Abstract

Purpose: To conduct a pilot survey to assess acceptance of mobile teledermoscopy (MTD) by primary care nurse practitioners (NPs) working in Arizona.

Data Sources: Sixty-two participants recruited from NP and academic listservs in Arizona completed an online survey prefaced by a MTD definition, device photographs, and a practice case, followed by 33 items measuring Teledermatology Technology Acceptance Model (TeleTAM) constructs.

Conclusions: Participants were highly interested in using MTD to assess skin lesions. They perceived MTD utility to greatly improve diagnosis and positively impact their practice. Most participants had never used MTD, but had high mean scores for MTD attitude and moderate scores for MTD perceived ease of use, perceived use, and facilitators of MTD. They had moderate scores for intention to use MTD. The construct Facilitators (organizational infrastructure), was most strongly associated with intention to use MTD. Cronbach alphas were 0.70 or higher for all subscales except compatibility and habit.

Implications for Practice: Moderate acceptance of MTD may reflect NPs' knowledge of the technology, self-confidence for using it, or MTD financial constraints. Future research will address these factors to foster use of MTD by NPs, thereby improving patients' access to early skin lesion assessment and diagnosis.

Introduction

The United States (US) *Surgeon General's Call to Action to Prevent Skin Cancer* states that skin cancer is a major public health problem and healthcare providers are well-positioned to help detect skin cancer early (US Department of Health and Human Services, 2014). New technology, such as mobile teledermoscopy (MTD), has potential for early skin cancer detection. However, user acceptance often is a barrier to successful adoption and performance of new technology (Holden & Karsh, 2010). We surveyed nurse practitioners' (NPs) potential acceptance of MTD for skin lesion assessment targeting skin cancer early diagnosis.

Skin cancer is a major public health issue in the US (American Cancer Society (ACS), 2015). The incidence of the most common type of cancer and skin cancer, nonmelanoma skin cancer approximates about 3.5 million cases per year, with incidence and morbidity-associated costs increasing (Rogers et al., 2010). Melanoma, the most serious skin cancer, ranks in the top six cancers diagnosed in American men and women (ACS, 2015). According to the ACS, melanoma is particularly problematic in men and women age 65 years and older, is the most common cancer in young adults age 25-29 years, and is increasing in incidence at a rate of 2.3% yearly (ACS, 2015). In Southeastern Arizona, melanoma incidence is approximately 2-fold higher in men and women compared to US estimates (Harris et al., 2015).

Early diagnosis is critical for reducing skin cancer morbidity and mortality. Dermatologists typically are better at diagnosing skin cancer than primary care providers (PCPs) (Corbo, Vender & Wismer, 2012). NPs also play a role in early diagnosis (Loescher, Harris & Curiel-Lewandrowski, 2011); however, there is a dearth of research on their lesion detection ability. Oliveria et al. (2001) conducted the only study to evaluate NPs' accuracy in identifying suspicious lesions in a clinical setting. Five NPs with no previous skin cancer examination attended a

workshop that included clinical apprenticeship (patient skin examinations). They were able to distinguish between pictures of benign and malignant lesions and perform full body skin examination and naked eye assessment of skin lesions with 100% sensitivity (95% CI, 82-100) but had less success identifying lesions with benign characteristics (specificity ranged from 53-100%, with lowest 95% CI, 31-74) (Oliveria et al., 2001). More research is needed to draw conclusions about primary care NPs' lesion identification skills.

Although PCPs are capable of assessing skin lesions, they tend to refer patients with suspicious skin lesions to dermatology specialists (Corbo et al. 2012). This is problematic owing to insufficient dermatologists to handle these referrals, which potentially increases patient wait time to over a month for a diagnosis. (Slade, Lazenby & Grant-Kels, 2012). One-third of melanomas grow at a rate of 0.5mm or more/month, increasing chances of a thicker lesion and poor prognosis at presentation (Liu et al., 2006). Additionally, PCPs may choose to refer or biopsy lesions with benign characteristics, adding to unnecessary patient cost and provider burden (Coates, Kvedar & Granstein, 2015).

There are available methods and tools to aid with skin lesion assessment. Dermoscopy is allows examination of the skin's subsurface with a handheld microscope (dermoscope), which reduces the amount of light reflected, refracted, and diffracted on the skin (Benvenuto-Andrade et al., 2007). Dermoscopy enhances and magnifies the lesion, making identification of critical features easier (Benvenuto-Andrade et al., 2007). This magnification of lesion structures cannot be accomplished using regular photography during naked eye examination. Dermoscopy improves PCPs' ability to triage suspicious lesions without increasing the number of unnecessary expert consultations (Argenziano et al., 2006).

Mobile teledermoscopy, MTD, is a form of teledermatology that uses a mobile phone and camera optics, dermoscope attachment, and an application (app) to further enlarge and capture images of pigmented skin lesions. MTD enables the user to independently assess and make decisions about a skin lesion or send an image of it to a dermatologist for teleconsultation (Ebner et al., 2008). MTD serves as a filtering or triage system that allows for management of patients without scheduling an appointment for further evaluation (Ebner et al., 2008), thereby easing patient referral and financial burden (Moreno-Ramirez et al., 2009). NPs initiate teledermatology consultations: in a study of teledermatology consultations for skin diseases by healthcare providers working in rural clinics, most requests (94%) for teleconsultation came from NPs (Vallejos et al., 2009); however, they were asked to make these requests as participants in a research study. Therefore, the likelihood of NP requests in a non-research setting is unknown.

Patients who have a teledermatology consultation also are more likely to have an earlier diagnosis by biopsy and hence, earlier definitive treatment (Hsiao & Oh, 2008). Several studies have demonstrated concordance (80%-95%) of lesion diagnosis and diagnostic accuracy between teledermatology consultation and in-person skin lesion examination (Ebner et al., 2008; Hsiao & Oh, 2008; Massone et al., 2014), including some that included diagnostic accuracy of NPs (Hsiao & Oh, 2008).

In summary, skin cancer is increasing in the US and early diagnosis is paramount for optimal outcomes. NPs have the ability to distinguish between benign and malignant skin lesions, and may desire to add to their skill set by using technology such as MTD. Previous reports suggested that NPs use or are open to using new technology (Phelan & Heneghan, 2008). The purpose of this pilot study was to survey primary care NPs' potential acceptance of MTD.

Specifically, the study elicited new information on the specific factors involved in intention to use (acceptance of) MTD.

Methods

This cross-sectional, online study was approved by the University of Arizona Institutional Review Board (IRB). The study was conducted from April 2014 to August 2014.

Conceptual Model. The conceptual model for this study was the Teledermatology Technology Acceptance Model (TeleTAM) (Orruño, Gagnon, Asua and Abdeljelil, 2011), which was based on the Technology Acceptance Model developed by Davis (1989). The TeleTAM posits that three contexts are important for understanding teledermatology technology acceptance. The *Technology Context* consists of the constructs of perceived usefulness (PU) of the technology for identified tasks, perceived ease of use of the technology (PEOU), and habit (HAB) (behavior that has become routine). The *Individual Context* consists of compatibility (COM) of the technology, or the degree of correspondence between an innovation and one's existing values, past experiences and needs; and attitudes (ATT), which is the perception of the positive or negative consequences related to adopting the technology. The *Organizational Context* consists of facilitators (FAC)—the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the technology, and subjective norms (SN) or the extent to which individuals who are attempting the new technology will receive the encouragement and support from the people who are important to them. The contexts via their constructs directly or indirectly influence *Intention* (INTENT) to use the technology, or acceptance.

Sample. The sample consisted of Arizona NPs of any age who were certified in adult, family, gerontologic or adult-gerontological practice, and had a minimum of a Master's degree. Participants were recruited listservs for the Coalition of Arizona Nurses in Advanced Practice, the

Southeastern Arizona and Advanced Practice Nurse/Nurse Practitioner Society, and NP faculty at the University of Arizona College of Nursing.

Survey. Assessment of MTD acceptance was accomplished using an online survey that was adapted with permission from an existing teledermatology acceptance survey based on the TeleTAM model (Orruño et al., 2011). The 33 items on the survey measured the TeleTAM factors (PU, PEOU, HAB, ATT, COM, FAC, SN, INTENT). Items were scored on a 7-point Likert-type scale with response options ranging from strongly disagree (score = 1) to totally agree (score = 7). Internal consistency (Cronbach's alpha) of the TeleTam scales reported by Orruno et al. were all acceptable above 0.70, with the exception of COM (0.67) and HAB (0.69). The survey also collected demographic information (age, NP gender, certification, professional experience and education). A disclaimer approved by the University of Arizona IRB at the beginning of the survey facilitated obtaining consent by completion and submission of the survey. The survey did not collect identifying information. Participants had to respond to each item before progressing to the next. The survey took no more than 20 minutes to complete and no incentives were offered.

Qualtrics, a commercial survey software program, was used to adapt the survey to online template, create a link to access the survey via email, and allow data from the survey to be exported directly into SPSS version 22 (Armonk, NY: IBM Corporation) for analysis. We further adapted the original survey by (1) prefacing the items with a description of MTD, photograph of the MTD device (see Figure 1), and a clinical case description of MTD use; and (2) changing the term "teledermatology" in the items to "mobile teledermoscopy".

Procedures. The investigators asked the listserv Webmasters to email a summary of the study and the survey link to listserv subscribers. The survey disclaimer summarized the study and reassured potential participants that they did not have to participate and could drop out at any

point. If the participant opened the survey but failed to submit it, then the survey was ineligible for analysis. Non-completers did not lose access to the listserv.

Data Analysis Procedures. Data were exported into SPSS version 22 for data analysis, consisting of descriptive statistics (frequencies, measures of central tendency, standard deviation). Based on previous TeleTAM research, high scores were ≥ 5.70; low scores were < 3.50. Internal consistency of subscales was calculated using Cronbach alpha. The relationship of TeleTAM constructs to INTENT was analyzed with bivariate correlations.

Results

Sample. Opening (consenting to) the survey were 96 participants. Of those, 62 completed the survey (65% response rate) and comprised the sample for analysis. Table 1 shows the characteristics of the sample. The mean age of the sample was 48 years (*SD* = 10.3). Over half the sample was FNPs *(N* = 50); most participants worked in a group work setting *(N* = 48). The mean number of years in practice was 9.08 years (range: 0-32 years). There were significant relationships between NP age and years in practice with intention to use MTD (*p* = .000 respectively). NPs age 40-60 or who had been in practice for 1-15 years tended to have moderate-to-high scores for intention.

Survey Items. Participants perceived that MTD would have a positive impact on their practice (*M* = 5.69, *SD* = 0.92). High item scores (≥ 5.7) indicated that participants felt comfortable with information and communication technologies (*M* = 5.85, *SD* = 0.88), would find it interesting use MTD for skin lesion diagnosis (*M* = 5.98, *SD* = 0.89), and could easily learn MTD (*M* = 6.26, *SD* = 0.70). Participants also perceived that MTD would help with rapid diagnosis of skin cancer (*M* = 5.77, *SD* = 1.12), it was a good idea to use MTD for lesion diagnosis (*M* = 5.82, *SD* = 1.06), MTD would be useful to improve the diagnosis of their patients (*M* = 5.74, *SD* = 0.81), it would be

easy to perform tasks necessary to diagnose and manage patients using MTD (M = 5.71, SD = 1.09), and they would use MTD if they received training (M = 5.71, SD = 1.41). The one low score (< 3.50) was "I have already used MTD in my practice" (M = 1.73, SD = 1.28).

TeleTam Subscales. The scale scores for the TeleTAM factors are shown in Table 2. The highest mean score was for the construct of attitude toward MTD (M = 5.76) and the lowest mean score was habit (M = 4.45). All constructs had a significant positive correlation with intention, with facilitators having the strongest correlation (r = 0.77). The TeleTAM construct scales had acceptable internal consistency (Cronbach alpha ≥ 0.70) with the exception of the habit and compatibility scales.

Discussion

Sample. The sample consisted of masters-certified or doctorate- prepared NPs, similar to the sample in the original TeleTAM study (Orruño et al. 2011) in which 74% of the participants were general practitioners. In both studies, participants were within the ages of 40-60 years, an age range reflecting the predominant ages of NPs in Arizona (Wilson, Harootunian, Sama & Johnson, 2012). Persons in this age range often are considered "digital immigrants"—they have not grown up with the Internet or other current technology. Digital immigrants learn to adapt to their environment—some better than others (Prensky, 2001); we found this in our participants in this age range who had a positive perception of MTD, higher intention to use MTD, and were receptive to technology use, in general.

Survey items. In the original of the TeleTAM survey (Orruño et al., 2011) and in a subsequent report using a similar survey (Gagnon, Orruño, Asua, Abdeljelil & Emparanza, 2012), the mean item scores were not available for comparison. In the current study, participants positively viewed MTD and were open to learning more about this technology. This receptiveness

previously was reported in other studies of nurses' use of novel skin assessment technology (Govindan et al., 2007) and other mobile technologies (Bell, Fonda, Walker, Schmidt & Vigersky, 2012; Orchard, Freedman, Lowres, Peiris & Neubeck, 2014). The lowest scoring TeleTAM survey item (previous use of MTD to diagnose a patient's skin lesions) likely reflected unfamiliarity with the technology rather than hesitancy to use it. Additionally, dermatology nurses and dermatology NPs have reported limited use of dermoscopy (Phelan and Heneghan, 2008), suggesting that primary care NPs have even more limited use.

TeleTAM constructs. The TeleTAM is an acceptable framework to study NPs' intention to use MTD. The participants perceived that MTD is useful for patients and their practice, perceived that it is easy to use, had positive attitudes toward MTD, and perceived that their fellow professionals and patients would approve of their adoption of the new technology. The facilitators construct had the highest correlation with intention to use. Our participants perceived that the facilitator of "organizational infrastructure supporting MTD" was moderate and that they needed training for MTD. The habits and compatibility constructs had low mean scores and low reliability. The habit construct would be slightly strengthened by eliminating the item, "I have already used MTD for the diagnosis of my patients' skin lesions"; however, this item was key for interpreting NPs' use of MTD. No removal of items could significantly strengthen the compatibility scale. Further, these scale findings were not surprising, given that NPs had not used MTD, and likely neither had skin lesion assessment training nor used dermoscopy (Loescher et al., 2011; Phelan and Heneghan, 2008). However, compatibility had the second-highest correlation with intention, suggesting that there is underlying correspondence of MTD knowledge and NPs' own values and experiences with other technology with intention to use MTD. The intention construct had the lowest score in our study ($M = 4.30$), which could be attributed to cost of the dermoscope

attachment (a facilitator), although we did not directly measure this factor. MTD is expensive, a German company, sells its least expensive dermoscopy attachment for an iPhone for about $673 USD (Fotofinder® Systems, 2015). However, the cost of this device is lower than comparable devices from other manufacturers (Tyagi, Miller & Cockburn, 2012).

Limitations. Findings from this study reflect opinions of NPs working in Arizona and cannot be generalized to other populations. This study was limited by self-selection bias; a limitation of the anonymous online survey was the inability to determine why participants deselected themselves (stopped and exited the survey). The study also was limited by a small sample size, although our findings are congruent with those of previous studies of the TeleTAM and adaptations of the survey with larger sample sizes (Gagnon et al., 2012; Orruño et al., 2011). This study may have been biased by social desirability—the tendency to respond to questions in a way participants think is acceptable to the investigators. We did not include items to measure social desirability.

Practice Implications. By opening the survey, our NP participants received information about MTD (device description, photograph, case exemplar). This is important information for NPs working in Arizona, a state with a high incidence of skin cancer. The findings from this study may encourage NPs to consider their current early diagnosis and management practices for suspicious skin lesions and need for further training in skin lesion assessment and dermoscopy. Dermatology education for NPs is deficient and there is no standard dermatology curriculum or practicum for NPs (Bobonich & Cooper, 2012). Additionally, NPs may not be self-confident in their ability to clinically assess skin lesions (Loescher et al., 2011). Consequently, primary care NPs likely make more referrals to dermatologists, thereby contributing to dermatologists' patient overload. MTD has the ability to reduce referrals by allowing better triaging of skin lesions so as

not to refer lesions with benign characteristics to dermatologists. NPs can take the image of a suspicious lesion and have a teledermatologist diagnose the lesion. This action constitutes a referral; however, another referral for (unnecessary) biopsy can be avoided through teleconsultation. Based on participants' strong perceptions about organization facilitators, it is likely that NPs would be more accepting of MTD if their organizations covered the cost of MTD and lesion identification training, and the MTD device. NPs clearly are interested in MTD. Ultimately, if they use MTD with high levels of lesion identification sensitivity and specificity, there could be many benefits, including decreased wait time for a patient to be seen by a dermatologist, decreased NP time spent referring patients to dermatology, and earlier diagnosis of skin cancer, particularly melanoma.

Research Implications. A strength of this study is use of an established theory and survey to determine NPs acceptance of technology prior to the expense of training and device purchase. The TeleTAM construct scales have good internal consistency with the exception of habits and compatibility, which limit our ability to make strong conclusions about these two constructs. Future research of the TeleTAM should include item revision and re-testing of these constructs to fully capture their association with acceptance. This study offers insight into the technology acceptance of NPs. Our findings may encourage more theory-based research on NPs' acceptance of other technologies.

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