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EXPLORING NEW TECHNOLOGY INTERVENTIONS IN NURSING FIELD.

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Abstract:

Using technology to improve precision health, the National Institute of Nursing Research (NINR) Research Centers are leading the way. They specialize in defining biomarkers, delivering customized therapies for a range of health issues, and characterizing symptom profiles. Technology is more effective as a tool in nursing science when it is used within a

framework that is focused on the needs of the user. Establishing precise theoretical connections between interventions and technology use, in addition to open practices in user-centered design, testing, and evaluation, are essential to this attempt. To stop health disparities from growing, it is essential to incorporate best practices for involving minority and underprivileged groups. Even if the use of technology for self- and symptom management has grown significantly, it is still crucial to provide accurate and consistent data to enable its application in clinical settings. Adopting the multistep, standardized process described in this article for technology creation and testing is relevant to nursing research worldwide.This roadmap can be used by interdisciplinary teams in conjunction with nurse scientists to develop new technologies or implement those that already exist. Ultimately, the goals of precision health and nursing science are aligned when it comes to supporting each other and providing tailored therapies that improve health and well-being. Technology has the potential to completely transform healthcare delivery and meet the vast range of demands of people on the planet, thanks to the cooperative efforts of NINR Research Centers and the application of reliable methodology.

Key Words: Nursing, Technology, Innovations, National Institute of Nursing Research.

Introduction:

Improving the health of individuals, families, and communities is the goal of nursing science (National Institute of Nursing Research [NINR], 2016). With more than 3.2 billion people globally online and 5 billion with a mobile phone (Sawers, 2017), there is a great deal of potential to use technology to broaden the scope of nursing science research, especially in the area of precision health. Personalized healthcare could benefit from precision health, which entails tailoring therapy based on environmental, behavioral, and genetic factors (Grady, 2017). Effective integration of technology in research is a topic of discussion among transdisciplinary and nursing scientists in May 2018, with some NINR Research Centers leading the way in this regard. The topic is significant internationally because technology progress presents opportunities and challenges that are shared by people in different countries and communities. In order to support the development, testing, and application of technology for precision health across a range of populations, this article will: (a) describe the current state of science; (b) present examples of technology integration in research pilot projects carried out by NINR Research Centers; and (c) offer a roadmap for nursing science to follow when designing, testing, and implementing precision health-related technologies.

The extramural NINR Research Centers, which include the Centers of Excellence (P30) and Exploratory Centers (P20), are actively working to develop a variety of technologies that will make interventions easier by gathering, analyzing, and sharing health information in an easy-to-understand manner. But incorporating technology into precision health programs—like smartphone apps, sensors, or websites—requires thought and planning. Although technology provides the foundation for interventions, it is important to understand that technology is only a means of delivering interventions, not the intervention itself (Marquard, 2018). As such, the

efficacy and dependability of the underlying technology determine how well interventions work. In order to ensure that treatments are not dependent on particular technologies that could quickly become outdated, careful design and testing of the technology are therefore essential before its use in interventions (DeVito Dabbs, 2018).

It is crucial to determine the precise requirements, functions, and alignment with the theoretical framework of the study and intervention when choosing technologies to support precision health. The design of technology ought to be guided by theoretical principles, smoothly incorporate the intervention, and stimulate user involvement. Novel technologies could include a range of instruments and data science techniques designed to improve illness avoidance, identification, and treatment. These tools could be passive systems that gather symptom data via online patient portals, interactive systems that facilitate contact between patients and healthcare practitioners, and active systems for real-time physiological monitoring (like wearable technology).

Models of Technology:

The idea that the individual or end user should be at the center of project design is commonly known as user-centered design (Bradley, 2010; Gibbons, 2016; Holden et al., 2013; Marquard, 2018; Venkatesh, Thong, & Zu, 2012). A variety of person-centered or user-centered design paradigms provide insights into design elements or processes. In order to determine the end user's needs, Marquard (2018) modified a model that shows how three structures intersect (Figure 1). These constructs include the evaluation of the business proposal's viability and human considerations, which determine if the design is desirable to users (Marquard, 2018). Furthermore, Venkatesh et al. (2003) present the Theory of Acceptance and Use of Technology (UTAUT), which provides a framework for comprehending user acceptance of technology. This framework can be used to evaluate the potential success of new technologies and to guide interventions aimed at user populations that are less likely to adopt new systems. In addition to moderators like age, gender, and experience, UTAUT2 includes mediators of intention and usage like performance expectancy, effort expectancy, and social impact (Venkatesh et al., 2012).

The Systems Engineering Initiative for Patient Safety (SEIPS) 2.0 framework captures the complexities of the sociotechnical work system and its impact on processes and outcomes for technologies involving interactions between end users, study teams, healthcare providers, and institutions (Holden et al., 2013). This framework recognizes the physical, cognitive, and social/behavioral processes influencing outcomes and considers interactions between the individual, technology, organization, internal environment, and tasks. These well-established models offer a range of viewpoints on creating, evaluating, and applying user-centered technology, and they serve as a basis for technological advances examined in the NINR Research Centers. They also offer methods for testing and improving the technology as well as for creating designs that are centered on the demands of the user.

A variety of methods are used in the several stages of user-centered technology design to ascertain the demands of the users, create and test the technology, and plan its distribution and execution. Iterative techniques include testing and fine-tuning prototypes, focusing on user performance and satisfaction with program content and functionality, and collecting user input via qualitative methods such as semi-structured interviews and user observation. The research on human-computer interaction suggests that in order to capture a variety of user experiences, usability testing should be repeated several times with various user groups.Stakeholders and end users are quantitatively assessed using metrics at every level of technology development to gauge their experience (see Figure 1). Metrics measuring desirability determine if people find the technology valuable and like using it. Viability measurements consider aspects like functionality, reliability, and intended use while concentrating on the technology's affordability and sustainability. Feasibility metrics evaluate the likelihood of designing and developing the technology for its intended use, taking acceptability, usability, simplicity, and ease of use into account. Metrics for security procedures and compliance with privacy laws are also essential, particularly in research involving humans. Contextual elements are important in defining how technology helps people communicate with their health and healthcare professionals. The UTAUT2 Model (Venkatesh et al., 2012) emphasizes the need of addressing moderators and mediators who predict end-user behavior. Developmental stage, cognitive function, health disparities, user expenses, and inequities in technology access are additional factors that are pertinent to research in the field of symptom and self-management science.

Challenges and Barriers to Use Technology:

Researchers need to be well-versed on end-user needs and potential roadblocks to technology adoption in order to guarantee successful technology adoption. People who are managing their symptoms could find it difficult to use technology because of things like reduced mobility, sensation, and eyesight. Within the field of symptom and self-management science, researchers have started to address a number of health inequality issues, recognizing differences in Internet and mobile technology availability and utilization related to personal preferences, age, literacy, race, and language. The design, testing, and implementation of technology are made more complex by the need to take language, literacy, and cultural factors into account when developing interventions suited to end-user demands. One of the biggest obstacles to the development of technologies for precision health interventions is access to devices and infrastructure. The cost of laptops, tablets, and smartphones can be high, and not everyone has access to cellular networks or the Internet. The lack of dependable cell phone service and high-speed Internet in many rural locations across the world has led to a decrease in rural inhabitants' access to technology for personal health. As such, technology-enhanced research needs to be carefully planned to maximize accessibility and usability while guaranteeing sufficient recording and reporting of results.

New Health Interventions:

The P20 and P30 NINR Exploratory Centers and Centers of Excellence, respectively, are devoted to many facets of nursing science, including the science of symptom management, the science of self-management, and the treatment of populations with complicated chronic diseases. A large number of these centers use technology in their precision health research. Four NINR Research Centers have used the following technologies in their research endeavors: Researchers are using technology to improve symptom self-management at the P20 UManage Center for Building the Science of Symptom Self-Management (University of Massachusetts Amherst). For example, in order to help older people improve their sleep hygiene, they have integrated the use of readily available actigraphs to track sleep, in addition to sleep diaries and a peer network. Wearable technology is used by the P20 Center for Accelerating Precision Pain Self-Management at the University of Connecticut School of Nursing to track health behaviors, including sleep patterns, diet, and physical activity, in patients who suffer from painful disorders. Real-time nurse coaching or consultation to encourage behavior modification and enhance the results of pain self-management is also made possible by this technology.

Researchers at the University of Texas, Austin's Center for Transdisciplinary Collaborative Research in Self-Management (P30) use machine learning and interactive digital games to examine behavioral data related to self-care in people with chronic illnesses. In order to address health inequities, this study seeks to find patterns that are predictive of distal outcomes and provide guidance for the creation of tailored interventions. A technology-based sleep self-management intervention design (SMID) for youth has been developed by the University of Washington's Center for Innovation in Sleep Self-Management (P30) using a user-centered design methodology. This intervention combines self-management techniques with teaching about good sleep hygiene. Stakeholder input and expert consultation are included, and the intervention is refined iterativelydepending on user feedback. These illustrations show the numerous ways that technology is being used in nursing research to enhance symptom management, pain self-management, chronic illness management, and sleep hygiene across a range of demographics.

Roadmap of Health Technology:

Five iterative processes compose the roadmap for the development, testing, and deployment of technology-based self-management interventions in precision health. These steps were established via insights acquired from research initiatives conducted by the NINR Center and analysis of present difficulties. This roadmap is directed by the CeHRes Roadmap and contextualized within the NSPH Translational Model. It is informed by important themes that were highlighted during discussions in May 2018. The significance of integrating technology in nursing science is highlighted by the NSPH Model, which emphasizes precision in intervention design and the characterization of genotype, phenotype, and environment. It highlights the relevance of information and data science infrastructure, including technology, in allowing

precision interventions and defines precision into four characteristics. In order to assist end users, caregivers, and healthcare providers, the roadmap builds theoretical links between interventions and technology use at every stage. The concepts in this roadmap, albeit originally rooted in symptom science and self-management, can be widely applied to the design and application of technology in a variety of nursing science domains.

Step 1 of the roadmap, contextual inquiry, focuses on understanding the relationship between humans and the tools they use in their daily lives, particularly in the context of technology for personalized health interventions. It aims to identify the key problems faced by end users and determine whether personalized technology solutions are desired. This step involves assembling an interdisciplinary team comprising nurses, engineers, computer scientists, and technology designers to explore gaps in the literature related to end users and potential technology applications in nursing science.The initial phase involves identifying a diverse group of end users, including individuals, families, and healthcare providers, considering factors such as health disparities, culture, and literacy. The team then gathers feedback from these end users through focus groups or interviews using participatory design sessions. Design thinking, a user-centered process that fosters innovation, guides this process. Qualitative research techniques are employed to analyze the data from focus groups and identify themes and individual values related to technology, informing the subsequent steps of the roadmap.

In Step 2, value specification, end-user values are translated into specific requirements for the technology. This involves conducting further focus groups to gather detailed data on user needs, technology requirements, and feature specifications. Additionally, constraints such as performance expectancy, effort expectancy, and resistance to change are identified using models like UTAUT2. System-level constraints, including resource availability and intervention development costs, are also considered during this phase.The goal of the third step of the roadmap, design, is to make sure that the technology or product can be made realistically given the financial and resource limitations that are in place. In this step, prototypes that satisfy the technical requirements determined in the preceding steps and are in line with user values are developed. Whether the technology is an Internet intervention, a tablet app, or a phone app, the design process changes based on the modality.

The process of designing technology include developing user-friendly interfaces that complement end users' cognitive and behavioral patterns. It ought to make use of the infrastructure and support systems currently in place that end users frequently visit. In order to consider end-user characteristics unique to variables like geography, capabilities, and access, human-centered design elements are also included. This process can be efficiently guided by models such as the Hierarchy of wants design, which make sure that the design considers the basic wants and preferences of the user.Establishing the information architecture is the main goal of Step 3 of the roadmap, or operationalization, which guarantees that the technology provides end users with relevant and customized information. The team assesses system-level functioning in this phase, considering user-friendliness, suitability for the intended setting, responsiveness,

and related expenses such hardware, software, and technological support requirements. In order to get input from end users and gauge the efficacy and efficiency of the technology, prototypes are developed and put to the test. It is essential to comprehend the meaning end users ascribe to technology and its applications in order to forecast usage and accomplish desired behaviors. This procedure can be guided by quantitative methods such as the UTAUT2 model's Consumer Acceptance component.

Step 4: Operationalization entails putting the intervention into practice in a real-world situation. The system is taught for usage by end users, and an adoption strategy is created while considering workflow and any obstacles. A small group of stakeholders participates in feasibility trials, which include components of ideation from The Field Guide to Human-Centered Design and exploration from the Design Thinking Model. Ultimately, the emphasis moves to gathering viability measures and examining process data in Step 5, summative review. In order to improve the technology and intervention, more end-user feedback is obtained in addition to evaluating patterns of technology use and intervention effectiveness. In addition to addressing issues of scalability, equitable distribution, and accessibility, success benchmarks are set. Pilot studies are carried out to test clinical feasibility, efficacy, and validity, and a business model is created to measure sustainability and cost-effectiveness.

It is imperative in intervention creation to ensure that interventions are culturally responsive and customized to the level of health literacy of intended users. End-user-focused frameworks, like the CeHRes Roadmap, result in interventions that are more appropriate for tailored usage and application in particular social circumstances, possibly demonstrating increased efficacy. Effective interventions have the ability to improve individual and family health outcomes and raise the likelihood that users will embrace and promote them in the future. There is an opportunity to advance nursing science as a whole through the use of technology in support of precision health. To successfully engage end users and adapt interventions, NINR Research Center pilot projects are utilizing machine learning algorithms and data visualization. Detailed reporting on model/version utilized, participant usage, and study conditions is helpful in understanding end-user behaviors when using existing technology in research. Additional information including theoretical foundations, demographic emphasis, participation in participatory design, and user-centered testing procedures improve rigor and reproducibility for research creating precision health devices. The recent put forth roadmap provides an organized method for creating user-centered precision health technologies. Its procedures offer a starting point for developing nurse-driven self-management interventions or phenotyping technology. Using technology to precision health may make it easier for a wider range of people to receive individualized care in a variety of venues, which could result in better patient outcomes.

Conclusion:

In order to further the development and application of technologies that support precision health, the NINR Research Centers are essential. Technology is currently being used in a number

of health issues to give customized interventions, detect biomarkers, and classify symptom profiles. Technology can be an effective tool in nursing science when it is created within a framework that prioritizes the needs of the user. Clearly defining the theoretical connections between technology use and interventions is essential, as is maintaining openness in user-centered design, testing, and assessment processes. Incorporating best practices for engaging marginalized and minority people is crucial to optimizing the use of technology to enhance nursing science and limiting the widening of health disparities. Even though the use of technology for self- and symptom management is growing exponentially, it is critical to make sure that the data underlying its clinical usage are reliable and consistent. Globally nursing research can benefit from using the standard multistep process described in this article for technology creation and testing. This roadmap can be used by interdisciplinary teams of nurse scientists to develop new technologies or implement those that already exist. Supporting precision health and providing tailored therapies that improve health and well-being ultimately have goals that are quite similar to those of nursing science and precision health.

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