Telemedicine in dermatology: Evaluation of secondary and tertiary teledermatology

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Evaluation of accuracy and reliability of teledermoscopy with images taken by general practitioners during regular practice


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Abstract

Background: Teledermoscopy enables the general practitioner to obtain a diagnosis from a dermatologist by sending dermoscopic images through the internet, instead of physically referring the patient (in vivo).

Objective: The aim of this study was to assess the accuracy and reliability of teledermoscopy with images taken by the GP in regular practice, as compared to in vivo dermatological examination.

Methods: Instructed GPs selected patients for teledermoscopy and took both macro and dermoscopic photographs (Sony Cybershot DSC-W560 (SONY, Japan) with 3Gen DermLite Pro II HR (3Gen, USA), epiluminescence, no flash, auto-focus, 2 megapixels) in real world clinical setting. Accuracy and inter-observer reliability of teledermoscopy were calculated for diagnostic group and management plan compared to the in vivo setting using Cohen’s Kappa statistic. Image quality was rated on a three-point scale.

Results: All 108 teledermoscopy consultations sent by 13 GPs and assessed by 4 dermatologists between February 2010 and May 2011 were included. The accuracy was $\kappa$ 0.61 on diagnostic group and $\kappa$ 0.23 on management plan. The inter-observer reliability was $\kappa$ 0.65 on diagnostic group and $\kappa$ 0.36 on management plan. The image quality was reported as bad (36.1%), reasonable (27.7%), and good (36.1%). Cases with good quality images had an accuracy of $\kappa$ 0.68 and a reliability of $\kappa$ 0.66 on diagnostic group and accuracy and reliability of $\kappa$ 0.42 on management plan.

Conclusions: Teledermoscopy used in general practice had a lower accuracy and reliability compared to in vivo consultation. Due to its high dependence on the quality of the provided images, teledermoscopy can have a potential value in general practice when staff is properly trained in acquiring high quality dermoscopic images.
Introduction

The prevalence of melanoma continues to grow in Europe and The Netherlands.\(^1\)\(^-\)\(^3\) Since the therapeutic options for metastatic melanoma are still very poor, methods for early diagnosis, which will have a positive effect on the prognosis, are needed. Dermoscopy is a technique often used by dermatologists, and increasingly in primary care, for early diagnosis of melanoma and other types of clinically suspicious skin lesions.\(^4\)\(^,\)\(^5\)

Dermoscopy is a non-invasive examination method often used to look at pigmented and non-pigmented skin lesions. A dermoscope is a lens with 10x magnification combined with either immersion fluid or light-emitting diode (LED) lighting with polarizing filters for glare reduction of the corneal layer of the skin allowing a clear examination of the entire epidermis and the superficial papillary dermis. The use of dermoscopy by trained dermoscopists increases diagnostic accuracy for pigmented skin lesions, especially for melanoma.\(^6\)\(^,\)\(^7\)

Table 1 - Diagnostic accuracy of dermoscopy and teledermoscopy

<table>
<thead>
<tr>
<th>Year</th>
<th>Patients</th>
<th>Lesions</th>
<th>Golden Standard</th>
<th>Face-to-face (observers)</th>
<th>Teledermoscopy (observers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999(^12)</td>
<td>66</td>
<td>66</td>
<td>Histo-Pathology</td>
<td>92% (2)</td>
<td>86,00% (1)</td>
</tr>
<tr>
<td>2000(^13)</td>
<td>51</td>
<td>55</td>
<td>Histo-Pathology</td>
<td>(\kappa 0,742 (1))</td>
<td>(\kappa 0,742 (1))</td>
</tr>
<tr>
<td>2000(^17)</td>
<td>40</td>
<td>43</td>
<td>Histo-Pathology</td>
<td>(\kappa 0,740 (1))</td>
<td>(\kappa 0,35 - \kappa 0,87 (11))</td>
</tr>
<tr>
<td>2003(^14)</td>
<td>-</td>
<td>100</td>
<td>Histo-Pathology</td>
<td>91,1% (1)</td>
<td>88,8% (1)</td>
</tr>
<tr>
<td>2004(^16)</td>
<td>12</td>
<td>12</td>
<td>Histo-Pathology</td>
<td>-</td>
<td>83% (1)</td>
</tr>
<tr>
<td>2006(^20)</td>
<td>61</td>
<td>-</td>
<td>Histo-Pathology</td>
<td>-</td>
<td>(\kappa 0,940 (1))</td>
</tr>
<tr>
<td>2007(^19)</td>
<td>18</td>
<td>18</td>
<td>Face-to-face</td>
<td>-</td>
<td>89,00% &amp; 94,00% (2)</td>
</tr>
<tr>
<td>2008(^15)</td>
<td>-</td>
<td>44</td>
<td>Histo-Pathology</td>
<td>(\kappa 0,696 (1))</td>
<td>(\kappa 0,450 (1))</td>
</tr>
<tr>
<td>2009(^17)</td>
<td>-</td>
<td>64</td>
<td>Histo-Pathology</td>
<td>(\kappa 0,730 (1))</td>
<td>(\kappa 0,660 (1))</td>
</tr>
<tr>
<td>2009(^22)</td>
<td>542</td>
<td>542</td>
<td>Histo-Pathology</td>
<td>80,77% (1)</td>
<td>67,00% (1)</td>
</tr>
<tr>
<td>2010(^22)</td>
<td>200</td>
<td>491</td>
<td>Face-to-face</td>
<td>-</td>
<td>(\kappa 0,95 (2))</td>
</tr>
<tr>
<td>2011(^18)</td>
<td>88</td>
<td>113</td>
<td>Histo-Pathology</td>
<td>-</td>
<td>(\kappa 0,840 (1))</td>
</tr>
</tbody>
</table>

* Mobile teledermoscopy
Teledermatology, which is telemedicine applied to the field of dermatology, has been one of the most studied applications of telemedicine to date. Several review articles have shown teledermatology as diagnostically accurate and reliable for non-pigmented skin conditions.\(^8\)-\(^10\) A recent study shows teledermatology as a fully integrated healthcare service provided by general practitioners (GPs) contributes to more efficient and cheaper healthcare.\(^11\)

Teledermoscopy consists of combining digitalized dermoscopic images with the technology provided by teledermatology. The concept of teledermoscopy has been around for some time, with early studies dating back to 1999.\(^12\) Since then several articles have been published on the diagnostic accuracy\(^12\)-\(^23\) and reliability\(^22\)-\(^24\)-\(^27\) of teledermoscopy for pigmented and non-pigmented skin lesions.

Some studies have reported good accuracy of teledermoscopy, comparable with accuracy found in face-to-face dermoscopic examination. (Table 1) The accuracy of teledermoscopy is mostly dependent on the observer’s (usually the dermatologist) level of experience.\(^21\) Studies reported moderate to good concordance between observers on diagnostic reliability. (Table 2)

### Table 2 - Diagnostic inter-observer reliability of teledermoscopy

<table>
<thead>
<tr>
<th>Year</th>
<th>Patients</th>
<th>Lesions</th>
<th>Observers</th>
<th>Inter-Observable Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003(^24)</td>
<td>128</td>
<td>128</td>
<td>40</td>
<td>(\kappa 0.470 - \kappa 0.630)</td>
</tr>
<tr>
<td>2004(^24)</td>
<td>73</td>
<td>77</td>
<td>11</td>
<td>(\kappa 0.490 - \kappa 0.880)</td>
</tr>
<tr>
<td>2007(^25)</td>
<td>18</td>
<td>465</td>
<td>2</td>
<td>(\kappa 0.584)</td>
</tr>
<tr>
<td>2010(^22)</td>
<td>200</td>
<td>491</td>
<td>2</td>
<td>(\kappa 0.920)</td>
</tr>
<tr>
<td>2010(^27)</td>
<td>206</td>
<td>979</td>
<td>5</td>
<td>(\kappa 0.440 - \kappa 0.930)</td>
</tr>
</tbody>
</table>

Teledermoscopy enables a diagnostic tool for clinically suspicious skin lesions to be used in the general practitioner’s practice. A recent study by Lim et al. reported on the first completely implemented and reimbursed teledermoscopy triage service for skin lesions.\(^28\) Instead of a live visit, patients could be referred to a commercially run virtual lesion clinic. Results showed 88% of referrals to the
dermatologist could be prevented and two-thirds faster access to a screening clinic for the teledermoscopy patient group. However, most studies on accuracy and reliability have taken place in a lab setting with a clinical photographer or a highly skilled dermoscopist with experience in taking dermoscopic images. As high quality measurements are an important factor in the success of any teleconsultation service, the aim of this study was to assess the accuracy and reliability of teledermoscopy with images taken by GPs applied during regular practice.

**Methods**

**Teledermoscopy process**

A Sony Cybershot DSC-W560 (SONY, Japan) was used for all macro images of the lesions (camera setting: no flash, auto-focus, 2 megapixels, resolution 2048x1536, 72 DPI, JPEG compression: best). For all dermoscopic images (epiluminescence, no flash, auto-focus, 2 megapixels) a 3Gen DermLite Pro II HR (3Gen, USA) with adapter kit for the Cybershot camera was used. The store-and-forward TeleDermatology Consultation System (KSYOS TeleMedical Centre, The Netherlands) was used for all teleconsultations. This system is part of a telemedicine platform that, over the last 7 years, has been used by approximately 3.500 GPs in The Netherlands for teledermatology and also in numerous other fields such as teleophthalmology, telepulmonology and telecardiology. The platform integrates with GP information systems by means of single sign-on solutions and outcome reports.
All participating GPs received an onsite training course of one hour in using the teledermatology system and the camera and how to apply the dermoscope in order to obtain a high quality image. During each teleconsultation the following information was recorded: patient identification information, medication, patient history specified to dermato-oncology (patient and family history of skin cancer (a) non-melanoma and b) melanoma), location of the lesion, recent changes in the lesion, sun exposure in hours last 3 months, estimated number of moles and skin type (Fitzpatrick scale)), up to 4 images and the questions posted to the dermatologist. Patient history and questions were free text. (Figure 1) It was recommended that 4 images of the lesion (1 overview, 1 macro, 2 dermoscopic) were included.
The dermatologists were required to answer a teledermoscopy consultation within 2 working days. For comparison with in vivo examination by a dermatologist, all patients who had a teledermoscopy consultation were also referred to the local dermatologist (who was not necessarily the teledermatologist). A histopathological examination was not mandatory, but depended on the decision of the treating dermatologist during the in vivo consultation. As this decision was a standard care process independent of teledermoscopy and extra costs for the patient were associated with histopathology, it could not be made mandatory. For those patients who did receive histopathological examination the final diagnosis was collected. The time between the teledermoscopy consultation and in vivo consultation was dependent on the waiting period for the local dermatologist, but was not more than 2 weeks.

**Inclusion criteria**

All dermatologists that participated in this study had a minimum of 5 years experience of dermoscopy and 3 years experience of regular teledermatology. All GPs who participated had a minimum of three years experience using regular teledermatology, but no experience with dermoscopy prior to this study. The participating GPs selected all consecutive patients that presented with a (pigmented) skin lesion and that were, in the GP’s opinion, suitable for a teledermoscopy consultation. Urgent cases were excluded as KSYOS policy instructs GPs to not use teleconsultation in case of urgency. Patients gave informed consent for the teledermatology consultation and its use for research purposes.

**Statistics**

Both accuracy and reliability were calculated using Cohen’s Kappa statistics. Interpretation of Kappa values follows $\kappa < 0$ as indicating no agreement and $\kappa 0.00 - \kappa 0.20$ as slight, $\kappa 0.21 - \kappa 0.40$ as fair, $\kappa 0.41 - \kappa 0.60$ as moderate, $\kappa 0.61 - \kappa 0.80$ as good.
as substantial, and $\kappa$ 0.81 - $\kappa$ 1.00 as almost perfect agreement.\textsuperscript{30} Power analyses for an intraclass Kappa test using the following parameters: 0.05 significance level, 2-sided test, 0.70 proportion successes, alternative agreement 0.80, null hypothesis agreement 0.40, power at 80% resulted in a sample size of 107 cases.

**Accuracy**

All teledermoscopy consultations were assessed by four independent dermatologists, one of whom reported on the initial teleconsultation and three at a later time. Each provided a diagnosis blinded to the diagnosis of the other dermatologists and the three latter dermatologists also provided a management plan. The management plan consisted of four options: no treatment, excision, cryotherapy or topical medication. All diagnoses (in vivo, histopathologic and teledermatologic) were assigned to an aggregated diagnosis group (categorization shown in Table 3) based on consensus decision by three of the authors (PS (dermatologist), LW (non-practicing dermatologist), JH (medical informatician). Diagnostic accuracy was calculated based on the outcome of the diagnosis group for all four teledermoscopy assessments compared to the in vivo assessment. Where histology was available it was compared with the four teledermoscopy assessments and the diagnostic accuracy of the in vivo assessment. Management accuracy was calculated between the teledermoscopy assessments provided by the latter three dermatologists and the in vivo assessment.

**Inter-observer Reliability**

Inter-observer reliability (agreement between observers) was calculated between 4 dermatologists on the outcome of diagnosis group and between 3 dermatologists on management plan.
Chapter 3 - Evaluation of accuracy and reliability of teledermoscopy

Image quality
The two most experienced dermatologists (> 20 years of practice) of the four who assessed the teleconsultations, independently rated the quality of the images provided in each teledermoscopy consultation on a 3-point scale (bad, reasonable, good). If ratings differed per case, the lowest quality rating was used.

Results
Between February 2010 and May 2011 a total of 108 teledermoscopy consultations were performed by 13 GPs and reported by 4 dermatologists. The teleconsultations concerned 105 patients (3 patients had two lesions) with an average age of 46 years (median: 47, min: 6, max: 84) and consisted of 54.6% females (n=59). The number of excluded patients due to urgency is not known. Four images were added in 83 teledermoscopy consultations, three, two and one image(s) in 17, 7 and 1 teledermoscopy consultation(s), respectively.
Of the 108 lesions diagnosed through teleconsultation, 76 were seen in vivo (70%). Table 3 shows the number of cases per in vivo diagnosis. The in vivo diagnosis was not available for the other 32 lesions because of various reasons: patient did not go to the dermatologist (n=25), patient moved away (n=6), GP did excision (n=1). A histopathological diagnosis was made for 36 lesions (33%), of which 35 also had a known in vivo diagnosis.

Accuracy
Kappa concerning teledermoscopic diagnosis and histopathological diagnosis ranged between $\kappa 0.41 - \kappa 0.63$, kappa concerning the teledermoscopic diagnosis and the in vivo diagnosis between $\kappa 0.55 - \kappa 0.73$. Kappa between in vivo diagnosis and histopathological diagnosis was $\kappa 0.90$. The Kappa between teledermoscopic management plan and in vivo management plan ranged...
between $\kappa 0.19 - \kappa 0.29$. Histopathology diagnosed 7 cases as skin cancer (2 melanoma, 5 non-melanoma skin cancers); concordance of management plan for these 7 patients was 100%. All Kappa values are shown in Table 4.

**Table 3** - Diagnostic group categorization used (number diagnosed in vivo)

<table>
<thead>
<tr>
<th>Benign melanocytic pigmented lesions (n=45)</th>
<th>Benign vascular lesions (n=4)</th>
<th>Non-pigmented lesions (n=20)</th>
<th>Melanoma skin cancer (n=3)</th>
<th>Non melanoma skin cancer (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atypical / Dysplastic naevus 3</td>
<td>Angioma senilis 1</td>
<td>Actinic keratosis *^</td>
<td>Amelanotic melanoma</td>
<td>BCC 3</td>
</tr>
<tr>
<td>Congenital naevus 1</td>
<td>Haemangioma 3</td>
<td>Benign lichenoid keratosis *</td>
<td>Melanoma / Lentigo maligna melanoma 0</td>
<td>Morbus Bowen 1</td>
</tr>
<tr>
<td>Ephelide 0</td>
<td>Venous lake 0</td>
<td>Comedo 1</td>
<td>Melanoma in situ / Lentigo maligna 0</td>
<td>Pigmented BCC 0</td>
</tr>
<tr>
<td>Lentigo solaris / senile / benigna / simplex 5</td>
<td></td>
<td></td>
<td>Dermatofibroma / Histiocytoma * 3</td>
<td>SCC 0</td>
</tr>
<tr>
<td>Melasma 1</td>
<td></td>
<td></td>
<td>Foliculitis / Furuncle 0</td>
<td></td>
</tr>
<tr>
<td>Mongolian spot 0</td>
<td></td>
<td></td>
<td>Hyperthrophic scar 1</td>
<td></td>
</tr>
<tr>
<td>Naevus naevocellularis (junction, compound, halo, papillomatosis, blue, spitz) 34</td>
<td></td>
<td></td>
<td>Impetigo 1</td>
<td></td>
</tr>
<tr>
<td>Physiological pigmentation 1</td>
<td></td>
<td></td>
<td>Insect bite / Culicosis 1</td>
<td></td>
</tr>
<tr>
<td>Post inflam. hyperpigmentation 0</td>
<td></td>
<td></td>
<td>Pityriasis lichenoides 0</td>
<td></td>
</tr>
<tr>
<td>Reed naevus / Spindle cell naevus / Epithelioid 0</td>
<td></td>
<td></td>
<td>Urticaria pigmentosa 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Verruca vulgaris 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Verruca seborroica / Keratosis seborroica * 9</td>
<td></td>
</tr>
</tbody>
</table>

* Can also be categorized as pigmented

^ Can also be categorized as skin carcinoma in situ, this category was not used in this study
### Table 4 - Accuracy and Inter-rater Reliability of teledermoscopy

#### Accuracy

<table>
<thead>
<tr>
<th>Diagnostic group</th>
<th>Management</th>
<th>PA - IV (n=35)</th>
<th>PA - TD1 (n=32)</th>
<th>PA - TD2 (n=35)</th>
<th>PA - TD3 (n=35)</th>
<th>PA - TD4 (n=35)</th>
<th>IV - TD1 (n=68)</th>
<th>IV - TD2 (n=76)</th>
<th>IV - TD3 (n=74)</th>
<th>IV - TD4 (n=75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good image quality</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reasonable image quality</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Bad image quality</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td>Overall</td>
<td>TD1 - TD2 (n=99)</td>
<td>TD1 - TD3 (n=98)</td>
<td>TD1 - TD4 (n=100)</td>
<td>TD2 - TD3 (n=105)</td>
<td>TD2 - TD4 (n=106)</td>
<td>TD3 - TD4 (n=104)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good image quality</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reasonable image quality</td>
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<tr>
<td>Bad image quality</td>
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</tbody>
</table>

Teledermoscopic diagnosis (TD), Histopathological diagnosis (PA), In vivo diagnosis (IV)
Inter-observer Reliability

The Kappa for the 4 observers on the outcome diagnostic group ranged between $\kappa 0.56 - \kappa 0.78$, the Kappa for 3 observers on the outcome management plan between $\kappa 0.31 - \kappa 0.38$. The Kappa values are shown in Table 4.

Image quality

The image quality was reported as bad (36.1 %), reasonable (27.8 %), and good (36.1 %). Accuracy for the teleconsultations with a good image quality rating between teledermoscopic diagnosis and histopathological diagnosis ranged between $\kappa 0.53 - \kappa 1.0$. Kappa between the teledermoscopic diagnosis and the in vivo diagnosis ranged between $\kappa 0.53 - \kappa 0.77$. Kappa between in vivo diagnosis and histopathological diagnosis was 1.00. The Kappa between teledermoscopic management plan and in vivo management plan was $\kappa 0.34 - \kappa 0.47$. (Table 4)

Reliability for teleconsultations with rated good image quality on the outcome diagnostic group ranged between $\kappa 0.48 - \kappa 0.79$ and on the outcome management plan $\kappa 0.33 - \kappa 0.57$. (Table 4)

Kappa scores for bad and reasonable image quality are also displayed in Table 4.

Discussion

The aim of this study was to assess whether teledermoscopy can be equally accurate and reliable compared to in vivo consultation when images are taken by the GP during regular practice. The results showed a moderate diagnostic accuracy, a moderate diagnostic reliability, fair management accuracy and management reliability. An important outcome was that diagnostic and especially management accuracy scored higher in cases with good quality photos.

The diagnostic accuracy was lower than outcomes of studies in which dermatologists or highly trained nurses provided the dermoscopic images. (Table
1) Management plan accuracy in other studies was higher (κ 0.70, κ 0.68\textsuperscript{25} and concordance of 73.9%\textsuperscript{23}) than reported in this study. A limitation on the accuracy estimation is the incomplete in vivo diagnoses due to patients not visiting the dermatologist after the physical referral. For 70% (n=76) of the cases an in vivo diagnosis was available, and histopathology diagnosis was available in 33% (n=36). There is a risk of bias (type 1 error), as the most probable cause that most patients did not go to the in vivo assessment was because their complaints had ceased or because they were adequately reassured (telediagnosis for these 32 cases with no in vivo assessment were melanocytic naevus (n=19), seborrhoeic keratosis (n=11), 1 lentigo, and 1 mongolian spot). In vivo assessment of specifically these more simple cases might have improved the accuracy. Few other studies that have been based on more than 100 included cases cannot be compared with our results as the images in those studies were all gathered in either a lab setting (by the researchers) or by a dermoscopic nurse.\textsuperscript{22-24;27} Although no significant conclusions on the outcome of accuracy could be made, our findings do underline the hypothesis that getting a high accuracy from dermoscopy applied in regular general practice is more difficult compared to other settings.

The diagnostic reliability is comparable to the higher end of reported reliability outcomes in teledermoscopy studies. (Table 2) Management plan reliability has been reported in one other study as moderate (κ 0.58)\textsuperscript{25} and is thus better than in our own study. However, results on reliability (and maybe even accuracy when compared to in vivo) may not entirely be ascribed to teledermoscopy, as in vivo diagnosis and management of skin lesions can differ among dermatologists as a result of different definitions of terms, lack of consensus guidelines, diagnostic drift and different perspectives on treatment. In contrast with teledermatology and teledermoscopy, literature on clinical inter-rater reliability in dermatology is scarce.

Results found on reliability of clinical examination are comparable to our own.\textsuperscript{15;31;32}
In this study seven cases were high-risk patients (diagnosed with skin cancer). In these cases diagnostic and management accuracy was 100%. Other studies also show accurate diagnosis and management of high risk patients\textsuperscript{12;13;21;25;26}, but there are also examples of false negatives\textsuperscript{17;23}.

Image quality was rated as good in only just over a third of the cases. This result shows clearly that taking a good quality dermoscopic image was difficult for the GPs participating in this study. Several reasons have been reported by participants: \textit{Lack of time}: GP practices were generally busy and overloaded, thus taking the time to take proper dermoscopic images could have been difficult. \textit{Lack of skills}: GPs did receive training in the use of the equipment, but since suitable patients for inclusion did not present themselves on a daily basis, skills were lost over time. \textit{Equipment issues}: GPs reported failing/empty batteries of the camera and the dermascope, most likely because of large intervals between uses. In addition, difficulties with attaching and detaching the adapter and focussing the camera with the adapter attached were reported. This study did not make a distinction between image quality of macro clinical images and dermoscopic images. In future research it is recommended to add this distinction as the clinical image can provide at least equivalent information for the diagnosis\textsuperscript{18}.

As melanoma skin cancer has a high mortality rate, the following issues merit particular attention before starting to practice teledermoscopy (and require regular reassessments): training the doctors (both GPs and dermatologists), quality of the equipment, and as a result quality of the acquired images. Regular training sessions could be organized by the local dermatologists or by the telemedicine provider. To stimulate participation, the training program should be accredited for CME credits. Automatic peer review could be implemented in the telemedicine system by having dermatologists anonymously assess image quality and feedback sent to the GPs.
In cases where a good quality image was reported, accuracy increased compared to the overall results in this study and vice versa for cases with bad image quality. The higher accuracy found in cases with good quality images is comparable to other research in which conditions for image quality were considerably better due to well-trained staff and frequent repetition (Table 1). This result underlines the notion that teledermoscopy (and consequentially all teleconsultations services) are highly dependent on a good quality measurement (i.e. clinical/dermoscopic image, spirogram, ECG). Next to image quality, the number of (dermoscopic) images presented per case, as well as the completeness and correctness of the patient history could have had an effect on the results. Patient history has not been taken into account in this study. Incompleteness of images was not rated separately, as the rating was done for the overall set of images per case including incompleteness.

Conclusions

This study is, to the authors’ knowledge, the first to report on both diagnostic accuracy and reliability of teledermoscopy applied in a real world general practice setting. Our findings provide valuable insights in the use of dermoscopy during regular primary care. When teledermoscopy is used in general practice under the conditions described in this study, it has mediocre image quality leading to an overall lower accuracy and reliability compared to in vivo examination. However, high accuracy and reliability was and can be achieved under the right circumstances: both clinical and telemedical examination can only be accurate and reliable if measurements are of a sufficiently high quality to be suitable for assessment. Therefore, teledermoscopy can have a potential value in general practice if staff are properly trained in acquiring high quality dermoscopic images.
Reference List


