

Evaluation of digital skin images submitted by patients who received practical training or an online tutorial

Abrar A Qureshi*, Heather A Brandling-Bennett[†], Steven Giberti[‡], Douglas McClure[‡], Elkan F Halpern[§] and Joseph C Kvedar^{‡¶}

*Department of Dermatology, Brigham and Women's Hospital, Harvard Medical School; [†]Department of Pediatrics, Massachusetts General Hospital, Harvard Medical School, Boston; [‡]Partners Telemedicine, Boston; [§]Massachusetts General Hospital Institute for Technology Assessment, Boston; [¶]Department of Dermatology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, USA

Summary

We evaluated the ability of subjects to capture and submit teledermatology images with a digital camera. We also examined whether participants who received individual training sessions would capture better-quality images than participants who were provided only with self-training. Fifty participants were randomized between in-person training and self-training via an online tutorial. The majority of participants were young, well educated women. Two dermatologists reading the images for quality indicators had high agreement that digital images acquired were of high quality: images were well framed, appropriately bright, in focus and did not have a shadow. There was moderate agreement on diagnosis-related indicators, such as the presence or absence of pustules or papules and acne versus rosacea. There was no difference in the image-quality attributes between participants personally trained and those trained with the online tutorial. Subjects participating in this study were able to acquire images of good quality, irrespective of whether they received practical training or used an online tutorial.

Introduction

Dermatologists manage numerous chronic diseases, primarily in the outpatient setting, and this often requires multiple follow-up visits. Asynchronous, or store-and-forward, telemedicine offers promise for the delivery of efficient remote medical care.¹⁻³ A report from the Agency for Healthcare Research and Quality (AHRQ) stated that 'teledermatology is the most-studied clinical specialty in store-and-forward telemedicine; its diagnostic accuracy and patient management decisions ... are comparable to those of in-person clinical encounters'.⁴ If store-and-forward teledermatology is used to provide follow-up of chronic

disease patients rather than to make diagnoses, it may represent a more cost-efficient way of caring for dermatology patients coming in for frequent office visits. In conventional store-and-forward teledermatology, images are taken by a professional; therefore patient participation has not been well studied. However, the feasibility of patients doing follow-up from home using digital images has been demonstrated.¹ Empowering patients with the ability to capture and transmit images of their skin seems to be a logical step towards patient participation in their dermatological care.

In a study published in 2003, Du Moulin *et al.* compared dermatology diagnoses based on digital images sent by general practitioners with diagnoses made in person by dermatologists and concluded that general practitioners need to be trained to take digital images.⁵ This suggests that patients may also need training to take their own images. Training individuals, however, would add a significant cost to store-and-

Accepted 26 June 2005

Correspondence: Dr Abrar A Qureshi, Department of Dermatology, Brigham and Women's Hospital, Harvard Medical School, 45 Francis Street, 221L, Boston, MA 02115, USA (Fax: +1 617 228 4634; Email: aqureshi@partners.org)

forward telemedicine services. There has been no study to date that has addressed the effectiveness of training patients to take images in dermatology.

In a previous survey study of 430 patients, we found that more than half the patients at the dermatology clinics at the Massachusetts General Hospital (MGH) in Boston would consider using a teledermatology service.⁶ The purpose of the present study was to evaluate the ability of patients to capture and submit teledermatology images and to determine if in-person training affected the quality of the images. We hypothesized that participants who received individual training sessions would capture better-quality images than participants who were provided only with access to an online tutorial.

Methods

.....

Invitations to participate in the study were mailed to adult patients who had a diagnosis of acne or rosacea and who visited the dermatology clinic at the MGH from October 2002 to July 2003. Subjects were also recruited via notices put up in the dermatology clinics at the MGH and the Brigham and Women's Hospital. Patients were eligible if they had been diagnosed with acne or rosacea, regardless of disease severity or therapy received. Note that we did not attempt to use digital imaging as a diagnostic modality. The first 50 patients who responded and met the eligibility criteria were invited to participate. Patients who agreed to participate were required to make one visit to the MGH to complete the study. Informed consent was obtained prior to participation. The study protocol was approved by the appropriate ethics committee.

Eligible patients who agreed to participate were randomized into one of two groups: trained versus online tutorial. The randomization was performed in pairs to ensure equal numbers of participants in each group. The trained subjects received individual instruction. They underwent a 10-min training session on how to use the digital camera (Coolpix 4500, Nikon) to take their own facial images and transfer the digital images to a personal computer (PC). The other group of participants were asked to use an online tutorial.

All participants were seated in front of a PC and asked to go through the same questions and procedures as directed on a Website. They were first asked to answer questions on age, gender, education level and their prior experience of using a digital camera. Subsequently, participants were instructed to take three images of their face, with front, left and right sides of the face captured by holding the digital camera at arm's length. Participants then transferred the three facial

images from the digital camera to the computer. They were able to view the images on the camera and computer to decide if they were good enough before transmitting them to the Website. Participants had the opportunity to delete and re-capture an image they felt was not of good quality.

Prior to beginning the work, participants were asked to remove makeup or spectacles if applicable. The participants in both groups were monitored during the time they spent in the examination room performing their tasks. No assistance was provided once the patients started work on the tasks given, except to clarify written instructions on the online tutorial. The hypothetical scenario presented to all participants was that they were sending images to their own dermatologist for diagnosis and treatment considerations. Participants were responsible for making a decision on image quality prior to submitting images on the Website.

The images were reviewed by two board-certified dermatologists. The dermatologists did not train on any test images, and did not discuss consensus findings for acne or rosacea prior to the study. Each dermatologist answered 10 questions based on the three images for each subject using a Web-based form. Four questions were asked about photographic quality (focus, brightness, shadows and framing). The remaining questions asked were about diagnosis and confidence in making diagnosis and treatment recommendations based on the images.

A Web application was built to facilitate the workflows for the study. First, the participants needed to answer demographic questions and accomplish image transfer from the camera to the Web application. Second, the readers used the application to evaluate images and answer a set of questions. Answers to demographic questions, digital images and the readers' answers were all stored in a database.

Data were tabulated using the software SAS. Kappa scores were used to evaluate agreement between the two dermatologists. A kappa score of >0.7 is considered good agreement, 0.4–0.7 moderate agreement and <0.4 poor agreement. χ^2 values were calculated to compare the dermatologists' responses for trained versus online tutorial subjects.

Results

.....

There were 25 subjects in the trained group and 25 subjects in the online tutorial group. The study population was mainly female, young and highly educated, and the majority of the study participants had computers at home with Internet access (Table 1).

Table 1 Participant characteristics (n=50)

Description	Value
Age (years)	40 (SD 14)
Gender (% women)	90
Education, above college level (%)	78
Computer at home (%)	88
Internet access at home (%)	78
Digital camera at home (%)	30

About one-third of them owned digital cameras. The distribution of responses to each question was similar in the two groups. The response rate was 100% for all questions.

There was high agreement between the two dermatologists for image focus, brightness and framing; there was moderate agreement for the presence or absence of a shadow on the images (Table 2). For clinical questions, there was high agreement on confidence with the diagnosis and therapy, moderate agreement on presence or absence of papules, and diagnosis of acne versus rosacea. There was less agreement on presence or absence of pustules.

To evaluate if the disagreement on clinical questions was due to participant training methods or the readers themselves, we stratified the responses by the two groups (Table 3). The results were comparable between readers. Although there was no significant difference,

the two readers differed in their opinions about the presence of pustules. Reader 1 found pustules on 26 participants (10 personally trained and 16 self-trained) whereas reader 2 found pustules on only five participants (one personally trained and four self-trained).

There was no difference in the image-quality attributes between participants personally trained and those trained with the online tutorial. There were no significant associations between the characteristics of the participants, and how they performed on image-quality parameters. There was no significant relationship between owning a digital camera and how participants performed on image-quality questions.

Discussion

The results of the present study suggest that patients may be able to take and submit their own images using a digital camera and a PC. This agrees with the findings of Eminović *et al.*¹ We also found that participants who were randomized to the online tutorial performed as well as those who received individual training. This was contrary to our initial hypothesis that in-person training would result in better-quality images.

The results of the present study were analysed using the kappa statistic. Two dermatologists evaluated the

Table 2 Reader responses and agreement for image quality and clinical indicators

Questions	Both readers responded 'Yes'	Both readers responded 'No'	Disagreement between readers	Kappa (95% confidence interval)
At least two images in focus?	48	0	2	—*
At least two images bright?	49	0	1	—*
Any images with a shadow?	8	33	9	0.53 (0.28–0.79)
At least two images well framed?	48	0	2	—*
Erythematous papules?	37	5	8	0.47 (0.17–0.77)
Pustules?	5	24	21	0.19 (0.03–0.34)
Acne vulgaris?	23	13	14	0.43 (0.19–0.67)
Rosacea?	13	23	14	0.42 (0.18–0.67)
Confident with diagnosis?	44	0	6	—*
Confident with therapy?	44	0	6	—*

*High agreement: kappa not computed because all images considered high quality by both readers

Table 3 Comparison of the clinical indicators in the two participant groups for each reader

Question	Reader 1			Reader 2		
	Personal training	Online tutorial	P value	Personal training	Online tutorial	P value
Papules present	22	22	—*	18	20	0.51
Pustules present	10	16	0.09	1	4	0.16
Acne vulgaris	15	19	0.22	10	16	0.09
Rosacea	11	6	0.14	14	9	0.16
Confident with diagnosis	25	25	—*	20	24	0.08
Confident with therapy	25	25	—*	20	24	0.08

*No difference, hence P value not computed

images using a Web-based application. There was high agreement on image quality. While the two readers had been trained to read specific types of digital images for other research protocols and teledermatology consultations, they were not specifically trained to read acne and rosacea facial images for the purpose of this study. Hence, the two readers had moderate agreement on questions related to the presence of papules and the diagnosis of acne or rosacea, suggesting that they needed training on a sample of cases with acne and rosacea. Although there was no relationship between participant training methods and reader responses for these questions, there may be several reasons for the moderate agreement. First, we did not recruit patients with severe disease only and in patients with milder disease a diagnosis of acne versus rosacea may be difficult to make. Second, the images were not taken with side-lighting which made comedones difficult to visualize, an important distinguishing feature. Third, readers were blinded to other information about the patients, such as age, which may have assisted in the diagnosis.

We chose to study patients with acne and rosacea to standardize the protocol, so that only facial images needed to be taken. This study design, however, has limitations. We recruited acne and rosacea patients from two hospital-based practices. We did not impose criteria such as severity of disease, and only required that the subjects self-report an active diagnosis of acne or rosacea to be eligible. The majority of the subjects were women and well educated, and most had computers at home, and hence this was a biased sample. The study was performed in a simulated environment, and did not test the ability of the patients to take images at home using their own equipment. The testers occasionally had to explain written instructions regarding uploading the images onto the computer if the patient was unable to proceed, suggesting some modifications to the Website need to be made. The Nikon Coolpix 4500 digital camera was chosen because of its swivel design, allowing the study participant to view the image they were taking on the digital screen prior to capturing the

image. The use of this camera, which may or may not be manufactured in the future, is a potential limitation of this work.

Digital imaging has been studied mainly for diagnostic use and there are some suggestions that imaging may be used for patient follow-up as well.¹ For patients with chronic conditions where disease flares need to be monitored, self-imaging may allow these patients to submit images of their skin periodically to their physician. This may reduce the number of return visits to the dermatology clinic.² Another possible application of this technique is in population-based research where large numbers of participants can be recruited into long-term follow-up studies based on self-imaging of specific skin lesions or body parts.⁷ Hence, although the scope of the present study was limited, the work has wider implications. High-quality digital self-imaging by patients creates new opportunities for both clinical care (i.e. telemedicine) and population-based research studies.

Acknowledgements: This work was funded in part by grants from the NIAMS/Herzog Foundation and from the Dermatology Foundation.

References

- 1 Eminović N, Witkamp L, Ravelli AC, *et al.* Potential effect of patient-assisted teledermatology on outpatient referral rates. *J Telemed Telecare* 2003;**9**:321-7
- 2 Baldwin L, Clarke M, Hands L, Knott M, Jones R. The effect of telemedicine on consultation time. *J Telemed Telecare* 2003;**9** (suppl. 1):71-3
- 3 Stensland J, Speedie SM, Ideker M, House J, Thompson T. The relative cost of outpatient telemedicine services. *Telemed J* 1999;**5**:245-56
- 4 Hersh WR, Wallace JA, Patterson PK, *et al.* Telemedicine for the medicare population. *Evid Rep Technol Assess (Summ)* 2001;**24**:1-6
- 5 Du Moulin MF, Bullens-Goessens YI, Henquet CJ, *et al.* The reliability of diagnosis using store-and-forward teledermatology. *J Telemed Telecare* 2003;**9**:249-52
- 6 Qureshi AA, Kvedar JC. Patient knowledge and attitude toward information technology and teledermatology: some tentative findings. *Telemed J E-Health* 2003;**9**:259-64
- 7 Qureshi AA, Kvedar JC. Telemedicine experience in North America. *Curr Probl Dermatol* 2003;**32**:226-32