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Home Care and Technology: A Case Study

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Abstract. Health care aides (HCAs) are the backbone of the home care system and provide a range of services to people who, for various reasons related to chronic conditions and aging, are not able to take care of themselves independently. The demand for HCA services will increase and the current HCA supply will likely not keep up with this increasing demand without fundamental changes in the current environment. Information and communication technology (ICT) can address some of the workflow challenges HCAs face. In this project, we conducted an ethnographic study to document and analyse HCAs' workflows and team interactions. Based on our findings, we designed an ICT tool suite, integrating easily available existing and newly developed (by our team) technologies to address these issues. Finally, we simulated the deployment of our technologies, to assess the potential impact of these technological solutions on the workflow and productivity of HCAs, their healthcare teams and client care.

Keywords. Mobile apps, home care, scheduling, electronic health record

Introduction and Overview

Health care aides (HCAs) are the backbone of the home care system and provide a range of services to people who, for various reasons related to chronic conditions and aging, are not able to take care of themselves independently. In Canada, about 1.2 million people, 65 and older, use home-care services annually (Carrière, 2006) [1]. The demand for these services is expected to increase, as Canada's aging population is expected to increase and fewer adult children will be able to care for their older parents (Home Care Sector Study Corporation, 2003) [2]. In Alberta, one in five persons will be senior by 2030 and may need assistance from a HCA. At this point, it is clear that the demand for HCA services will increase and the current HCA supply will likely not keep up with this increasing demand without fundamental changes in the current environment.

The general question that we set out to address in this project was whether information and communication technology (ICT) can alleviate some of the workflow challenges that Alberta HCAs face.

Specifically, our objectives (and the corresponding phases of our project) were as follows. In Phase 1, we conducted an ethnographic study to document and analyse HCAs' workflows and team interactions. In this phase, our objective was to understand

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and describe specific challenges that affect workflow. Based on Phase 1 findings and consultations and meetings with service providers and expert groups, we identified some key challenges that could potentially be addressed by technology. In Phase 2 we designed an ICT tool suite, integrating easily available existing and newly developed (by our team) technologies to address these issues. Finally, in Phase 3 we simulated the deployment of our technologies. In this context, our objective was to assess the potential impact of these technological solutions on the workflow and productivity of HCAs, their healthcare teams and client care.

To the best of our knowledge, the methodology we adopted for our study makes it unique in the number of front-line HCAs consulted, in addition to representatives of organizations delivering home care. In total, 421 HCAs provided input to our study through focus groups, questionnaires, interviews or observations.

The findings of our study echo and amplify findings of similar studies in Canada and internationally. If we exclude the issue of compensation, which did come up in our data but for which there is no role for technology-based improvements, we identified three major challenges. The first challenge refers to problems in the HCAs' working conditions. Working alone, HCAs experience fear, anxiety, trepidation and loneliness, citing situations where they found themselves in unpredictable situations while travelling or in the homes of their clients, which threatened their sense of well-being.

Second is the issue of supporting HCAs to provide better care. Scheduling is still done manually for the most part and changes are very difficult to handle, resulting in inefficient use of staff and HCA time. In addition, there are frequent communication issues. Since documentation is paper-based and there is a lag between the data collection and transcription, HCAs are not necessarily informed about the current status of their clients. In addition, given the fairly limited scope of HCA practices, this lag implies delays in providing necessary care to clients, based on HCA findings. This is further exacerbated by the fact that HCAs may be able, i.e., knowledgeable and competent, to provide such care but they are prevented from doing so by the current legal framework defining their scope of practice. Essentially, they have no authority to perform any services outside the defined care plan without explicit (signature-based) authorization by the head-office case manager.

Finally, there is a need for improved training and access to relevant knowledge. Frequently faced with new situations, HCAs need easy access to more formal content, as well as more just-in-time learning. The fundamental barriers to making this possible were identified as lack of time and insufficient access to authoritative online resources.

We identified a set of technologies that could potentially be deployed to mitigate the above challenges. The specific technologies we deployed in our Phase 3 simulations were as follows:

(a) A scheduling service that flexibly takes into account a configurable number of preferences, including travel-time minimization, maximization of client-HCA affinity, schedule load balancing, etc. This technology addresses 'efficiency' concerns.

(b) A mobile application that enables HCAs to access and edit the client's care plan as well as to provide textual information, images and videos to document the client's state. This technology also addresses 'quality of care' concerns.

(c) A set of third-part tools, including:
(i) navigation support (thus addressing travel-related safety concerns)
(ii) messaging tools (to address ad-hoc communication needs)
(iii) GPS-enabled alarm service (to address safety concerns)
(iv) Access to the authoritative on-line Community-Care Desktop (addressing just-in-time knowledge needs).

During our ethnographic study in Phase 1, we had the opportunity to meet and interview many HCAs of different ethnic and educational backgrounds and ages. The diversity of the HCA population prompted us to develop a training program that meets individual learning needs, which we used in our simulated deployment of Phase 3.

The data we collected through our simulated deployment of the technology in Phase 3 led us to the following conclusions. Technology can improve HCA safety, quality of client care and HCA knowledge and expertise. A centralized record system that is accessible to all health care providers who work with a client would enable information to flow more easily and be up-to-date. Being entrusted with ICT may contribute to a HCA feeling more validated, appreciated and acknowledged in their work. Mitigating today's challenges with technology and improving the HCA's sense of how they are recognized and appreciated by the overall health-care system could positively impact recruitment and retention. As a result, the scale of the currently estimated labour shortages may be decreased. Of course, the deployment of technology is not without challenges, including: (a) developing effective training procedures (b) establishing proper information privacy and security safeguards and (c) evolving the current legal framework around the HCA's scope of practice to enable them to provide the range of services they are capable of.

1. Background: Related Studies and Findings

The increasing demand for HCAs has spurred research into the rewards and challenges that HCAs encounter in their workday and how these relate to and influence recruitment, retention and turnover.

Most studies involving HCAs have been undertaken in the United States (US). In a survey of 3,468 workers involved in direct care provision across the continuum of care in several states in the US, Kemper et al., (2008) [3] found that they want higher wages and better working relationships including communication with and supervision, appreciation and respect from their colleagues. After surveying 823 HCAs who worked in homecare in New York City, Sherman et al., (2008) [4] found that the state of a client's house, exposure risks (dust, mould, pet dander, smoke), abusive client and family behaviours, and dangers of travelling ranked higher than workload or travel time when correlated to job satisfaction and retention. Mittal et al., (2009) [5] found that lack of respect from colleagues, insufficient supervision, competing demands outside of work, difficulty of the work itself (both physical and emotional), and more lucrative job opportunities were associated with turnover. Conversely, the rewards of being in a job that was perceived to be a spiritual calling, bonding with clients and being able to advocate for them, and having flexible work hours were associated with retention. In a related study, Faul et al., (2010) [6] found that these rewards gave HCAs an intrinsic satisfaction that in turn overrode low wages as a predictor of retention. Ashley et al., (2010) [7] found that HCAs valued helping others and were invigorated and fulfilled by

providing care to their clients; however, low wages, absence of benefit plans and lack of recognition from other healthcare colleagues were related to job quits. In a comprehensive survey administered to over 650 HCAs, twice over two years, Morris (2009), [8] found that irregular hours of work (casual or part-time hours) were most strongly correlated to decreased job satisfaction and increased intent to leave.

There is a strong consensus in these studies regarding the most important factors that impact the HCA's job satisfaction and retention. On one hand, the perception of the social value of the work and the personal relationships that HCAs build with their clients lead them and keep them to this profession. On the other hand, low wages, the physical and emotional difficulty of the job itself, dangers in travelling, abusive clients and family members, exposure risks, variant schedules and lack of communication and support from their colleagues tend to lead them to quit. Technology support can potentially help alleviate many of these negative factors, by increasing the consistency of their schedules, improving their travel conditions, by keeping them better informed about and prepared for their clients and their family situations and by increasing the degree of communication among HCAs and proving a support network for them to better deal with the emotional challenges of the job.

The Canadian Home Care Association has highlighted ICT solutions as being 'essential to serving Canadians and effectively addressing their health and social care needs of today and tomorrow,' but that 'to date there is limited application of technology to support frontline home care clinicians – nurses, home support/personal support staff, therapists – in direct care provision' (Canadian Home Care Association, 2008) [9]. The question then becomes, 'Exactly what technology supports should be put in place'? ICT solutions provided in a mobile, hand-held format (e.g., cell-phones, Personal Digital Assistants - PDAs, tablet devices and smartphones) are a particularly appealing solution (Norris, Stockdale, & Sharma, 2008) [10]. This is the case for those who provide care in clients' homes in urban or rural areas and developing countries where traditional, land-line communications infrastructure may be limited (Effken & Abbott, 2009; [11] Lu, Xiao, Sears, & Jacko, 2005 [12]; World Health Organization, 2011 [13]). To date, rigorous evidence to support the use of ICTs by HCAs or any other health care providers is limited (Black et al., 2011,) [14]. As HCAs make up the largest number of front-line service providers in health care, there is a need to examine whether ICTs could address at least some of the challenges HCAs face in their workday and potentially bring about improvements in workload, efficiencies, and job satisfaction.

2. The Study

Our project was divided into three phases. The first phase focused on establishing a baseline of the home-care aide workflows in Alberta today. The second phase developed a technology-based solution to mitigate key problems identified in the first phase. Finally, in the third phase, we conducted a simulation of the use of the above technology as a first step towards evaluating its effectiveness.

2.1. Phase 1

In order to study 'how HCAs work today and what challenges they face', we used a qualitative and quantitative approach, incorporating focused ethnography, and utilizing questionnaires, interviews, and focus groups. To mitigate the threat to the validity of the overall project findings arising from the selection of a non-representative sample of health care teams to study, we established partnerships with different service providers who could refer to us HCAs who work with home care clients. A convenience sample of 90 health care aides and 68 health care professionals (non-HCAs) participated in interviews, 129 HCAs participated in focus groups, while 153 HCAs and 16 health professionals responded to questionnaires. All five home care zones in Alberta were represented. Sites also represented rural and urban as categorized by Alberta Health Services (AHS). Providers included AHS, and partner agencies. A total of 13 sites across the five Alberta home care zones participated in the project. Due to time constraints, we used focused ethnography with all 13 sites, and traditional ethnography with one site in Vulcan where a research team member followed and observed four HCAs. This provided an opportunity to triangulate the qualitative data collected through focused ethnography.

Data collection (158 interviews, 152 questionnaires and focus groups with 129 individuals) for Phase 1 occurred from May 2011 to November 2011. The data collected through interviews and focus groups were transcribed and, in each case, an interviewer or focus group facilitator verified the transcriptions. We used Roper and Shapira's (2000) framework for our data analysis. This process consisted of (a) coding the data with descriptive labels, (b) sorting to identify patterns, (c) identifying outliers, (d) generalizing the identified constructs and (e) memoing to derive meaning from the data, and at the conceptual level to help understand relationships between the emerging themes. Through this process, we were able to identify several recurring themes in our data, which gave us a strong sense of the most important challenges facing HCAs in their daily workflows.

2.2. Phase 2

In order to derive technology requirements from our Phase 1 data analysis, we adopted a procedure drawn from the context-aware business processes literature (Ploesser et al., 2010, 2011; Rosemann et al., 2008). This work seeks to account for how business processes and their quality-of-service attributes are impacted by their dynamic context, for example, how passenger throughput in airports can be affected by the weather. In adopting this theory, we had to adapt it to our objectives. First, we acknowledge the difference in our objectives. Our task is not to change the HCA process workflow, but rather to recognize and mediate the environmental factors that give rise to the issues of concern that the HCAs described to us in Phase 1. More importantly, we note that our results from Phase 1 show that the HCA workflow is subject to varied, and potentially conflicting, goals from the perspective of HCAs, where context-aware business process analysis assumes that one overarching goal drives the subject process. To that end, we integrate constructs from agent-oriented modelling with the context-aware business-process modelling method, in order to represent and analyse varied qualitative actor goals (Soffer & Wand, 2005; Yu et al., 2011).

The HCA workflow consists of the following main activities (shown as rectangles in the bottom of Figure 1): assignment, scheduling, travel to patient, first meeting, service delivery, and end of service. In this analysis, 'first meeting' is not taken to be part of the typical HCA workflow, but rather to lead to a specific workflow in planned-for circumstances. Moreover, 'end of service' is replaced by 'reporting', which is aligned with the scope of the analysis, the workflow of a given patient care delivery. This process is subject to a variety of inter-related goals, shown in the Figure as curved shapes, including three high-level goals, HCA personal safety, effective care plan delivery and efficient use of HCA time. These goals are affected by a multitude of contextual factors. The blue squares in Figure 1 represent the technological interventions envisioned in the 'to-be' situation. These technologies (a combination of hardware and software) replace current practices with improved ones when possible. When the contextual elements are beyond the control of technologies, they mitigate the impact of 'hurtful' contribution links.

In order to meet the requirements corresponding to the 'blue boxes' of Figure 1 we adopted and developed the following technologies.

The **HCA Mobile app** enables the HCAs to access their schedule for each day and all the relevant information about the clients they have to visit. For each individual client, the HCA can access the client's care plan, known risks in the client's home and the client's history. The application enables the HCA to record whether each activity in the care plan was completed or not, or refused by the client, or somehow otherwise prevented. The HCA may also add a (set of) text/image/video notes on the visit record. These notes are shared synchronously (and through an encrypted channel) with the head office and the nurse may also comment on them with further notes. Video recording, through the HCAMobile app, could also be used as an alternative method of the client authorizing (for the record) the HCA to perform a particular task.

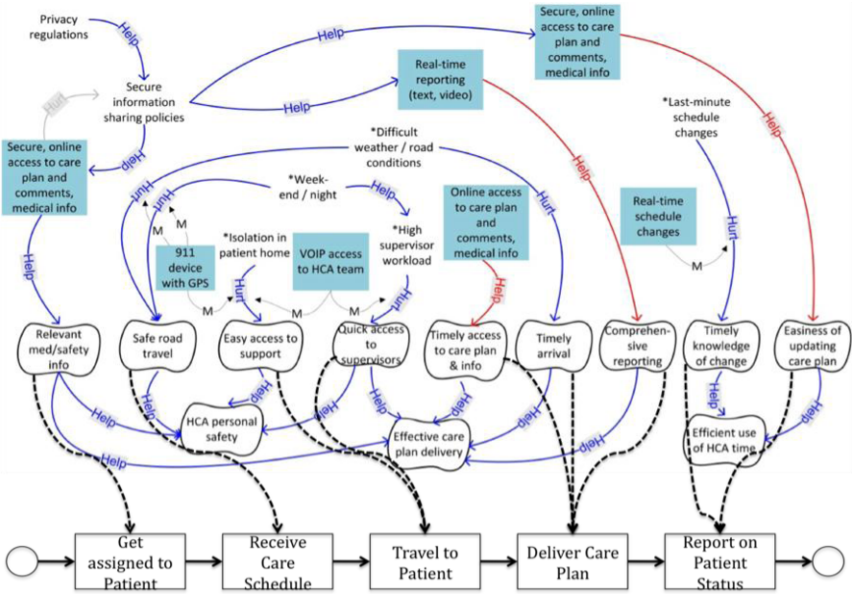

Figure 1: The 'to be' HCA workflow, including technology support

The **HCA heuristic scheduling service** generates weekly schedules for HCAs and is able to adapt to unexpected changes. The HCA scheduling and routing heuristic seeks to optimize a combination of objective functions selected by the scheduler. The default combination of the objective function, for which we have performed our experiments, include HCA travel times, HCA over-time working hours, client visit time window violations and also an HCA-client related index we refer to as the comfort index.

For general communication purposes, we chose **Skype** and **TiKL**. Skype enables text messaging and voice and video calls. This last functionality is essential for enabling the direct communication between the client and the head nurse, a feature that both our HCAs and client educators identified as very desirable for two reasons. Firstly it shortens the time between when the client raises a concern and when the health-care team becomes aware of it. Secondly it enables the clients to be their own health advocates, instead of the HCAs having to mediate through every communication. TiKL is a Push To Talk (PTT) walkie-talkie application that enables the chat and voice communication within the home-care team. It is particularly useful when the home office wishes to communicate with all HCAs at once.

The **Continuing Care Desktop** (CCD) is a secure virtual learning community available exclusively to individuals working in Alberta's continuing care community, and selected guests. Making this resource available on the tablet enables the HCAs to easily access information when they need it in the client's home and share it with the client.

SafeTracks is a GPS-based location reporting (via cellular infrastructure) and cellular phone service for panic/emergency alerts. It is physically separate from the tablet and hence provides a redundant path of communication than that of the tablet.

Finally, to support navigation, we adopted **Google navigation**, primarily because of the familiarity of most users with the underlying Google Maps interface.

2.3. Phase 3

The pilot testing of the simulation protocol and technology simulations with health care aides occurred from January 2012 to March 2012 with 53 simulation participants, 32 of whom were HCAs. The individuals who participated in this third phase of the project were also from rural/urban, community/facility, public/private locations. In this last phase we used simulations of ICT use to address workflow issues and to develop a knowledge translation plan. As the proposed ICT solutions were not covered by provincial health services policies, we could not roll out ICT solutions across the province in current health care practice using real clients. Therefore, it was premature to collect data on ICT uptake by users, efficiency of the health care team and quality of care. Instead, we developed a simulation protocol using three client educators[2] and two occupational therapy students. The training and simulation protocol was piloted tested with two health care aides from CBI, an Edmonton-based agency that was not a participant site in the project. Similar to Phase 1, we conducted interviews and focus groups to gather data on the perspectives of health care aides and some managers on simulations using ICT solutions we introduced. These interviews and focus groups were audio-recorded and transcribed verbatim by a professional transcription service.

[2] A client educator is a real client who volunteers or is paid to role play in a scenario for educational or research purposes.

Finally, we analysed the transcribed data following a focused-ethnography analysis methodology, according the same protocols as in Phase 1.

Training and simulation sessions took place at the main office where HCAs worked. The sessions occurred over a period of four to seven hours and covered the following topics: informed consent, pre-training questionnaire (30 min), introduction to the tablet and applications and a short video (30 min), training (1 to 2 hours), lunch (1 hour), simulation with a 'tech buddy', simulated client and simulated remote case coordinator (1 hour), post-training (or post-simulation) questionnaire and focus group (1 hour). In terms of applications, we introduced participants to apps that would be useful in their work as well as personal lives.

The order of the training content facilitated the acceptance of ICT. Training was planned so as to first build on what HCAs might be familiar with, and then introduce applications in the order in which they might be used in their workflow: receiving a client file, to navigating to a client's home, accessing a client's information and care plan, communicating with health care professionals and EMS, documenting and receiving/accessing just in time information and support. During the simulations, HCAs and their tech buddies followed the cues of their simulated client and the scenario. Over the course of each simulation, the following apps were used, some were developed by the research team, and some were 'off-the-shelf': 'Fruit Ninja' (to develop comfort with swiping), taking and emailing photos, writing emails, texting, voice dictating, accessing client information and task lists through the HCAmobile application (developed by the HCA-T team), documenting task completion and follow up notes (typed and via voice dictation), speaking with one another over TiKL, initiate and receiving calls via Skype, using navigation application to find the way to a client's home, and to determine road and traffic conditions, make emergency calls on Safetracks, and accessing information through a mobile simulation of the Continuing Care Desktop.

3. Results

As stated, the general question that we set out to address in this project was whether information and communication technology (ICT) can address some of the challenges facing HCAs in Alberta today and how specifically, in the Phase 3 simulations, participants completed pre- and post-training and simulation questionnaires. These questionnaires were designed to elicit the HCAs' attitude towards the usefulness of the technologies deployed in the simulations. Since these technologies were designed to mitigate the challenges identified during Phase 1 of our project, a positive HCA attitude towards them would validate our hypothesis that the technologies could address the challenges facing HCAs.

Table 1: Pre-training questionnaire responses.

Question (36 respondents)	Strongly Agree n (%)	Agree n (%)	Disagree n (%)	Strongly Disagree n (%)
1) I think this tablet will be easy to use	8(22)	22(61)	3(8)	3(8)
2) I believe a tablet will be useful in my work	12(33)	15(42)	7(19)	2(6)
3) I feel positive about using a tablet in my work	10(28)	19(53)	6(18)	1(3)
4) I would use a tablet in my work	11(30)	21(58)	2(6)	2(6)
5) I would use a tablet in my personal life	15(42)	14(39)	5(14)	2(5)

Table 1 summarizes the pre-training questionnaire results. In each of the five questions anywhere between 4 (11%) and 9 (25%) respondents appeared negatively pre-disposed to technology. The HCA's attitude after the simulations was much more positive towards the technology.

Participants answered three questionnaire items after the training and simulation session. 30 of the 32 participants (94%) agreed with the statement, 'I plan to use a tablet in work', and 23 of the 32 participants (72%) agreed with the statement, 'I plan to use a tablet in my personal life'. Finally, after the simulation only one of the respondents was not interested in learning more about the technology while 68% were eager (strongly agreed) to learn more. Informally, many HCAs indicated that going back to the current paper-based system would be quite frustrating.

To obtain more information about the appeal of specific technologies, after each simulation session, participants (n=32) were also asked to check all that applied to the statement, 'I would use the following in my work' (Figure 2). The most popular choice was the camera, which is not surprising given the fact that it adds substantively different (and thus potentially very useful) information to the client's record. All technologies however turned out to be quite appealing, thus validating our decisions to embed them in our study.

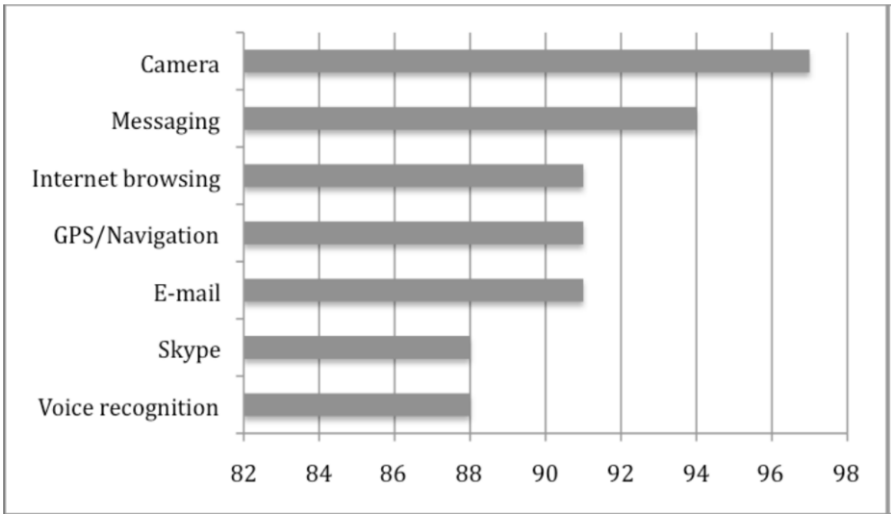

Figure 2: What apps would HCAs use on the tablet?

4. Conclusion

Based on our analysis of the current workflow of HCAs and professionals on their teams, as well as the findings of similar studies in the literature, there are many activities whose effectiveness and efficiency could potentially be improved through the introduction of technology. In particular, through automatic and adaptive scheduling, the number of missed appointments and the travel time of HCAs could be decreased. Through off-the-shelf communication tools, relevant information can be made available to all the HCAs caring for a client in a timely manner, and the clients can communicate with other members of the home-care team, in addition to the HCAs. Through existing GPS-enabled navigation applications and communication devices, the HCAs can travel more efficiently and communicate their location to their team, thus increasing their sense of safety when travelling and at the clients' home. Finally, through special-purpose mobile applications, HCAs can have access to relevant authoritative knowledge and can securely access and modify a client's care plan in real time.

Due to current health service policies, we could not objectively measure the actual impact that these technologies would have, were they actually put in place. However, in our simulated deployment we found that:

- HCAs were receptive to using new technology.
- home-care teams as a whole recognized that these technologies and apps have the potential to increase productivity, reduce workload and improve the team's overall efficiency.

An indirect benefit of these improvements would also be recruitment and better retention of workers to the profession, which would have a positive impact on the envisioned shortage of front-line health-care workers. Future deployment and implementation of technologies in home care should be further evaluated for outcomes. Policies and other barriers would need to be addressed before technologies are implemented. In addition, future technology design should involve end users, and

implementation should incorporate carefully planned training approaches that meet the needs of the users. Finally, budgets should include ongoing support, in order to make possible the regular upgrading of the devices used.

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