Section Editor: Susan Alexander, DNP, ANP-BC, ADM-BC

Integration of Mobile Health Applications in Health Information Technology Initiatives

Expanding Opportunities for Nurse Participation in Population Health

Yeow Chye Ng, PhD, CRNP, CPC, AAHIVE, Susan Alexander, DNP, CRNP, ADM-BC, Karen H. Frith, PhD, RN, NEA-BC, CNE

The potential for access to wireless technology continues to expand globally. According to estimates from the International Telecommunication Union, mobile broadband subscriptions have grown at an annual rate of 20% in the past 5 years, totaling 4.3 billion subscriptions internationally in late 2017.[1] In developing countries, expanded fiber deployment is increasing fixed broadband speeds, as international bandwidth speeds also increase.[1] Prices for mobile broadband subscriptions have dropped as much as 32% in some countries, and 95% of the world's population now lives in a geographical area with access to, at a minimum, a basic second-generation, or 2G, mobile wireless network.[1]

Proximity to wireless signal networks has increased the use of devices capable of connecting users to the Internet. Even in countries where there are large, sparsely populated geographic regions, such as exist in the continent of Africa (Ghana, Kenya, Nigeria, Senegal, South Africa, Tanzania, and Uganda), and where landline penetration may be close to zero in areas, the use of cell phones is growing rapidly. In this group of countries, only 17% of residents do not own a cellular phone; 35% of cellular devices owned by these residents are smartphones. Mobile technological devices with basic features, such as interactive voice response and short message service (SMS) or text messaging, along with more sophisticated devices like smartphones, are increasingly used to support and expand health information technology (HIT) initiatives designed to improve healthcare outcomes across the globe.

In the United States, cellular phone devices are ubiquitous. According to a 2018 survey, 95% of adults in the United States own a cell phone, and 77% of these devices are smartphones.[2] A third of Americans live in a home with three or more cell phone devices,[3] and 42% of adults 65 years or older own smartphones.[4] While many smartphone users are 30 years of age or younger, usage of smartphones has increased in the older population.[5] Globally, an estimated 5.07 billion people, or 62.9% of the world's population, own cell phones; ownership is divided between smartphones (50%) and nonsmartphones (50%).[6] Smartphones, which function as handheld computers and are able to accomplish multiple tasks flexibly across time and space, are ideal tools to support the adoption of HIT and mobile health (mHealth) applications by facilitating the exchange of information between patients and healthcare providers across platforms.[5,7,8] The multiple functionalities of smartphones make them ideal tools to address patient needs for health information with the use of communication technologies.[7]

Mobile technological devices with basic features such as interactive voice response and text messaging, along with more sophisticated devices such as smartphones, have the capabilities to support and expand HIT initiatives needed to improve healthcare outcomes across the globe. In addition, the international popularity of cellular phone devices offers a platform for the integration of HIT elements that are increasingly accepted by both patients and healthcare professionals (HCPs).[8–10] Defined broadly, HIT can be viewed as the amalgamation of hardware and/or software technologies or intellectual property through licensing of a product, packaged solutions, and services to support functionality for healthcare entities and/or consumers in the creation, assessment, maintenance, or exchange of health information.[11] Adoption

KEY POINTS

- The expansion of infrastructure to support wireless access has spurred both the adoption of mobile devices and opportunities to use such devices in addressing healthcare needs.
- Multiple opportunities for the use of technologies that vary in ease of design and user interface, including interactive voice response calls, short message services, and smartphones, exist across regions and markets.
- The combination of clinical insight and technological skills possessed by nurse informaticists enables this highly trained group to make significant contributions in the design and delivery of mHealth applications.

Author Affiliation: College of Nursing, University of Alabama in Huntsville, AL.

The authors have disclosed that they have no significant relationships with, or financial interest in, any commercial companies pertaining to this article.

Corresponding author: Yeow Chye Ng, PhD, CRNP, CPC, AAHIVE, College of Nursing, University of Alabama in Huntsville, 301 Sparkman Drive, Huntsville, AL 35899 (YeowChye.Ng@uah.edu).

Copyright © 2018 Wolters Kluwer Health, Inc. All rights reserved.

DOI: 10.1097/CIN.0000000000000445

Copyright © 2018 Wolters Kluwer Health, Inc. All rights reserved.

of devices that support HIT efforts, particularly those containing mHealth applications, offers ways to improve the quality, efficacy, and safety of healthcare delivery, and contribute significantly to productivity within healthcare settings.[12] Mobile health can be defined as, "…the use and capitalization on a mobile phone's core utility of voice and short message service (SMS) as well as more complex functionalities and applications including general packet radio service (GPRS), third- and fourth-generation mobile telecommunications (3G and 4G systems), global positioning system (GPS), and Bluetooth technology."[13(p14)] The purpose of this article is to briefly review common strategies in the design of mHealth applications and to describe the role and strategies that can be used by nurse informaticists to improve healthcare delivery and outcomes for patients.

Mobile Health Applications Use of Common Technologies

Call Centers. Mobile health applications integrated into basic and smartphones enhance the functionality of cellular devices and are critically necessary to extend the reach of health initiatives. At first, mHealth initiatives both nationally and internationally capitalized on the widespread use of basic phones. Although the use of mHealth applications in nonsmartphones is more limited, basic functionalities of the devices typically include SMS along with voice calls. Historically, frequently used initiatives were associated with voice functionalities inherent in basic phone devices, enabling efforts including health call centers (59%), emergency toll-free telephone services (55%), emergencies (54%), and mobile telemedicine (49%).[13] The least frequently reported initiatives associated with basic phone devices were health surveys (26%), raising awareness (23%), surveillance (26%), and decision support systems (19%).[13]

Mobile health applications that are appropriate for basic phone devices are still used in healthcare, especially for the dissemination of health and facility information. In the United States, 60% of hospitals continue to use call centers for an array of purposes, such as health advice lines, marketing campaigns for health-related programs (seminars, training courses, or exercise classes), and disease management initiatives.[14] Facility-based call centers can be essential to the improvement of awareness of healthcare institutions and their services. As hospitals transition to comprehensive healthcare organizations, their call centers are expanded to support affiliates such as HCPs, health plans, and medical device suppliers.

Short Message Service. Short message service, known also as text messaging, is an additional mode of communication found in basic and smartphone devices. Efforts to integrate HIT originating from multiple healthcare settings, including primary care, can use SMS in relatively simple ways to support large-scale communications.[15] Short message service technology works through the application of software that supports scheduling, scripting, routing, and replying, based on preconfigured algorithms. These algorithms can be standardized to ensure that systems operate consistently and eliminate the need for users to monitor, send, and respond to each text message.[16]

Even in basic mobile devices, SMS platforms have become more complex and sophisticated, supporting HIT initiatives using both unidirectional and bidirectional texting. Bidirectional texting can be configured to require users to enter closed-ended responses (such as choosing 1, 2, or 3 from a list) or to collect open-ended responses that require users to read the message and enter an individual response.[16] In this case, if more than one message is sent, an automated trigger is needed. Moreover, outgoing responses may use conditional branching logic for customized messages.[15] The use of branching logic also enables HCPs to send automatic customized responses to users that are triggered by the closed-ended responses. A viable example is a physical exercise SMS application that allows one to send "yes" as a positive response and receive "keep up the good work" as an answer, while a negative response will receive an answer such as "try to get an hour's exercise tomorrow."[15]

Health information technology projects based on SMS can accommodate both basic and smartphone users in the evolving field of mHealth applications, tapping the nonsmartphone's simplicity to deliver primary healthcare information that may be more effective for users who are less tech-savvy.[16] Health information technology projects based on SMS enable communications that can be characterized according to three levels of engagement: simple, specific, and serious.[17] Short message services may be used as *simple* reminders for healthcare appointments or other interventions such as self-monitoring of physiological parameters. Text messages may incorporate *specific* responses from HCPs or be automated to send preprogrammed messages to individuals. Text messages may be *serious* if they offer a mechanism for a client to initiate a disclosure of a concern or an event.[17] The levels of engagement supported by SMS accommodate both smartphone and nonsmartphone users within the framework of HIT projects.

The efficacy of text messaging is tied to several factors that are important for HCPs to consider. An assessment of end-user requirements for SMS use should be conducted to establish the framework of HIT project delivery.[17] All stakeholders must enter into discussions that establish a common local policy to assist in the implementation of the service. Anticipation of increased workload for staff and the technical requirements of text message distribution across patient populations using both basic and smartphone devices are fundamental to the design of a successful mHealth project.

Copyright © 2018 Wolters Kluwer Health, Inc. All rights reserved.

Barriers to mHealth Integration. Geographic patterns in the adoption of mHealth have been identified in surveys conducted by the World Health Organization. Barriers to implementation of mHealth applications are related to the assessment of efficacy and associated costs of applications, conflicting priorities in health delivery systems, lack of policies to support mHealth initiatives, and legal issues such as data security and participant privacy.[13] Incorporating evaluation strategies into the project management life cycle and sharing global standards for information technology exchange have also been suggested as ways to improve participation in mHealth initiatives.[13] Global effort is needed to promote best practices and data flow between diverse systems and applications in the development of enterprise architecture in order to improve participation in and results of HIT initiatives based on mHealth applications.[13]

Contribution of Nurses to Mobile Health Initiatives: Potential and Practical Considerations

Infrastructure that supports wireless access to the World Wide Web increases opportunities for nurses to participate in HIT initiatives. In Zambia, 64.5% of households own a mobile phone.[18] In a 2015 survey, 85% of households in urban areas had access to mobile phones, compared to only 50% in rural areas; a higher percentage owned smartphones.[18,19] The Zambian government, in cooperation with other national organizations, began an mHealth initiative designed to improve healthcare service delivery and follow-up for patients across the country.[12,19] An mHealth tool named "RemindMi," in which SMS is used to monitor postnatal visits, is available and promoted by the government of Zambia. The tool enables registry of new births, sends text messages to new mothers to remind them of postnatal visits, and encourages continuity of care by engaging them in the review of topics such as laboratory results.[19] Despite Zambia's use of mHealth applications such as SmartCare and RemindMi, none of the nurses reported using other mHealth applications in daily tasks.[19]

Public Health. It is important to note that many governments in middle- and low-income countries are showing renewed interest in mHealth as a core strategy to strengthen healthcare systems and attain millennium development goals.[20] A combination of clinical insight and specialized technological competencies necessary for the integration of mHealth applications in HIT initiatives offers opportunities for nurse informaticists. The need for verification by clinical experts has been noted in studies of mHealth applications targeting women's health initiatives, revealing a preference to defer inclusion of content at the expense of disseminating information that potentially could be misleading, inaccurate, or dangerous.[21] Increasing global deployment of mHealth applications highlights the special challenges associated with their use.[5]

Public health is an area that has been quick to embrace SMS, especially in HIT initiatives directed at primary care.[14] Because text messages can reach large population segments quickly and often at a low cost, SMS is commonly used in HIT initiatives targeting disease outbreaks, populations, and health promotion. For example, more and more public and medical treatment centers offer free access to wireless connections, which allows patients to communicate using HIT. The feasibility of mobile technologies has been tested in many practice areas, such as maternal and child health. The mobile platform has been essential in hosting applications within diverse scenarios, such as the overall improvement of general health services and information, as well as access to emergency services. The mobile platform has also been a reliable way to enhance transparency, management, and accountability regarding patient health information.

Disease Surveillance Initiatives. In Madagascar, SMS has been a critical tool in monitoring influenza rates.[22] Nurses and staff members at 34 sentinel centers participated in disease surveillance (N = 862 585) from 2008 to 2012; 87% of the influenza-like illness data were transmitted to the network within 24 hours. The real-time data enabled the Ministry of Health in Madagascar to learn from and immediately respond to new infectious disease outbreaks and initiate strategically targeted local public health responses.[22]

Population-Directed Initiatives. Short message service has been used in initiatives for vulnerable populations, such as homeless patients and those for whom transportation to educational programs may be an issue. In a cross-sectional survey of patients (N = 290) at a clinic dedicated to care of the homeless population in a Virginia city, 89% reported owning a mobile phone.[23] Study participants identified interest in use of SMS for appointment reminders (77%), refill medication reminders (66%), and medication information messages (54%). Readability, user-friendliness of the interface, and low cost of the mHealth application were factors that contributed to the success of the TXT2DASH program, which targeted socioeconomic groups who had difficulty attending monthly on-site meetings.[24]

Other creative initiatives, such as the Text4Baby campaign in the United States, are examples of successful campaigns supported by the Health Resources and Services Administration for the use of SMS within the HIT framework.[25] In the Text4Baby campaign, expectant mothers were asked to text their due dates, engaging patients and HCPs to create a prenatal health history that might have been difficult or impossible to obtain otherwise.[14] Programs such as these focus on meeting primary care goals for preventive interventions.[15]

Copyright © 2018 Wolters Kluwer Health, Inc. All rights reserved.

It is also notable that public health initiatives that are tailored to assist individuals to quit smoking or lose weight have been successful even for nonsmartphone users. Text messages have also been important in providing follow-up services.[15] Patients who have undergone surgery can be given information regarding their condition and expected postoperative recovery at home. This ensures that the information is accurate and always available.

SUMMARY

The use of mobile phones has revolutionized the field of HIT in multiple care delivery settings by offering access to high-quality health information and seemingly endless customization of that information. Nurses will continue to play a significant role in the proliferation and support of initiatives incorporating mHealth applications, including the development of organizational policies and guidelines for use (Table 1). Mobile health apps are increasingly combined with telehealth and remote patient-monitoring approaches in many disease management programs designed to reduce hospital readmissions.[26]

The emergence of new technologies is accompanied by limitless possibilities and potential benefits in the delivery of high-quality and cost-effective patient care. The key to sustainability for mHealth technologies will be the use of an appropriate tool, at an appropriate time, for an appropriate patient. Collection of relevant data will also be needed to support use for patients and in clinical workflow. With their combination of clinical and technological expertise, nurse informaticists are poised to integrate mHealth applications in clinical practice and connect patients and HCPs in ways that are compatible with life, work, and the health of populations.[26]

Table 1. Six Decision-Making Strategies for Nurse Informaticists to Participate in Selection of mHealth Applications for Health Initiatives[21]

1. Recognition: In what ways can mHealth applications improve care delivery, increase reimbursement, and complement organizational HIT initiatives?
2. Identification: Does your organization have a list of mHealth apps that are approved to be recommended or prescribed to patients?
3. Recommendation: When is it appropriate to recommend mHealth applications to patients? What are recommendations for sharing information across the care team and settings?
4. Education: What will be the process of teaching patients to use the mHealth application? Who will monitor adherence to its use and associated outcomes?
5. Evaluation: What is the process of curating and evaluating solutions involving mHealth applications? How will benchmarks and markers of efficacy be established as adoption of the mHealth application grows?
6. Professionalization: What new training and competencies might be needed for nurses, informaticists, and executives?

References

1. International Telecommunication Union. ICT facts and figures 2017. Geneva, Switzerland: ICT Data and Statistics Division; 2017.
2. Pew Research Center. Mobile fact sheet. http://www.pewinternet.org/fact-sheet/mobile/. Accessed February 18, 2018.
3. Olmstead K. A third of Americans live in a household with three or more smartphones. Pew Research Center. http://www.pewresearch.org/fact-tank/2017/05/25/a-third-of-americans-live-in-a-household-with-three-or-more-smartphones/. Accessed February 18, 2018.
4. Anderson M, Perrin A. Tech adoption climbs among older adults. Pew Research Center. http://www.pewinternet.org/2017/05/17/tech-adoption-climbs-among-older-adults/. Accessed February 18, 2018.
5. Dennison L, Morrison L, Conway G, Yardley L. Opportunities and challenges for smartphone applications in supporting health behavior change: qualitative study. *Journal of Medical Internet Research*. 2013;15(4): e86.
6. Statista. Number of mobile phone users worldwide from 2013 to 2019 (in billions). https://www.statista.com/statistics/274774/forecast-of-mobile-phone-users-worldwide/. Accessed February 18, 2018.
7. Pandey A, Hasan S, Dubey D, Sarangi S. Smartphone apps as a source of cancer information: changing trends in health information-seeking behavior. *Journal of Cancer Education*. 2013;28(1): 138–142.
8. Ramsey AT, Wetherell JL, Depp C, Dixon D, Lenze E. Feasibility and acceptability of smartphone assessment in older adults with cognitive and emotional difficulties. *Journal of Technology in Human Services*. 2016;34(2): 209–223.
9. Putzer GJ, Park Y. The effects of innovation factors on smartphone adoption among nurses in community hospitals. *Perspectives in Health Information Management/AHIMA, American Health Information Management Association*. 2010;7(Winter): 1b.
10. Putzer GJ, Park Y. Are physicians likely to adopt emerging mobile technologies? Attitudes and innovation factors affecting smartphone use in the Southeastern United States. *Perspectives in Health Information Management/AHIMA, American Health Information Management Association*. 2012. [Epub ahead of print].
11. US Department of Health and Human Services. *What Is Health Information Technology?* Washington, DC: Office of the National Coordinator for Health Information Technology; 2017.
12. Kellermann AL, Jones SS. What it will take to achieve the as-yet-unfulfilled promises of health information technology. *Health Affairs (Millwood)*. 2013;32(1): 63–68.
13. World Health Organization. *Guideline on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV.* Geneva, Switzerland: World Health Organization; 2015.
14. Riley WT, Rivera DE, Atienza AA, Nilsen W, Allison SM, Mermelstein R. Health behavior models in the age of mobile interventions: are our theories up to the task? *Translational Behavioral Medicine*. 2011;1(1): 53–71.
15. Free C, Phillips G, Watson L, et al. The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis. *PLOS Medicine*. 2013;10(1):e1001363.
16. Neter E, Brainin E. eHealth literacy: extending the digital divide to the realm of health information. *Journal of Medical Internet Research*. 2012;14(1): e19.
17. Krist AH, Woolf SH. A vision for patient-centered health information systems. *Journal of the American Medical Association*. 2011;305(3): 300–301.
18. Zambia Information and Communications Technology Authority. *ICT Survey Report—Households and Individuals*. Lusaka, Zambia: Zambia Information and Communications Technology Authority; 2015.
19. Vélez O, Foster AA. ANI Emerging Leader Project: enhancing the role of nurses in zambia through mHealth. *CIN: Computers, Informatics, Nursing*. 2016; 34(1): 6–7.
20. McCuen C, Sayles NB. *Case Studies in Health Information Management*. Stamford, CT: Cengage Learning; 2014.

Copyright © 2018 Wolters Kluwer Health, Inc. All rights reserved.

21. Lee J, Kim J. Method of app selection for healthcare providers based on consumer needs. *CIN: Computers, Informatics, Nursing*. 2018;36(1): 45–54.
22. Rajatonirina S, Heraud JM, Randrianasolo L, et al. Short message service sentinel surveillance of influenza-like illness in Madagascar, 2008-2012. *Bulletin of the World Health Organization*. 2012;90(5): 385–389.
23. Moczygemba LR, Cox LS, Marks SA, Robinson MA, Goode JR, Jafari N. Homeless patients' perceptions about using cell phones to manage medications and attend appointments. *International Journal of Pharmacy Practice*. 2017;25(3): 220–230.
24. Welsh PD. Strategies in development of an mHealth technology for low socioeconomic groups in free healthcare clinics. *CIN: Computers, Informatics, Nursing*. 2016;34(1): 3–5.
25. Pirretti A. HRSA evaluation of Text4Baby finds program successes. https://partners.text4baby.org/index.php/news/489-hrsaevaluation. Accessed February 18, 2018.
26. Austin RR, Hull S. The power of mobile health technologies and prescribing apps. *CIN: Computers, Informatics, Nursing*. 2014;32(11): 513–515.

Copyright © 2018 Wolters Kluwer Health, Inc. All rights reserved.