

Viewpoint

Teledermatology: Comparison of Store-and-Forward Versus Live Interactive Video Conferencing

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Abstract

A decreasing number of dermatologists and an increasing number of patients in Western countries have led to a relative lack of clinicians providing expert dermatologic care. This, in turn, has prolonged wait times for patients to be examined, putting them at risk. Store-and-forward teledermatology improves patient access to dermatologists through asynchronous consultations, reducing wait times to obtain a consultation. However, live video conferencing as a synchronous service is also frequently used by practitioners because it allows immediate interaction between patient and physician. This raises the question of which of the two approaches is superior in terms of quality of care and convenience. There are pros and cons for each in terms of technical requirements and features. This viewpoint compares the two techniques based on a literature review and a clinical perspective to help dermatologists assess the value of teledermatology and determine which techniques would be valuable in their practice.

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KEYWORDS

teledermatology; live video conferencing; store-and-forward teledermatology; mobile phone; wait time; live interactive

Introduction

Background

Teledermatology, originating in 1995, was one of the first telemedicine services to be implemented, with other medical specialties following later [1-3]. Aging populations and a relative lack of dermatologists have prolonged wait times in the Western world, increasing the demand for new, more efficient strategies

to render dermatologic care [4]. Mobile phones have overcome the image resolution limitations seen with older devices, opening a new field of mobile teledermatology, with two approaches in use. Store-and-forward (SAF) teledermatology allows transmission of images and text to a clinician for review. Live video conferencing (LVC), on the other hand, allows patient and physician to meet virtually at the same time using a webcam or mobile phone camera.

Determination of Diagnostic Accuracy

Introducing any new diagnostic method in patient care requires testing to ensure the diagnostic accuracy is at least comparable to the accepted standard. Evaluating diagnostic accuracy in dermatology is quite complex. A clinical diagnosis made by a specialist of a lesion as benign is accepted as the reference standard. When a biopsy is performed, however, the reference standard is clearly the histopathology result. Yet even among pathologists, there may be considerable discord in distinguishing between melanoma and benign melanocytic lesions. A review of 392 cases in 2010 in the United States revealed discordant results between pathologists in 14.3% of cases [5]. A 2016 study from another US center indicated discord in 114 of 588 cases (19.4%) [6]. Given the level of disagreement between histopathologists, including those specializing in dermatohistopathology, studies investigating the diagnostic accuracy of a new method, compared with current standards, must be interpreted cautiously [5-7]. Misdiagnosis obviously can have serious impact on patients, but it also complicates studies of newer diagnostic methods.

Diagnostic Accuracy of Tele dermatology

A 2016 review systematically analyzed 21 studies, comparing tele dermatology diagnoses using SAF or LVC with results of histopathology or, for nonexcised lesions, clinical diagnoses from face-to-face (FTF) encounters [8]. Overall, FTF diagnosis performed slightly better (67% to 85% agreement with the reference standard, Cohen kappa=0.90) compared with tele dermatology (51% to 85% agreement, kappa=0.41–0.63) for the diagnosis of skin cancer. However, several studies have reported tele dermatology is more accurate, in some cases even better than in FTF encounters, perhaps because of the improved resolution of mobile phone cameras [9,10].

In the case of skin cancer, timely management is crucial. A review of 3 studies by Finnance et al [8] reported significantly shorter wait times for melanoma patients assessed by SAF mobile phone technology [11,12] compared with conventional procedures. Patients who were referred using tele dermatology triage systems tended to receive primary treatment at the first dermatology appointment and required fewer repeat visits [11,12]. We found no data for LVC on this aspect.

Diagnostic Accuracy With Mobile Phone Dermoscopes

While dermoscopic evaluation is the clinical practice gold standard for FTF visits and has been proven to increase diagnostic accuracy [13], tele dermatology requires the patient to purchase a dermoscope to use with a mobile phone even though it may not necessarily be superior to tele dermatology alone. In a landmark publication in 2011, Krömer et al [14] reported that tele dermatology had a very high sensitivity and specificity for both malignant melanocytic lesions (sensitivity, 100%; specificity, 97% to 98%; n=6) and malignant nonmelanocytic lesions (sensitivity, 97%; specificity, 92% to 94%, n=58). There was no significant difference between the clinical and dermoscopic diagnoses based on histopathology as the reference standard. The authors reported that, in terms of

detailed diagnoses, there were only 16 discordant diagnoses with tele dermatology versus 22 with tele dermatology [14]. A study by Senel et al [15] found that management plans based on tele dermatology did not differ significantly from those developed in a FTF encounter, although the accuracy was significantly improved with a mobile phone dermoscope. Further study will help determine what, if any, value is added by tele dermatology.

General Skin Conditions

A number of tele dermatology studies have focused on any visible skin condition, including a large proportion of nonmalignant lesions that were not biopsied. In these studies, the reference standard was the clinical diagnosis in a FTF visit, so diagnostic concordance conclusions were limited. Overall, however, both original studies and reviews confirm improved tele dermatology diagnostic accuracy, particularly because of improved digital image resolution. These investigators conclude that tele dermatology now had a diagnostic accuracy comparable to that in a FTF encounter [9,16,17].

Discussion

Comparison of Store-and-Forward and Live Video Conferencing

Data on direct comparisons of SAF and LVC in terms of diagnostic accuracy remain scarce [8]. A 2017 study of 214 patients examined video image resolution, assessing several tele dermatology formats for concordance with FTF examination as the reference standard. SAF and uncompressed video results were similar and were significantly better than lower resolution compressed video [18]. Uncompressed video may, therefore, close the resolution gap between LVC and SAF methods, although it requires the user to have a faster internet connection.

Comparison of Requirements for Store-and-Forward and Live Video Conferencing

SAF and LVC have different requirements which, in turn, affect their suitability for different patient subgroups and ultimate benefit in terms of care [16]. SAF has a number of advantages over LVC in terms of equipment and timing (Table 1), such that it may be preferable in more settings.

Interpretation of Requirements

SAF appears preferable for both the patient and dermatologist in terms of equipment and time requirements. This would particularly be the case in areas where a fast or stable internet connection is unavailable. SAF, therefore, would likely increase the number of patients for whom tele dermatology is available. It might also attract more clinicians to engage in it, since it offers more flexibility than either routine care or LVC. Hook et al [19] noted a particular advantage of the anonymity available with SAF tele dermatology, as patients with lesions in sensitive areas (eg, from sexually transmitted diseases) may not be willing to identify themselves to a doctor, potentially delaying diagnosis and treatment.

Table 1. Advantages of store-and-forward over live video conferencing in tele dermatology.

Requirements	Store-and-forward	Live video conferencing
Availability of internet connection	Can be prepared without internet (ie, photos, history) and uploaded or downloaded at any time.	Simultaneous and continuous internet connection is required for both parties.
Speed of internet connection	Internet speed unimportant.	Slow internet speed may lessen diagnostic accuracy.
Appointment	No appointment necessary as evaluation is asynchronous.	Appointment required for synchronous evaluation.
Webcam or mobile phone camera	Useful but not required. Pictures may be on file or taken with any device.	Webcam or mobile phone camera required for both parties for entire session.
Personal identification	Anonymous access possible.	Identification required for face-to-face consultation.

Table 2. Features of store-and-forward and live video conferencing for tele dermatology.

Features	Store-and-forward	Live video conferencing
Diagnostic accuracy	Higher for store-and-forward compared with that for low-resolution live video conferencing. ^a	Equally high if high-resolution live video conferencing is used. ^a
Physician-patient interaction	Usually low. Physician response may include asking for more information or other images by text.	Physician can directly ask the patient to perform certain tasks or show certain body regions.
Image resolution	Resolution of photographic images is usually higher.	Video images usually have a lower resolution.
3-dimensional view	Not possible for static images.	Live video feed allows clinician to view lesions from various angles.
Webcam or mobile phone camera	Useful but not required, as pictures may be taken with any device.	Webcam or mobile phone camera is required for both parties for entire session.
Free choice of location	Full flexibility.	Bound to locations with a fast internet connection and appropriate equipment.
Free choice of time	Full flexibility.	Bound to scheduled appointment.
Teledermoscopy	Often conducted. ^b	No published literature.
Wait time	Reduced.	No data.
Cost effectiveness	Higher.	Lower.
Security of data transmission	Most commonly transport layer security protocol (end-to-end encryption)	Most commonly transport layer security protocol (end-to-end encryption)

^aDepends on setting, reference standard, and technology.

^bData on increased diagnostic accuracy inconclusive.

Comparison of Features of Store-and-Forward and Live Video Conferencing

Tele dermatology method preferences may depend on the particular features (Table 2) desired by dermatologists and patients.

In regions where many households have no broadband internet connection, such as Germany and Switzerland, SAF is preferable over LVC because of higher diagnostic accuracy [18]. Inner cities offer a better availability of broadband internet connection than rural areas. In regard to an aging population, this aspect should be reinforced as the average age of the population in rural areas is higher which leads to an increased demand for accessible dermatologic care. In addition, SAF offers more time independence for both patient and clinician, letting older people take their time in setting up the technology before sending in their case. Interaction between patient and clinician about SAF images depends on the software used. In some cases, the dermatologist can chat with the patient to ask questions after

reviewing the images. The fact that LVC allows synchronous interaction does not appear to increase its diagnostic accuracy over SAF, even with high-resolution LVC [18]. SAF image resolution is higher and can include teledermoscopy. In fact, a systematic review showed SAF did no harm or even improved accuracy in diagnosing skin cancer [20]. Patients at high risk of melanoma are reportedly very accepting of teledermoscopy [21]. While SAF imaging is not currently available in 3D, sensor-in-motion technology that transfers a stored high-definition video along with standard images may become available. Even static images are useful if they are taken from at least two different angles. From a cost effectiveness standpoint, both methods have been shown to reduce costs, but LVC has been found to be more expensive than an SAF approach due to the need for expensive video conference equipment and more consultation time [22]. With regard to patient comfort, 18% of patients reported feeling uncomfortable and 17% reported feeling embarrassed during LVC [23]. However, in some cases SAF patients reported dissatisfaction with the absence of a face-to-face office visit with a

dermatologist and when being photographed by another person [24].

Conclusion

The authors regard SAF as the standard of care for teledermatology. It is well supported by evidence in the literature

and available to more patients than LVC (in terms of both location and equipment), offers greater privacy, reduces wait times, improves access to care, and provides both clinicians and patients greater flexibility than traditional clinic visits. Nonetheless, teledermatology is complementary to and not a replacement of FTF clinical encounters.

Conflicts of Interest

TJB is the owner of a health technology company (Smart Health Heidelberg GmbH).

References

- Nami N, Giannini E, Burrioni M, Fimiani M, Rubegni P. Teledermatology: state-of-the-art and future perspectives. *Expert Rev Dermatol* 2014 Jan 10;7(1):1-3. [doi: [10.1586/edm.11.79](https://doi.org/10.1586/edm.11.79)]
- Trettel A, Eissing L, Augustin M. Telemedicine in dermatology: findings and experiences worldwide—a systematic literature review. *J Eur Acad Dermatol Venereol* 2018 Feb;32(2):215-224. [doi: [10.1111/jdv.14341](https://doi.org/10.1111/jdv.14341)] [Medline: [28516492](https://pubmed.ncbi.nlm.nih.gov/28516492/)]
- Fabbrocini G, De Vita V, Pastore F, D'Arco V, Mazzella C, Annunziata M, et al. Teledermatology: from prevention to diagnosis of nonmelanoma and melanoma skin cancer. *Int J Telemed Appl* 2011;2011:125762 [FREE Full text] [doi: [10.1155/2011/125762](https://doi.org/10.1155/2011/125762)] [Medline: [21776252](https://pubmed.ncbi.nlm.nih.gov/21776252/)]
- Coates SJ, Kvedar J, Granstein RD. Teledermatology: from historical perspective to emerging techniques of the modern era: part I: history, rationale, and current practice. *J Am Acad Dermatol* 2015 Apr;72(4):563-575. [doi: [10.1016/j.jaad.2014.07.061](https://doi.org/10.1016/j.jaad.2014.07.061)] [Medline: [25773407](https://pubmed.ncbi.nlm.nih.gov/25773407/)]
- Shoo BA, Sagebiel RW, Kashani-Sabet M. Discordance in the histopathologic diagnosis of melanoma at a melanoma referral center. *J Am Acad Dermatol* 2010 May;62(5):751-756. [doi: [10.1016/j.jaad.2009.09.043](https://doi.org/10.1016/j.jaad.2009.09.043)] [Medline: [20303612](https://pubmed.ncbi.nlm.nih.gov/20303612/)]
- Patrawala S, Maley A, Greskovich C, Stuart L, Parker D, Swerlick R, et al. Discordance of histopathologic parameters in cutaneous melanoma: clinical implications. *J Am Acad Dermatol* 2016 Jan;74(1):75-80. [doi: [10.1016/j.jaad.2015.09.008](https://doi.org/10.1016/j.jaad.2015.09.008)] [Medline: [26514601](https://pubmed.ncbi.nlm.nih.gov/26514601/)]
- Heal C, Weedon D, Raasch B, Hill B, Buettner PG. Agreement between histological diagnosis of skin lesions by histopathologists and a dermato-histopathologist. *Int J Dermatol* 2009 Dec;48(12):1366-1369. [doi: [10.1111/j.1365-4632.2009.04185.x](https://doi.org/10.1111/j.1365-4632.2009.04185.x)] [Medline: [19930494](https://pubmed.ncbi.nlm.nih.gov/19930494/)]
- Finnane A, Dallest K, Janda M, Soyer HP. Teledermatology for the diagnosis and management of skin cancer: a systematic review. *JAMA Dermatol* 2017 Mar 01;153(3):319-327. [doi: [10.1001/jamadermatol.2016.4361](https://doi.org/10.1001/jamadermatol.2016.4361)] [Medline: [27926766](https://pubmed.ncbi.nlm.nih.gov/27926766/)]
- Nami N, Massone C, Rubegni P, Cevenini G, Fimiani M, Hofmann-Wellenhof R. Concordance and time estimation of store-and-forward mobile teledermatology compared to classical face-to-face consultation. *Acta Derm Venereol* 2015 Jan;95(1):35-39 [FREE Full text] [doi: [10.2340/00015555-1876](https://doi.org/10.2340/00015555-1876)] [Medline: [24889827](https://pubmed.ncbi.nlm.nih.gov/24889827/)]
- van der Heijden J, Thijssing L, Witkamp L, Spuls P, de Keizer NF. Accuracy and reliability of teledermatoscopy with images taken by general practitioners during everyday practice. *J Telemed Telecare* 2013 Sep;19(6):320-325. [doi: [10.1177/1357633X13503437](https://doi.org/10.1177/1357633X13503437)] [Medline: [24163296](https://pubmed.ncbi.nlm.nih.gov/24163296/)]
- Börve A, Dahlén GJ, Terstappen K, Johansson BE, Aldenbratt A, Danielsson M, et al. Smartphone teledermoscopy referrals: a novel process for improved triage of skin cancer patients. *Acta Derm Venereol* 2015 Feb;95(2):186-190 [FREE Full text] [doi: [10.2340/00015555-1906](https://doi.org/10.2340/00015555-1906)] [Medline: [24923283](https://pubmed.ncbi.nlm.nih.gov/24923283/)]
- Morton C, Downie F, Auld S, Smith B, van der Pol M, Baughan P, et al. Community photo-triage for skin cancer referrals: an aid to service delivery. *Clin Exp Dermatol* 2011 Apr;36(3):248-254. [doi: [10.1111/j.1365-2230.2010.03960.x](https://doi.org/10.1111/j.1365-2230.2010.03960.x)] [Medline: [21070338](https://pubmed.ncbi.nlm.nih.gov/21070338/)]
- Salerni G, Terán T, Puig S, Malvey J, Zalaudek I, Argenziano G, et al. Meta-analysis of digital dermoscopy follow-up of melanocytic skin lesions: a study on behalf of the International Dermoscopy Society. *J Eur Acad Dermatol Venereol* 2013 Jul;27(7):805-814. [doi: [10.1111/jdv.12032](https://doi.org/10.1111/jdv.12032)] [Medline: [23181611](https://pubmed.ncbi.nlm.nih.gov/23181611/)]
- Kroemer S, Frühauf J, Campbell TM, Massone C, Schwantzer G, Soyer HP, et al. Mobile teledermatology for skin tumour screening: diagnostic accuracy of clinical and dermoscopic image tele-evaluation using cellular phones. *Br J Dermatol* 2011 May;164(5):973-979. [doi: [10.1111/j.1365-2133.2011.10208.x](https://doi.org/10.1111/j.1365-2133.2011.10208.x)] [Medline: [21219286](https://pubmed.ncbi.nlm.nih.gov/21219286/)]
- Senel E, Sabancılar E, Mansuro lu C, Demir E. A preliminary study of the contribution of telemicroscopy to the diagnosis and management of skin tumours in teledermatology. *J Telemed Telecare* 2014 Jun;20(4):178-183. [doi: [10.1177/1357633X14533885](https://doi.org/10.1177/1357633X14533885)] [Medline: [24786415](https://pubmed.ncbi.nlm.nih.gov/24786415/)]
- Augustin M, Wimmer J, Biedermann T, Blaga R, Dierks C, Djamei V, et al. [Praxis der Teledermatologie]. *J Dtsch Dermatol Ges* 2018 Jul;16(Suppl 5):6-57. [doi: [10.1111/ddg.13512](https://doi.org/10.1111/ddg.13512)] [Medline: [29998512](https://pubmed.ncbi.nlm.nih.gov/29998512/)]
- Warshaw E, Hillman Y, Greer N, Hagel E, MacDonald R, Rutks I, et al. Teledermatology for diagnosis and management of skin conditions: a systematic review. *J Am Acad Dermatol* 2011 Apr;64(4):759-772. [doi: [10.1016/j.jaad.2010.08.026](https://doi.org/10.1016/j.jaad.2010.08.026)] [Medline: [21036419](https://pubmed.ncbi.nlm.nih.gov/21036419/)]

18. Marchell R, Locatis C, Burges G, Maisiak R, Liu W, Ackerman M. Comparing high definition live interactive and store-and-forward consultations to in-person examinations. *Telemed J E Health* 2017 Dec;23(3):213-218 [FREE Full text] [doi: [10.1089/tmj.2016.0093](https://doi.org/10.1089/tmj.2016.0093)] [Medline: [27705083](https://pubmed.ncbi.nlm.nih.gov/27705083/)]
19. Hook EW, Richey CM, Leone P, Bolan G, Spalding C, Henry K, et al. Delayed presentation to clinics for sexually transmitted diseases by symptomatic patients: a potential contributor to continuing STD morbidity. *Sex Transm Dis* 1997 Sep;24(8):443-448. [Medline: [9293606](https://pubmed.ncbi.nlm.nih.gov/9293606/)]
20. Bruce A, Mallow J, Theeke L. The use of teledermoscopy in the accurate identification of cancerous skin lesions in the adult population: a systematic review. *J Telemed Telecare* 2018 Feb;24(2):75-83. [doi: [10.1177/1357633X16686770](https://doi.org/10.1177/1357633X16686770)] [Medline: [28056600](https://pubmed.ncbi.nlm.nih.gov/28056600/)]
21. Horsham C, Loescher LJ, Whiteman DC, Soyer HP, Janda M. Consumer acceptance of patient-performed mobile teledermoscopy for the early detection of melanoma. *Br J Dermatol* 2016 Dec;175(6):1301-1310. [doi: [10.1111/bjd.14630](https://doi.org/10.1111/bjd.14630)] [Medline: [27037999](https://pubmed.ncbi.nlm.nih.gov/27037999/)]
22. Loane M, Bloomer S, Corbett R, Eedy D, Hicks N, Lotery H, et al. A comparison of real-time and store-and-forward teledermatology: a cost-benefit study. *Br J Dermatol* 2000 Dec;143(6):1241-1247. [Medline: [11122028](https://pubmed.ncbi.nlm.nih.gov/11122028/)]
23. Whited JT. Teledermatology: current status and future directions. *Am J Clin Dermatol* 2001;2(2):59-64. [Medline: [11705304](https://pubmed.ncbi.nlm.nih.gov/11705304/)]
24. Williams TL, Esmail A, May CR, Griffiths CE, Shaw NT, Fitzgerald D, et al. Patient satisfaction with teledermatology is related to perceived quality of life. *Br J Dermatol* 2001 Dec;145(6):911-917. [Medline: [11899144](https://pubmed.ncbi.nlm.nih.gov/11899144/)]

Abbreviations

FTF: face-to-face

SAF: store-and-forward

LVC: live video conferencing

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