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Résumé

Améliorer les compétences et les connaissances des infirmières grâce à la technologie : un exemple de télésanté à l'étranger

Pammla Petrucka, Sandra Bassendowski, Hazel Roberts, Cessarina Hernandez

L'usage des technologies mobiles (les cellulaires) dans la prestation des soins de santé se répand presque partout. Il s'étend des applications simples (envoi de messages courts ou SMS) à des applications complexes en temps réel (télédiagnostic et télésurveillance). Parmi les possibilités offertes par la télésanté, la plus importante concerne la perspective de propulser au 21e siècle les services de santé dans les pays en développement. Les chercheuses ont introduit une plateforme et une infrastructure portable et conviviale dans des établissements de santé sélectionnés dans cinq lieux de la région des Caraïbes, pour ensuite analyser l'expérience des infirmières à l'égard de ce type d'intervention. L'étude révèle des effets positifs sur différents plans : qualité de la vie au travail et des soins; interventions fondées sur des données probantes; contributions des infirmières à l'intégration de la télésanté aux politiques en matière d'informatique de la santé. Les auteures décrivent le cheminement nécessaire pour favoriser la participation des infirmières travaillant dans des contextes caractérisés par une pénurie de ressources à la prestation de soins facilitée par les technologies mobiles. Elles présentent les leçons à retenir, les défis et les possibilités, ainsi que des recommandations susceptibles d'implanter ces outils essentiels au sein de milieux semblables.

Mots clés : technologies mobiles, télésanté, prestation des soins, pays en développement, Caraïbes

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Enhancing Nurses' Care and Knowledge Through Access to Technology: An International m-Health Exemplar

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The use of mobile technologies (i.e., cell phones) in health care is becoming increasingly ubiquitous. From simple (i.e., short message service, or SMS) to complex and real-time applications (i.e., diagnostic remote monitoring), the greatest opportunities lie within the potential of mobile health (m-health) to leapfrog health care in developing countries into the 21st century. This study explored m-health at select health-care sites in 5 Caribbean settings. By introducing and evaluating a user-friendly handheld platform and infrastructure, the study examined nurses' experiences with an m-health intervention, revealing positive impacts on quality of work life and care, evidence-informed approaches, and nurses' contributions to m-health inclusiveness in health informatics policies. The authors describe the path, in resource-challenged environments, to fostering nurses' participation in m-enabled health-care environments. They share lessons learned, challenges and opportunities encountered, and recommendations for bringing these vital tools to similar contexts.

Keywords: mobile technologies, m-health, health informatics, information and communication technology (ICT), Caribbean

The Mobiles for Development project is funded by the International Development Research Centre (IDRC) to enhance nurses' uptake of and exposure to mobile health (m-health) and health information via handheld devices. It has established a user-friendly information and communication technology (ICT) infrastructure with two objectives: to augment quality of work life and care in select health-care sites in five Caribbean settings, and to establish an evidence-informed approach to national/regional health informatics inclusive of personal digital assistants (PDAs) or similar handheld devices for health-care providers.

Study Rationale

The project was launched at a time when ICTs such as m-health were emerging and being rigorously debated — often in the context of settings in the developed world. The team saw an imperative to introduce,

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integrate, and embed ICTs within health-care systems in developing countries. Hence five Caribbean settings were selected: Dominica, the Dominican Republic, St. Kitts and Nevis (two sites), and St. Lucia. Our team comprised academic researchers from the University of Saskatchewan and our Caribbean collaborators.

Based on local priorities, our project considered *places, people,* and *potentials* in the rationale for the project. *Place*s included the decision to conduct the work within the public health system in each of the participating Caribbean settings. This decision was based on both the perceived need to engage policy/decision-makers in the ICTs for health early on and the opportunity to strengthen the institutional health sector. *People* included a focus on the target group of health providers as direct participants and their patients, their co-workers, and the health-system team as indirect participants. In the discussions with governments and health-care bodies (i.e., professional regulating bodies), it was decided that nurses would be the direct participants, as nurses not only were the largest provider group but were a subset of health providers often disadvantaged or overlooked in the health-care systems in these Caribbean settings. *Potentials* reflected the key areas for integration of the ICTs to enhance nursing's presence and its capacities for quality care.

Literature Review

The growth of mobile technologies in health and health care over the past decade yielded nearly six billion mobile subscriptions globally by the end of 2011 (International Telecommunication Union, 2011), up nearly 20% since 2009. Despite this near ubiquity and immense potential in terms of health applications, Burke and Weill (2005) remind us that "technological developments make more effective health care a possibility; however, they do not make it a reality" (p. 205). Yet there is limited evidence of the impact of such technologies on health (Donner, 2004; Kaplan, 2006; Mechael, 2006), health providers (*The Economist,* 2005; Petrucka, Bassendowski, James, Roberts, & Anonson, 2010), health systems (Curioso, 2006; Ducat & Fontelo, 2008), and health information (Leon, Fontelo, Green, Ackerman, & Lui, 2007).

Many m-health studies have yielded inconclusive or tentative results (Ducat & Fontelo, 2008; SATELLIFE, 2005) in terms of the m-health agenda. Articulating the m-health agenda for development and research is hampered by the complexity and diversity of m-health devices, interdisciplinary interdependence, and complexity of deployment. Some authors have attempted to categorize existing and emerging applications. According to Tessier (2010), such applications fall into 12 m-health "application clusters": patient communication, access to resources, point-

of-care documentation, disease management, body-area networks, education programs, pharma/clinical trials, professional communication, public health, emergency medicine, financial applications, and administrative applications. Another challenge is the rapid evolution of m-health technologies. Silberglitt, Anton, Howell, and Wong (2006) describe a list of emerging technologies, expected to be adopted by 2020, among which the front-runners are health-services applications (i.e., improved diagnostic and surgical methods), access to information (i.e., wireless), and environmental sustainability (i.e., water purification). Additionally, there are necessary philosophical shifts, such as Fuscaldo's (2004) vision for a system based on m-health, where the "patient becomes the point of care, not the doctor or the hospital," especially through self- and remote monitoring applications (Lacal, 2003).

So, reflecting on the challenge of Burke and Weill (2005) noted above, the research that will be described herein embraces the vision of health-care providers and health systems taking on technological diffusion and transforming technological enablement into m-health realities.

Study Design

The project initially focused on the opportunity to introduce ICTs in a manner that would embed and integrate the technologies into clinical practice and clinical knowledge transfer and address local priorities. It considered the social and the technological equally at all stages. As the project developed, it became apparent that the participants were seeking quality care and evidence-informed practice; the project was based on the contextual reality of a lack of access to ICTs (specifically, m-health devices) within the health-care systems in the five participating settings. This deficit was seen to potentially impact negatively on clinical practice, clinical knowledge, and evidence-informed patient care in these settings. Further, enhancement and appropriation of ICTs was envisaged as enabling real-time or near-time access to relevant health-care information (ICT-mediated) within the settings, thereby impacting on the quality of care and the capacities of care providers.

Goals and Objectives

The overall research focus was to determine the role(s) and impact(s) of innovative ICTs such as PDAs or wireless system (PDA2W) in enhancing clinical practice and patient care through access to relevant health-care information (ICT-mediated) at select Caribbean public hospitals. As the project evolved, there was exponential development and uptake of m-health opportunities and innovations globally. So, although the original focus remained foundational and valid, it became incumbent on the

research team to increasingly shift the emphasis towards the emerging m-health environment and context. This research challenge informed the development of three objectives:

1. Demonstrate and analyze the use of the PDA2W system and integrated applications in enhancing patient care through access to evidence-informed/evidence-based resources in concert with regional protocols and standards.
2. Research and build capacity of the end-users (nurses, student nurses) with the PDA2W network to facilitate its appropriation and contributions to quality of work life and care through applications and technology, including podcasting, evidence-rich portals (i.e., Nurse ONE), and ongoing training/monitoring.
3. Assemble promising practices at the local and regional policy/decision-maker levels respecting findings from objectives 1 and 2 that demonstrate and facilitate integration of m-health initiatives across the spectrum, from point of care to health information management systems (HIMS), in the Caribbean context.

Method

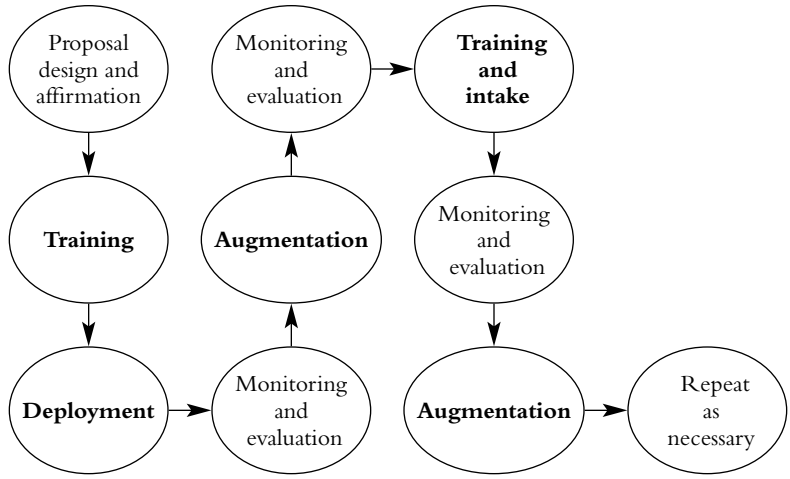
The research design was community-based participatory action research intended to monitor, facilitate, and evaluate the introduction of ICTs in select health-care settings. In accordance with Stoecker's (2009) initiator model, the research team focused on mobilizing the target population/community around the potential change/challenge of uptake and embedding of technologies for quality care and knowledge exchange. The design included a dynamic, cyclical process (see Figure 1), which intertwined *training, technology introduction/augmentation,* and *monitoring and evaluation* for each of the critical activities.

Sample

The sample comprised 254 nurses and 23 nursing students. Over 95% of the participants were female. The combination of practising and student nurses allowed for consideration of intergenerational practices, knowledge, and ICT competencies. The potential participants worked/studied at one of the selected public institutions. Information sessions were held at each site, during which the project was described, questions were addressed, and all practising and student nurses were invited to participate. From among those who agreed to participate, random selection was conducted, followed by random assignment to either the study group or the comparison group.

Research ethics approval was secured from the Behavioural Research Ethics Board of the University of Saskatchewan.

Figure 1 ***Iterative Research Design***



Data Collection

The research tools were a mixture of quantitative and qualitative approaches, purposefully chosen to capture empirical and theoretical aspects over a 4-year period. The strategy, rationale, and tool(s) for all components of data collection are summarized in Table 1.

Data Analysis and Key Findings

Data analysis was undertaken for each tool in accordance with the respective data sets; hence, text and numerical data were separately considered, with triangulation of data sources as appropriate. The analysis approach and key findings for each of the data-collection strategies are discussed briefly below.

Environmental scan. Initially, the research team drew up brief overviews for each of the five settings based on the templates and document reviews. Due to limited or still-emerging information, these reviews were incomplete, unavailable, or inconsistent. Additionally, the intended cross-setting comparisons became complex and non-contributory due to the often generic and early-stage content of the documents provided. However, key findings from the environmental scan were the common elements of a need for m-health and the imperative for a provider-driven m-health agenda.

QoWLC. For this research, our interest was limited to eight Likert-scale questions related to QoWLC and technologies. The participants'

Table 1 *Summary of Data-Collection Approaches*

Collection Strategy	Rationale	Tools
Environmental scan	To determine state of ICTs in health within the participating countries and across the Caribbean	STEEP (Social/demographic, Technological, Economic, Environmental, Political) technique to gather baseline and ongoing situational data. Document reviews
Quality of work life and care (QoWLC)	To measure impacts of introducing the PDA2W system on individual nurses	QoWLC tool examining nurses' demographics, situational analysis, and role perceptions, administered pre- and post-introduction of PDA2W
Work sampling studies	To assess impacts of deployment and stabilization of the PDA2W system on efficiencies and safety in care through access to information	Select work activities (patient education, time to obtain medication/ treatment information) monitored and compared across 4 to 5 data-collection points per setting, in both study and comparison groups, across time (i.e., participant as own reference)
e-HEALS	To ascertain level of confidence and use of Internet as a health resource in 25% of English-speaking participants	e-HEALS pre-/post-test
Key informant/ focus groups	To determine needs, challenges, and potential innovations across the life of the project	Directed and small-group interviews throughout study (i.e., environmental scan, annual meetings, podcast development)
Brief note	To provide continuous, near real-time feedback on the project generally and technologies specifically	Participants provided feedback on a quarterly basis through e-mails to the PI

responses reflected a favourable change in their work life and care environments and in their perspectives on technology, quality of work life, and impacts of technology. This change was measured using select questions (pre- and post-) from the QoWLC survey (see Table 2). The key finding for the QoWLC was that evidence and a workplace culture of evidence-based practice were significantly influenced by the availability and application of ICTs.

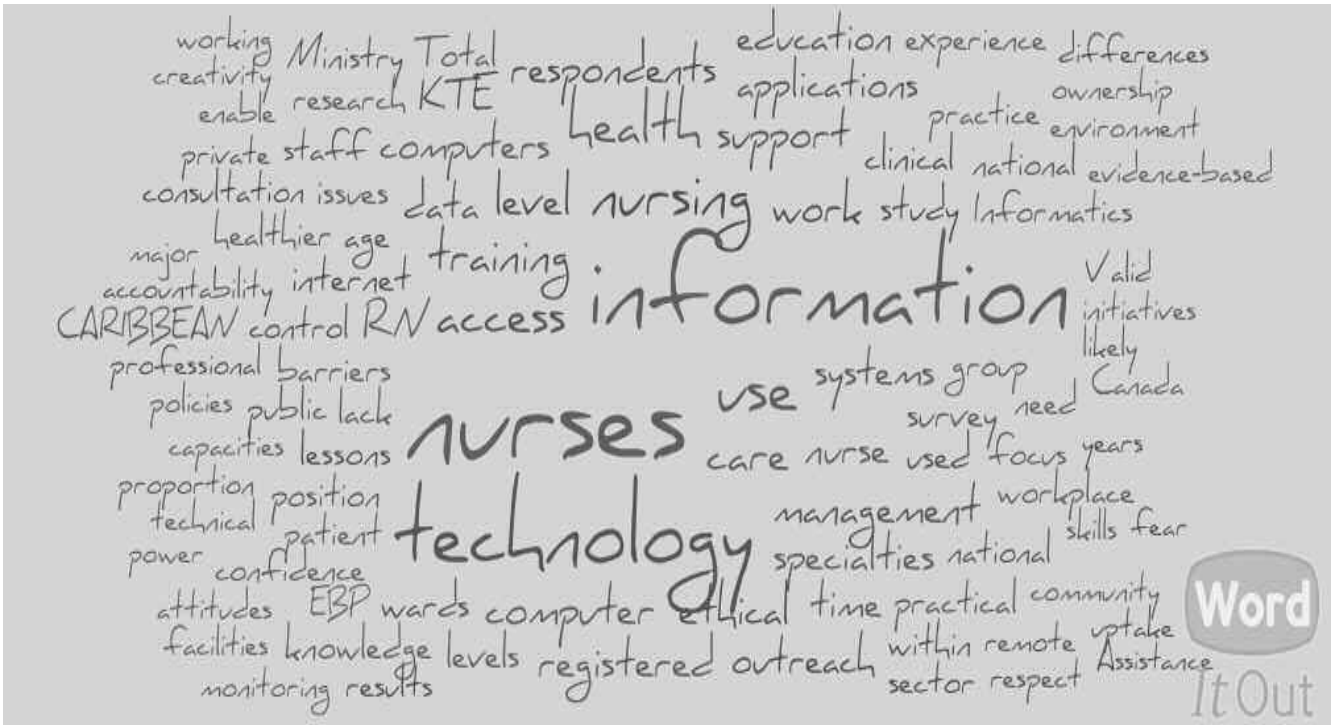
Work sampling studies. Our original intention was to use work sampling results as a surrogate indicator for time/resource economies related to the introduction of ICTs. To gauge the efficiencies associated with the PDA environment, the work sampling studies were conducted on a regular basis during the first 18 months of the project. This frequency was found to be sufficient to show the peaks and eventual plateauing of the benefits of reduced time to access evidence and clinical information. The analysis of the work sampling data was essentially reflected in descriptive statistics. The key finding was, in addition to savings of time, a novice-to-expert pattern, depending on participant capacities related to prior keyboard devices, Internet exposure, and health information literacy.

Table 2 ***QoWLC Survey: Pre- and Post-test Results for Impact of Technology***[a]

Quality of Nursing Work Life and Care	**Pre-introduction of ICT**	**Post-introduction of ICT**
Collaborating With Co-workers		
Openness in communication	3.03	3.88
Level of interaction with other health professionals	2.89	3.97
Support for Nurses' Work		
Availability of ICT	1.77	3.61
Availability of needed equipment	2.49	3.64
Work Life and Workplace Culture		
Currency related to new developments	3.24	3.79
Evidence-Based Practice		
Availability of best practice evidence	1.91	3.36
Application of evidence-based findings	1.03	3.77
Leadership		
Selection of technologies	1.08	2.59

[a] Scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree)

Figure 2 *Technology-Specific Thematic Word Cloud*



e-HEALS. The e-HEALS tool considered the likelihood of participants and patients using the Internet to access health information. Although the majority of respondents were aware of online resources and had used them in health decision-making, only one third (approximately) rated such resources as important or very important. The key finding for this tool was relatively low reliance on the Internet for health information, for both personal and professional purposes.

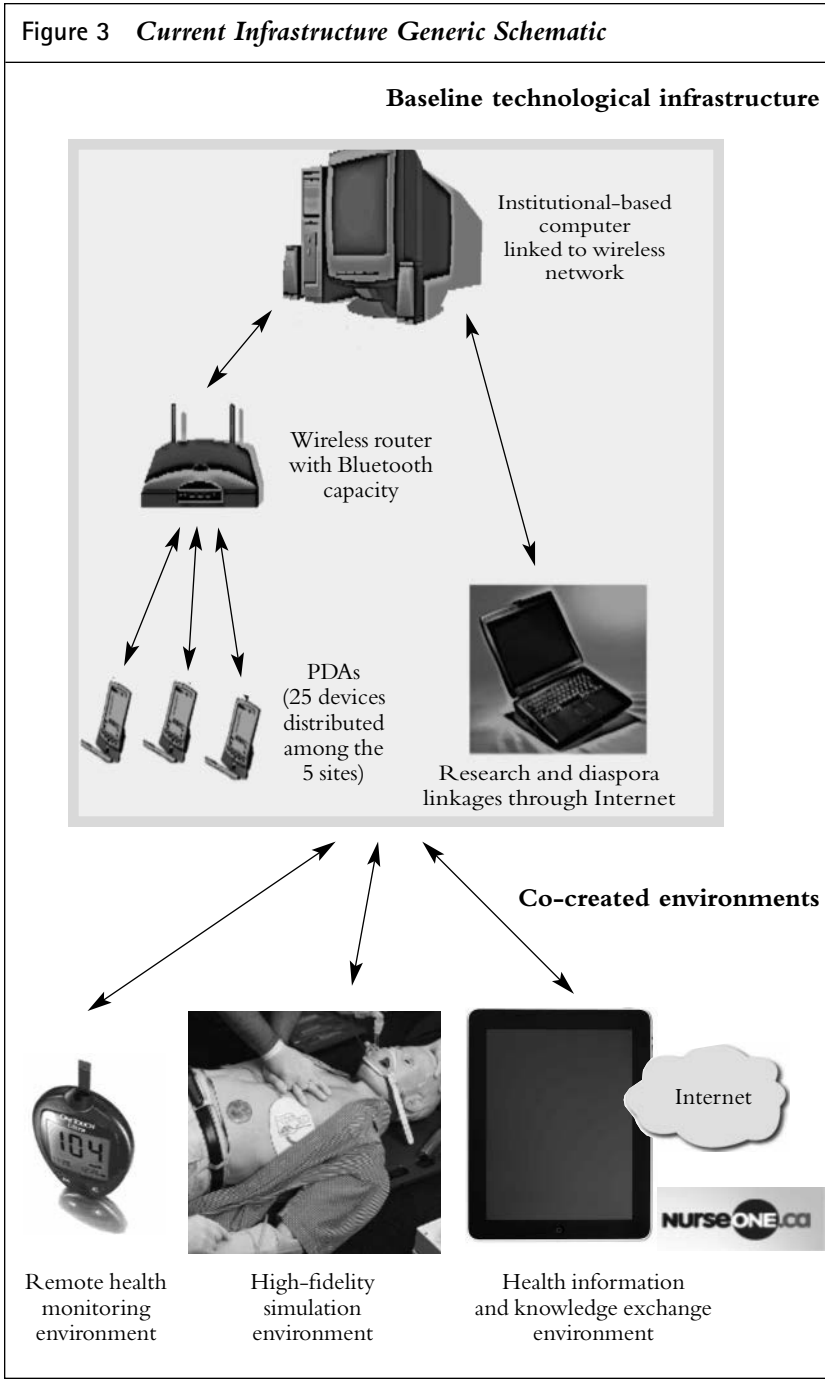
Key informant/focus groups and brief notes. The data were analyzed using thematic analysis and word-frequency analysis at both the midpoint and the conclusion of the study. This method was a familiar one for the participating agencies and partners, lending a richness and depth of insights and insider perspectives. At the midpoint, major themes categorized were *technology-specific* (i.e., value added, practice-changing); *content-specific* (evidence-based, competencies); and *general* (personal growth, appreciation). This list expanded in the final iteration to include *policy-specific* (advocacy, enabling policies). The *technology-specific* category became less of a focus as the project progressed, perhaps indicating a growing level of comfort with the technology, complacence, or normalization. The *content-specific* category was the most dynamic across the two time periods, showing evidence of increased momentum towards evidence-based protocols, care, and environments (nearly tripling in frequency). The added *policy-specific* category emerged in the latter portion of the project, appropriately, as participants likely had little insight or interest in the early stages (which were taken up with devices and learning curves). The themes were presented using a series of word clouds (see Figure 2). The key findings for this tool related to the interdependence of the categories to achieve a well-designed and sustainable way forward.

m-Health intervention findings. The technical aspect of the project was a critical contribution reflecting both core hardware and core software, with ongoing augmentation in response to the participants' needs and contextual changes. The outputs and impacts of these technical innovations were measured using a number of the tools, especially work sampling studies and QoWLC, as shown in Table 1.

PDA2W Core Hardware

The building of the PDA2W networks was a systematic and iterative process, highly individualized for each site. Initial determination of the PDA2W baseline requirements included potential compatibilities and capacities of wireless routers and peripherals within targeted units as well as identified technical constraints. PDA2W infrastructure became the backbone upon which the project supported a range of innovative and emergent tools and devices, hardware, and software (see Figure 3).

Figure 3 ***Current Infrastructure Generic Schematic***



This intervention demonstrated, from a technical standpoint, the functionality and stability of wireless capacity within select hospital environments.

Windows Mobile-based PDAs (i.e., Hewlett Packard IPAQ) were sourced, preconfigured, and deployed. Both English and Spanish versions were acquired to better meet the language needs of the participants. Each agency was provided with access to an Internet-capable desktop computer containing the same software as that available on the PDAs. This was essential and ethically imperative to ensure that all nurses had access to care guidelines, health information, and professional development resources.

Near the midpoint of the project it became obvious that an enabling environment for such technologies in health care was emerging. We likened our context to the movement from "infancy" to an energetic/active "youth" phase in which we could fully participate.

PDA2W Core Software

Basic programs such as Adobe Reader, Archimedes, and Diagnosaurus were installed in advance. We referred extensively to these free resources at http://library.uchc.ecu/pda for ongoing augmentation to the baseline software package, as well as to focus group feedback, research findings, and agency/unit requirements (e.g., obstetrics/midwifery). As the software palette was selected, a core package, including RNNotes, Manual of Nursing Practice and Procedures, Nursing Drug Handbook, Taber's Medical Dictionary, and Manual of Nursing Diagnosis, plus the 5 Minute Consult program, were included. In the latter stages of the project, participants were adding programs independently, mostly notably from sites such as www.studentdoc.com/free-pda-medical-software.html and www.epocrates.com.

PDA2W Augmentation

During the project, two hardware augmentations and one software were introduced. An overview will be provided, with publication of research findings anticipated.

Remote health monitoring (RHM). The project included a clinical RHM application related to blood pressure and blood glucose monitoring in partnership with SaskTel and Alcatel Lucent. These sensor devices were selected in consultation with the participants and the project team to focus on chronic conditions (diabetes, hypertension), as these are areas of increasing health concern in the Caribbean region. The purpose was to demonstrate the value of layering an RHM service onto the existing ICT infrastructure using existing PDAs as an aggregation device. This component was a technical feasibility element rather than a clinical trial, so information was linked not to specific patients but, rather, to particular

patient beds. As the project unfolded, opportunities arose to use RHM community-based applications. We used the units for free public clinics in malls and barber shops — essentially, places where people meet and have some "uncommitted" time. Although the sensor devices were, at times, limited to being data vaults when there was no wireless capacity, data were captured and later transmitted.

High-fidelity simulation (HFS). With the establishment of stable wireless systems within health-care environments and beyond, the implications and potential for innovation are seemingly endless. Given the stability of the wireless systems in St. Lucia, the research team, in consultation with the IDRC, moved to the introduction of a wireless-enabled HFS mannequin (Gaumard HAL 3101), to be used primarily for clinical training of the participating nurses. Our intention was threefold: (1) to establish a training model using HFS that will potentially create a "centre of excellence" model for this partner site; (2) to undertake the formative design of a study to be led by the partner site (i.e., St. Lucia) with the assistance of the lead PI; and (3) to enhance and extend the utility of the backbone wireless capacity and participant competencies potentiating sustainability. Following the training, the St. Lucia team continued to work with the Regina Qu'Appelle Health Region simulation site to plan scenarios, review protocols, and advance the potential of simulation training at their respective sites.

NurseONE. The focus on professional development was considered important given the identified gaps in available information and resources for quality evidence-informed care. Our interest was in using the PDA2W infrastructure and tools to address these gaps. The first task was to address the participants' varying levels of health informatics skill and competency. The second was to stimulate interest in professional development using technology. Many participants found that they lacked the time and opportunities to explore, experience, and learn this type of non-traditional approach. In order to address this concern, we introduced NurseONE/INF-Fusion, a portal of the Canadian Nurses Association (CNA) (www.nurseone.ca). NurseONE is a personalized, interactive Web-based resource providing nurses across Canada with a gateway through which to access resources for the delivery of effective evidence-based care and to enhance their clinical and professional expertise. The portal provides access to more than 1,000 full-text journals, 600 e-books, and a range of resources and databases for practising nurses. The CNA took steps to increase access to contextually and linguistically relevant resources for our participants.

Lessons Learned, Challenges, and Opportunities

The five key lessons learned through this project have informed future directions and current potential.

Lesson 1: Build m-Health Awareness and Availability First

In this study, participants (both the practitioners and the participating sites) had varying levels of experience with ICTs; however, they were all new to m-health. The research confirmed the growing trend towards ICTs generally and m-health specifically, within the health-care sector and within nursing. The project contributed to the participants' understanding, uptake, and development of competencies related to ICTs in a manner aligning closely with the first stage of Rogers' adoption process (Borrego, Froyd, & Simin Hall, 2010; Rogers, 2003). However, a significant effort at the front end was necessary to build an understanding of m-health using a practitioner lens as well as from a development perspective. The project was successful in increasing the participants' individual awareness and, later, collective interest in and advocacy for m-health (devices, processes, and policies) within their respective health sectors, paralleling findings of the European Technology Platform (2012).

Further, the participants clearly indicated that Internet access made health information available to both providers and patients; hence the technology and, more importantly, its appropriate use were critical to access to information.

Lesson 2: Ground Within the Local Context

Many of our efforts were focused on awareness, readiness, access, and process, which partly aligns with the suggestions of Heeks and Molla (2009). In this project, the challenge was to deal with the varying states of the participating sites in terms of their understanding of and/or belief in the potential of ICTs for their health-care delivery models. This included ensuring buy-in across sectors and on the part of relevant government departments, a finding shared by Woodward, Feldman, and Snider (1997). Through the project, each of these elements was considered and addressed, yielding a series of stable and functional augmented PDA2W infrastructures based on local priorities and building local capacities. These efforts were necessary, foundational, and informative for the way forward, and they mirror the experiences of Barab and Squire (2004) and the European Technology Platform (http://www.cordis.europa.eu/technologyplatforms/ict_en.html).

Lesson 3: Embed Evidence/Content to Catalyze Innovation Uptake

The true impact of this project and m-health projects in general resides in the uptake/utilization of the technology for evidence-informed practice (Hewapathirana, 2010; Tessier, 2010). Ultimately, the project addressed development through uptake/utilization to reduce inequities in distribution of ICTs (as a desired resource) and increase access to knowledge and evidence through this infrastructure. The participants were highly engaged in searching for health information, clinical evidence, and practice guidelines.

Lesson 4: Coordinate for Achievement at Different Levels

The multisite nature of the research made it imperative that we respond individually to the sites while concomitantly ensuring that key milestones were reached across all sites before moving forward. This allowed for economy of scale and possible reduction of duplication.

Lesson 5: Attend to Knowns and Be Attuned to Unknowns

The research team realized that Mick and Fournier's (1998) eight paradoxes were variably evident within this introduction to innovation. Most significantly, we were aware of examples of how the technology affected movement between control/chaos, competence/incompetence, and engagement/disengagement. As the project was being launched, we saw that there was a significant amount of work to be done upfront, revealing the need to allow more time for the first stage of the intervention. A prolonged time allowance for most activities remained a requisite throughout the project, in order to permit us to address the control/chaos and competence/incompetence paradoxes. Ensuring full engagement in the project, particularly with respect to research skills, was critical in terms of both competence/incompetence and engagement/disengagement. We found that comfort ended with the planning and collection phases but only limited engagement was possible for analysis and dissemination efforts from our partner researchers. A formal training module could facilitate and build capacities across multiple projects and become a mandatory training element prior to engagement, but this was beyond the scope of the project. As we continued to address each of the paradoxes, the work of Emanuel, Wendler, Killen, and Grady (2004), describing collaborative partnerships, was increasingly relevant in informing the imperative of balancing project needs with mutual respect and mutual benefits.

In addition to the lessons learned, a number of challenges and opportunities were identified. Methodologically, the pre- and post-QoWLC survey, as well as the brief notes, provided evidence of growth, develop-

ment, and success. The lack of a research ethics review process at the participating institutions, combined with a low overall level of understanding of research ethics, remains an area for future development. Data analysis was problematic due to lack of experience and confidence among the participating team members. This step defaulted almost exclusively to the PIs, which suggests a need for training at future partner sites. The international research team worked collaboratively, recognizing individual and collective strengths and capacity-development needs. The project built a number of relationships both locally and globally. Of note, several participants have undertaken further education or have expressed an interest in doing so. Significantly, South-to-North learning has been critical (Mechael & Curioso, 2010), with two projects modelled on the PDA2W and Canadian nurses following in the footsteps of their Caribbean counterparts — a validating experience for the Caribbean partners.

The Way Forward

This intervention was a Mobiles for Development project to enhance uptake and exposure to m-health technologies and health information via devices for nurses at five Caribbean sites. Its objective, which was achieved, was to improve quality of work life and care for nurses through capacity-building. The project built and co-created a user-friendly ICT infrastructure comprising an array of wireless-capable devices, ranging from handhelds to life-size high-fidelity simulation mannequins. The intervention holds promise as an appropriate, simple, and useful transition to ICTs and mobile technologies for the health sector at other resource-compromised sites.

The project yielded three recommendations for uptake and utilization of m-health tools for quality, care, and knowledge in resource-constrained environments. The first is to advance evidence-based health care through ICTs and m-health tools such as those implemented. Aligning the technology with this important step towards knowledge uptake and transfer represents an opportunity to increase utility and sustainability. The second recommendation is to encourage, enable, and empower participants and stakeholders to advocate for ICT-enabling health-care policies. Participants quickly become experts and the best voices for necessary changes. They understand, embrace, and envisage an m-health future as the preferred one. The third recommendation is to firmly root the introduction of m-health technologies in capacity-building efforts. This demonstrates that m-health is not about technologies for their own sake, but about the ability of practitioners, such as the participants in this project, to use technologies to improve quality, care, and knowledge in their respective contexts.

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