. The study received approval from the health service and university ethics committee.

Although the study was carried out in 2006, it is still of relevance today. The ergonomic orientation of this work to our knowledge has not been published before. Hence, we provide unique findings regarding ergonomics in relation to use of networked wireless computers in the unit setting. Our review of the literature on this topic shows that insufficient research has been conducted on this topic. Additionally, a finding presented later in the paper regards the new area of multi-disciplinary team meetings. This area has experienced very little research until now, therefore, the finding as reported in this paper is unique.

2.3 Materials

Two wireless laptop computers were fixed on trolleys so they could be wheeled to the patients' bed and around the unit. The MICT infrastructure and portable devices established in this unit as part of the larger project interacted with the existing legacy hospital network and software systems, but also had the ability to seamlessly migrate to future hardware and software platforms. Although a number of staff used the mobile-wireless laptops, the observation in this study was limited to a small group of about 6–8 nurses.

2.4 Data Collection

The second author collected data, recording observations weekly in a journal while in the unit setting. Descriptions of the observations were collated each week by the first author. A working party for the implementation phase of the MICT project comprised senior unit staff and hospital information systems personnel who provided assistance and input to the study.

2.5 Analysis

The data, collated weekly by the second author over the six month period, were analysed with a focus on how the descriptions from the observations elaborated how clinical nurses applied the technology, and what design issues needed to be addressed to support them to effectively use the technology.

3 Results

The unit had 30 beds notionally designated as 16 neurosurgical beds, 4 neurology beds and 10 stroke beds. Patient allocation to beds was flexible and allocation depended on clinical status. Staff comprised 59 nurses, 30 allied health professionals, six medical Registrars, four Resident Medical Officers as well as other clinicians who visited the unit on a regular basis, 1 clerical staff, and a Nurse Unit Manager. For a typical day, 9 nurses at different levels, 0.5 medical personnel, 0.3 allied health, and one clerical staff would be on the unit.

Two computer terminals were available on the unit; one in the Nurse Unit manager's office, and one at the nurse base. All staff needed to access the same records and the same data to track patients.

3.1 Nursing Staff Usage of Wireless Laptop on Trolley

It was observed that nurses used the mobile-wireless laptop during their everyday work within the multi-disciplinary team for four main purposes: for unit rounds, diagnostic information, team meetings and education.

3.1.1 Unit Rounds

The neurosurgical, neurology and stroke teams conducted unit rounds each morning and grand rounds were held on Thursdays. The round time period was more than 2 hours. The nurses stated that they were pleased to be able to use the mobile-wireless laptops to enter data into patient records as it became available at the bedside and while fresh in their mind. Direct input of data at the bedside, was preferred by the nurses who stated that this could lead to improved safety and patient care. A PC tablet was also used on the unit rounds so that x-rays could be seen on a reasonable sized (32cm) screen.

All nurses agreed that access to diagnostic results during unit rounds enhanced decision making by avoiding the need to leave the bedside to access radiology images and pathology results. Nurses indicated that this led to an enhanced level of patient/carer involvement as nurses and other clinical staff could show results of investigations as an image to the patient, which often conveyed more than an explanation. The image was provided in real time. Several nurses reported that patients and carers felt confident with their treatment processes when they saw up-to-date technology in use.

3.1.2 Diagnostics

Nursing staff used the wireless laptops to check the results of diagnostic tests with interprofessional colleagues. With physiotherapists they used the laptops to check the CT scans of patients with chest problems. With speech therapists, they used the laptops to check video-fluoroscopy (the process of X-ray fluoroscopic imaging where an image intensifier/video camera system is used to convert the dynamic X-ray images into an electronic format image that can be displayed in real time on standard or special purpose monitors). Nurses remarked about the time saving and convenience of access to patient information at the bedside without having to return to a central workstation.

3.1.3 Multi-Disciplinary Team Meetings

Using the wireless laptops, nurses and other inter-professional staff attending the multi-disciplinary team meetings (MTMs) were able to view pathology results and radiology information, such as CT scans on the computer screen. The laptop computer was also used to record the MTM meeting minutes. Rather than using hand-written notes that would be required to be keyed into the computer at a later time, comments about the patient were entered directly into the MTM record at the actual meeting. With the wireless infrastructure and mobile devices in place, it was possible to formulate action plans during the meeting and record them electronically. Following the meeting, a printout was filed in the paper-based medical records.

It was observed that there are several limitations for what could be captured in electronic at the MTM meetings. For example, the computer programs used did not interface with other programs used for patient management, which captured patient information such as social information. Staff at these meetings stated that such social information i.e. the availability of carers, or the community services available counselling services, visiting nursing service, physiotherapist, or case worker in the community was necessary for discharge planning. One nurse suggested that if there was a way of electronically capturing the discharge environment or resources in use, an enormous amount of time could be saved. The information on the wireless laptops was able to assist with many aspects of the patient discharge process but lack of online information detailing the type and availability of discharge services necessitated time intensive enquiries by telephone, fax or email before discharge could be finalised.

3.1.4 Education

An unforseen aspect of the introduction of the laptops was their use by nurses and the stroke liaison officer as an educational resource. When clinical staff communicate with patients and their relatives; the use of relevant visual information such as x-rays can be a useful education tool. Patient and family education helps to explain and give meaning to why particular care and treatment is given and helps to gain the trust and acceptance of family and relatives. Visual information such as CT scans of the patient's brain, were shown to patients in the relatives' room. One nurse suggested that relatives were better able to understand the severity of the patient's situation when they saw an image of the damaged brain tissue and they would more likely support further treatment to assist their relative with possible transition to a nursing home for appropriate levels of care.

Where previously overhead projectors were used for weekly case presentations, staff preferred to use the laptops connected to a data projector in a meeting room. The wireless computer equipment and the slide presentation programs have changed the way these presentations were conducted and the overhead projector is now obsolete. CT scans and x-rays can now be viewed conveniently on a monitor via the mobile-wireless laptop.

3.2 Ergonomic and Functional Design Issues for Mobile-Wireless Laptops

Unit rounds are conducted each day, and extend for two hours. One limitation to the use of the laptop computer was due to the limited battery life. Ideally, laptop batteries need to last a typical nursing shift, approximately 8 hours. The time limit on batteries supplied with the laptops was approximately 2.5 hours. An additional maintenance issue for the laptops was battery charging which impacted on procedures at the start and end of shifts.

Similarly to computers fixed at work-stations, laptop computers also require operating system maintenance such as security updates, defragmenting the hard disk drive, cleaning of the hard disk drive, cleaning of keyboard, screen, casing, mouse and trolley, anti-virus signature file updates, anti-spyware signature file updates, anti-Trojan signature file updates and upgrade of random access memory (RAM). Users were more likely to be familiar and comfortable with a conventional mouse. Some users did not like the feel of the touch pad mouse and/or found it difficult to use. A preference for the laptops to be supplied with a mouse was frequently

indicated.

The wireless technology was adapted to an existing and outdated legacy system. Clinicians were required to refer to a number of paper-based patient records that did not receive electronic support. On the unit, when staff used the laptops, particularly for unit rounds, a number of hard copy documents were required to be transported on the trolley. These included:

- Tablets of request forms for medical imaging and pathology (A5 &C6 size)
- Drug Chart (B4 size)
- Discharge Summary and Casemix Data Sheet (2 part) (A4 size)
- Discharge Summary Continuation Sheet (2 part) (A4 size)
- Cardiology Unit form (A5 size)
- Inpatient Care Progress Notes (A4 size)
- Patient File folder (Foolscap size)

4 Discussion

Nurses anticipate that most health assessment data that is currently entered in hard-copy form could be accessed using a wireless laptop or PDA. In addition to the paper-based lists already mentioned, diaries, staff communication books, worksheets, white board notes, and hospital protocols could all be accessed at the bedside. Some improvements regarding the sensitivity to subjective data of existing software could address some of the problems encountered by staff using the mobile-wireless laptops. With the wireless computer technology, nursing tasks could be scheduled into an electronic patient record and retrieved using the mobile devices to alert the nurse when something is due.

Wireless computer connections would enable instant access to clinical data, email, administrative and clinical support, the health service's intranet to access clinical policies and procedures, and internet access of pharmacological information. Such access would simplify multi-tasking activity on the unit.

Nurses are skilled in information management and routinely collect and organise data; much of it handwritten information. Computers, if used with scanning input devices, would eliminate mistakes and omissions during patient data collection. We anticipate that wireless computers will enable a great improvement in information flow around the process of handover as they could be used to facilitate real-time updating of handover sheets by staff at or near

the bedside.

Due to the number of paper forms still used by nurses, the design of the wireless laptop computer trolley must account for storage of the laptop computer and hardcopy forms; it required a stable surface for writing on the forms. While some of these forms may be eliminated by direct computer entry in the near future, some are likely to be around for some time to come. Thin, light and powerful laptops that strike a good balance between a desktop replacement and PDAs are becoming available. Use of these newer type ultra compact laptops coupled with the further elimination of paper forms will greatly simplify the requirements of a trolley or remove the need altogether.

Laptop battery life was inadequate in the laptops trialled. Battery life is an important consideration in the purchase of equipment and the authors recommend a minimum 8-hour battery life for wireless laptops.

Time was saved during unit rounds by using the wireless laptop computer and trolley for the storage of hardcopy patient information and forms. Being able to view results of diagnostic tests including x-rays and CT scans at the bedside was more convenient for clinicians involved in the unit round and enabled patients to be involved in decision-making processes.

A nurse equipped with a wireless laptop computer could order replacement consumables such as oxygen masks, medication, wound dressings or linen at the time of checking storage areas without having to return to the nurse base and wait for a computer to become available. Another advantage would be the ability to declare discharges as they occur from the bedside or alter patient's meal requirements in a timely manner.

The team has been working on a number of organisational and technical challenges and until all these are resolved, the system will not be fully utilised. The technical challenges are many and include:

- different levels of security and access needed by users, accommodating users' needs for different purposes to access the terminals and their different preferences
- battery life of laptops and ergonomic and functional design issues of the mobile-wireless laptop
- improved interfacing with existing IT systems
- difficulties being faced by the health service IT department which must deal with problems of

funding, privacy, clinical safety and the need for systems wide approaches

Our preliminary observations confirm the importance of understanding the design needs for use of mobile devices by nursing staff in a hospital setting and concurs with recent research [21-23] that explored and explained the experiences of nurses as they adapt to new clinical systems. We have found that portable devices are likely to improve information flows but the applications that could enhance changes to nursing workflow processes require refinement and the applications need appropriate technology solutions to fit the needs of nurses.

There are particular challenges faced by public health service organizations to standardize and store clinical and administrative data and to improve the interoperability of systems. Further research focused on determining the type of clinical information and interfaces needed at the point of care to make mobile computing effective is needed.

5 Conclusion

As part of the larger study, the MICT infrastructure was established with appropriate hardware to ensure the reliability of the system. In this reported study, we concentrated on the nurse as the end user of a wireless laptop on a trolley. The primary purpose has been to identify and describe practical outcomes arising from the experiences of a small group of nurses brought about by the introduction of wireless laptop computers in a unit setting.

Portable computing devices with wireless capacity will bring further workplace improvement, especially when data and voice communication devices may be the only device that nurses and doctors could need in the future to interact with an ICT system. Any need to interact with an ICT system could be prompted by this device and met by going to, or picking up, the nearest terminal.

We suggest several directions for further research concerning current work practices in an MICT environment and the factors and relationships that need attention for enhancing better uptake of the technology to enhance access to information. Further studies are required to improve the quality of the information experience and the needs of the end-user. We recommend foundation research such as surveys and focus groups to establish characteristics of nurses' information needs that reflect their role competencies and workplace culture. Foundation research on infrastructure trials is needed before

productivity benefits can be established as empirical data.

Acknowledgements

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Correspondence

Associate Professor Liza Heslop

School of Nursing and Midwifery
Victoria University
PO Box 14428
Melbourne Vic 8001, Australia

Phone: +61 (0)3 9919 2252
Fax: +61 (0)3 9919 2832