Using Remote Activity Monitoring and Guideline System for Home Care Clients to Support Geriatric Nursing Care in the Community

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Abstract

There is increasing concern to support older adults who want to live independently in their own homes. The purpose of this study is to investigate the integration of two non-intrusive approaches to monitoring home care clients activity level, along with access to best practice guidelines for clinicians at the point of care. A prototype Remote Activity Monitoring and Guidelines System has been developed that uses a GPS-equipped BlackBerry to monitor a person's mobility outside the home. The System includes a pressure-sensitive mat that is placed under a regular bed mattress and can monitor sleep disturbances, and how long it takes to enter and exit the bed. This research study provided valuable information about the feasibility and effectiveness of integrating bio-mobility information obtained through remote monitoring with decision support technologies to support safer client care for seniors.

Keywords: *remote patient monitoring; home care safety; decision support technologies*

I. INTRODUCTION

The purpose of this paper is to describe the development of remote patient monitoring on promoting safer client care for older adults in the community. The focus of the research study was specifically to investigate the user interface design and data fusion strategies for integrating bio-mobility information, about home care clients as they go about their daily lives, with a point-of-care (POC) decision support system for health care providers.

The research study focused on the integration of 1) non-intrusive monitoring approaches, using binary and analogue sensors, developed at Carleton University, and 2) a cell phone-based GPS-supported monitoring system to track patients' daily life events and health conditions developed by at Wilfrid Laurier University (WLU), with 3) a prototype web-based software application developed by Dr. Doran and her team at the University of Toronto that equips clinicians with handheld units to assist in the collection and utilization of bedside patient data and provide real-time feedback, such as suggested best-practice guidelines, tailored to an individual patient's needs. That software was adapted specifically for the homecare clinicians' environment. This study focused the knowledge gained through those three initiatives to evaluate a wireless patient monitoring and data collection system for use by health professionals for point-surveillance (e.g., falls risk), to record patients' vital signs data, to provide immediate feedback to clinicians, and to facilitate virtual healthcare management. The goal is to improve the efficiency and safety of homecare services through technological innovations that will reduce the demand on scarce and expensive human resources.

II. BACKGROUND

There are three compelling trends that must be addressed in healthcare planning: 1) Impact of demographics on community care; 2) Emerging health care technologies; and 3) Safety concerns among home care clients. Firstly, there is increasing concern in the health care community about the need to provide ways to support older adults who want to live independently in their homes as they age. A large percentage of clients receiving home care support are elderly and live alone [1]. Home is an unpredictable environment for care of older people

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because the healthcare provider visits each home for relatively short periods (an average of 45 minutes) and only a few times per week [2].

Furthermore, home health providers are relatively isolated in their work. This context of relative isolation for providers and clients poses unique challenges for health service delivery, particularly with respect to issues of coordination and communication [1]. Compounding these challenges, the rate of increase of home care expenditures in Canada is more rapid than all other areas of the publicly funded health care system, with the exception of medication [3]. The demographics in Canada suggest that the costs will escalate significantly over the next two decades. In Ontario, for example, the government has projected that the 65+ population will swell from 1,680,440 in 2007 to 2,282,630 by 2017, and it will almost double to 3,189,390 by 2027. Under the current delivery model, this increase would require a substantial number of additional home care nurses, which, given the current and anticipated shortage of nurses, is a goal that cannot be attained. Clearly, cost-effective solutions are needed to manage the spiraling costs and to address the social challenges of providing care to older adults at home.

Secondly, technology is providing a variety of alternatives and opportunities specific to healthcare issues and costs. It is imperative to move ahead with addressing the options pertinent to home care through reliable research that will support proven technologies, such as remote patient monitoring. Lastly, there is an increasing concern about the safety of clients in home care settings. A recent study in the United States investigated patient safety concerns among 3,013,287 home care clients. The results indicated that 13% of all home care clients had experienced an adverse event [2]. Clients who experienced such events were generally older. The types of adverse events experienced were unexpected death, urinary tract infection, fall or accident at home, wound deterioration, unexpected nursing home admission, increase in the number of pressure ulcers, improper medication administration or side effects, and hypo/hyper-glycemia. The results of a recent consensus conference suggest that Canada experiences a similar range of patient safety concerns among the home care population [4].

Remote patient monitoring interventions have the potential to address a number of these concerns through technological tools that will improve monitoring of client care in the home settings, and improve communication among providers, particularly at point of transition within the health system. This research study addressed each of the above challenges by investigating solutions for integrating bio-mobility information on client status with a point-of-care decision-support system that will provide home care clinicians with better scheduling capability, improved assessment of client mobility/activity in and out-of-home, and more timely access to decision support.

III. METHODS

This research study was divided into three phases that were conducted over 32 months: (1) Prototype Development; (2) Usability Testing; and (3) Pilot Field Testing.

A. Phase One (Prototype Development):

During the phase one of this research study, the two objectives for the prototype development phase were: (1) to determine the most appropriate user interface features for data extractions by mapping out information flow from the various information sources in real-life point-of-care (POC) scenarios, as well as engaging homecare nurses in researching most informative way of presenting the information; and (2) to develop a prototype Web-based platform for presenting information to healthcare providers.

In order to determine which client groups would benefit from bio-mobility monitoring, focus groups were conducted with homecare clinicians from the home care organizations in Ontario, Canada. There were twenty health care professionals who participated in a total of 3 focus groups. These health care professionals included nurses, occupational therapists, physiotherapists and case managers. The focus groups were led jointly by a member of the research team and students from both Engineering and Nursing. This arrangement ensured a truly multidisciplinary perspective and students from the two different programs have benefited from the collaborative training opportunity.

The focus group discussions were audio taped, transcribed, and the transcripts were jointly analyzed by a team of researchers and students from Nursing and Engineering. Over this period of time, monthly research meetings were conducted with the research team and students to ensure effective communication and to coordinate the activities of the three research centres. Collaboration among the different institutions occurred both in person and by teleconference to discuss the priorities, objectives and planning logistics of conducting the focus groups. In addition quarterly meetings were held with the research team and industry partners, who have been engaged in contributing ideas for data collection and analysis. For example, we collaborated with a human factors expert from Nortel in planning the focus group interview questions. We have also collaborated with HInext (IT application developer) in planning the prototype for the user interface. TELUS, a leading service provider has provided the wireless service to support the prototype development and testing. RIM has provided wireless handhelds that were both used by clinicians for demonstration purposes and by the research team for development work.

B. Phase Two (Usability Testing):

After the completion of prototype development in phase one, the phase two of this study was guided by the following objectives: To evaluate the feasibility, safety, and acceptability of the bio-physiological monitoring and decision-support system (the prototype system) to end users in a laboratory setting by assessing whether the prototype system performs to technical expectations, as well as assessing the nurse users' satisfaction with the system.

After the research team conducted the focus groups with home care providers about a proposed client monitoring system in Phase I, the information that was learned had to be compiled in order to begin designing a prototype client monitoring and decision support system. The research team agreed that a human-centered design approach was appropriate because it emphasizes user involvement and applies an iterative approach to the design and testing of the prototype. Therefore, the goal of this milestone was to be able to prepare the team for conducting a usability test on low-fidelity potential interfaces of the system. The results from the testing would then help the research team resolve conceptual and detailed design issues regarding the prototype displays.

The research team then conducted the low-fidelity usability testing with 9 homecare clinicians (1 physiotherapist, 1 occupational therapist, 3 nurses and 4 case managers). Each session was one hour in length and was audio and video recorded. The audio recording was transcribed and used together with the video-recording in the usability analysis. The sessions were conducted with clinicians who had also been participants in phase one study. The purpose of the interviews was to solicit feedback from potential end-users about the specific design and application of a client monitoring and decision support system.

C. Phase Three (Pilot Testing):

Followed by the completion of usability testing in phase two, the phase three of this study is the pilot field test of the prototype System (Remote Activity Monitoring and Guidelines System) in the community. The Pilot Field Testing of the Remote Activity Monitoring and Guideline System was guided by three objectives:

1. Determine the value of the mobility-related data to home care clinicians when they plan care
2. Assess the usefulness and placement of the Best Practice Guidelines (BPGs) in the electronic user interface.
3. Assess the clinician and client experience with the prototype System.

The Remote Activity Monitoring and Guideline System could collect the following bio-mobility data:

1. BlackBerry: Length of time in the home, time away from home, time walking outside the home, time using vehicular transportation, distance travelled. Although the actual locations visited were potentially identifiable by GPS, only the time and distance were retained as study data.

2. Pressure sensitive mattress: length of time in bed; time spent entering and exiting bed. The mat could also detect additional data such as pulse and respirations. These additional data elements were not the focus of the current study, but the research team will plan to evaluate the quality of this additional data and to test algorithms for processing the data into usable information.

Proxy client who was over the age of 55 and was requested to carry a BlackBerry (e.g. Storm II) for a period of 4 days. The BlackBerry passively logs GPS co-ordinates accurately within 5 meters, and provides valuable data about the physical activity of the study participant. The participant was asked to wear the device clipped at their hip (using a standard BlackBerry "holster" style clip) as much as possible during the day, and was taught how to recharge it overnight. Proxy client has been informed that they can turn off the BlackBerry at any time if they wish. Client has also been asked to allow the research team to place a pressure sensitive mat under their existing mattress, and to place a research laptop computer nearby. A member of the research team was available to provide ongoing technical support during the pilot field testing.

Beginning after 4 days of data collection, 4 different home care clinicians made home visits to the proxy client. A member of the research team performed a joint visit to observe clinicians interacting with the prototype System in the proxy client's home. Each clinician assessed the client's needs and created a care plan based on the mobility related data available from the System, in consultation with the client. The research team provided the proxy client with an enhanced health history in order to make the home care visit more realistic and to evaluate various features of the System. The client was able to see the graphs of his/her own activity during the nursing visit. The clinicians were asked to complete a questionnaire about how the mobility information influenced their clinical decision making, the usefulness and location of the links to the best practice guidelines, their opinions about how the System enabled their clinical workflow, and their "wish list" of other bio-physiological data that they would like to be able to monitor remotely in the future. The client has been asked to comment on his/her experience being monitored by the BlackBerry device and the bed mat.

IV. RESULTS

A. Phase One (Prototype Development):

During Phases one and two of the study, the research team consulted with home care clinicians to determine their requirements for information flow and their preferences for types of client information that they would like to be able to monitor remotely. A prototype Remote Activity Monitoring and Guidelines System has been developed that uses a GPS-equipped BlackBerry to monitor a person's mobility outside the home (e.g. how far they walk each day in the community, etc.). The System includes a pressure-sensitive mat that is placed under a regular bed mattress and can monitor sleep disturbances, and how long it takes to enter and exit the bed. Depending on specific bed characteristics, it can also monitor pulse and respirations, although this was not the focus of the current study.

During the phase one of prototype development, four themes were explored in the focus groups: 1) the client groups for whom it would be beneficial to have remote monitoring technologies; 2) the type of client data or resources that would be helpful to clinicians; 3) the format and frequency of data to be received by the clinicians; and 4) the potential users of remote monitoring technologies.

The findings from the focus group interviews indicated that the client groups that would benefit the most from remote monitoring technologies are those with mobility issues, with cognitive impairments or who require continuous monitoring due to high risk conditions. A wide range of client data were considered helpful and the need for specific data is context dependent. For example, the type of data providers use to support decision making varies with the clinical expertise and role of the caregiver. Graphical representation of monitoring data was preferred to numeric presentation, with the importance of displaying trends over time and the value of including methodology of alerting clinicians of deviation in trends. In addition to the different types of client groups were identified by the interview participants, different target end-user groups were also identified. These included other formal healthcare providers, but also informal providers such as family members.

Home care clinicians reported that detailed information about client mobility would be helpful when they are planning care for clients who are trying to increase their activity levels (e.g. following hip or knee surgery, to help manage chronic health conditions such as diabetes and COPD, or during cardiac rehab, etc). It would also provide reliable data about how often a client's sleep is interrupted which can be helpful when managing pain. In addition, the prototype System includes embedded links for clinicians to access Best Practice Guidelines such as pain management, diabetes management, COPD, pressure ulcers, prevention of falls, etc. Clinicians were consulted in an iterative process during the development of the System to determine the characteristics of the graphical user interface, and the display was developed and modified based on user feedback.

B. Phase Two (Usability Testing):

From the findings of the focus groups, homecare client scenarios were developed and refined to match the identified client groups. Scenarios were generated for each homecare clinician type and described such aspects as what the clinician might intend to do and why, in what context and how, and what the outcomes and consequences might be during typical client visits. These scenarios helped to guide the design of the prototype displays in understanding what features might be important to display and where they should be placed. These same scenarios were then slightly modified for use during the usability testing.

The Phase two of the study included usability testing of the System with home care nurses and therapists, and integrating their recommendations about the User Interface into the prototype. The prototype was tested in a controlled lab setting in order to assess whether it performed to technical specifications. The Remote Monitoring and Guideline System was ready for implementation in a field study after the safety and feasibility have been demonstrated and confirmed in a lab setting. It is important to understand the value of the mobility data to the clinician's decision making process. Understanding the end user's needs and interaction with the prototype in actual home care settings is important to making the prototype successful. It is critical that the technology provides clinical support to assist clinicians when planning care. The Phase three of this study tested the Remote Monitoring and Guideline System with a proxy client in his/her home. This pilot test highlighted design issues, implementation challenges, and clinical benefits that will be addressed when planning a future clinical trial.

C. Phase Three (Pilot Testing):

During the pilot field testing, data were collected on usability and acceptability for both the client and nurses. Semi-structured interviews and a questionnaire was used to identify questions that arose about the client or care-giving situation as a result of having access to the bio-mobility information, to describe the types of clinical issues for which the monitoring information was helpful, and to describe its perceived impact on clinical decision making, client outcomes, and the quality of nurses' work life. Interviews with the client and the nurses during the field test revealed that the Remote Monitoring and Guideline System was helpful for all of the stakeholders and the system was not perceived as being intrusive by the client.

During the interview, the elderly described: "The remote capture of mobility data provided detailed information that allowed me to learn more about my own health status, and made it possible to track my ongoing progress towards health goals, such as being more physically active". Another added benefit from remote capture of health information was that the client "felt empowered by the increased understanding of own health condition that helped in the management and care of chronic diseases". The client suggested that the use of remote monitoring has the potential to enhance client safety, especially for older adults in the community who are living alone.

Following one week of monitoring, four nurses made independent visits to review the mobility data in consultation with the proxy client, and created a plan of care using the remote monitoring system. During the interviews, nurses described the usefulness of mobility and bedmat data in supporting the care of their home care client. The nurses indicated that the remote capture of data was helpful to the management of client care including assessment, client teaching, evaluation and care planning. For nursing assessment, the remote monitoring data was helpful to assess client status, such as "determining client's risk for falls; level of pain based on client's mobility level and amount of time spent in bed, as well as using bedmat data to assess quality of sleep pattern, such as insomnia and urinary frequency at night. Nurses also described: "The facts provided by the System can be used as evidences to evaluate client's condition, and the trending graphs and numbers can be used an educational tool to help explain client progress and set targets for future health goals".

For care planning, nurses found the point-of-care access to best practice guidelines provided by the System was useful in the development of individualized care plan tailored to client's needs. In particular, the nurses indicated that "the use of practice guidelines helped the development of client care plan during the initial visit, and then the evaluation of nursing interventions for subsequent

client visits". When real-time information about mobility was integrated with access to practice guidelines to complement standard assessments, nurses felt that they were "better able to make informed decisions about client care". For example, the nurses explained: "the remote capture of data could help them decide if a telephone call is appropriate, or if a home visit is warranted". Overall, nurses revealed that remote monitoring system was an excellent communication tool that could help facilitate inter-professional collaboration when being used by different health care professionals. Proper clinician education, training and support regarding the use of System are important to its successful implementation in home care settings.

V. CONCLUSION

According to Statistics Canada, the fastest growing segment of the Canadian population is the "over 65" age category. There is increasing concern to provide ways to support older adults who want to live independently in their homes as they age. Many home care clients are elderly and live alone with only a few visits a week from healthcare providers. As a result, both clients and health providers feel isolated with unique challenges for health service delivery. Creative health care solutions are needed in order to reduce the demands on the health care system from this older population and to support older adults who want to live independently in their homes as they age.

In this study, Remote patient monitoring intervention was found to have the potential to address a number of these concerns through technological tools that would improve monitoring of client care in the home settings, and improve communication among providers. The Remote Monitoring and Guideline System that integrates bio-mobility information on client status with a point-of-care decision-support system would provide home care clinicians with better scheduling capability, improved assessment of client mobility/activity in and out-of-home, and more timely access to decision support. Although this study was conducted with a limited pilot field-testing in the community, the results provided valuable knowledge about the integration of bio-physiological monitoring technologies into the routine clinical practice of homecare practitioners.

In the future, more and larger field-testing is needed for such applications and for research purposes. For instance, costs/benefits analysis needs to be performed to examine the cost-effectiveness of remote client monitoring. Pilot field-testing could also investigate the potential system application that extends beyond home care populations, such as long-term care and rehabilitation settings. Finally, it is imperative that future research could generate evidence-based knowledge about the efficacy and efficiency of remote monitoring technologies, and their influence on quality of care and client outcomes.

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REFERENCES

1. A, Lang., and N. Edwards, "Safety in home care: broadening the patient safety agenda to include home care services". Canadian Patient Safety Institute: Edmonton, Alberta. 2006: pp.1-42

2. E.A, Madigan. , and R.H. Fortinsky, "Alternative measures of resource consumption in home care episodes". Public Health Nursing, 1999. vol 16, pp.198-204.

3. P.C., Coyte, and P. McKeever, "Home care in Canada: passing the buck", Canadian Journal of Nursing Research, 2001. vol 33, pp.11-25.

4. P, Masotti., et al., "Adverse events in communication care: developing a research agenda", Healthcare Quarterly, 2007. Vol 10, pp. 63-69.

BIOGRAPHY

Winnie Sun (RN, MN, PhD) was graduated from the BscN program at the University of Toronto in Canada with practice expertise in palliative care and home care nursing. She was a faculty member for the Nursing program at the Trent University with teaching interests in community health nursing and gerontology. Winnie Sun completed her doctorate studies at the Faculty of Nursing with research interests in home care patient safety research, remote patient monitoring technologies, and best practices for home care nurses. Her doctoral dissertation was examining the relationship between therapeutic self-care and the occurrence of adverse events for home care clients in Ontario, Canada.