Teledermatology and Teledermoscopy: Old Technology Just Waiting to be Exploited

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Over two decades have passed since the first publications on store-and-forward teledermatology (TD) (1) and teledermoscopy (TDS) (2) were presented as feasible and useful applications within telemedicine. The fact that our specialty was chosen as one of the primary targets for electronic teleconsultations was not surprising since the absolute majority of dermatological conditions are visible on the skin surface allowing for digital photographic documentation. The electronic transmission of such images together with clinical information between remote parties for the improvement of patient management has since then been evaluated in an exponentially increasing number of clinical settings and studies (Fig. 1). Recent reviews have shown that TD and TDS avoid unnecessary visits and reduce waiting times, resulting in earlier assessments and treatment, improved cost-effectiveness and a high degree of satisfaction among both patients and users (3–5).

In the beginning, images were sent via e-mail, but the true revolution started with the arrival of high-resolution cameras in smartphones and user-friendly app software about 10 years ago. Personally, I got involved in TD and TDS just before Apple launched their first iPhone® with third-party apps in 2008. At that time, my doctoral student Alexander Börve and I started working on the idea of mobile TD using images taken with a Sony Ericsson K800 (Sony Ericsson, Lund, Sweden) mobile phone with a built-in digital camera and sent to dermatologists via multimedia messaging service (MMS). Despite the small image size of 680 × 420 pixels, the images and added clinical information in the messages was enough to provide adequate triage decisions by two dermatologists separately in 85% and 95% of the cases (n=40), respectively (6).

We soon realized, however, that smartphone apps were bound to become the future of mobile TD and TDS and were the first group to create and successfully test a smarthphone app for store-and-forward TD and TDS in 2011 (7). One year later, we tested an improved version of this same app (Fig. 2) in a real-life scenario for patients referred for a suspicion of skin cancer from 20 primary care centres to two dermatology departments in a rural and an urban setting, respectively. We compared the triage decisions made upon assessing 746 traditional referral letters without images with those of 816 smartphone TDS referrals containing one clinical and one dermoscopic image together with a standardised clinical history. The triage decisions with TDS were more reliable, >40% of the patients could potentially have avoided face-to-face visits and patients with confirmed skin cancer received faster and more efficient management (8). In 2013, our app was awarded Dagens Medicin's prestigious "Gold Scalpel" award for innovation of the year in Swedish health care (Fig. 3).

In order to study the safety, advantages and disadvantages of TDS for triage of skin cancer referrals, we designed a study to look further at the diagnostic agreement and the interobserver concordance when more than one teledermatologist was making the assessments. For this, we used referral information

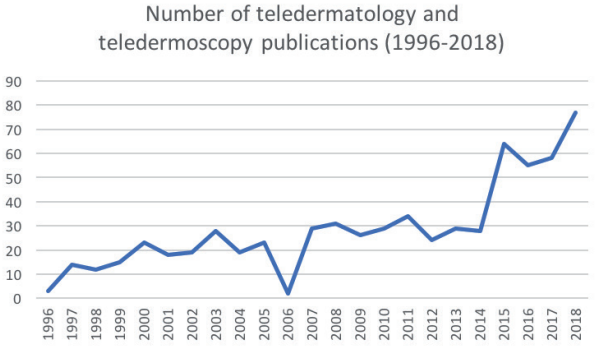

Fig. 1. The continually increasing number of publications on teledermatology and teledermoscopy between 1996 and 2018 (PubMed data).

Fig. 2. Images of the first smartphone app for TDS (iDoc24® PRO), which used a digital dermoscope (Handyscope®, Fotofinder®) coupled with an iPhone® 4.

Fig. 3. Most members of our teledermatology and teledermoscopy research group were present when we received Dagens Medicin's "Gold Scalpel" award for innovation of the year in Swedish health care for our smartphone app for mobile teledermoscopy referrals in 2013.

from 80 TDS referrals and 77 paper referrals from the previous trial and asked 6 Swedish dermatologists to evaluate them and provide a probable diagnosis, the priority of the case and a management decision. TDS allowed for higher diagnostic agreement, better triage decisions and more patients with skin cancer booked directly to surgery when needed (especially in the cases of invasive melanoma). Furthermore, TDS resulted in significantly more patients with benign lesions being resent to primary health care avoiding unnecessary visits. On the other hand, 5 assessments made on feature-poor melanoma *in situ* lesions were incorrectly prioritised by teledermoscopists in this study. It is therefore essential to be generous in offering face-to-face visits when assessing TDS referrals for melanocytic lesions, even if they are just slightly atypical. Finally, the interobserver concordance was found to be moderate with both TDS and paper referrals (9).

Finally, we also studied the quality of clinical and dermoscopic images acquired by primary care physicians with little or no training using an iPhone® 4 (Apple, Cupertino, California, USA) and a compatible digital dermoscope (Handyscope®, FotoFinder® Systems GmbH, Bad Birnbach, Germany) to images of the same lesions taken by dermatologists and trained nurses at a Dermatology department using a Canon EOS D550 camera (Canon Inc., Tokyo, Japan) together with a Heine D20 dermoscope (Heine Optotechnik GmbH & Co., Herrsching, Germany). When assessing the image quality of the two image sets of the 172 included tumours, images taken by primary health care physicians and those obtained at the Dermatology department were of intermediate to high quality in the absolute majority of cases (95.5–97.7% and 96.5–98.8%, respectively). Moreover, no significant differences in the diagnoses made based on the two image sets were seen and most image pairs received the same main diagnosis by the two evaluators (81.4% and 83.7%, respectively) (10).

Since our early publications and lectures promoting TDS, many Dermatology departments in Sweden have started to implement similar systems to improve their triaging of referrals from primary care. The Regions of Västerbotten (Umeå) and Gävleborg (Gävle) were two of the first regions to implement similar digital, although not app-based, solutions for TD and TDS, also making it mandatory for primary care physicians to send digital images with their referrals to Dermatology departments. In the region of Stockholm, a copy of our original smartphone app has been used in pilot studies during the past few years and has unsurprisingly shown the same benefits demonstrated by our group initially. And, as the years go by, an increasing number of regions in Sweden are catching on to the idea. Sadly, in our own region of Västra Götaland, a digital solution for TD and TDS was not implemented until March of 2018 and is still only available for about 50% of the region's primary care centres. On a brighter note, discussions are ongoing at a national level with the clear goal of imple-

menting digital solutions to allow for TD and TDS for all Swedish patients in the near future.

Conclusion

TD and TDS for improved referral triage is here to stay regardless of the digital system used to implement the technique. Those of us who have worked with TD and TDS could never imagine working in a health care system in which it was not available. It is a pity that implementation has been so slow up until now, but a positive trend towards problem-solving seems to be growing. The technology has been around for what seems like an eternity. Now, we just need politicians, bureaucrats and IT "experts" to stop blocking the progress of our work so that everyone can reap the benefits of TD and TDS.

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