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The Value of Teledermoscopy to the Expertise of General Practitioners Diagnosing Skin Disorders Based on ICD-10 Coding

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Abstract

Early recognition of skin cancer is vital to enhance patient outcomes. Teledermoscopy (TDsc), a telemedicine service, supports general practitioners (GPs) in gaining fast access to dermatologists' feedback to detect skin cancer. This study aimed to assess if GPs gain expertise in diagnosing skin disorders after continued use of TDsc, based on diagnosis classification by the International Statistical Classification of Diseases and Related Health Problems (ICD-10). A retrospective study was conducted on TDsc consultations sent by GPs to teledermatologists in the Netherlands (July 2015 - June 2018). GP sensitivity and confirmed cases in diagnosing skin disorders slightly increased over time. However, the total positive predictive value showed a decrease. In three years, 43 melanomas were diagnosed by the TD for which the GP did not provide a (correct) pre-diagnose. Though GPs appear to improve their expertise in skin disorder detection after continued TDsc use, TDsc remains imperative to early melanoma detection.

Keywords:
Skin cancer, telemedicine, ICD-10

Introduction

Melanoma, a malignant tumor of the skin, evolves fast and is currently recognized as the deadliest type of skin cancer [1,2]. Early recognition and treatment is essential in improving these patient outcomes. When diagnosed in the early phase, melanoma is almost always curable. General Practitioners (GPs) have a vital role in detecting and diagnosing melanoma early, as often the first care contact patients visit. However, literature shows that GPs expertise in detecting melanoma is insufficient [3-5]. Previous studies showed low agreement between GPs and dermatologists in diagnosing suspicious skin lesions [4,5]. In addition to the inadequacy in melanoma detection, long waiting times before consultation of a dermatologist also limits early melanoma detection. A telehealth service that supports GPs in diagnosing melanoma could be a solution to optimize early detection and access to specialist skin care services.

Teledermoscopy consultation (TDsc) is a growing online service for melanoma detection. In TDsc, dermoscopic images (10-30x magnification) are sent via a secured internet connection to a (tele)dermatologist, who examines these suspicious skin lesions online. The (tele)dermatologist then provides a patient's caregiver with an accurate diagnosis and advice on the need for referral based on the assessment of the dermoscopic images [6]. This service would thus provide the GP with direct feedback on the correctness of their pre-diagnosis of a patient's skin disorder. Research has shown that GPs expertise in melanoma detection increases after training [3] and that fewer melanomas were missed by experienced and trained consultants [6]. It therefore remains a question, whether a telehealth service will also enhance GP expertise in melanoma detection after continual system use.

Ksyos is a healthcare organisation in the Netherlands which provides TDsc consultation between the GP and teledermatologist [7]. While performing TDsc the GP takes an overview, detailed and dermoscopic picture of the suspicious lesion and sends it together with some patient characteristics and a pre-diagnosis in the Ksyos digital health record system to a teledermatologist (TD). The TD assesses the consultation and provides a diagnosis. Recording this diagnosis is mandatory for the TD but optional for the GP. Figure 1 gives an overview of this TDsc consultation process. Data from the Ksyos digital health record system shows that GPs indicate that they learned from the TDsc consultations and the total number of teleconsultations per GP is indeed decreasing over time. However, the question is if frequently diagnosing TDsc consultations and exposure to this service increases the expertise of GPs in diagnosing skin lesions after continual use.

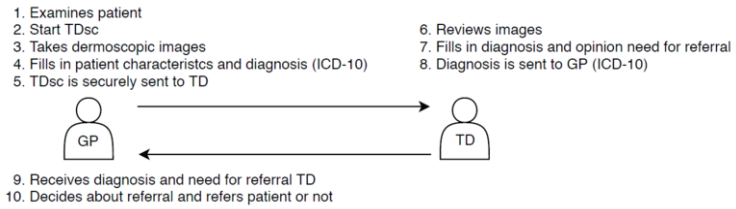


Figure 1 – Overview of the teledermoscopy consultation process between general practitioner (GP) and teledermatologist (TD)

Table 1 – 2x2 table to calculate sensitivity and positive predictive value

		Diagnosis TD (golden standard)	
		Diagnosis **confirmed** with ICD-10 code of TD	Diagnosis **not confirmed** with ICD-10 code of TD
Diagnosis GP	Diagnosis **present** according to ICD-10 pre-diagnosis of GP	**a**	**b**
	Diagnosis **absent** according to ICD-10 pre-diagnosis of GP	**c**	**d**

a = True positives, Diagnosis present according to ICD-10 pre-diagnosis of GP and confirmed by TD
b = False positives, Diagnosis present according to ICD-10 pre-diagnosis of GP and **not confirmed** by TD
c = False negatives, Diagnosis absent according to ICD-10 pre-diagnosis of GP and confirmed by TD
d = True negatives, Diagnosis absent according to ICD-10 pre-diagnosis of GP and **not confirmed** by TD

Positive predictive value (PPV) of GP = a / (a+b)
Sensitivity of GP = a / (a+c)

In the Netherlands, diagnoses given by the GP and TD within a TDsc consultation are classified to the corresponding ICD-10 code. The International Statistical Classification of Diseases and Related Health Problems (ICD) is an international diagnostic classification standard for reporting health conditions and diseases released by the World Health Organization [8]. This ICD-10 code can be used to analyse, compare and monitor diagnoses worldwide. Since July 2015, classifying diagnoses in compliance to this ICD-10 code has been mandatory in specialized care for reimbursement according to the Dutch Healthcare Authority (Dutch: Nederlandse Zorgautoriteit, NZa). And since this date, the 10th revision of this standard (ICD-10) has also been used in the Ksyos digital health record system. However, the effect of TDsc on GPs expertise in diagnosing skin disorders, based on the ICD-10 codes in the Netherlands has not been systematically investigated.

The aim of this paper is therefore to assess if, since the introduction of the ICD-10 codes in July 2015, GPs are gaining expertise in diagnosing (specific) skin problems conform ICD-10 after one, two and three years of TDsc use. In our analysis we specifically focused on the development in the number, ICD-10 type and correctness of GPs in pre-diagnosing skin disorders compared to the TD diagnoses. In doing so, we aimed to address the added value of continued use of TDsc for GP melanoma detection.

Methods

Setting and study population

We conducted a retrospective study in the Netherlands on the value of TDsc to GPs expertise in diagnosing skin disorders in three years' time. All TDsc consultations sent by affiliated GPs to TD between July 2015 and June 2018 and completed before the 18th of October 2018 were extracted from the Ksyos digital health record system.

A cohort of *experienced* GPs was selected for inclusion in the data analysis. GPs were classified as *experienced* if they performed at least five TDsc consultations for each of the included years, respectively (July 2015 - June 2016, July 2016 - June 2017, July 2017 - June 2018), and did not perform any consultation before January 2015. Unexperienced GPs were excluded in this study. The pre-diagnosis of the GP was compared with the diagnosis of the TD on the group level of the ICD-10 codes. Examples of group levels included are among others: C43-C44 *Melanoma and other malignant neoplasms of skin*, D00-D09 In situ neoplasms, D10-D36 *Benign neoplasms*, L20-L30 *Dermatitis and eczema*. The ICD-10 diagnosis of the TD was considered as the golden standard for the diagnosis confirmation.

Statistical analyses

The total percentage of cases a GP correctly diagnosed is calculated as the number of confirmed diagnosed GP cases by TD divided by the number of obtained TDsc cases minus the number of patients for which the TD did not provide a diagnose.

To assess the surplus value of continuing use of teledermoscopy the GP sensitivity and GP positive predictive value (PPV) in diagnosing skin disorders were calculated overall (total) and on the ICD-10 diagnosis group level for three subsequent years. The 95% confidence intervals (CI) of the PPV was calculated according to the Wilson score interval method without a correction for continuity [9].

The 2x2 table in table 1 shows the formulas used to calculate the PPV for each diagnosis category separately. The PPV was calculated as the proportion of consultations where the ICD-10 code was present according to the pre-diagnosis of the GP and confirmed by the TD divided by the total number of diagnosis scored within this group ICD-10 code by the GP. The sensitivity was calculated as the number of cases where the ICD-10 pre-diagnosis of the GP was confirmed by the TD divided by the total number of diagnosis scored within this group based on the ICD-10 codes of the TD.

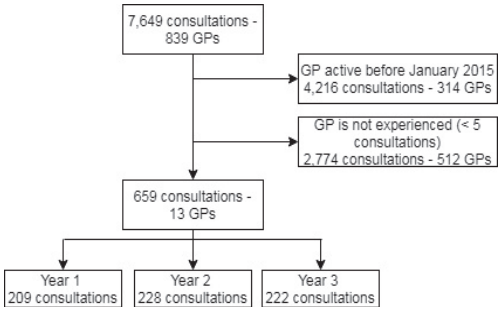


Figure 2 – Number of consultations

Results

In total 7,649 completed TDsc consultation requests by 839 GPs were extracted from the Ksyos digital health record system (figure 2). Overall, 314 GPs were active before January 2015 and for this reason the corresponding 4,216 consultations in the study period were excluded. In addition, 512 GPs did not perform five or more consultations for each study year respectively and were excluded. After exclusion, thirteen experienced GPs and 659 consultations were analysed (minimum of 20, maximum of 157 consultations per GP). The total number of consultations performed by the included GPs for each year were 209, 228, 222 respectively and were assessed among 32 TDs.

the TD as *no assessment possible* and for these cases no diagnosis was filled in by the GP as well.

The number of diagnoses inserted by the GP increased over time from 13 (7.1%) to 27 (13.0%) and 34 (18.0%) in year 1, 2 and 3 respectively. Conversely, this indicates to the added value of TDsc, which therefore starts out as relatively high as 92.9 percent of diagnoses are provided by the TD and were not filled in by GPs starting with TDsc. This number then slightly decreases after GP's continuing use of TDsc to 82.0 percent of the patients diagnosed by TD in year 3.

In three years' time, TDs diagnosed the majority of the patients as benign neoplasm (year 1 35.5%, year 2 43.0%, year 3 41.8%) or other disorders of the skin and subcutaneous tissue (year 1 37.7%, year 2 23.2%, year 3 33.3%).

Table 2 – Number of (in)correct diagnosed GP cases and positive predictive value over three years' time

	Obtained TDsc cases	Not diagnosed by TD (%)	Not diagnosed by GP* (%)	Diagnosed by GP* (%)	Confirmed diagnosed GP cases by TD (%)	PPV [95% CI]	Incorrect pre-diagnosed by GP (%)
Year 1 July 2015- June 2016	209	26 (12.4)	170 (92.9)	13 (7.1)	11 (6.0)	0.85 [0.58-0.96]	2 (15.4)
Year 2 July 2016- June 2017	228	21 (9.2)	180 (87.0)	27 (13.0)	19 (9.2)	0.70 [0.52-0.84]	8 (29.6)
Year 3 July 2017- June 2018	222	33 (14.9)	155 (82.0)	34 (18.0)	25 (13.2)	0.74 [0.57-0.85]	9 (26.5)

Notes: PPV is calculated as the number of confirmed diagnosed GP cases by TD divided by the number of total obtained TDsc cases minus number not diagnosed by TD and GP.

* Total number = obtained TDsc cases minus the cases not diagnosed by TD

CI= confidence interval; **PPV**= positive predictive value

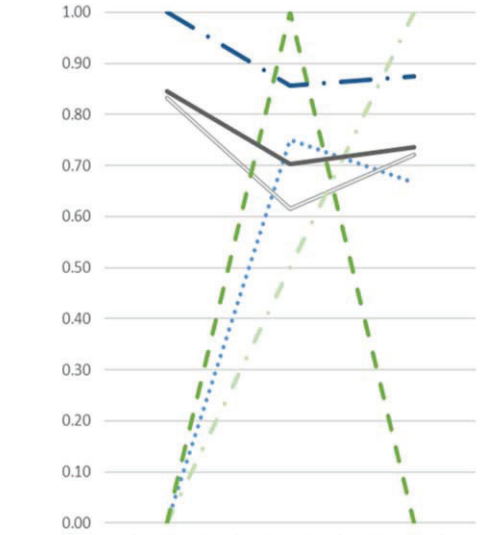
Sensitivity and PPV of GP in TDsc

No diagnosis was provided by the TD in 26 (12.4%), 21 (9.2%) and 33 (14.9%) of the cases. These cases were excluded from the statistical analyses. As shown in table 2, the percentage of confirmed GP diagnosed cases is increasing over years from 6.0 percent in year 1 to 13.2 percent in year 3. However, the GP's PPV is slightly decreasing over time from 0.85 [95% CI 0.58-0.96] to 0.74 [95% CI 0.57-0.85]. As presented in figure 3 the GP PPV though is increasing over time for diagnosis category L20-L30 *Dermatitis and eczema*. The number of incorrect pre-diagnosed cases by the GP is marginally increasing from 15.4 percent in the first year to 26.5 percent in the third year.

The sensitivity for all the diagnoses categories together increased from 0.07 in year 1 to 0.10 in year 2 and 0.14 in year 3. The sensitivity for the diagnosis categories C43-C44 *Melanoma and other malignant neoplasms of skin*, D10-D36 *Benign neoplasms*, L20-L30 *Dermatitis and eczema* (figure 4) also increased. The sensitivity for *melanoma* (C43-C44) improved from 0 out of 12 cases confirmed (0.0%) in year 1, 3 out of 22 cases (13.6%) in year 2, and 4 out of 16 cases confirmed (25.0%) in year 3 (total 7 out of 50 cases diagnosed as melanoma). The sensitivity for *Benign neoplasms* (D10-D36) improved from 5 out of 65 cases confirmed (7.7%) in the first year to 13 out of 79 cases in the third year (16.5%).

Added value of the teledermoscopy

Thirty-four diagnoses were scored by the TD to fourteen ICD-10 categories not chosen by the GPs (table 3). In these cases the GP did not fill in a diagnosis. Five consultations were scored by

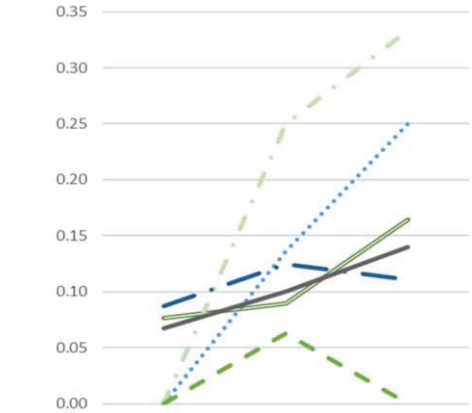


	Year 1	Year 2	Year 3
C43-C44	0.00	0.75	0.67
D10-D36	0.83	0.62	0.72
L20-L30	0.00	0.50	1.00
L55-L59	0.00	1.00	0.00
L80-L99	1.00	0.86	0.88
Total	0.85	0.70	0.74

Figure 3 – PPV per diagnose category

In the first year, patients in TDsc were not diagnosed by the GP with the ICD-10 code *Melanoma and other malignant neoplasms of skin* (C43-C44). In the second year GPs diagnosed two consultations as benign neoplasms, while the TD diagnosed these patient cases as *melanoma or other malignant neoplasms of the skin* (C43-C44). In the third year one consultation was diagnosed as *radiation-related disorder* (L55-L59) by the GP, that was diagnosed as melanoma by the TD.

Overall, 12 (6.6%), 19 (9.2%) and 12 melanoma cases (6.3%) were diagnosed by the TD in three years' time respectively and not or not correctly pre-diagnosed by the GP. This suggests that in 7.4 percent of the total TDsc consultations performed in three years' time melanoma was detected, which were not and/or not-correctly pre-diagnosed by the GP. Also, 1 out of 3 (35.8%) of TDsc consultations were diagnosed as benign by the TD and not and/or not-correctly pre-diagnosed as such by the GP.



	Year 1	Year 2	Year 3
C43-C44	0.00	0.14	0.25
D10-D36	0.08	0.09	0.16
L20-L30	0.00	0.25	0.33
L55-L59	0.00	0.06	0.00
L80-L99	0.09	0.13	0.11
Total	0.07	0.10	0.14

Figure 4 – Sensitivity per diagnose category

Discussion

We conducted a retrospective study in the Netherlands to assess the potential value of TDsc to GPs expertise in diagnosing skin disorders over three years' time. Overall, of the total number of cases included in the study, the GPs provided more pre-diagnoses for each subsequent year from 7 percent in year 1 to 18 percent in year 3. Our study shows that the total percentage of correct pre-diagnosed cases of GPs is low, but during continual use of TDsc it slightly increased over time from 6 percent to 13 percent.

However, the number of incorrect pre-diagnosed cases also increased over time from 15.4 to 26.5 percent. This corresponds to a decrease in the overall PPV for all diagnosis categories. A possible explanation might be that after continual TDsc use, GPs might select the more difficult cases for TDsc and handle the less complex cases themselves. GP PPV specifically increased over time for diagnosis category L20-L30 *Dermatitis and eczema*. This may indicate that GPs become more attune to correctly diagnosing patients with dermatitis and eczema over time.

In general, GP sensitivity over all diagnosis categories showed a slight increase from 0.07 in year 1 to 0.14 in year 3. More importantly, GPs appear to become more sensitive in accurately pre-diagnosing skin disorders in the categories: C43-C44 *Melanoma and other malignant neoplasms of skin* and D10-D36 *Benign neoplasms*. As TDsc is especially important in early diagnosis of melanoma, these results are promising. When GP clinical expertise in recognizing melanoma improves, the sensitivity in melanoma detection increases. This finding is supported by a Cochrane review on accuracy of dermoscopy that shows that this sensitivity increases with more clinical expertise [6].

What we know from a previous study is that 95.1% of the GPs learned from the TDsc [10]. TDsc provides the GPs with direct feedback on the correctness of their pre-diagnosis by the confirmation of the TD. However, the system does not provide any active feedback on the GP performance. Literature on audit and feedback mechanisms shows that feedback leads to minor improvements in professional practice, but the effect is influenced by the way which the feedback is delivered [11]. New studies on analysing and advancing the effect of the feedback mechanism incorporated in TDsc consultations might lead to a higher GP learning curve.

Due to the rising number of correct pre-diagnosis of GPs, the percentage of TDsc in which the TD provides the GP with ICD-10 diagnoses decreases over time from 93 percent in the first year to 82 percent in the third year. This decrease might imply advancement in GP skin disorder diagnosing expertise. However, of the total TDsc consultations included in this study, in the subsequent three years 6.6%, 9.2% and 6.3% were diagnosed as melanoma by the TD for which the GP did not provide a (correct) pre-diagnose. In addition, two consultations which were pre-diagnosed by the GP as a benign neoplasm and a radiation-related disorder, were classified by the TD as *melanoma or other malignant neoplasm of the skin* (C43-C44). The high number of incorrectly diagnosed cases by GPs, indicates that the added value of TDsc after three years is still very high. However, these cases were not histopathological proven. Also, fourteen ICD-10 diagnosis categories were given by the TD which were not pre-diagnosed by GPs at all. This could indicate that GPs are unfamiliar with these diagnoses.

The results of this study reveal a potential learning effect of TDsc on GP skin disorder diagnose expertise. An increase in the number of pre-diagnosed consultations by the GP, an increase in diagnosis sensitivity and a modest increase in positive predictive value after three years for specific diagnose categories of TDsc usage were seen. However, overall, GPs pre-diagnose expertise of skin disorders appeared low in this study. Especially *Benign neoplasms* (D10-D36) and *other disorders of the skin and subcutaneous tissue* (L80-L99) appear difficult to diagnose by the GPs since a pre-diagnosis for these disorders was often lacking.

In this study GP were not obliged to fill in a pre-diagnosis, but the number of provided pre-diagnoses appears comparable to normal practice. In the study of Rijsingen et al. they assessed the quality of referral letters of GPs to the dermatologist of patients with skin tumours [4]. Their study showed that GPs do not always provide a diagnosis for suspicious lesions in referral letters to the dermatologist. A diagnosis was missing in 18.3% of the cases. In addition, only two out of eight melanoma were correctly pre-diagnosed in the GP referral letters. In our study, GPs detected 14 percent of all melanoma diagnosed by TDsc. The positive predictive value of GPs in melanoma detection for both studies was equal, 0.67.

Table 3 – Diagnosis categories chosen by Teledermatologist (TD) and not by General Practitioner (GP)

Category	Description
B00-B09	Viral infections characterized by skin and mucous membrane lesions
B35-B49	Mycoses
C81-C96	Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue
D65-D69	Coagulation defects, purpura and other haemorrhagic conditions
D70-D77	Other diseases of blood and blood-forming organs
H60-H62	Diseases of external ear
I80-I89	Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified
L00-L08	Infections of the skin and subcutaneous tissue
L40-L45	Papulosquamous disorders
L60-L75	Disorders of skin appendages
M30-M36	Systemic connective tissue disorders
O94-O99	Other obstetric conditions, not elsewhere classified
Q80-Q89	Other congenital malformations
T08-T14	Injuries to unspecified part of trunk, limb or body region
	No abnormalities

One of the limitations of this study is that in Dutch GP practice diagnoses are registered according to the International Classification of Primary Care (ICPC) and recorded according to SOAP notes (Subjective, Objective, Assessment, Plan). The ICD-10 classification of diseases was thus a new classification method where GPs were unfamiliar with, when it was implemented in 2015. GPs becoming more familiar with ICD-10 coding might therefore have contributed to the increase in the number of (correct) ICD-10 pre-diagnoses registered by the GPs in our study. Hence, in this study we only included GPs who started with TDsc after the ICD-10 was implemented in the Ksyos system, to research how their pre-diagnosing patterns changed according to the ICD-10 coding in three years' time. Also, GPs might use TDsc in general practice to fasten the face-to-face consultation with the patient and not solely for support in diagnosing. If a GP correctly pre-diagnosed the patient, but did not fill-in this diagnosis in the system, this would affect the GP PPV in diagnosing skin disorders. During the time of our study it was not mandatory for the GP to fill in the ICD-10 code in the system and this would thus not be seen in our data. Though this study has several limitations, the strength of the study is that we had a large database available of TDsc users and were able to include only GPs who started with TDsc when the ICD-10 coding system was first implemented in the Ksyos system and had continued and frequent use of the system in the past three years. We could therefore accurately address their progress in expertise in pre-diagnosing skin disorders based on ICD-10 coding.

Conclusions

TDsc supports GPs in assessing suspicious lesions of patients and their need for referral to a dermatologist. Continual use of TDsc over the years appears to slightly enhance GP sensitivity in diagnosing skin disorders based on ICD-10 coding. However, GPs PPV for the main ICD-10 codes showed a decrease over the years. Though GPs become more perceptive in recognizing benign neoplasms (D10-D36) and melanoma (C43-C44), TDsc detected a high number of melanoma not correctly pre-diagnosed or otherwise not detected by GPs in this cohort. Hence, TDsc has the potential to enhance GP expertise in skin disorder diagnosing, but remains essential in early melanoma detection even after GP continued and frequent TDsc use.

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Conflicts of interests E.T., F.v.S are employed (part-time) by Ksyos, and L.W. is the director of Ksyos. The remaining authors state no conflicts of interest.