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Evaluating healthcare practitioners' views on store-and-forward teledermoscopy services for the diagnosis of skin cancer

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Abstract

Objective: The aim of the study is to evaluate healthcare practitioners' views on and satisfaction with (i) digital image acquisition and storage and (ii) store-and-forward teledermoscopy services for the diagnosis of skin cancer in their clinical practice.

Methods: An online survey was conducted among 59 healthcare practitioners (GPs (n=17), dermatologists (n=22), dermatology registrars (n=18), a dermatology research fellow (n=1) and a plastic surgeon (n=1)) to assess usability of digital image acquisition and storage for when the imaging process is conducted by the healthcare practitioners themselves, or by their patients. The study identifies the enablers and barriers of this emerging mode of medical practice. A thematic analysis was used to extract key themes from open-ended responses, which involved identifying themes and patterns within and across participants.

Results: Thirty-four healthcare practitioners (58%) had previously used a mobile dermatoscope within their practice. Participants most appreciated its use in their practice for lesion monitoring (59%) and record keeping (39%). Challenges reported were the increased time to support the additional workload (45%), technical issues (33%) and cost of equipment (27%). Practitioners were unsure (36%) or did not advocate teledermoscopy for direct-to-consumer use (41%). Only 23% supported the use of direct-to-consumer teledermoscopy.

Conclusion: While most practitioners are receptive to mobile teledermoscopy, there was less support for patient-initiated use, whereby the patient controls the imaging process. As technology improves rapidly it is important to evaluate practitioners' acceptance and satisfaction of evolving telehealth services, moving forward with models of practice where healthcare practitioners and other healthcare providers will feel comfortable engaging in telehealth services.

Keywords

Service providers, teledermatology, telemedicine, skin cancer, technology acceptance

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Introduction

With the proliferation of mobile technology, healthcare practitioners face changes to traditional models for delivering professional services, including increasing demand for telehealth. Mobile technology provides alternatives to traditional face-to-face service provision by providers offering telescreening, telemonitoring and teleconsultations for various health concerns.[1] In principle, dermatology is well suited to telehealth service delivery:[2] skin lesions often are diagnosed visually, and, when required, are biopsied for a histopathologic diagnosis with minimal risk to the patient. Indeed, dermatology was one of the first specialties to engage in telehealth. Teledermatology and teledermoscopy demonstrates good accuracy when provided via video consultations (real-time) or transmitting via store-and-forward still digital macro or dermoscopy images, or hybrid combinations of both.[3–5] Teledermatology has been evaluated for skin cancer early detection, lesion follow-up, and many other skin conditions such as rashes and wounds,[6] and diagnosis and monitoring of acne[7] and psoriasis.[8] Teledermatology services have consistently demonstrated reduced waiting times for assessment and diagnosis,[9] increased access to services in rural and remote areas[10] and high patient satisfaction.[11,12] The choice of whether or not to adopt telehealth delivery rests with practitioners' willingness to provide such service beyond the research or academic setting.[13]

Since 2012, direct-to-consumer dermatology services have increasingly become available to the public. Accordingly, instead of trained practitioners selecting a lesion or area of interest, taking the patients' medical history and conducting the imaging process, these tasks are performed by either technical support persons or the patient themselves. There are different variants of direct-to-consumer services such as web-based sites or apps where the user is asked to submit skin lesions with a brief medical history to a service provider with whom they have no doctor–patient relationship. A large number of private companies are focusing on these services, with currently 22 direct-to-consumer teledermatology services available to US residents.[14] Patients can use teledermatology to select their own suspicious skin conditions and then submit one or several images for telediagnosis, or to monitor a skin condition initially identified by a healthcare practitioner. One study reported that 100% of patients (n=129) would recommend the teledermatology service they participated in to others.[15] In a previous study by the authors assessing people's acceptance of direct-to-consumer mobile teledermoscopy, 91% of 228 consumer participants agreed it would be in their best interest to use such services.[12] Participants who were provided dermatoscopes and asked to photograph lesions of potential skin cancers for telediagnosis found them easy to use (94%, n=46/49), and 78% (n=38/49) wished to use the service again in the future.[12] In a more recent study, the authors have found 95% (n=84/88) of consumers would consider sending photos of their skin lesions to a medical practitioner via an app.[16] Alternatively, another variant of direct-to-consumer services is patients sending images to a medical practitioner with whom they have a known doctor–patient relationship. This would be useful for monitoring a lesion over time, or could be used to select a suspicious lesion that the patient identifies for telediagnosis.

While the acceptance of such services by potential users is important, few studies have assessed the attitudes and opinions of practitioners as potential providers of teledermatology services.[13,17,18] One of the recognised barriers of teledermatology is difficulty gaining health practitioners' acceptance.[19] The purpose of this research was to assess: (i) practitioners' use of dermatoscope attachments or point-and-shoot cameras for taking photographs of potentially cancerous skin lesions and issues related to image acquisition and storage, and (ii) practitioners' perceptions of direct-to-consumer store-and-forward teledermatology for skin cancer services.

Methods

Healthcare practitioners were invited to complete an online survey about image acquisition and storage, teledermatology and mobile teledermoscopy via email (available in English only). To be eligible, practitioners had to be a clinician with an interest or expertise in dermatology or skin cancer. Recruitment of practitioners occurred via an announcement through the International Dermoscopy Society (https://dermoscopy-ids.org/), Rural Doctors Association of Australia weekly e-newsletter, members of HealthCert International (medical education provider) and through a snowballing technique by asking interested practitioners to pass on the invitation to others. The ethics committee of the Queensland University of Technology (QUT) approved the study (QUT approval number 1400000807).

Survey structure

The survey had five sections and took approximately 20–30 minutes to complete (Supplementary File 1). Section 1 obtained demographic details including gender, occupation, practice location and years practising medicine after graduation. Section 2 explored the type of imaging systems the healthcare practitioners used in their current practice for photographing

potential skin cancers, and how satisfied they were with the systems (5-point Likert scale ranging from 1 'very satisfied' to 5 'very unsatisfied'). Imaging devices included: (i) dermatoscopes attached to smartphones or tablets, or (ii) single-lens reflex (SLR) cameras (i.e. macro imaging using a point-and-shoot camera without dermoscopy). Participants were asked about the advantages and barriers, whether they had encountered any problems with, stopped using or changed their imaging devices. Section 3 asked participants if they used any dermoscopy apps or online databases for facilitating teledermatology consults and, if so, to reflect on the advantages and disadvantages of those technologies. Section 4 consisted of a 16-item questionnaire on mobile teledermatology acceptance in the workplace, regardless of participants' previous use of teledermatology. The responses were recorded on 5-point Likert scales ranging from 1 'strongly agree' to 5 'strongly disagree'. Section 5 queried participants about provision of dermatoscopes for mobile devices to patients for their use at home, to facilitate direct communication with the reviewing doctor or dermatologist (we refer to as direct-to-consumer use). An open-ended question elicited responses describing advantages and disadvantages of patients selecting and photographing suspicious skin lesions at home to detect skin cancer early.

Survey design

The survey questions were designed for this study based on the literature, and measured for face validity by three dermatologists (HPS, CCL and RHW). In Section 4, the mobile teledermatology acceptance scale was based on the adapted Technology Acceptance Model by Orruno et al.[20] and structured around six constructs: perceived usefulness (3 items); ease of use (4 items); compatibility with current practice (3 items); intention to use (1 item); colleagues' and patients' opinions (subjective norms, 2 items); and facilitators (3 items).

Statistical analysis

Descriptive statistics were used to summarise frequencies and percentages for each question. The 5-point Likert scales were combined into the following categories for reporting: 'satisfied' and 'very satisfied' combined into one category of 'satisfaction'; 'very unsatisfied' and 'unsatisfied' combined into one category of 'unsatisfactory'. For open-ended questions content analysis was used to group answers into themes. This approach involved several phases, including familiarisation with the data by reading and re-reading open-ended responses; generating initial codes; searching for themes; and identifying the key themes relevant to the survey question.[21] Codes and theme development were led entirely by the data. This process was conducted by a single researcher (CH) who generated the list of themes. The themes were then reviewed, refined and agreed through discussion with team members (MJ, UK).

Results

Fifty-nine healthcare practitioners started the survey and 44 (75%) completed the survey. Missing data is due to participant attrition (dropout) towards the middle to end of the survey. Data from both those who completed the survey and those who did not complete the survey were both kept for analysis as the survey questions at the beginning provided valuable insight into the topic. The sample consisted of general practitioners (GPs) (n=17), dermatologists (n=22), dermatology registrars (n=18), a dermatology research fellow (n=1) and a plastic surgeon with an interest in skin cancer (n=1). The sample for those who completed the survey (n=44) consisted of GPs (n=11), dermatologists (n=16), dermatology registrars (n=15), a dermatology research fellow (n=1), and a plastic surgeon with an interest in skin cancer (n=1).

Section 1 Demographics

Thirty-three females (56%) and 26 males (44%) started the survey, and 24 females (55%) and 20 males (46%) completed the survey. Participants' geographic locations were Australia (85%, 50/59), Europe (7%, 4/59) or other countries of the world (7%, 4/59). Location data was missing for one participant. On average, respondents had been practising medicine for 10.4 years (range 1–32 years) and reported high confidence in diagnosing skin cancers (mean=8.07, range 3–10).

Section 2 Use of skin cancer imaging systems

Fifty-four participants (92%, 54/59) had previously participated in some form of teledermatology or teledermoscopy by imaging lesions for their work. The remaining five participants (8%, 5/59) had not imaged lesions previously for their work. Of those five participants four were dermatology registrars and one was a GP.

Digital image acquisition and storage

More than half of the healthcare practitioners (58%, 34/59) had previously used dermatoscopes attached to a smartphone or a tablet in their practice. Reasons for use included (multiple options possible): lesion monitoring (44%, 26/59); case documentation (46%, 27/59);

keeping records before an excision (44%, 26/59); and taking photos for presentations or teaching (39%, 23/59). Use of store-and-forward teledermoscopy by practitioners included: sending an image for a second opinion (44%, 26/59); or for referrals (25%, 15/59). Of the 10 GPs that used a dermatoscope attached to a smartphone or tablet for seeking a second opinion, nine were either 'very satisfied' or 'satisfied' with the process, and one answered they had 'neutral' attitudes.

Table 1 displays healthcare practitioners' satisfaction with their prior use of dermatoscopes attached to a smartphone or tablet. Most participants were satisfied with the dermatoscope, particularly for keeping records before an excision (71%, 24/34) and documenting cases (71%, 24/34).

Thirty-two healthcare practitioners previously had used an SLR camera. These participants were largely satisfied with the use of the point-and-shoot camera (Table 1), particularly 78% (25/32) who were satisfied with its use for presentations or teaching. When monitoring a lesion over time, most participants were satisfied (84%, 27/32), while three (9%, 3/32) were unsatisfied with the device for these uses.

Advantages to digital image acquisition and storage by doctors

Data for the advantages and barriers to digital image acquisition and storage by doctors were available for 51 participants. Table 2 displays their quotes on advantages and disadvantages to use. Monitoring and follow-up of a skin condition or lesion was the most cited advantage (59%, 30/51), followed by record keeping (39%, 20/51). Other advantages of digital image acquisition and storage included: use for teaching and learning (27%, 14/51), improved diagnostic ability and ability for post-biopsy review (20%, 10/51), a record for legal purposes (14%, 7/51), convenience and ease of use (12%, 6/51), reduces unnecessary excisions (8%, 4/51), second opinion (8%, 4/51) and to accompany referrals (8%, 4/51). Patient reassurance was also cited as an advantage to allow participants to see the lesion is not changing over time (10%, 5/51).

Barriers to digital image acquisition and storage use by doctors

Forty-six of 51 participants (90%) cited one or more barriers to using digital image acquisition and storage in their daily clinical practice. The most cited barrier was time constraints (45%, 23/51). Other barriers included: costs to purchase the equipment (27%, 14/51), issues with technology including image quality, data storage, loss or retrieval of data (33%, 17/51), legal concerns (12%, 6/51), privacy (4%, 2/51), providing results to patients remotely (4%, 2/51), availability or integration difficulties for the public hospital medical record system (4%, 2/51), expertise necessary to conduct telediagnosis (4%, 2/51), and that only selected lesions can be viewed (2%, 1/51).

Participants were asked to specifically note any perceived barriers to *diagnostic accuracy* using teledermoscopy. Forty-one participants (80%, 41/51) listed one or more perceived barriers. Image quality was the highest cited barrier (33%, 17/51). Participants also noted the importance of viewing the lesion in context to other lesions (22%, 11/51). Some participants were concerned about not being able to touch the lesion if they used teledermoscopy (18%, 9/51). Other concerns to diagnostic accuracy were the need to obtain full clinical history of the lesion, which may not be the case with teledermoscopy (18%, 9/51), and medico-legal concerns (6%, 3/51).

Problems encountered with imaging devices

Fifteen participants (25%, 15/59) encountered one or more problems with their imaging devices that prohibited use or led them to stop using the device, or to change or upgrade to a different device. Four participants (10%, 6/59) cited resolution and clarity issues with images, four participants (7%, 4/59) cited the camera breaking down or getting old and needing to be regularly upgraded, and two participants (3%, 2/59) cited issues finding a dermatoscope attachment to fit their camera device. One participant noted that the time taken to download and transfer images led them to stop using the device. Two participants did not elaborate on why they stopped using their device.

Section 3 Dermoscopy apps or online databases

Ten participants (20%, 10/51) had experience with apps or online databases for image storage. A limitation of these databases cited by a dermatologist was "*The online databases are only image databases without any supporting analysing functions*" (ID13).

Section 4 Acceptance of mobile teledermoscopy conducted by doctors

Table 3 shows participants' acceptance of digital image acquisition, storage and mobile teledermoscopy when the imaging process is conducted by healthcare practitioners in their practice (n=48). For the construct ease of use, the majority of participants (82%, 39/48) agreed they could easily learn how to use mobile teledermoscopy; however, 50% (24/48) indicated it may not be currently compatible and that implementing mobile teledermoscopy in their practice would involve major

Table 1. Satisfaction with digital image acquisition.

	Dermatoscope attached to smartphone or tablet (n=34)		SLR camera* (n=32)	
To keep records before an excision				
Not used for this purpose	8	(23.5)	5	(15.6)
Satisfied	24	(70.6)	25	(78.1)
Neutral	1	(2.9)	–	
Unsatisfied	1	(2.9)	2	(6.3)
To send to a colleague for second opinion				
Not used for this purpose	8	(23.5)	9	(28.1)
Satisfied	23	(67.6)	18	(56.3)
Neutral	2	(5.9)	4	(12.5)
Unsatisfied	1	(2.9)	1	(3.1)
To monitor a lesion over time				
Not used for this purpose	8	(23.5)	2	(6.3)
Satisfied	19	(55.9)	27	(84.4)
Neutral	4	(11.8)	–	
Unsatisfied	3	(8.8)	3	(9.4)
For referral				
Not used for this purpose	19	(55.9)	10	(31.3)
Satisfied	12	(35.3)	18	(56.3)
Neutral	3	(8.8)	2	(6.3)
Unsatisfied	–		2	(6.3)
To document your cases				
Not used for this purpose	7	(20.6)	3	(9.4)
Satisfied	24	(70.6)	26	(81.3)
Neutral	2	(5.9)	1	(3.1)
Unsatisfied	1	(2.9)	2	(6.3)
To use the photos for presentations or teaching				
Not used for this purpose	11	(32.4)	4	(12.5)
Satisfied	20	(58.8)	25	(78.1)

(continued)

Table 1. Continued

	Dermatoscope attached to smartphone or tablet (n=34)		SLR camera* (n=32)	
Neutral	2	(5.9)	–	
Unsatisfied	1	(2.9)	3	(9.4)

*missing data for two participants; Satisfied and very satisfied combined into one category of satisfaction; Very unsatisfied and unsatisfied combined into one category of unsatisfactory.

Table 2. Qualitative responses about provider-performed digital image acquisition and second opinion using teledermoscopy in clinical practice.

Advantages	Disadvantages
Theme: Monitoring lesions	
"The image is available to monitor lesions over time and see subtle changes. The image can be enlarged and viewed in detail especially if it is a difficult one" (ID21, dermatology registrar).	"Important information is garnered from having the patient in front of you through palpation, tenderness, different lighting and illumination techniques. . .stretching of the skin. . ." (ID15, dermatologist).
"If a patient is particularly perplexed regarding a lesion that I know is benign, it can be reassuring to monitor over time so the patient can also see there is little change" (ID20, dermatology registrar). "Have detected many early melanoma lesions [through] the ability to monitor lesions over time" (ID49, GP).	"In cases of melanocytic lesions, doing a full skin examination is best rather than looking at one melanocytic lesion in isolation as one may find that there are several other naevi that look the same. On the other hand, if the naevus is the only ugly-duckling, then that is also very relevant. Also, clinically palpating the lesion is omitted if relying only on mobile teledermoscopy e.g. lesion may feel fibrotic, depressed, indurated and one cannot appreciate that on an image" (ID21, dermatology registrar).
"Very useful in order to monitor a pigmented lesion for 3/12 rather than excise if it is borderline (thus saving biopsy if not actually necessary)." (ID1, GP).	"If using short term digital follow-up for lesions need to have a patient you are sure will turn up" (ID22, dermatology registrar).
Theme: Legal	
"From a medico-legal perspective, one can always go back and review the images" (ID 21, dermatology registrar).	"Variable insurance coverage for image procurement" (ID34, dermatologist).
Theme: Time	
"Takes extra time to image unusual but not quite suspicious enough (lacking dermoscopic clues or change on history) lesions during a consultation however it can be very useful in some cases so worth it" (ID1, GP).	"Sometimes [a] high rate of patients with little time to examine" (ID30, dermatology registrar). "Time of upload and manual linking to patient file" (ID19, dermatology registrar).
Theme: Record keeping	
"[Teledermoscopy is] invaluable for documenting lesions prior to surgery" (ID12, dermatologist).	"Integration into medical software a main issue" (ID4, GP).
"Removal of correct lesion if patient returns or is being referred for excision" (ID23, dermatology registrar).	"Patients can be hesitant about having photos taken" (ID58, dermatologist).
"Allows a review of the diagnosis through clinicopathologic correlation" (ID45, dermatology registrar).	

Table 3. Mobile teledermoscopy acceptance (n=48).

Items	Agree *n* (%)	Unsure *n* (%)	Disagree *n* (%)
Perceived usefulness			
Mobile teledermoscopy could help me to diagnose patients more rapidly	25 (52.1)	9 (18.8)	14 (29.2)
In my opinion, the use of mobile teledermoscopy will have a positive impact on my practice	25 (52.1)	13 (27.1)	10 (20.8)
Teledermoscopy could help me get the most out of my time	15 (31.3)	18 (37.5)	15 (31.3)
Ease of use			
Mobile teledermoscopy could improve my patient care performance	25 (52.1)	13 (27.1)	10 (20.8)
I could easily learn how to use the mobile teledermoscopy software	39 (81.3)	6 (12.5)	3 (6.3)
The diagnosis made through mobile teledermoscopy will be clear and easily understandable	18 (37.5)	23 (47.9)	7 (14.6)
It would be easy to perform the tasks necessary for the diagnosis and management of my patients using mobile teledermoscopy	21 (43.8)	15 (31.3)	12 (25.0)
Compatibility with current practice			
The use of mobile teledermoscopy may involve major changes in my clinical practice	24 (50.0)	9 (18.8)	15 (31.3)
The use of mobile teledermoscopy is compatible with my work habits	28 (58.3)	8 (16.7)	12 (25.0)
The use of mobile teledermoscopy may interfere with the usual follow-up of my patients	17 (35.4)	9 (18.8)	22 (45.8)
Intention to use			
I have the intention to use mobile teledermoscopy routinely with my patients	16 (33.3)	11 (22.9)	21 (43.8)
Subjective norms			
Other health professionals (nurses, other specialists etc. . .) would welcome the fact that I use mobile teledermoscopy	22 (45.8)	16 (33.3)	10 (20.8)
Most of my patients will welcome that I use mobile teledermoscopy	26 (54.2)	14 (29.2)	8 (16.7)
Facilitators			
I would use teledermoscopy if I receive adequate training	24 (50.0)	14 (29.2)	10 (20.8)
My centre has the necessary infrastructure to support my use of teledermoscopy	25 (52.1)	9 (18.8)	14 (29.2)
I would use teledermoscopy if I receive technical assistance when I need it	26 (54.2)	12 (25.0)	10 (20.8)

*Strongly agree and agree combined into one category of agreement; Strongly disagree and disagree combined into one category of disagreement.

systems and individual changes. Just over half these participants (52%, 25/48) indicated that mobile teledermoscopy would help them to diagnose patients more rapidly and may have a positive impact on their practice. Thirty-three per cent (16/48) agreed that they intended to use mobile teledermoscopy routinely with their patients in the future, while 44% (21/48) did not intend to use mobile teledermoscopy in their practice. The majority (52%, 25/48) indicated that mobile teledermoscopy could improve their patient care performance.

Section 5 Direct-to-consumer mobile teledermatology

Data were available for 44 participants. There was no uniform agreement that dermatoscope attachments for mobile devices should be provided to patients, with 10 participants (23%) responding yes, 18 (41%) responding no, and 16 (36%) were unsure. If patients were to conduct direct-to-consumer mobile teledermoscopy themselves at home, participants would prefer patients to use it for monitoring a doctor-identified lesion (77%, 34/44), rather than for detection of a new lesion.

Advantages of direct-to-consumer use of mobile teledermoscopy included: facilitating earlier skin cancer detection (34%, 15/44), useful for rural and remote residents who would otherwise not be able to easily access skin checks by a health professional (16%, 7/44), reduced waiting times (11%, 5/44) reduced patient anxiety (11%, 5/44), and allows the patient to monitor changes over time (21%, 9/44). Another advantage of direct-to-consumer use was patient convenience (16%, 7/44), and increase of patients' awareness of their skin or to aid sun protection behaviours (9%, 4/44) (Table 4).

The main barrier to direct-to-consumer mobile teledermoscopy identified was patient education and selecting the right concerning lesions (36%, 16/44). Other perceived barriers were: it could stop patients from presenting for a whole-body clinical skin examination by a doctor (20%, 9/44); image quality and the ability to reach all body areas when imaging by yourself (23%, 10/44); overuse by anxious patients taking excessive images of benign spots (11%, 5/44); medicolegal and insurance issues (9%, 4/44); training the patients to use the technology (11%, 5/44); or the risk of fostering a false sense of security in the patient (5%, 2/44). Three (7%, 3/44) noted the high cost of imaging devices, and two (5%, 2/44) were concerned about the time it would take to view the images in addition to their current workload (Table 4).

Discussion

Our survey findings contribute to the health services literature by advancing understanding of the acceptability and uses of mobile teledermoscopy from the healthcare practitioners' perspective. Most participants have already used a form of lesion imaging in their practice, mostly to aid in documentation and monitoring. Participants who had previously used mobile teledermoscopy were generally satisfied with these store-and-forward systems within their practice, and seeing benefit of integrating these systems into their workflow. Few health professionals used dermoscopy apps or online databases for teledermatology processes. The majority of participants were critical of or unsure whether patient-performed mobile teledermatology services were useful or would provide a good service.

This survey identified the key advantages of mobile teledermatology for daily practice by healthcare practitioners. Key advantages of using such services were for record keeping, post-biopsy review, monitoring and follow-up, and teaching purposes. Acceptance of mobile teledermoscopy was assessed using the Technology Acceptance Model (TAM). Just over half of participants agreed with the items within the construct perceived usefulness, except for when it came to mobile teledermoscopy improving time. Similarly, just over half of participants agreed with all the items within the facilitator construct, indicating practitioners agreed they would require training to use the technology and already have the infrastructure available to them. The item in the construct intention to use that had a higher disagreement (44%) than agreement (33%) was 'I have the intention to use mobile teledermoscopy routinely with my patients'. In a 2016 survey of 221 British dermatologists 30% intend to use teledermatology in the future.[22]

Our findings are consistent with other studies which found that healthcare practitioners tend to report less satisfaction with teledermatology methods than patients.[23] Fifty-two per cent of doctors in our study reported their patients would welcome use of mobile teledermoscopy. Dermatologists have previously ranked in-person examinations as superior and preferable to teledermatology.[24,25] Studies indicate satisfaction rates of 74% for dermatologists, 71% for primary care providers and 91% by imaging technicians using a store-and-forward teledermatology service to monitor psoriasis in a rural clinic. In our survey, 52% of respondents agreed the use of mobile teledermoscopy would have a positive impact on their practice.

Despite feeling that certain aspects of their current healthcare services could improve with teledermatology, healthcare practitioners also expressed concerns about integrating these systems. In our study,

Table 4. Qualitative responses about direct-to-consumer mobile teledermoscopy.

Advantages	Disadvantages
Theme: Patient education and awareness	
"It does encourage patient awareness of skin lesions. If they are regularly checking their skin, they may be able to identify any new lesions or changing lesions" (ID20, dermatology registrar).	"[Patients] will often select benign but symptomatic lesion(s) (seborrhoeic keratoses) when a malignant lesion may lie nearby" (ID11, dermatologist).
"This [teldermatology] may lead to more sun protective behaviours" (ID25, dermatology registrar).	Teledermoscopy by a patient is "supermarket medicine" and "a patient is unlikely to find them [skin cancers] on their own" (ID1, GP).
"Astute patients can detect changes in their lesions early and be more appropriately managed" (ID21, dermatology registrar).	"There needs to be some training prior use to avoid excessive photography" (ID18, dermatology registrar).
"This would improve the early diagnosis of skin cancer" (ID13, dermatologist).	"If a patient is high risk they should be having full skin examinations. It is not uncommon for the lesion the patient is concerned about to be benign, but a separate lesion they were unaware of is a skin cancer" (ID12, dermatologist).
Theme: Patient anxiety	
"May pick up the patient who is scared to go to the doctor or cannot access a doctor" (ID1, GP).	"It has the potential to foster paranoia in patients - some would abuse the service and take images of every single lesion on their body" (ID20, dermatology registrar).
"[Teledermoscopy may] ease patient anxiety during waiting time" (ID30, dermatology registrar).	"It will increase the excision rate and their anxiety" (ID14, dermatologist).
Theme: Training to use the technology	
"a short training video will allow the patient to take a suitable image" (ID35, GP).	"... for old patients, their coping with technology will be a problem" (ID32, plastic surgeon).
	"Difficult to ensure an adequate image (clear enough, correct part of the lesion, pressure etc.)" (ID2, GP).
Theme: Convenience	
"Patients will find it more convenient" (ID10, dermatologist).	"We are all time poor" (ID4, GP).
"Definite advantage for rural and remote patients who would otherwise not be able to access GP/dermatologists for skin checks" (ID12, dermatologist).	"...in my current practice, I shouldn't have time enough to see all the photos that all patients could send" (ID6, dermatologist).

the healthcare practitioners' most common concerns were time constraints and the ability to handle the extra demand for teledermatology services. The item with lowest agreement in our TAM scale related to mobile teledermoscopy allowing practitioners to get the most out of their time. This was also reported as the most common concern in the study by Weinstock and colleagues,[26] who reported data from telephone interviews with doctors, nurse practitioners and physician assistants (n=19). However, our sample of healthcare practitioners voiced concern about patients using mobile dermatoscopes as a complete replacement, and not presenting for whole-body skin examinations by a doctor. Importantly, healthcare practitioners felt that issues relating to reimbursement and medico-legal concerns were yet to be overcome, and these are difficult issues given that telemedicine allows health care to cross both national and international borders. In contrast to previous findings, healthcare practitioners did not report teledermatology as a threat to their jobs or loss of control.[27] In our survey, 77% of participants advised they would not provide, or are unsure of

providing, services for patient-performed teledermatology where participants take photos of suspicious skin lesions selected themselves at home. For participants using direct-to-consumer services, they would be required to purchase their own dermatoscope or hire/borrow a dermatoscope, adding to either additional costs or logistical requirements. Factors identified in the literature that characterise a successful teledermatology programme include quality images, dermoscopy, infrastructure, training programmes and adequate technical support.[28,29] In our survey, the lack of these components was listed as a barrier to implementation.

The main limitation of this study was the low response rate. The results may not fully represent healthcare practitioners, and those responding are more likely to hold strong viewpoints. Including dermatology registrars who may not have yet fully experienced the burden of providing clinical care may have influenced the results. Participants were mostly from Australia, so the findings may not be generalisable to other countries. Recruitment using a snowball technique may also result in sample bias; however, this method is useful for recruiting participants that are typically hard to reach. Non-responders may differ from responders in ways that bias our results. Another limitation is the missing data. The survey took approximately 30 minutes to complete, hence a moderate dropout rate occurred towards the middle to end of the survey. Medical practitioners are time-poor and this was mentioned by some participants in our survey. Future online surveys on healthcare practitioners should be less than 30 minutes.

Conclusion

Most participants in the study have previously used imaging devices primarily for documentation and monitoring. Of these participants, most were receptive to the use of mobile teledermoscopy in their practice. It is likely that in the immediate future the majority of healthcare practitioners will be using telemedicine procedures in some aspect of their practice. However, most participants disagreed or were unsure whether patient-performed mobile teledermoscopy services were useful. An important distinction for patient-performed mobile teledermoscopy is that it is not designed to completely replace in-person care, but rather act as a complementary service, for which there is currently no reimbursement pathway. Addressing issues such as time and workload are other important factors in ensuring system uptake and continuing effectiveness. While difficulties exist, overcoming barriers to teledermatology it has the potential to improve patient health outcomes.

Conflict of interest: H. Peter Soyer is a shareholder of e-derm consult GmbH and MoleMap by Dermatologists Ltd Pty. He provides teledermatological reports regularly for both companies. He is also Advisor of First Derm™.

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