ORIGINAL ARTICLE

# Assessment of Readiness for a Community-based Teleaudiology Program of Selected Primary Care Health Facilities in the Philippines

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## ABSTRACT

**Introduction.** Access to appropriate and timely care underpins the Republic Act 9707 or the Universal Newborn Hearing Screening and Intervention Act of 2009. However, less than 10% of babies born every year have been screened for hearing loss. The Hearing for Life (HeLe) research program aims to increase the rate of newborn hearing screening (NHS) nationwide through the development and deployment of novel digital health or eHealth technologies in government rural primary care health centers (PCHC). The HeLe is also built on the global call for increased and systematic use of eHealth to strengthen health systems. Effectiveness of eHealth innovations requires acknowledgment of the product's life cycle; one consideration is *organizational* readiness at this development stage of the HeLe.

**Objective.** This study assessed readiness of the eight PCHC selected to use the HeLe technologies.

**Methods.** This research utilized the Khoja-Durrani-Scott (KDS) eHealth evaluation tool to assess the PCHC's readiness level prior to the implementation of HeLe. The KDS tool was distributed through a self-administered survey; data was analyzed using descriptive statistics. Readiness is measured in terms of seven dimensions or outcomes resulting from the use of the HeLe technologies.

**Results.** The study revealed that the eight PCHC were most to least ready, in decreasing order, in the following areas: Ethical, Health, Technology, Social & Cultural, Readiness & Change Management, as well as Economic, and Policy outcomes. The study affirms the PCHCs' value for equity in health care, i.e., providing accessible NHS services in the community setting closest to where the families and their newborns are. Likewise, results confirm the PCHC staff's preparedness for another set of innovations, through agreement with statements on Technology, Social & Cultural as well as Readiness & Change Management parameters.

**Conclusions.** The results informed the training and technical support strategies to be implemented by the HeLe program proponents. However, even in this early development phase of the HeLe technologies, the PCHC are already concerned with how to sustain NHS services after the research. Fully aware that the HeLe ICT tools need to be maintained and upgraded, the PCHC views that economic and policy support should also be in place to ensure continuous delivery of the ICT-enabled NHS services. While results are illustrative, usefulness is limited by the small sample size and character of the study sites. Nevertheless, social dimensions still have to be carefully considered as innovative NHS tools are introduced to primary care health workers nationwide.



eISSN 2094-9278 (Online)
Published: September 28, 2023
https://doi.org/10.47895/amp.v57i9.4984

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Researchers have to be deliberate in working with broader health systems and policy advocacy efforts to allow novel NHS technologies to be smoothly introduced at the community level and frontlines of care.

*Keywords: eHealth, readiness, preparedness, ICT, health, technology, social, change management, economic, policy, ethics, primary care, rural*

## INTRODUCTION

Implementation of eHealth is evidenced to be a cost-effective and secure means of health information management.[1] In the Philippines, at least Php 296.9M (equivalent to around USD 5.55M) was allocated for eHealth by the government from 2013 to 2017.[2] Private sector expenditure remains undetermined, but in general, it is expected to increase in the future. This follows a global trend in public health care: an investment on eHealth is thought to potentially improve processes and outcomes even if current research shows a mix of outcomes.[3,4]

The National Telehealth Center (NTHC) of the University of the Philippines Manila, National Institutes of Health (UPM NIH) pioneered eHealth innovations in the country. These became platforms for introducing eHealth nationwide and policy advocacy for ICT for health.[5,6] Because of the UP's mandate as a research and service university, especially targeted by the UPM NTHC are the rural health units or urban local health centers, which provide services especially for the poor. These are collectively referred to as government primary care health centers, where the majority of the Filipinos access care. Among others, these eHealth innovations are telehealth (the Buddyworks, National Telehealth System [NTS], Medical Teleparasitology platforms), electronic medical records (the Community Health Information Tracking System, CHITS) and mHealth (R4Health, mCHITS; NTS also integrated an SMS function). CHITS expanded to rCHITS[7] which incorporated the Mag-Ina (Maternal - Neonatal) Tele Referral System and mCHITS. R4Health was introduced and incorporated in the National Telehealth Service Program (NTSP), a mobile technology-based reporting system of routine health services from rural remote communities.[8] R4Health, in 2012, introduced the use of smartphones in over 300 remote rural communities nationwide. mCHITS (in the rCHITS) improved on the R4Health and allowed synchronization of data collected from the isolated and disadvantaged barangays with the health center-based CHITS server, preserving one database of patients for each PCHC.[9] The RxBox diagnostic telemedicine device was also built into the NTSP earlier in 2007, envisioned to support trauma or emergency care. Its current iteration supports routine maternal and child, and non-communicable diseases care rendered in primary care health centers. This current version demonstrates standards-based and seamless interoperability of the RxBox with the CHITS and the NTS platform, deployed to over 160 government health centers.[10]

Effectiveness of eHealth innovations requires acknowledgment of the product's life cycle and should be evaluated based on different factors relevant to each stage of its life cycle.[3] One consideration is *organizational* readiness; that is, the implementers' receptiveness, willingness, and preparedness to achieve an objective.[11] Roger's diffusion of innovations theory is a springboard for readiness evaluation: an innovation (in this case, the eHealth product) gradually diffuses and spreads to a target population over time.[12,13] Rogers identifies five categories: *innovators,* also called the inventors, are the trailblazers, the most optimistic as well as eager and keen to develop new technologies. *Early adopters* are those who will readily try what the innovators develop. They are usually the opinion leaders and enjoy positions of influence. The rest – the *early majority*, *late majority*, and *laggards* – account for the majority of the population; these are, in increasing degrees, skeptical of change and are traditionalists.[14]

This study assessed organizational readiness among primary care health center (PCHC) staff for another eHealth innovation after CHITS, rCHITS, and the RxBox-Telehealth-CHITS were implemented. These PCHC health professionals are considered to be *early adopters,* having imbibed new ICT for health in their services in the immediate past.

### HeLe Project: Increasing the Rates of Newborn Hearing Screening with Novel Technologies and Telehealth

The Hearing for Life (HeLe) research program is led by UP Manila (the Philippine National Ear Institute [PNEI] and the NTHC) and UP Diliman (College of Engineering, Electrical and Electronics Engineering Institute) together with University of California Berkeley and Davis campuses. It aims to increase the newborn hearing screening rates nationwide using novel digital health or eHealth technologies. At higher risk to congenital hearing loss are low-income settings such that of the Philippines.[15] Worse, congenital hearing loss detection remains low at 0.13% at birth.[16] Despite the Republic Act 9709 or the Universal Hearing Screening and Intervention Act of 2009, screening among newborns is at less than 10% annually. Appropriate hearing services remain lacking or entirely unavailable in many areas across the country.[17] Category A sites which conduct the most basic hearing screening among newborns are largely located in hospitals based in city or provincial centers.

The HeLe aims to fill this gap through the development of novel eHealth tools for newborn hearing screening that are affordable, accurate, clinically validated, and cost-effective. This suite of Hele technologies includes a hearing screening device seamlessly linked to an electronic medical record that pulls data for transmission for telereferrals while transactions are displayed in a dashboard for monitoring.

A computer-based training course as part of the blended learning strategy is also introduced. The HeLe tools will be deployed to selected primary care health centers that are more accessible to communities. The Newborn Hearing Screening program was more deliberately introduced for the first time to the government PCHC, with the view of scaling this to over 2,500 PCHC nationwide. These facilities are specially accessed by the poor for routine maternal, neonatal, and child care.

Successful implementation will likely be in sites which are receptive to this innovation, and in line with Rogers' theory, the *innovators* and *early adopters* among all primary care health centers nationwide. Since HeLe would introduce a complex set of new technologies and procedures, the PCHC were purposely chosen and identified as the innovators of their breed, champions for eHealth among their peers.

## The Khoja-Durrani-Scott eHealth Evaluation Tool

This study utilized the Khoja-Durrani-Scott or PANACeA eHealth evaluation tool to assess the PCHC's readiness level prior to the implementation of HeLe. This was chosen among other technology adoption models because of its prior use among eHealth innovations introduced to health facilities in resource poor settings such as the ones targeted for HeLe.

The Khoja-Durrani-Scott (KDS) eHealth evaluation framework and tools were developed by a group of researchers from the Pan Asian Collaborative for Evidence-based eHealth Adoption and Application (PANACeA) research and innovation program. The KDS or PANACeA (terms used alternatively) evaluation tools were developed based on relevant theories and tested in various PANACeA eHealth projects.[18] These PANACeA innovations were implemented in developing countries in South and Southeast Asia with support from Canada's International Development Research Center. Research groups from various countries, including the NTHC, collaborated on projects. The NTHC had three PANACeA projects: CHITS and OpenMRS implementations were in two rural health units, exploring its synchronization, and two district hospitals in the Philippines, respectively.[19,20] The third was the electronic Tuberculosis Diagnostic Committee which was implemented in a city and province in the Philippines as well as in a province in Pakistan.20 Another Philippines-based project was an mHealth SMS-reminder system for maternal and child health also in a rural municipality.[21]

The KDS eHealth evaluation framework is useful for any technology at any time in the different stages of eHealth implementation. *Pre-eHealth* stage is the status quo, the situation wherein the PCHC delivers routine health services where documentation of care is manual and paper-based. The eHealth innovation is introduced during the *development* stage. Considered a disruptive stage, routine processes need to be adjusted to accommodate the innovation, hypothesized

**Box 1.** KDS Conceptual Framework: Evaluation themes or outcomes for eHealth or information and communication technology use in healthcare

***Health services outcomes.*** Health services outcomes are based on the principle that every clinical or health intervention produces a change in the health status of a patient or community and that change can be measured on the basis of change in disease or health status, impact on quality of life, change in health indicators.

***Technology outcomes.*** Technology refers to the software, hardware, and connectivity infrastructure used to implement and sustain any eHealth solution. eHealth technology outcomes can be measured in terms of appropriateness, relevance, use, safety, and effectiveness of the technology.

***Affordability and cost-effectiveness.*** This considers the extent to which a health service is affordable, as measured by its cost relative to the amount that the user (patient, family member, clinician) is able—or willing—to pay for it. Cost-effectiveness will determine the least costly system that is capable of delivering a specified set of outcomes.

***Social and behavioral impact.*** Social impact assessment includes the processes of analyzing, monitoring, and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment.

***Ethics.*** A general term for what is often described as the science of morality. In philosophy, ethical behavior is behavior that is good. The goal of a theory of ethics is to determine what is good, both for the individual and for society as a whole. Ethics in eHealth address the moral and ethical issues arising from clinical practice, medical and biomedical research, resource allocation, use, and access to technology solutions.

***Readiness and change.*** eHealth readiness refers to the preparedness of healthcare institutions and individuals to implement programs that involve use of eHealth in the provision and management of health services. The process of change management includes changes in the existing business processes and ensuring appropriate training and support for adopting new processes.

***eHealth policy.*** eHealth policy (defined as "a set of statements, directives, regulations, laws, and judicial interpretations that direct and manage the life cycle of eHealth") is required to facilitate structured and consistent eHealth practice.

*Note. This list of outcomes for eHealth is from "Conceptual framework for development of comprehensive eHealth evaluation tool," by Khoja S, Durrani H, Scott RE, Sajwani A, Piryani U, Telemed JE Health. 2013;19(1):48-53.*

to address an identified health care service *need*. This study focused on this *development* stage of innovation.

The KDS Framework incorporates seven parameters, namely, health services, technology, economic, readiness and change management, social and cultural, ethical, and policy factors and outcomes (Box 1). These are conceptually related to each other and can be measured how each influences the development, implementation, integration, or sustained operation of any eHealth program.[18]

With the introduction of HeLe, the PCHC's clinical care and referral system, documentation and transfer of relevant medical information, and health worker training processes will need to be adjusted from their traditional way of doing things, and transformed to what the HeLe proposed as alternative (and suggested to be better) measures. While the need is identified by the inventors and PCHC leaders (i.e., the municipal health officer [MHO]), not all in the PCHC agree nor appreciate the changes. Hence, efforts should focus on measures that would influence individual and collective health worker behavior to try and continuously use the eHealth innovations. These are steps to sensitize and prepare the health system to integrate innovations that would guarantee to work.

This paper assessed the readiness of Health Care Providers working in PCHC facilities selected to use the HeLe technologies. This readiness assessment is intended to inform the training and technical support strategies to be implemented by the HeLe program proponents. In the long run, it can help define how HeLe and other novel eHealth technologies can permeate throughout the over 2,500 government PCHC facilities nationwide.

## METHODS

### Study Design

An operations (epidemiologic) research was employed to assess the participants' readiness through a survey using the modified *pre-deployment* stage questionnaire of the Khoja-Durrani-Scott eHealth evaluation tool. Descriptive quantitative analysis was used to determine the participants' level of readiness for the implementation of eHealth.

### Setting and Participants

The target population was purposely recruited from existing partner facilities implementing the NTHC projects. Found in Luzon (five towns in two provinces) and the Visayas (four towns in one province), these are sites where CHITS, rCHITS, and the RxBox-Telehealth-CHITS are implemented. These facilities were selected since they were deemed early adopters of eHealth. Their previous generally successful implementation of health ICT innovations is theorized to enable implementation of a community-based teleaudiology program. The sample consisted of program managers (i.e., the doctors: municipal health officers/ MHO and doctor-to-the-barrios) and Health Care Providers (i.e., nurses, midwives, medical technologists, nursing aides, and health IT designates) ensuring the particular categories of participants are well represented.

### Survey Instrument

The survey tool comprised a Likert scale questionnaire adopted from the PANACeA / KDS eHealth evaluation tool, specific to the development stage of the innovation. It covered seven outcome themes of eHealth evaluation: 1) health services outcomes, 2) technology outcomes, 3) economic outcomes, 4) readiness and change management, 5) social and cultural outcomes, 6) ethical outcomes, and 7) policy health outcomes (also briefly explained by Khoja et al., 2012; Table 1). The questionnaire was based on a four-point Likert scale (1 = Don't know/Strongly disagree, 2 = Disagree, 3 = Agree, and 4 = Strongly agree) to assign perspectives on readiness by participants. The degree of agreement with statements in the survey instrument reflects the readiness of the PCHC to adopt the HeLe technologies.

The KDS questionnaire, available in English, was translated to Tagalog and pilot tested among respondents from PCHC not included in the HeLe program. It was modified accordingly for internal validity. Simple descriptive statistics was used to describe the collective results.

### Reliability Analysis

The reliability of each item in the modified questionnaire was assessed using Cronbach's alpha to examine its internal consistency. Table 1 shows standardized alpha results which considered inter-item correlations instead of covariances; most met the minimum coefficient at 0.8 which indicates high reliability. In investigating those that did not meet the minimum (highlighted in red), it was found that a few questions fail to fully support the thematic area they are in. Thus, we have been cautious in pointing out observations in the next section as these may not contribute in providing a clear picture of their respective thematic area.

**Table 1.** Reliability Analysis of KDS eHealth Readiness Tool (Standardized Cronbach's alpha)

| Participant | Health | Technology | Economic | Readiness & Change | Social & Cultural | Ethical | Policy |
|---|---|---|---|---|---|---|---|
| ***Program Manager*** | 0.7753142 | 0.9127372 | 0.8092201 | 0.9675444 | 0.96256 | 0.9111879 | 0.8628562 |
| # of items | 8 | 7 | 4 | 4 | 5 | 3 | 4 |
| ***Health Care Provider*** | 0.9179584 | 0.8430655 | 0.8109395 | 0.7881293 | 0.8448621 | 0.9337341 | 0.7933631 |
| # of items | 13 | 8 | 4 | 4 | 5 | 7 | 4 |

### Data Collection

Eight PCHC were selected as HeLe sites. Municipal local chief executives and municipal health officers were engaged for the HeLe project, and upon agreeing to be part of the study, the deployment team members conducted face-to-face orientations with the PCHC health professionals. The informed consent forms, provided in Filipino and English, and the eHealth survey forms were distributed to the PCHC staff. There were separate questionnaires used for program managers and Health Care Providers which reflected specific individual tasks and capacities within the health unit. Only questionnaires of the participants with signed consent were included in the analysis.

### Ethical Considerations

Ethical approval was obtained from the University of the Philippines Manila Research Ethics Board before its implementation.

## RESULTS

### Demographic Characteristics of Respondents

There were 34 respondents from eight PCHC. Majority were midwives (41.2%); physicians (26.5%) and nurses (23.5%) were represented in almost the same proportion (Table 2). The doctors are also referred to as NHS program managers in this study, especially since they are the intrinsic champions who introduced the HeLe into their PCHC.

Most of the participants were female (70.6%) and belonged to the middle-age group 40 years and above (61.8%) while about a third are considered young (20-29 years old).

### Characteristics of Participating PCHC

The eight PCHC are primarily administered by local governments in rural communities (Table 3). These towns are in three provinces: six have coastal areas while two are inland. In terms of income classification, three of the municipalities (37.5%) were identified as first class with an average annual income of at least 55 million pesos.

Three belong to the 4th and 5th income class, with 25 to 34.9 and 15 to 24.9 million pesos annual income, respectively. All eight rural towns have remote, isolated, or difficult to reach barangays, serving especially the rural poor.

Moreover, it is also important to point out that all PCHC, even if they routinely provide maternal and child care services, have no hearing screening device in their facility, and thus do not provide newborn hearing screening services. These eight were prior research partners of the National Telehealth Center that also tested eHealth innovations within the immediate past two years of the HeLe research program.

The PCHC health staff use their mobile phones (39%) and/or the computers or laptops (34%) in their health facilities. In relation to internet accessibility, 22% of the participants have an internet connection at home. Only 5% (or two) of the 34 respondents go to an internet cafe when needed.

**Table 2.** Demographic Characteristics of Respondents

| Variable | Frequency (n=34) | Sample (%) |
|---|---|---|
| ***Sex*** | | |
| Male | 10 | 29.4 |
| Female | 24 | 70.6 |
| ***Age Group Distribution*** | | |
| 20-29 | 10 | 29.4 |
| 30-39 | 3 | 8.8 |
| 40-49 | 12 | 35.3 |
| >50 | 9 | 26.5 |
| ***Occupation*** | | |
| Nursing Aide | 1 | 2.9 |
| Midwife | 14 | 41.2 |
| Nurse | 8 | 23.5 |
| Medical Technologist | 2 | 5.9 |
| Physician | 9 | 26.5 |

**Table 3.** Characteristics of Participating PCHC

| Variable | Frequency (n=8) | Sample (%) |
|---|---|---|
| ***Municipality Class*** | | |
| 1st | 3 | 37.5 |
| 2nd | 1 | 12.5 |
| 3rd | 1 | 12.5 |
| 4th | 2 | 25.0 |
| 5th | 1 | 12.5 |
| **Variable** | **Frequency (n=34)** | **Sample (%)** |
| ***Previous experience in using any hearing screening device?*** | | |
| Yes | 0 | 0 |
| No | 34 | 100 |

A total of 34 respondents answered the questionnaire: eight Program Managers (PM) and 26 Health Care Providers (HCP). Both PM and HCP were most ready in meeting ethical, health, and technology outcomes. The PCHC staff were least ready to meet *policy* and *economic* outcomes for implementation of the HeLe (Table 4 and Figure 1).

## DISCUSSION

Majority of the 34 respondents from eight PCHC were midwives, while doctors and nurses were almost equally represented. This picture reflects the country's distribution of health human resources; however, the current ratios (0.81 midwives per 5,000, 0.61 doctors per 20,000, and 0.57 nurses per 10,000 Filipinos) are all below the targeted health professional to population ratio for the Philippines.[22] In the HeLe study sites in the country, midwives represent the most healthcare providers in PCHC across the Philippines. Midwives specialize in maternal and child care from pregnancy to birthing to postnatal care. With the global campaign for safe motherhood, midwives have been the focus of attention to further improve their skills in this part of the

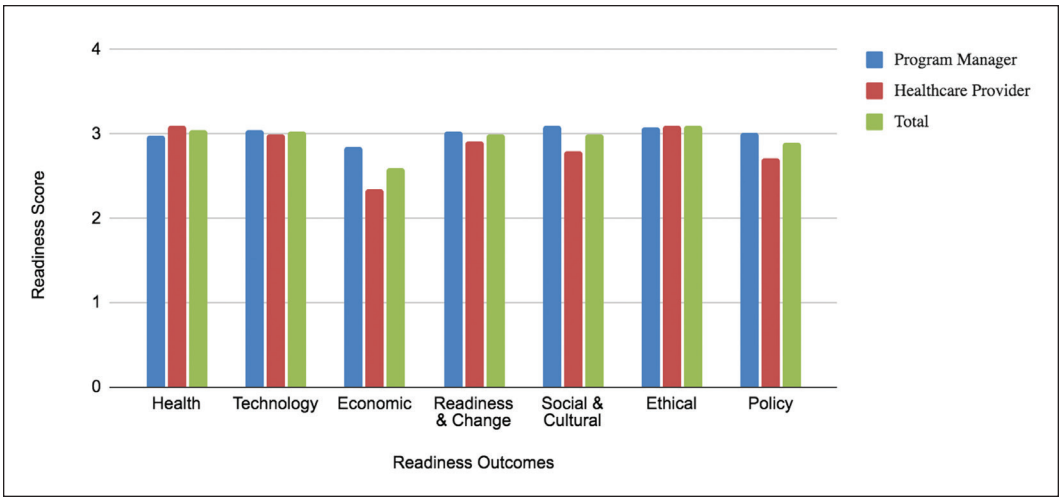


**Figure 1.** Average readiness scores of participants per thematic area.

**Higher score indicates better readiness level with a maximum of 4.*

**Table 4.** Summary of Readiness Scores of Participants per Thematic Area

| Evaluation Themes | Mean score* (Standard deviation) | | Total average score* |
|---|---|---|---|
| | Program Managers | Health Care Providers | |
| ***Health Outcomes*** | 2.98 (0.37) | 3.09 (0.44) | 3.04 |
| ***Technology Outcomes*** | 3.05 (0.66) | 3.00 (0.42) | 3.03 |
| ***Economic Outcomes*** | 2.84 (0.83) | 2.34 (0.73) | 2.60 |
| ***Readiness & Change Management Outcomes*** | 3.03 (0.82) | 2.92 (0.57) | 3.00 |
| ***Social and Cultural Outcomes*** | 3.10 (0.75) | 2.80 (0.56) | 3.00 |
| ***Ethical Outcomes*** | 3.08 (0.83) | 3.10 (0.59) | 3.10 |
| ***Policy Outcomes*** | 3.02 (0.75) | 2.72 (0.72) | 2.90 |
| ***Total*** | **3.01** | **2.85** | 2.95 |

**Higher score indicates better readiness level with a maximum of 4.*

millennium. In terms of newborn hearing screening (NHS), the abundance of midwives affirms the capacity for maternal and child health services rendered in these PCHC. The universal NHS program can thus be folded into the routine services provided by the PCHC. Whilst NHS screeners need to be certified by the DOH and the National Newborn Hearing Screening Reference Center, note that the NHS Law requires screeners to be "at least be 19 years old, high school graduate, proficient in English, with good communication skills".[23] True to the vision of equity – reaching those who are historically not reached and *universal* NHS, being a health professional is not a requirement to be a screener.

Despite overall low national ratios for health providers, health professionals serve in the HeLe sites. Having skilled birth attendants and government-certified clinicians, as well as a clear public health policy and program for the NHS are seen to facilitate the acceptance of processes and use of HeLe technologies.

PCHC readiness is measured in terms of seven dimensions or outcomes resulting from the use of the HeLe technologies. The study revealed that the eight PCHC were most to least ready, in decreasing order, in the following areas: Ethical, Health, Technology, Social & Cultural, Readiness & Change Management, as well as Economic, and Policy outcomes.

It is important to note that the Program Managers (PM) rate is higher – five of seven parameters – than the other Health Care Providers (HCP). However, the designation is artificial for the physicians and nurses; they are clinicians and at the same time perform health program and facility management roles. Typically, the municipal health officer, also a physician, is the accountable officer for major health facility, program, and clinical decisions. For the project HeLe, the PCHC doctors were engaged by the research team and are identified as HeLe PM to ensure smooth introduction of the HeLe technologies in their PCHC.

Thus, the observation of higher scores among the PM is not surprising, since the PM has the duty bearer role of marshaling efforts of the PCHC staff to test and embrace the changes s/he himself/ herself is a proponent of. This higher

score also shows the confidence of the PM on their staff's capacity to take in the HeLe innovations, at least within this immediate development stage.

Concerns on health that innovators and early adopters raise relevant to the introduction of eHealth inventions during this development stage include issues such as that innovations can still allow 'periodic assessment of health status', support 'existing services, and needs', and provide new opportunities to address the health concern. In the HeLe sites, there is general agreement that NHS tasks will redound to the expected health outcome of timely identification of newborns with possible hearing loss, and eventually positively impact on quality of life of these patients. As such, a universal NHS is an important result of the HeLe project. This is seen among the physician-Program Managers (PM), the rest of Health Care Providers (HCP), and among the totality of the PCHC health professionals, with scores of 2.98, 3.09, and 3.04 correspondingly.

Very much related to health outcomes are views on ethical dimensions of HeLe.

The PCHC collectively scored this the highest among the seven outcomes of dimensions.[18] There is agreement regardless of being a PM or an HCP that justice and equity are valued in the selection of HeLe beneficiaries. Specifically, that the HeLe research program will equip the PCHC to provide the NHS services to their rural communities whilst this did not exist before. Furthermore, the PCHC staff recognize that the use of technology can improve the autonomy of their patients' families. Having their children identified to need confirmatory tests to ascertain congenital hearing loss at an early stage will mean options are also provided early, and that the interventions become more impactful. The HeLe research program, as it introduces universal NHS, is considered to be 'good, both for the individual and for society as a whole'.

Along with health and equity (ethical) domains, the PCHC health staff regard themselves most ready in the technology domain. Roger's diffusion of innovation theory, in addition to describing the type of innovators, also explains why innovation spreads.[14] This relates to the qualities of the new technology: that such is an improvement over the existing tools or procedures, its congruence with the pre-existing workflows, its ease in learning how to use or test it, and the readily observed and expected positive effects after testing. These eight PCHC have tried and continued to use for at least six months the eHealth innovations introduced previously by the NTHC. They expect that the HeLe technologies would also meet similar expectations. That is, they expect that the HeLe innovations will provide advantages previously listed, and that these are well-designed, reliable, and would contribute to the clinical efficiency in their PCHC eHealth technology outcomes. Such outcomes can be measured in terms of appropriateness, relevance, use, safety, and effectiveness of the technology.

Early in this millennium, innovators and KDS refer to *technology* as just 'the software, hardware, and connectivity infrastructure used to implement and sustain any eHealth solution'. This has since evolved. There is better recognition that eHealth innovations must be introduced as a *system* not just as a technology input, but a composite of the software and hardware as well as processes and arrangements that lay out how these are supposedly seamlessly integrated into the user-health worker workflows. Thus, Hele was conceived as a system of innovations for universal NHS:

- **software:** the NHS module in the CHITS EMR, NTS modules for the HeLe Telereferral, Appointments and HeLe NHS Registry
- **hardware:** HeLe NHS telemedicine device (hearing screening device and headset and its NHS software, the CHITS EMR computer
- **processes:** computer-based training and face-to-face practicum of NHS screeners, certification of the NHS screeners by the National Newborn Hearing Screening Reference Center, NHS service delivery, telereferral of specific newborns for confirmatory hearing test; review of current PCHC workflow (and assignment of health workers) and arrangements to accommodate HeLe innovations
- **arrangements:** recognition that PCHC can and should be equipped as Category A NHS centers, organization of the NHS service delivery network with participating PCHC and more complex NHS diagnostic and treatment facilities within the locale, aligning this with PhilHealth financing of NHS services rendered.

While KDS listed expectations of end-users, at this *development* stage of innovative technologies, the inventors are hard pressed to demonstrate that the new *system* actually works. The World Health Organization[24] lists eHealth innovation-related questions that inventors must expect positive responses to once these are deployed for testing and use: "Does the eHealth system meet the defined technical specifications? Is the system stable and error-free? Does the system perform its intended tasks consistently and dependably? Are there variations in implementation across and/or within sites?" Thus, the HeLe technologies are expected to be functional, usable and efficacious (they do what they are expected to do), stable (they do what they are expected to do reliably and consistently within an extended period, and not just during the duration of the research), and uncomplicated to operate and used easily.

Noteworthy is the reality of poor and limited internet accessibility in the rural areas of the Philippines. Only 22% of the PCHC respondents have internet connection at home, which reflects the availability of internet connectivity in the eight towns where these PCHC are located. The situation is actually worse in the country. Government reports that nationwide in the year 2019, only 17.7% of Filipino households have internet access at home.[25]

While there is eagerness on both the research team and the PCHC to use telehealth modalities for care, social

development especially in the regions away from the urban centers need to be intensified. With health as a clear value, investments by the government have to be made for the internet which is now considered as basic infrastructure. Four of eight towns also suffer from regular electrical power interruption – a condition that has not changed across at least four years of collaborative research on eHealth. In the short term, the HeLe research has considered these limitations. It is affirmed that the HeLe technologies must be able to run on battery, that the technologies should be stand-alone and can be used singly, and that telereferral can be made periodically with the lowest internet bandwidth.

The HeLe study sites are in general agreement that they are prepared in *social and cultural*, as well as *readiness and change management* outcomes, with average scores for both is 3.0 (out of 4.0). Indeed, these sites were selected due to their positive response to and active participation in using prior eHealth innovations. The health staff manifest that their PCHC has the organizational and individual arrangements needed to support a new eHealth-enabled health program. Conversely, the HeLe is thought to result in improved organizational and individual professional outcomes. This confidence is likely primed by prior eHealth innovations they welcomed and continue to use.

Innovations are thought to improve services being delivered. This health outcome is the motivation for both *social and cultural* outcomes as well as *readiness and change management* outcomes. Alternatively referred to as *behavioral and sociotechnical* outcomes, the new eHealth tools should ultimately "bring about a more sustainable and equitable biophysical and human environment". That is, the respondents believe that HeLe will provide the needed NHS services for their constituents, and that their PCHC can effectively provide this service through the HeLe research program.

Associated issues are essentially human resource factors that enable the introduction of new technologies. These relate to both individual and organization levels. For the former, involvement of the end user (i.e., the PCHC health worker) in the elicitation of their requirements for the innovation, communications flow, staff motivation, and individual readiness to technology change are considerations. Hence, user-centered design methodologies must be intensified by the HeLe researchers, especially at this early research and development stage.

On the organization level, relevant concerns are the management style, working relationships, communications flow, staff motivation, plan for change management, and organizational readiness to technology change. Findings of this study affirms processes already undertaken by the HeLe research team. The concept of HeLe was introduced to all eight PCHC as a requisite to introduce the NHS program and the HeLe research. Similarly, engagement of the local chief executives and the PCHC-physician (as HeLe PM in their sites) was a necessary step, since peers and leaders have been shown to significantly positively influence intent for technology adoption among health staff.[26] The subsequent HeLe processes for change management included identifying specific changes in the existing health services delivery to accommodate NHS as well as ensuring appropriate training and support for adopting new processes.

Noteworthy, however, is that one in four of the 34 participants surveyed think the contrary. Specifically, organizational and individual professional measures in the area of behavioral, organizational, and sociotechnical realms are not in place, nor will these result in improved organizational and individual professional outcomes.

In fact, in all seven parameters, while there is general agreement that the HeLe technologies would lead towards better NHS service and improved health systems outcomes, the composite score is low at 2.9 out of four. The use of eHealth is not new to the PCHC health staff, having had at least two years of eHealth innovation use. Yet, only about 73% of these health professionals declare use of these ICT for health. These findings are important and should be carefully considered how the health staff should be closely supported towards the effective usage and foster eventual adoption of ehealth technologies.

Even lower are HCP scores for policy and economic outcomes, 2.72 and 2.34, respectively. These are indicative of disagreement with readiness among a large proportion of the care staff.

The eight study sites represent a spread of income classes from poor to relatively well off. While three rural municipalities were identified as first class, three are also poor – 4$^{th}$ and 5$^{th}$ class towns. All have remote, isolated, or difficult to reach barangays where agriculture remains a major source of income. Moreover, it is also important to point out that, even if they routinely provide maternal and child care services, all eight PCHC do not provide newborn hearing screening services and none has a hearing screening device in their facility.

Considering both cohorts received the same set of questions on this thematic area, there was near consensus on the concern of the PCHC ability to sustain the technologies as well as the training and personnel certification beyond research and development. While newborn hearing screening is part of the newborn care package (NCP) of services financed by the Philippine National Health Insurance Program (PhilHealth), the process for the PCHC to actually benefit from this does not yet exist. The NCP, as with other social health insurance programs, incentivizes facilities to perform needed services especially those that reflect national priorities. However, since these HeLe study sites are pioneers among peers on the pipeline to become Category A NHS centers, benefiting from the PhilHealth NCP package is yet unreal, and is not an actual motivation to participate in the HeLe research program. This lack of *economic* readiness is also reflected in lack of *policy* readiness to support the innovation especially after the research phase. At this stage of *development* – and in fact, the stage prior to receipt of the

technologies – the PCHC respondents have not begun to contemplate any economic nor policy support needed for the successful implementation of HeLe.

The health and equity outcomes scores should be regarded as well with the PCHC respondents' views on other five outcomes listed by the KDS framework: policy, economic, socio-cultural, readiness and change, and technology outcomes. Any eHealth innovation should redound into improving the health status of the community in a more efficient and equitable way. This paper is constrained however to describing the perceptions on individual factors by the limited number of PCHC respondents. Whether the trends are significant, and the interaction of factors, if such exists, were not explored. Nevertheless, the results are instructive in its intent to support these PCHC in modifiable aspects of the HeLe project within its lifetime – i.e., training strategies, technology support by the HeLe proponents to the PCHC study sites within the research period.

The WHO[24], culling more lessons from global experience on the implementation of eHealth, affirms the KDS framework that an innovative technology goes through stages across a lifespan; that the goal is for this technology to diffuse widely and permeate throughout the health system. The KDS framework identifies five phases: pre-eHealth, development, implementation, integration, and sustained operation. In contrast, the WHO describes six stages: pre-prototype, prototype, pilot, demonstration, scale-up, and integration/ sustainability. Concerns evolve from a focus on the technology factors to the interaction between the health worker and that eHealth system, and ultimately confronting more complex issues around the innovation's effects on the health system, and sustainability concerns as it scales in scope and demand by the health sector.

## CONCLUSION

This study elucidates the readiness of selected PCHCs and personnel in implementing a teleaudiology program in their communities. In this paper, we described the preparation for the deployment of the HeLe system of technologies and health system coordination. We focused on understanding behavioral and sociotechnical factors, readiness and change parameters among health professionals already predisposed to accept eHealth innovations. We found that the selected rural PCHC are *ready* to provide newborn hearing care in their communities, and that the HeLe system of technologies is anticipated to deliver on its promise of early identification of newborns who need hearing care. While the Program Managers are clear champions, hand-holding and technology support measures for the rest of the Health Care Providers must be in place. Further, this study points out that economic and organizational policies to reinforce and sustain HeLe are concerns of the PCHC. These must be considered by NHS researchers working with the PCHC, their local governments, and other relevant stakeholders, even at this early stage of innovation development. After all, while the PCHC health staff are eager to collaborate with researchers, committed leadership and governance of the community and the health sector are needed to ensure that quality health services continue to be provided consistently.

Though readiness for the teleaudiology program was shown in the study sites, our findings are constrained by the small sample size and limited representation of Philippine communities. That is, the study did not include those that have no previous telehealth / eHealth experience, communities from Mindanao nor those that have even more geographically and economically disadvantaged areas. However, our paper can still serve as a reference to prepare PCHC for a technology-enabled NHS program in areas that have had prior involvement with eHealth. Yet, with the rapid growth of technologies for health in the global arena, we also expect more widespread use in the near future throughout the country including low and lower middle-income jurisdictions. Amidst resource limitations, it is best that the health sector is prepared, and sociotechnical factors be highly considered in the process.

### Acknowledgments

The authors express their gratitude for the health staff and local chief executives of the eight towns engaged for the HeLe research program. Their openness to collaborate is highly valued, for shared health and equity goals, especially for universal access to better hearing care services. Much appreciated likewise is the guidance of Dr. James Marcin, Director of the UC Davis Center for Health and Technology, University of California Davis, and Dr. David Lindeman, Director of CITRIS Health, University of California.

### Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

### Author Disclosure

The study on which this report was based was undertaken with the financial and administrative support of the Commission on Higher Education, Philippines – California Advance Research Institutes, and the National Institutes of Health, University of the Philippines Manila. These, however, did not have any influence on the content of this paper.

### Funding Source

This research was funded by the Commission on Higher Education, Philippines – California Advance Research Institutes (CHED-PCARI), Grant # IHTM-001.

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