



NRC Publications Archive Archives des publications du CNRC

Nurses' perceptions and attitudes towards new ADU technology and use

Sirois, Pascal; Fournier, Helene; Lebouthilier, Annette; Guerette-Daigle, Lise; Robichaud, Suzanne; Leblanc-Cormier, Gaetane; Molyneaux, Heather; O'Donnell, Susan; Mather, Lyndsay

This publication could be one of several versions: author's original, accepted manuscript or the publisher's version. / La version de cette publication peut être l'une des suivantes : la version prépublication de l'auteur, la version acceptée du manuscrit ou la version de l'éditeur.

For the publisher's version, please access the DOI link below. / Pour consulter la version de l'éditeur, utilisez le lien DOI ci-dessous.

Publisher's version / Version de l'éditeur:

<https://doi.org/10.3233/THF-2012-120708>

Technology and Health Care, 21, 1, pp. 41-47, 2013-01

NRC Publications Record / Notice d'Archives des publications de CNRC:

<https://nrc-publications.canada.ca/eng/view/object/?id=96f0827c-5a47-4cc4-a9f4-bbf3e8d1bba2>

<https://publications-cnrc.canada.ca/fra/voir/objet/?id=96f0827c-5a47-4cc4-a9f4-bbf3e8d1bba2>

Access and use of this website and the material on it are subject to the Terms and Conditions set forth at

<https://nrc-publications.canada.ca/eng/copyright>

READ THESE TERMS AND CONDITIONS CAREFULLY BEFORE USING THIS WEBSITE.

L'accès à ce site Web et l'utilisation de son contenu sont assujettis aux conditions présentées dans le site

<https://publications-cnrc.canada.ca/fra/droits>

LISEZ CES CONDITIONS ATTENTIVEMENT AVANT D'UTILISER CE SITE WEB.

Questions? Contact the NRC Publications Archive team at

PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca. If you wish to email the authors directly, please see the first page of the publication for their contact information.

Vous avez des questions? Nous pouvons vous aider. Pour communiquer directement avec un auteur, consultez la première page de la revue dans laquelle son article a été publié afin de trouver ses coordonnées. Si vous n'arrivez pas à les repérer, communiquez avec nous à PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca.



Nurses' perceptions and attitudes towards new ADU technology and use

Pascal Sirois^a, H     Fournier^a, Annette Lebouthilier^b, Lise Guerette-Daigle^b, Suzanne Robichaud^b, Gaetane, Leblanc-Cormier^b, Heather Molyneaux^a, Susan O'Donnell^a, and Lyndsay Mather^a

^a *National Research Council of Canada*

^b *Vitalit   Health Network*

ABSTRACT

BACKGROUND: The introduction of a new technology in hospitals – Automated Dispensing Units (ADUs) – aims to contribute to more secure, safe, efficient and cost effective health services. Several studies highlight the beneficial effects of similar technologies as well as their cost-savings potential but there is little literature exploring nurses' perceptions and attitudes towards technology acceptance and the impact on technology use in a healthcare unit.

OBJECTIVE: This research aimed to explore nurses' perceptions and attitudes towards current technology use on their units and towards the introduction of ADU technology and use with nursing staff in two different hospitals in South-East New-Brunswick, Canada.

METHODS: Semi-structured interviews were realized with the collaboration of nursing staff from two hospitals which were in urban and rural settings, prior to the introduction of ADUs in hospital wards.

RESULTS: Findings in this study highlight the fact that missing medications (i.e., doses not available in cart) are inherently related to the completion of nursing staff's medication distribution routine. Missing doses cause delays in medication delivery which may increase the occurrence of medication errors. Participants described current technology use as an intricate part of their routine. The latter is mainly utilized for patient monitoring and information retrieval. Overall, interview data indicated that ADU technology introduction is positively perceived by nursing staff particularly if the technology reduces missing doses events.

CONCLUSIONS: Findings in this study underscore important concerns expressed by nursing staff regarding ADU technology integration into the current medication process and its impact on time management. Pre-implementation training and technical support were identified as important factors in facilitating technology acceptance and proper technology use.

Keywords: New technology, healthcare, medication distribution

1. Background

During the last decade the Canadian government declared that the health system must prioritize measures that would diminish the number of medication dispensing errors and medication near misses in care units to ensure safe patient care. Multiple initiatives have been elaborated to achieve this goal, particularly the introduction of medication distribution technologies, automatic distribution units. Technology in a given health care unit has been the subject of numerous studies but its effect is mitigated: some wards have experienced dramatic decrease in medication errors while the introduction of technology has also created other types of errors.

2. Objective

Because of the ambiguous impact of technology on health care units, this research aimed to explore nurses' perceptions and attitudes towards current technology use on their units and towards the introduction of Automated Dispensing Units (ADUs) technology and use. This study is part of a NRC-CNRC funded project with the close collaboration of the Vitalité Health Network.

3. Literature review

Medication errors (e.g., mistake in dosage, failure to administer correct drug, incorrect time for administration) have been described as a daily recurrence in a given hospital which has a cumulative impact on patient health, staff's workflow and also represents a substantial economic burden. To diminish medication error occurrence multiple actions have been put forward nationally, including automated dispensing units (ADUs) [10] [1] [2].

Automated medication dispensing technology is the subject of numerous studies addressing medication errors in healthcare units and has been described as an efficient way to reduce medication errors, to better organize doses and to reduce costs. Although its holistic impact on

medication errors is mitigated since it may lead to new types of errors induced by technology use caused by mechanical failures and development of workarounds, or machine misuses, which originates from nursing staff's perceptions regarding technology use [3] [4] [8].

Technology acceptability and its integration into the medication distribution routine will have an impact on technology use optimization and its inherent medication error reduction potential [11]. According the technology acceptance model (TAM) and others (unified theory of acceptance and use of technology- UTAUT; theory of reasoned action- TRA TPB), behavioral intention to use technology, or acceptance, is the main determinant to proper technological use. According to these models acceptance is defined as perceived usefulness, perceived ease of use and as behavioral, normative or control beliefs [5] [6] [9].

Three themes emerged as relevant to appropriately evaluate nurses' perceptions and attitudes towards technology use as to appraise the perceived usefulness of their current technology use and of the upcoming technology:

- The medication distribution process and its subjective description;
- Current technology use and its implications in a healthcare setting;
- Attitudes towards technology introduction and facilitating the introduction of technology in a healthcare unit.

4. Methods

Semi-structured interviews were realized with the collaboration of nursing staff from two hospitals which were in urban and rural settings, prior to the introduction of ADUs in hospital wards. The interview questions aimed to explore participants' perceptions, feelings and opinions of nursing staff regarding workload, time efficiency and error rates before the introduction of new technology (automatic medication distribution) in their workplace. Prior to the interview

process, informal observations on hospital wards were realized to comprehend nurses' medication distribution routine and its variability, as well as a means to develop open-ended questions. Interviews were completed with seven license practical nurses (LPN), eight registered nurses and two nurse managers of healthcare units. The length of the interviews ranged from 18 minutes to an hour and each interview was recorded using a portable recorder. Interviews were then transcribed by a third a party. The analysis of verbatim has been achieved by coding with the use of NVivo qualitative data analysis software. Inter-rater reliability of coding was conducted with 84% agreement. The coding items were utilized as part of a coding matrix to further our understanding of nurses' perceptions, attitudes, acceptance of technology and their ramifications for technology introduction in a health care environment. This study has been approved by the NRC-CNRC and Vitalité Health Network Research Ethics Boards.

5. Results

During the observation process and with the nursing staffs' description of the medication distribution routine, missing doses and its impact on task completion and time efficiency has been described as an inherent part of the distribution routine. Perceived impact of missing doses was related to its recurrence: nurses who experienced frequent missing doses incidents reported a heavier workload associated with the latter's organizational procedures for prescription renewal. The role of nursing staff also influenced their perceptions of the medication distribution process since LPNs seldom complete the morning distribution which was when missing doses occurred most often. The description of the communication process between staff from both hospitals lead to the same finding, that is, missing doses were also more frequent on medication cart refilling days.

An LPN at a rural setting hospital stated, “Sometimes some doses will be missing but it hasn’t occurred often” while another RN at an urban setting hospital stated, “Often, there are medications that are missing in the morning distribution”. An RN at an urban setting hospital stated, “This is what is frustrating, I think, about our system; it’s that medication is always missing”.

Nurses at the urban setting hospital described the effects of missing doses on the completion of the medication distribution process within a range of nuisance; an occasional benign occurrence to a daily organizational and time management problem. Nurses responsible for the morning medication distribution described missing doses incidents as frequent and an inherent part of their routine. Missing doses and dispensing of “first dose” may take from several minutes to several hours. This type of incident has been associated with delays in medication delivery to patients which may exacerbate error incidence by exceeding the time frame allocated for medication administration and by creating conditions that may lead to forgotten medication doses. Its impact described by nursing staff was broadly defined as time consuming rather than error inducing. An RN stated, “There is lots of lost time in the medication preparation process”. Another RN affirmed, “Sometimes it happens that five or ten minutes go by and we forget. It happens to forget”.

Errors have been defined by nursing staff as rare events. Medication errors were defined as an event that could result in longer hospital admissions or result in patient’s death. According to the literature, medication errors are defined more broadly than events inducing death or illnesses and, as such, are probably more frequent than what is observed in the health care units. Nursing staff were aware that medication distribution delays could be considered a type of error but its recurrent occurrence attributable to missing doses made it impossible to report them, especially

when considering the supplementary workload required by error reporting. Nurses' perception of time reveals that they give much importance to time efficiency. Its significance was even more apparent when nurses described the effects of missing doses or the completion of certain tasks by describing its impact on time distribution rather than task complexity or its impact on workflow. As such, time management has been identified as a key determinant in the completion of the nurses' routine. An RN stated, "It takes time because often medication isn't there. This is what's taking time: always searching for medication doses". Emerging themes from the interviews regarding the medication distribution process and their intricacies are summarized in Figure 1.

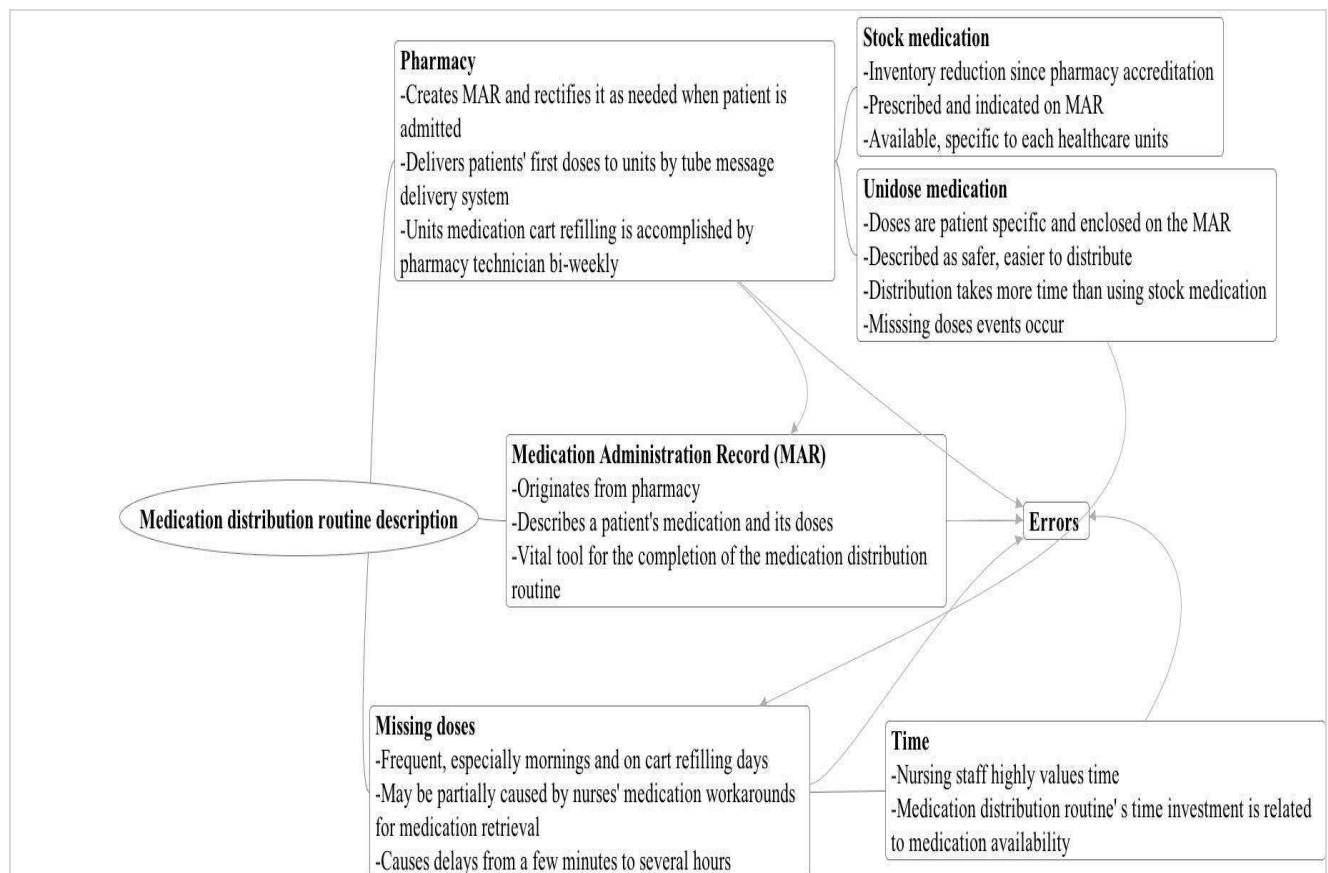


Figure 1: Medication distribution routine description synthesis and its underlying themes

6. Technology use and its implications in a healthcare setting

Nursing staff self-described computer use as daily. Computers are most often used to retrieve patient file information, to retrieve medication information and to monitor their patients' conditions. Most nursing staff interviewed perceived technology use as a means to better organization and alleviating their workload. But some have depicted technology use as being impersonal and sometimes imprecise to report a patient's condition. Also it has been identified as impractical in an emergency room setting or to monitor an unstable patient's condition. Nursing staff suggested that, "We could say that that this (computers) is our main working tool". Asked about technology use at home, a majority (>8) of nursing staff confirmed using a computer at home and for basic utilization (web browsing, email), although some staff reported no use of technology outside of work. Interview participants who expressed advantages in the use of technology in general, also mentioned using technology at home and satisfaction with the use of technology at work.

The age of nursing staff (i.e., older staff) has been described as a barrier to technology use and acceptance from participants. In the current study, nursing staff with the most years worked (age not considered) defined technology use as a positive experience and their technological skill development as rapid, although they perceived other experienced nursing staff's perceptions of technology as being less positive than their own. Participants have self-defined as open to adopt technologies, describing technological changes as an inevitable part of their profession's evolution and expressed their confidence in the advantages of introducing ADU technology.

7. Attitudes and facilitating the introduction of technology in a healthcare unit

When technology introduction was discussed all participants expressed the importance of pre-implementation training for optimizing the technology's features by facilitating adoption of use.

Training and a consultation process beforehand have been described as ways to facilitate the introduction of a technology, especially for people who may be reticent to change or may be apprehensive towards its use. Technical support during the first weeks of ADU utilization was described as being a fundamental part of a successful implementation of technology and particularly for those who self described as slow technological learners. This individualistic approach would create an appropriate learning environment for the latter since some concerns have been expressed regarding their ability to learn as rapidly as their co-workers who would be more at ease with technology.

RNs have stated the importance of training and support, “We really have to be ready for technologies, even if it’s faster afterwards”. Another RN expressed that, “Information and practice” are essential in learning to use new technology. Training and support should underscore ADUs’ advantages for its better organizational properties, better medication availability and its cumulative impact on medication safety to boost the positive perception of technology use, particularly if the latter’s introduction may involve longer medication preparation time.

Concerns have been expressed regarding the integration of ADUs in the current medication distribution process especially for its impact on time distribution for morning medication dispensing. Tensions between staff members may occur if one is less agile than others to operate the ADU, since time distribution has previously been identified as a major determinant of nursing staff’s routine completion. There is the perception that the medication administration record (MAR), a vital tool in the nursing staff’s routine, may be less relevant with the introduction of ADUs. Also nurses usually prepare medication distribution for every individual patient so there is the perception that ADUs may not permit them to do so or would represent a bigger time investment to proceed as described. The inherent changes to the medication

distribution routine subsequently to ADU introduction has been identified as an issue to technology acceptance. An RN stated, “I see this as either everything will go smoothly because we will always have access to our medication so we would save the time invested looking for them and for constantly filling up sheets....or are we going to be three nurses fighting for the medication of 22 patients”.

ADU technology acceptance by nursing staff might be facilitated, even though its use for medication preparation might be a lengthier process than the current one, if missing doses events preponderance and their inherent time investments are diminished. Adopting a holistic approach to technology integration into healthcare units and its advantages may encourage better comprehension of technology’s role for efficient and safe medication distribution, positively shaping nursing staff’s intentions to properly use technology by putting in place favorable conditions for its acceptance. Nursing staff’s current technology use and their perceptions regarding new technology introduction are synthesized in Figure 2.

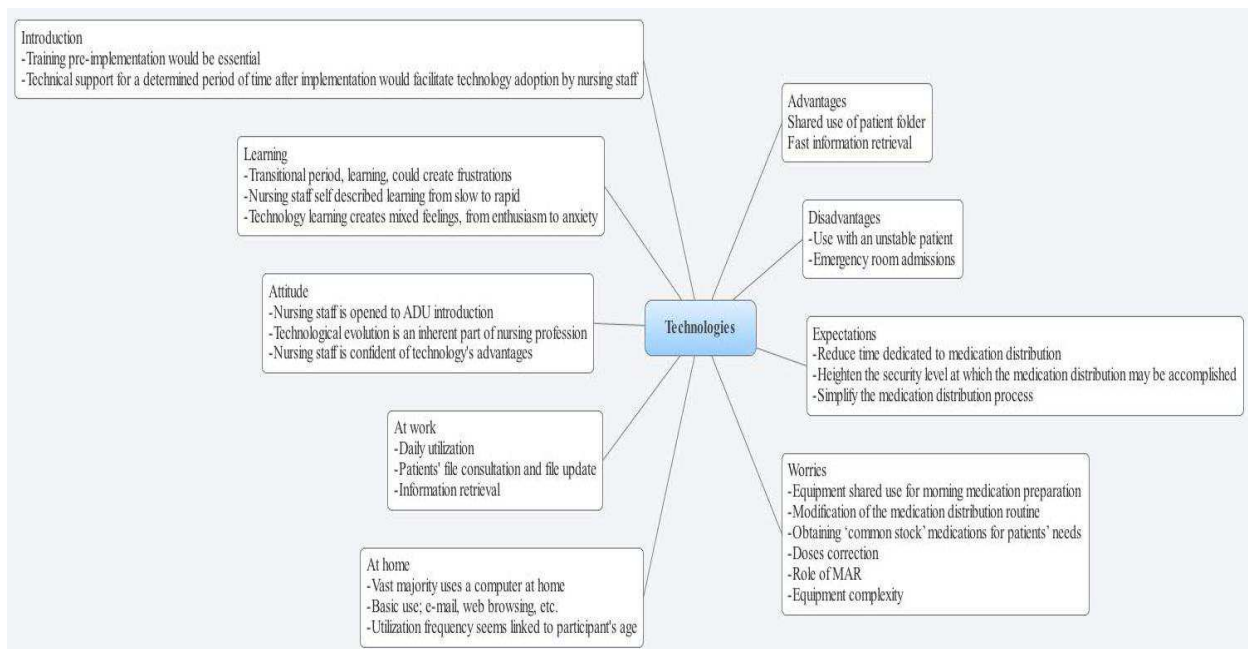


Figure 2: Nursing staff’s current technology use and perceptions of new technology

8. Conclusions

Interviews with nursing staff underscore that the current medication distribution process has some flaws particularly regarding missing doses and its inherent effect on medication errors, especially wrong timing errors and forgotten doses errors. When discussing technology use most participants perceived technology use and technological changes as an intrinsic part of their profession's evolution independently of their level of satisfaction associated with technology use at work or their technology use at home. The introduction of a new technology was positively perceived by the majority of nursing staff interviewed. Nursing staff positively perceived technology's better organizational properties and information retrieval potential although current technology use has been defined as inappropriate to monitor an unstable patient's condition or into an emergency room setting as previously stated by Perras et al. [10].

As for ADU introduction a majority of nursing staff seemed opened to the arrival of technology, insisting that tools which would decrease missing doses events and facilitates medication doses coordination between pharmacy and healthcare units would increase their level of satisfaction, and acceptance, with the medication distribution process which would encourage proper technology use as stated by [5] [6]. Some concerns have been expressed regarding the impact of ADU on the completion of the medication distribution process whereas the nurses would have to access the needed medication in the same time frame which may cause time delays for medication retrieval and may lead to frustrations among staff members, as previously stated by ISMP Canada, 2007 [7]. Appropriate technology introduction into the current medication process and its ramifications was also perceived as a source of apprehension to technology acceptance. Pre-implementation training and technical support has been identified as facilitators to technology introduction especially among self described slow technological learners or staff who

may be reticent to technology use. Training and support should also serve to boost positive perceptions of technology use by nursing staff especially if the introduced technology does not directly imply time saving advantages, considering the perceived value of time amongst nursing staff.

Limitations of this study are mostly attributable to the lack of pre-interview information regarding ADU introduction to the interviewed staff, which would have developed more depth to their technology introduction perceptions and their attitude regarding this technology. Further research should be directed towards better understanding nursing staff and technology interface interactions, determinants which could prove to be a fundamental aspect to technology use and acceptance and optimizing of its advantages.

References

- [1] Allan E, Barker K. Fundamentals of medication error research. American Journal of Health-System Pharmacy. 1990; 47(3): 555.
- [2] Baker GR, Norton, P. Patient safety and healthcare error in the Canadian healthcare system: A systematic review and analysis of leading practices in Canada with reference to key initiatives elsewhere: A report to Health Canada. Health Canada; 2002. Available from: http://www.hc-sc.gc.ca/hcs-sss/alt_formats/hpb-dgps/pdf/pubs/2001-patient-securit-rev-exam/2001-patient-securit-rev-exam-eng.pdf
- [3] Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly. 1989; 319-340.
- [4] Dillon TW, Lending D Crews TR, Blankenship R. Nursing self-efficacy of an integrated clinical and administrative information system. Comput Inform Nurs. 2003; 21 (3): 173-191
- [5] Holden RJ, Karsh B-T. The Technology Acceptance Model: Its past and its future in health care. J Biomed Inform (2009), doi:[10.1016/j.jbi.2009.07.002](https://doi.org/10.1016/j.jbi.2009.07.002)
- [6] Holden RJ, Karsh BT. A theoretical model of health information technology usage behaviour with implications for patient safety. Behaviour & Information Technology. 2009; 28(1): 21-38.
- [7] Institute for Safe Medication Practices in Canada. Automated dispensing cabinets in the Canadian environment. ISMP Canada Safety Bulletin. 2007; 7 (3): 1-3. Available from : <http://www.ismp-canada.org/download/safetyBulletins/ISMPCSB2007-03ADCs.pdf>
- [8] Keil M, Beranek PM, Konsynski BR. Usefulness and ease of use: Field study evidence regarding task considerations, Decision Support Systems. 1995; 13(1): 75-91.
- [9] Marini SD, Hasman A, Huijter HA, Dimassi H. Nurses' attitudes toward the use of the bar-coding medication administration system. Computers Informatics Nursing. 2010; 28(2): 112.

- [10] Perras C, Jacobs P, Boucher M, Murphy G, Hope J, Lefebvre P, McGill S, Morrison A. Technologies to Reduce Errors in Dispensing and Administration of Medication in Hospitals: Clinical and Economic Analyses [Technology report number 121]. Ottawa: Canadian Agency for Drugs and Technologies in Health; 2009.
- [11] Van Onzenoort HA, van de Plas A, Kessels AG, Veldhorst-Janssen NM, van der Kuy PH, Neef C. Factors influencing bar-code verification by nurses during medication administration in a Dutch hospital. *American Journal of Health-System Pharmacy*. 2008; 65(7): 644-648.



National Research Council
Canada

Institute for Information
Technology

Conseil national de recherches
Canada

Institut de technologie
de l'information

Nov 16, 2012
(Date Drafted)

COPYRIGHT RELEASE FORM AND IP CONTENT
FORMULAIRE DE CESSIION DES DROITS D'AUTEUR ET CONTENU DE PI

To / À: Andrew Reddick, Director Research

From / De: Rodrigue Savoie

Title: Nurses' perceptions and attitudes towards new ADU technology and use

Titre: _____

Author(s): Pascal Sirois, Helene Fournier, Annette Lebouthilier, Lise Guerette-Daigle, Suzanne Robichaud,

Auteur(s): Gaetane, Leblanc-Cormier, Heather Molyneaux, Susan O'Donnell, and Lyndsay Mather

Journal, Conference, Workshop / journal, conférence, atelier:

Technology and Health Care Journal

Planned Publication Date:

Date prévue de publication: Jan. 2013

Attached is an article that I have reviewed and am recommending for publication. I have consulted with the author(s) and our Business Development Office as appropriate to ensure that the BD Office is aware of the technology and has had the opportunity to make recommendations on IP protection and technology transfer. The IP protection & technology transfer aspects have been considered within the context of related NRC-IIT technology and existing and potential licenses.

I have verified that the publication procedure has been followed in filling out the selected form, and that to the best of my knowledge, we are granting the publisher only those rights that are necessary to have the work published. I believe that publication of this document will enhance the reputation and influence of NRC-IIT and the authors in the knowledge commons.

Vous trouverez ci-joint un article que j'ai examiné et dont je recommande la publication. J'ai mené les consultations nécessaires avec le ou les auteurs et notre Bureau de développement commercial pour vérifier si celui-ci connaît la technologie et s'il a eu la possibilité de formuler des recommandations au sujet de la protection de la propriété intellectuelle et du transfert de la technologie. Ces deux aspects ont été examinés dans le contexte de la technologie connexe de l'ITI-CNRC et des licences actuelles et éventuelles.

J'ai vérifié si la procédure de publication a été suivie pour remplir le formulaire sélectionné et si, au mieux de mes connaissances, nous n'accordons à l'éditeur que les droits requis pour faire publier le document. Je crois que la publication de ce document permettra à l'ITI-CNRC et aux auteurs d'améliorer leur réputation et d'accroître leur influence au sein de la communauté du savoir.

☐ 19 - Copyright Licence / Licence de droit d'auteur ☐ 22 - Licence to Publish / Droit de publier (IEEE)

☐ 21 - Copyright Transfer

☐ 22 - Publication Agreement / Entente de publication (SPRINGER)

☒ 22 - Licence to Publish / Droit de publier

(Rodrigue Savoie)

Learning & Collaborative Technologies /
Technologies pour la formation et la collaboration

(Group / groupe)

2012.11.14

(Date)



Manuscript number: _____

No changes are to be made to this licence without prior consent of NRC Legal Services.

To: IOS Press Science Press
International Cooperation Dept
Attn: BOKCTP / IOS Press
Beijing, China
(contact name and address of publisher)

This refers to the manuscript entitled (hereinafter the "manuscript"):

Nurses' perceptions and attitudes towards new ADU technology and use

written by the author(s):

Pascal Sirois, Helene Fournier, Annette Lebouthilier, Lise Guerette-Daigle, Suzanne Robichaud, Gaetane,
Leblanc-Cormier, Heather Molyneaux, Susan O'Donnell, and Lyndsay Mather

to be published in:

Technology and Health Care Journal

1. Definitions

Accepted Manuscript:

The version of a manuscript that has been accepted for publication following peer review. Content and layout follow publisher's submission requirements.

Version of Record:

A fixed version of an Accepted Manuscript that has been made available by a publisher. This includes any "early release" article that is formally identified as being published even before the compilation of a volume issue and assignment of associated metadata, as long as it is citable via some permanent identifier(s). This does not include any "early release" article that has not yet been "fixed" by processes that are still to be applied, such as copy-editing, proof corrections, layout, and typesetting.

2. The authors (except those listed in this paragraph) contributed to the manuscript on behalf of the National Research Council of Canada ("NRC"), thereby establishing a copyright belonging to the Crown in Right of Canada, that is, to the Government of Canada. NRC is not able to deal with the rights relating to the contribution of any co-authors listed below, and you should seek their permission separately: (*may say none*)

Annette Lebouthilier, Lise Guerette-Daigle, Suzanne Robichaud, Gaetane, Leblanc-Cormier and Lyndsay Mather

(list author names as well as their respective organization, email address and phone number, if available)



3. With respect to the Crown's copyright, NRC grants you permission to publish the Version of Record in the publication named above, on the condition that clear attribution is given to the authors and the National Research Council of Canada. After that publication, you may re-publish the Version of Record in any form or medium, with the same condition about attribution.
4. You are granted the right to license others to copy or publish the Version of Record. (If this right is granted, it is subject to the same condition about attribution).
5. NRC, for itself and the authors not listed in section 2, warrants that:
 - a. The manuscript is the original work of the names author(s).
 - b. A Version of Record has not been published elsewhere and will not be permitted to be published elsewhere, if you accept the manuscript for publication.
 - c. The manuscript contains no infringing, libellous or other unlawful statements.
6. NRC retains the following rights, provided that when reproducing the manuscript or extracts from it, the publisher is acknowledged:
 - a. To post a copy of the Accepted Manuscript on the NRC's website, the author(s)' funding body's designated archive and any other open access digital repository, subject to the embargo period specified herewith: none. For the purposes of clarity, where the embargo period is left blank, NRC will assume that a copy of the Accepted Manuscript may be posted immediately upon the date of acceptance of the manuscript for publication. A copy of the Version of Record will only be posted if so directed by the publisher. For this article, the publisher's preference is that we not replace the Accepted Manuscript with the Version of Record once the Version of Record becomes available.
 - b. To reproduce the Accepted Manuscript for non-commercial purposes including other formats and other forms of expression.
 - c. To reproduce the Accepted Manuscript for the purpose of education or research by the Government of Canada and to permit other institutions with which the author(s) is affiliated to reproduce the Accepted Manuscript for the purpose of education or research.
 - d. To reuse figures, tables or an abstract created by the author(s).
 - e. To authorize others to make any non-commercial use of the Accepted Manuscript so long as the author(s) receives credit as author(s) and the publication in which the Version of Record has been published is linked to the source of publication of the Version of Record (link to the publisher's or journal site).
7. It is believed that this authorization will provide you with all the scope of authority you require from the Government of Canada, but it does NOT transfer the copyright to you.

JAN 09 2013

Signed at Fredericton, New Brunswick on _____
(City and Province) (Date)

NATIONAL RESEARCH COUNCIL OF CANADA

Per: Andrew Reddick
Andrew Reddick, Director Research

INSTITUTE FOR INFORMATION TECHNOLOGY