Mobile Device Digital Photography for Teledermatology Consultation: Real-Life Situations

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ABSTRACT

Objective: The use of mobile phones for teledermatology consultations is increasing. In this study, we aimed to describe photographic problems in teledermatology performed via mobile phones and their effects on diagnostic decision-making.
Materials and Methods: Three dermatologists independently reviewed the medical histories and photographs of patients taken by primary-care physicians for teledermatology between January 2018 and August 2020. The consensus of the dermatologists' decision-making was categorized into "definite diagnoses given," "probable diagnoses given," and "unable to provide any diagnosis." Relationships between photographic errors and dermatologist decision-making were investigated. Factors related to photographic problems were evaluated.
Results: In all, 899 images from 220 patients were reviewed. The most common purpose of teledermatology was to make a diagnosis. The most frequent diagnoses were eczema, infection, and autoimmune diseases. Consultants gave definite diagnoses for 63.2% of patients and probable diagnoses for another 29.5%. However, diagnoses were not made in 7.3% of cases. Defocusing and non-eczematous lesions were significantly associated with the inability to give diagnoses (P = 0.002 and 0.037, respectively). Pictures from peripheral areas showed higher frequencies of distortion errors, improper framing, wasted space, and improper background, while truncal regions tended to have lighting problems. The outpatient department setting was associated with a lack of overview and defocusing.
Conclusion: Focusing was the central factor for making diagnoses in teledermatology. Lighting should be more concerned in truncal regions. While using smartphone cameras, distortion should be aware. These factors should be considered to improve the effectiveness of teledermatology.

Keywords: Consult; dermatology; smartphone; teledermatology; telemedicine (Siriraj Med J 2023; 75: 871-879)

INTRODUCTION

Telemedicine is increasingly being used in dermatology. Diagnoses are based mainly on inspection, with additional information from palpation and patient history.[1] Two types of teledermatology are currently in use: (1) store and forward techniques, in which clinical data are sent electronically to dermatologists for evaluation; and (2) live interaction techniques, involving real-time synchronous communication between the patient and dermatologist, typically facilitated through videoconferencing technology, enabling direct visual and audio communication.[2] In the store and forward technique, high-quality images can replace primary-care physician descriptions of skin lesions, which are susceptible to describer bias.[1]

It is undisputed that clinical photographs are beneficial for educational purposes, research, and the management of dermatological conditions, especially in healthcare facilities without dermatologists.[1-4] Moreover, teledermatology in outpatient settings enables the immediate diagnosis of complicated cases by general physicians

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https://doi.org/10.33192/smj.v75i12.264488

consulting with dermatologists located elsewhere. This joint approach avoids the referral delays and travel costs that would otherwise be incurred if patients have to visit dermatologists for in-person examinations. These benefits were demonstrated by Zakaria et al. (2010) and S. Paradela de la Morena et al. (2015), who found that approximately two-thirds of patients could be treated without a clinic-based evaluation after the implementation of teledermatology.[5,6] The diagnostic accuracy reported for teledermatology was approximately 80%, compared with face-to-face diagnoses.[3,7-9]

In addition to the complex nature of certain diseases, the evolution of lesions, and incomplete clinical data, poor image quality negatively affects the accuracy and reliability of teledermatological diagnoses.[6,7,10] Inadequate pictures result from the photographic techniques used rather than any shortcomings of the technology or the camera options.[1] The photographic technique standard mainly comprises light and shadow, background, the field of view, orientation and framing, distortion, focus and resolution, scale, color calibration, and patient confidentiality.[1,11-13] From previous studies, approximately 80% to 90% of images obtained with store-and-forward teledermatology were considered adequate or excellent.[6,8,14]

Smartphones are used daily for dermatological consultations. Advancements in related camera technologies have resulted in a tool that can capture high-quality images and is easy to use.[15] Nevertheless, few articles have discussed the quality of pictures obtained from mobile phones in practice. Thus, this study evaluated photographic problems in mobile-phone teledermatology, the factors associated with inadequate photographs, and their effects of the various shortcomings on diagnostic decision-making. Therefore, these findings could be beneficial for physicians seeking consultations in teledermatology.

MATERIALS AND METHODS

Ethics consideration

This retrospective study was conducted at the Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand. Before the research began, its protocol was approved by the Siriraj Institutional Review Board (COA no. Si 801/2020).

Data collection and evaluation

Photographs of patients taken by primary-care physicians between January 2018 and August 2020 were collected from a private social-media group for dermatology teleconsultation. The clinical information collected from the group consisted of baseline characteristics, consultation setting, and purpose of consultation. Three independent board-certified dermatologists, each with over a decade of teaching and consulting experience, including their roles as committee members of monthly dermatologic photographic assessment conferences, reviewed the patient histories and images to describe lesion morphology and provide diagnoses. For each patient, the dermatologists' diagnoses were categorized into "definite diagnoses given," "probable diagnoses given," and "unable to provide any diagnosis." In terms of image quality assessment, photographs of the same body area of the patients were compiled and placed into a corresponding body-region group. We further evaluated these groupings by drawing upon an image-quality checklist we had adapted from various established recommendations[11,12,16] and adjusted to suit mobile phone photography (Supplementary Table 1). Assessments were made of the domains of photographic techniques (the presence of overview photographs and close-up views, focus, lighting, background, framing, orientation, wasted space, perspective distortion, color saturation, and white balance). Any disagreements on clinical diagnoses and photographic assessments were resolved through discussion and consensus. Data related to patient confidentiality issues were also evaluated.

Statistical analysis

Data analyses were performed using PASW Statistics for Windows, version 18 (SPSS Inc., Chicago, IL, USA). With each patient, we selected photographs that had the best quality of photographic technique from representative regions. Subsequently, these were used to evaluate the relationships between image quality and dermatologist diagnostic decisions. As appropriate, Chi^2 tests or Fisher's exact tests were used. In addition, the worst quality photographs from each body region were chosen to identify factors associated with inadequate images.

RESULTS

We collected 899 images from 220 patients and grouped them into 385 body regions. As shown in Table 1, most patients were older than 18 years (81.6%). The primary source of consultation was an outpatient department (OPD; 82.3%), with 17.7% consulted in an inpatient department (IPD) setting. In most of the cases (55%), general physicians were seeking the diagnosis of a skin condition. In another 25% of the cases, general physicians required advice on diagnosing and managing the presenting condition. In the remaining cases (20%), general physicians had formed a diagnosis and were only seeking advice on managing the condition. Most skin lesions were erythematous and eczematous (31.8% and 24.5% of the patients, respectively). In 42 cases (19.1%),

TABLE 1. Patient demographic data.

Demographic data	Number of patients n = 220 (%)
Mean age at the onset ± SD (years)	41.64 ± 22.47
Age group	
0–5 years	15/207 (7.2)
6–17 years	23/207 (11.1)
18–64 years	134/207 (64.7)
> 65 years	35/207 (16.9)
Median duration of disease (IQR; months)	1.00 (0.22–3.00)
Gender	
Male	105/209 (50.2)
Female	104/209 (49.8)
Consultation setting	
Outpatient	181/220 (82.3)
Inpatient	39/220 (17.7)
Purpose of consultation	
For diagnosis	122/220 (55.5)
For proper management	42/220 (19.1)
For diagnosis and proper management	56/220 (25.5)
Provided data in teleconsultation	
Disease duration	186/220 (84.5)
Underlying disease	148/220 (67.3)
Previous treatment	134/220 (60.9)
Current medication	133/220 (60.5)
Occupation	33/220 (15.0)
Pet or animal exposure	4/220 (1.8)
Drug allergy	1/220 (0.5)
Family history	1/220 (0.5)
Environmental exposure	0/220 (0.0)
Diagnosis category	
Definite diagnosis given (spot diagnosis)	116/220 (52.7)
Definite diagnosis given (requiring provided history)	23/220 (10.5)
Probable diagnoses given along with proper management	65/220 (29.5)
Unable to provide any diagnosis	16/220 (7.3)
Disease morphology	
Erythematous lesions	70/220 (31.8)
Eczematous lesions	54/220 (24.5)
Tumor, nodules, and plaques	29/220 (13.2)
Vesiculobullous lesions	17/220 (7.7)
Pustular lesions	14/220 (6.4)
Hair and nail lesions	11/220 (5.0)
Ulcer and erosion	9/220 (4.1)
Papulosquamous lesions	8/220 (3.6)
Hyperpigmentation	8/220 (3.6)
Concurrent skin disease	34/216 (15.7)

Abbreviations: IQR, interquartile range; SD, standard deviation

a lack of patient confidentiality was an issue. Specifically, hospital names or logos, patient faces, patient tattoos, and name tags were visible in images associated with 29, 8, 5, and 4 cases, respectively. Patient consent for photography from referring general practitioners was explicitly mentioned in only 11 of the 220 cases (5%), while the verbal consent was obtained in the remaining cases. The scale measurement was found in only 1 patient.

The diagnostic concordance rate between the three consultant dermatologists was 184 of 220 cases (83.6%). No significant associated factors with the discordance were found, including sex, age, lesion type, location of the lesion, and image quality. Nevertheless, for the final diagnosis, disagreements were resolved through discussions and consensus among three experienced dermatologists. In 63.2% of all cases, the three consulting dermatologists could provide definite diagnoses. With 29.5% of cases, a definitive diagnosis could not be determined, but lists of probable diagnoses were given and case management plans were given. The three consultant dermatologists could not provide diagnoses for only 7.3% of the patients.

The diseases of the patients receiving definite diagnoses are listed in Supplementary Table 2. Eczema was the most common disorder in 33.8% of the cases, followed by cutaneous infection (14.5%) and autoimmune and connective tissue diseases (8.6%). The main reason given by the dermatologists for not making a diagnosis (Table 2) was problems with the photographic technique used. Predominant were the lack of a close-up shot (31.3%) and defocusing (25.0%).

As shown in Table 3, there were no statistically significant differences in the age at onset, duration of symptoms, or consultation setting of the different dermatologist decision-making groups. However, in terms of disease morphology, eczematous lesions were significantly more frequent in patients with a definitive diagnosis (30.2%) than in those with probable (15.4%) and no (12.5%) diagnoses (probability value [P] = 0.037). Additionally, we demonstrated a statistically significant difference between the focus of images and the decision-making of the dermatologists. Defocus was found in 37.5% of the cases without any diagnosis, 24.6% of the probable diagnosis group, and 10.1% of the definite diagnosis group (P = 0.002).

According to Table 4, we evaluated 385 body region images captured by primary-care physicians. The common technical errors with the photographs were the lack of a close-up view (61.3%) and inadequate lighting (55.6%). Relative to the other areas of the body, the photographs of peripheral areas had a significantly higher proportion with distortion (P < 0.001), improper framing (P < 0.001), wasted space (P < 0.001), and improper background (P = 0.005). However, photographs from the truncal region had a significantly higher proportion with poor lighting than those from other regions (P < 0.001). Head and neck photographs lacked an overview shot (P = 0.049). Moreover, defocusing and lack of overview photographs were more common in the OPD setting than the inpatient setting (37.8% versus 25.9% [P = 0.046]; and 14.8% versus 4.9% [P = 0.018]). The photographs of patients under 5 years of age tended to have more wasted space than those of children over 5 (61.5% versus 38.0 %; P = 0.018).

TABLE 2. Reason for inability to provide diagnosis, as given by the dermatologists.

Reason for ambiguous diagnosis[†]	Number of patients n = 16 (%)
Photographic techniques	11/16 (68.8)
No close-up shot	5/16 (31.3)
Defocusing	4/16 (25.0)
Need additional photos from specific area	3/16 (18.8)
Distortion	2/16 (12.5)
Inadequate lighting	1/16 (6.3)
Disease-related factors	7/16 (43.8)
Evolution of the lesions	5/16 (31.3)
Need more physical examination	2/16 (12.5)

[†]One case could have more than one cause of ambiguous diagnosis.

TABLE 3. Factors effecting dermatologists' decision-making to give diagnoses.

	Definite diagnosis n = 139 (%)	Probable diagnoses n = 65 (%)	Unable to provide diagnosis n = 16 (%)	*P*
Mean age ± SD (years)	42.89 ± 22.22	40.02 ± 24.17	37.29 ± 18.47	0.482
Median duration of disease (IQR; months)	1.00 (0.22 – 3.00)	0.75 (0.22 – 6.00)	1.75 (0.22 – 10.50)	0.709
Consultation setting				
Outpatient	118 (84.9)	50 (76.9)	13 (81.3)	0.379
Inpatient	21 (15.1)	15 (23.1)	3 (18.8)	
Disease morphology				
Eczematous lesions	42 (30.2)	10 (15.4)	2 (12.5)	0.037*
Erythematous lesions	41 (29.5)	23 (35.4)	6 (37.5)	0.617
Tumor, nodule, and plaque	16 (11.5)	10 (15.4)	3 (18.8)	0.592
Vesiculobullous lesions	11 (7.9)	4 (6.2)	2 (12.5)	0.689
Pustular lesions	10 (7.2)	3 (4.6)	1 (6.3)	0.905
Hair and nail lesions	7 (5.0)	4 (6.2)	0 (0.0)	0.787
Papulosquamous lesions	5 (3.6)	3 (4.6)	0 (0.0)	0.844
Ulcer and erosion	4 (2.9)	4 (6.2)	1 (6.3)	0.305
Hyperpigmentation	3 (2.2)	4 (6.2)	1 (6.3)	0.243
Photographic techniques of the representative images				
Defocusing	14 (10.1)	16 (24.6)	6 (37.5)	0.002*
No close-up photo	71 (51.1)	31 (47.7)	9 (56.3)	0.805
Inadequate lighting	60 (43.2)	31 (47.7)	7 (43.8)	0.830
Improper background	54 (38.8)	27 (41.5)	4 (25.0)	0.475
Wasted space	37 (26.6)	15 (23.1)	6 (37.5)	0.499
Improper framing	20 (14.4)	13 (20.0)	3 (18.8)	0.580
No overview photo	20 (14.4)	13 (20.0)	2 (12.5)	0.551
Improper white balance	9 (6.5)	6 (9.2)	0 (0.0)	0.566
Inadequate color saturation	6 (4.3)	5 (7.7)	1 (6.3)	0.480
Distortion	4 (2.9)	1 (1.5)	2 (12.5)	0.132

* $P < 0.05$ indicates statistical significance, Chi^2 test.

Abbreviations: IQR, interquartile range; SD, standard deviation

TABLE 4. Factors associated with photographic technical errors.

Photographic techniques	Total	Body regions			*P*	Consultation setting		*P*-value	Age group (years)		*P*
		Head /neck n (%)	Trunk n (%)	Peri pheral n (%)		OPD n (%)	IPD n (%)		0–5 n (%)	≥ 6 n (%)	
	385	**99**	**98**	**188**		**304**	**81**		**26**	**342**	
Inadequate lighting	214 (55.6)	50 (50.5)	73 (74.5)	91 (48.4)	<0.001*	169 (55.6)	45 (55.6)	0.955	18 (69.2)	186 (54.4)	0.142
Wasted space	154 (40.0)	28 (28.3)	12 (12.2)	114 (60.6)	<0.001*	121 (39.8)	33 (40.7)	0.878	16 (61.5)	130 (38.0)	0.018*
Improper framing	97 (25.2)	11 (11.1)	10 (10.2)	76 (40.4)	<0.001*	76 (25.0)	21 (25.9)	0.865	9 (34.6)	86 (25.1)	0.287
Distortion	25 (6.5)	0 (0.0)	1 (1.0)	24 (12.8)	<0.001*	21 (6.9)	4 (4.9)	0.523	0 (0.0)	25 (7.3)	0.239
Improper background	163 (42.3)	37 (37.4)	31 (31.6)	95 (50.5)	0.005*	121 (39.8)	42 (51.9)	0.051	12 (46.2)	147 (43.0)	0.753
No overview photos	49 (12.7)	19 (19.2)	13 (13.3)	17 (9.0)	0.049*	45 (14.8)	4 (4.9)	0.018*	3 (11.5)	43 (12.6)	1.000
Out of focus	136 (35.3)	28 (28.3)	35 (35.7)	73 (38.8)	0.205	115 (37.8)	21 (25.9)	0.046*	12 (46.2)	123 (36.0)	0.299
No close-up view	236 (61.3)	58 (58.6)	61 (62.2)	117 (62.2)	0.813	190 (62.5)	46 (56.8)	0.348	18 (69.2)	207 (60.5)	0.380
Improper white balance	34 (8.8)	12 (12.1)	6 (6.1)	16 (8.5)	0.325	26 (8.6)	8 (9.9)	0.709	1 (3.8)	31 (9.1)	0.714
Inadequate color saturation	23 (6.0)	6 (6.1)	6 (6.1)	11 (5.9)	0.995	15 (4.9)	8 (9.9)	0.113	2 (7.7)	20 (5.8)	0.662

* $P < 0.05$ indicates statistical significance, Chi^2 test.

Abbreviations: IPD, inpatient department; OPD, outpatient department

DISCUSSION

In the situation of a limited number of dermatologists, waiting times for face-to-face consultations are likely to become extended. Moreover, with a steadily growing population, dermatologists will likely face pressure to expand their services.[9] Teleconsultation is a promising solution in these scenarios. Our data confirmed its benefits as our three consulting dermatologists could provide definite or probable diagnoses and management plans in most cases.

From our literature review, the quality of photographs affects the accuracy of diagnoses.[6,7] We found that focus was the most critical factor since good focus was the only domain significantly associated with the ability to make a definitive diagnosis in our study. This finding underscores the need to have high-quality images for teleconsultation. It is recommended to use the flash function to avoid shadows, improve exposure, and obtain better focused and more detailed photographs than otherwise. The need for the flash function is especially critical in low-light areas such as the oral cavity (Fig 1).[12,16,17] However, a loss of morphological features could occur if the flashlight is placed too close to lesions.[16-18] Furthermore, photographs should reveal the distribution of the lesions and their associated anatomical structures. The morphological details of the lesions should also be obtained through a well-lit and focused close-up shot.[16,17]

Other techniques that should be considered are lighting, background, wasted space, framing, distortion, white balance, and color saturation. Diffused and broad-spectrum lighting is appropriate, and the light source should be oblique to the skin surface.[11,16] Natural light can vary in intensity and color. While the light from a camera flash is more consistent, it can cause reflection, especially in scalp and nail photographs.[11,19] Regarding background, patient-identifiable objects and distracting elements such as jewelry should be removed, and solid non-reflective backgrounds are preferable.[11,12,16-18] In terms of framing, an orientation following the direction of the body area is recommended to eliminate wasted space in the background (i.e., horizontal and vertical orientation for the chin and legs, respectively).[12] To take a picture of fingernails, we suggest that patients flex all fingers to bring the fingertips together (Fig 2).[20] Next, distortion is expected in the photograph from a mobile phone due to the automatic wide-angle camera setting. To prevent distortion, it is recommended to zoom in slightly and move backward until the image fits the frame, with the camera placed perpendicular to the photographic plane.[12] For color temperature, the skin tone might appear red in warm light, whereas a cool tone will decrease redness. Therefore, a non-neutral white balance can interfere with the diagnosis of erythematous lesions. Finally, a preset filter that affects color tone and saturation should be avoided.

Fig 1. Using a camera flash for the photographs avoids shadows and provides improved exposure results in more detailed photos, especially in low-light areas such as the oral cavity. Fig 1A demonstrates a blurry photo with poor light exposure, in which the lesion could not be identified. Fig 1B shows a focused and appropriately exposed image with the use of the camera flash.

Fig 2. Nail photography. Flexing the fingers at the proximal interphalangeal joints in order to bring all of the fingertips toward the palm will demonstrate the distribution of lesions in nail disorders.

We also analyzed factors associated with poor photographic techniques. Body regions seemed to have the most effect on photographic quality. The peripheral areas were more likely to have distortion, improper framing, wasted space, and improper background. On the other hand, truncal regions tended to have lighting problems. The photographs from the inpatient consultations frequently had inappropriate backgrounds. This finding was partly because of the more distracting elements found in the inpatient setting versus the OPD setting. However, the difference was nonsignificant. The OPD setting was associated with a lack of overview and defocusing. Possibly, this was due to the enormous number of patients visiting the OPD of primary care hospitals in Thailand, making it challenging to take high-quality images. Finally, wasted space was more frequent in pictures of patients under 5 years of age than in older patients. This finding would have resulted from the smaller body sizes of the younger patients. All of the factors above should be considered when taking photographs for teledermatology.

Finally, previous studies reported dermatitis, psoriasis, tumors, and onychomycosis as common consultation problems, with a lower frequency of cases with erythematous morphology (such as urticarial lesions).[21-23] However, the typical morphology in our subjects was erythematous, followed by eczematous and tumoral or nodular lesions. As a result, more education on eczematous, tumoral, and especially erythematous lesions would be advantageous.

In terms of patient confidentiality, patient consent for photography from referring general practitioners was mentioned in only 5% of cases. In most Thai hospitals, there were no standardized forms for obtaining patient consent for photography. Given the existence of the Personal Data Protection Act in Thailand, physicians should be more conscientious about obtaining documented consent for photography.

The main limitation of this study was related to the image-quality checklist. Even though we based it on various established guidelines, there was a lack of standardized criteria for assessing photographic quality. More specifically, there were no prescribed criteria to determine whether individual photographs are acceptable for each domain (overview photographs, close-ups, focus, lighting, background, framing, and orientation, wasted space, perspective distortion, color saturation, and white balance). Another limitation was the broad spectrum of the information with various dermatologic conditions. Consultant experience also was a factor influencing the success of teledermatology but this study faced challenges in collecting relevant data. Collecting such data could prove beneficial in future research.

In conclusion, teleconsultation can increase patient access to dermatologists, especially in facilities without specialists. When mobile phones are used for teledermatology, good camera focus is the most important photographic technique. An acceptable image quality can enhance the diagnostic accuracy of dermatologists.

ACKNOWLEDGMENTS

We thank Assistant Professor Chulaluk Komoltri for help with the data analyses. We are also indebted to Mr. David Park for the English-language editing of this paper.

Conflict of Interest

All authors declare that there are no conflicts of interest related to this study.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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