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Improving Diagnosis of Skin Cancer in Primary Care

Nina Badertscher

Some terms have been standardized throughout the text for reasons of consistency within the thesis. Therefore, the text may differ in some details from the articles that have been published.

All studies have been performed at the Institute of Primary Care at the UniversityHospital Zurich, Switzerland.

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Improving Diagnosis of Skin Cancer in Primary Care

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Chapter 1

General introduction

This thesis focuses on the clinical management of skin cancer in primary care, especially on the competence of general practitioners to diagnose skin cancer. To investigate different aspects of this topic, a survey (chapter 2), a randomized controlled trial (chapters 3 to 5) and a process analysis (chapter 6) were performed. Additionally, in chapter 7, the role of patients' skin self-examination was investigated.

Background

Epidemiology of skin cancer

Over the past decades, the incidence of skin cancer, especially melanoma, was rising. Switzerland and the Netherlands are two of the countries with the highest incidence of melanoma in Europe [1-6]. With around 26 cases per 100,000 residents (Switzerland) and 24 cases per 100,000 residents (the Netherlands), Switzerland and the Netherlands have a higher incidence of melanoma than comparable Western Europe countries like Germany (around 15 cases per 100,000 residents) or Austria (around 13 cases per 100,000 residents) [1].

Hollestein et al. [7] investigated if the increasing incidence of melanoma in the Netherlands since 1989 is caused by a real melanoma epidemic or by increased awareness leading to overdiagnosis. They found that the incidence of melanomas among all Breslow thickness categories increased, so "the melanoma epidemic in the Netherlands seems to be real and not only due to overdiagnosis". Around 1900 new cases of melanoma are diagnosed in Switzerland per year [8] and melanoma is the fourth most frequent cancer in Switzerland in men as well as in women [9]. For men, only prostate cancer, lung/bronchus/trachea cancer and colorectal cancer have a higher incidence than melanoma; for women only breast cancer, colorectal cancer and lung/bronchus/trachea cancer have a higher incidence than melanoma [9]. Melanoma is one of the most frequent cancer diagnoses in young adults: one third of Swiss patients with melanoma are under 50 years old [8]. In general, there is a major gap between incidence and mortality of melanoma: Despite the relatively high incidence of melanoma, the mortality is low. This is caused by the often early diagnosis in stages where a total surgical remove is possible. Nevertheless, there remains room for improvement, especially because most of the melanomas are located on the body surface and therefore mortality is potentially preventable. Melanoma mortality in Europe is with 1.5 cases per 100,000 residents the third highest in the world, only Australia/New Zealand (3.5 cases per 100,000 residents) and North America (1.7 cases per 100,000 residents) have higher mortality rates [1].

Types of skin cancer

The three main types of skin cancer are melanoma, basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). Of these three types, melanoma is the most aggressive one and responsible for more than 90% of all skin cancer related deaths. Because there are no adequate therapies for metastatic melanoma, the best management option remains early detection and immediate surgical removal of the primary cancer. There are different subtypes of melanoma, the most

frequent ones are: superficial spreading melanoma (70%), nodular melanoma (15%), lentigo maligna melanoma (10-15%) and acral lentiginous melanoma (1-3%) [11]. The prognosis of melanoma depends much on the tumor thickness according to Breslow (distance from the stratum granulosum to the deepest point of invasion).

BCC and SCC (summarized as nonmelanoma skin cancer NMSC) are clinically less aggressive than melanoma, but more prevalent. They are less dangerous because they rarely build metastases, but generate high morbidity and health costs because of their higher incidence, their local destructive growth pattern and their tendency to recur after treatment [12].

Risk factors for skin cancer

The main risk factor for melanoma in white populations is intermittent exposure to ultraviolet radiation (UVR) [4, 10]; in contrast to melanoma, BCC and SCC (summarized as nonmelanoma skin cancer NMSC) are more strongly linked to cumulative sun exposure. Depending on the geographical location, UVR differs a lot, an example for a very high intensity of UVR is Australia with a very high incidence of melanoma. The mechanisms of skin cancer induction by UVR are: 1. direct DNA damages/mutations, 2. DNA damage caused by activated oxygen molecules and 3. local immunosuppression.

Beside these environmental risk factors, there are also different host risk factors for melanoma, for example the number of nevi (especially dysplastic nevi), a family history of melanoma (and with weaker evidence also a personal history of nevi), skin phototype I and II (with sun sensitivity or inability to tan, blue or green eyes, blond or red hair) and immunosuppression (e.g. after organ transplantation).

The role of primary care

The rapidly rising incidence of skin cancer connected with a higher awareness of patients for this topic leads to the fact that GPs are more and more faced with suspicious skin lesions in their patients. They are often the first contact person for examination and potential referral to a dermatologist. To handle suspicious skin lesions correctly, appropriate knowledge and high diagnostic competence are crucial for the GPs. In Switzerland, no specific skin cancer training is given during medical school. Even during their vocational training, very few GPs receive further education on dermatology.

Also in the UK, a compulsory dermatological training is absent during vocational training for GPs but Kerr et al. found in a survey in the UK that 71% of the assessed GPs thought that dermatology training should be included in undergraduate as well as postgraduate training [13]. Koelink et al. [14] showed that in the Netherlands, from 2001 onwards, the demand for care due to suspicious skin lesions increased annually 7.3% in primary care. This shows the increasing burden of suspected skin malignancies on primary care and most likely on healthcare costs in general.

Teledermatology

The broad use of the internet and of computer technology as well as the availability of digital cameras offers the option to introduce teledermatology in primary care. Teledermatology is a technical supported medical diagnostic method. It combines the possibility to take pictures or videos of skin lesions by non-physicians (or non-experts) with the diagnostic ability of remote dermatological experts. Several studies [15-19] showed that teledermatology can be a viable alternative to face-to-face consultations and even showed positive effects on earlier diagnosis of melanoma. Teledermatology can be divided into two systems: 1. “store-and-forward-teledermatology” with a time gap between the consultation/photo/video documentation of the skin lesion by the GP and the assessment of the photo or video by the dermatologist. 2. “real-time teledermatology” with video- or telephone connection between the dermatologist and the GP during patients’ consultation. In the research presented in this thesis we focused on a system of “store-and-forward-teledermatology”.

Aims of the thesis

The main aims of this thesis were:

1. to record the actual situation for GPs in the Canton of Zurich regarding the relevance of skin cancer in their daily practice (chapter 2)
2. to investigate the feasibility and effects of dermatological education on GPs’ competence to diagnose skin cancer (chapters 3 to 6)
3. to explore the role of skin self-examination for a clinical diagnosis of skin malignancy (chapter 7)

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Chapter 2

Skin cancer in primary care: frequency, need for further education and subjective diagnostic certainty. A cross sectional survey among general practitioners in the Canton of Zurich.

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Abstract

Introduction

The incidence of skin cancer in Switzerland is rising. The aim of our survey was to investigate the frequency of malignant suspicious skin lesions in primary care, to ask for the diagnostic certainty of general practitioners (GPs) regarding skin cancer and to assess the need for further education regarding skin cancer.

Material and methods

We conducted a survey with 1212 GPs in the Canton of Zurich. Descriptive analysis, assessment of different influence factors on the need for further education regarding skin cancer (regression analysis).

Results

41.4% response rate. Of the GPs, 23.2% saw daily/weekly patients with malignant suspicious skin lesions in their private practice, further 34.8% saw monthly such patients. Of the GPs, 79.0% stated their need for further education regarding skin cancer; this need was lower for urban GPs and for GPs with a high diagnostic certainty.

Conclusions

GPs in the Canton of Zurich saw relatively often patients with malignant suspicious skin lesions in their private practice. Despite a quite high subjective diagnostic certainty, a clear need for further education regarding skin cancer was stated by the GPs.

Introduction

Skin cancer is one of the most common forms of cancer in Switzerland [1]. In recent years, cases of skin cancer have increased significantly, and a further rise is expected [2-4]. Currently, around 1900 people per year are affected by melanoma [1]. For those born in the year 2000, the lifetime risk of melanoma is 1:80 [2]. By European comparison, Switzerland is one of the leading countries concerning melanoma prevalence [5]. This could be due to common skin cancer risk factors such as light skin types with a tendency to dysplastic nevi, a family history of melanoma and chronic sun damage [6-9]. Another risk factor is intermittent exposure to UV radiation in populations usually unused to sun exposure. This is a relatively common free time or holiday occurrence in Switzerland and explains the heightened risk of skin cancer in populations with higher income [10].

The three most significant forms of skin cancer are basal cell carcinoma (BCC), spinocellular carcinoma (SCC) and melanoma. Melanoma is the most aggressive form of skin cancer. If it is not diagnosed and correctly treated in time, there is a high risk of metastases. Once metastases have occurred, the melanoma is usually no longer treatable and often leads to death in a very short time. Basal cell carcinoma and spinocellular carcinoma very rarely metastasize, but due to their local destructive growth and recurring nature, they can lead to increased morbidity and high health care costs [11].

The increasing frequency of skin cancer, paired with the population's rising awareness of skin cancer, has led to patients with suspicious skin conditions seeking their GPs advice before seeing an expert. In order for these patients to receive suitable care, GPs need access to high quality further education regarding skin cancer. The Institute of Primary Care Zurich is examining together with the Department of Dermatology of the UniversityHospital Zurich a new approach to further education for GPs, which combines the technique of teledermatology with the principle of continuous medical education (Project "minSKIN") [12].

In advance of the minSKIN study, this survey aims to determine whether GPs in the Canton of Zurich require further education on skin cancer diagnosis. We also asked GPs how often they encounter this topic in their daily practice and how they subjectively judge their diagnostic certainty concerning malignant suspicious skin lesions.

Material and methods

For this survey, a short questionnaire was developed. The questionnaire consists of demographic data, one open question and seven multiple-choice questions; of which one required multiple answers and six required only one answer. The questions examined, amongst other things, the frequency of the subject of skin cancer in daily practice, the subjective diagnostic certainty, the need of further education on the topic and the specific procedure with patients with malignant suspicious skin lesions.

Pilot phase: In January 2011, the questionnaire was given to the roughly 60 participants of a conference of teaching doctors of the Institute of Primary Care Zurich. The questionnaire did not require adjustment after the pilot phase as 39 responded to the questionnaire and the questions were judged as relevant and clear.

Definite dispatch: In March 2011, the questionnaire was successfully sent to 1212 GPs in the Canton of Zurich. The 60 participants of the conference of teaching doctors did not receive the questionnaire again, to avoid collecting the same data twice. The questionnaire was sent with an addressed and pre-stamped return envelope. The questionnaire was re-sent with a reminder to those who did not reply within six weeks.

All questionnaires were evaluated anonymously. The locations of the private practices were classified by postcode. Postcode areas with at least one practicing dermatologist were classified as “urban”. Areas with no skin specialists were classified as “rural”.

The statistics program STATA, version 12, was used for the statistical analysis. The data were first evaluated descriptively. Then, in a second step, Spearman’s correlation coefficient was used to analyze the correlation between possible influence factors on the GPs’ need for further education on dermatology. Due to multiple testing, the Bonferroni correction was used to adjust the correlation analysis. The association between influence factors and the need of further education on dermatology was investigated using bivariate and multiple logistic regressions. For the analysis, the independent variable “need of further education” was dichotomized (yes/generally yes vs. no). The answers for the factors “frequency” (once a day/once a week vs. once a month/rarely) and “certainty” (generally certain/very certain vs. generally uncertain/very uncertain) were also dichotomized. The factors “age” and “experience” were calculated as continuous variables. The factors “gender”, “city”, “education” and “work quota” were included in the analysis with two or three categories, as in the original questionnaire.

An overview of the definition of the examined influence factors and their significance to the need of further education can be found in **Tab. 1**. The p-value 0.05 was chosen as the significance level.

Sex	Sex: male=0, female=1
Age	Age in years
Experience	Number of years working in primary care
Urban	Practice location: rural=0, urban=1
Work Quota	Work quota: <50%=1, 50-80%=2, >80%=3
Education	Further education on dermatology no=0, yes=1
Frequency	Frequency of topic in daily practice: monthly/fewer=0, daily/weekly=1
Certainty	Subjective diagnostic certainty: generally/very uncertain=0, generally/very certain=1

Tab. 1: Definition and characteristics of the possible influence factors on the need for further education

Results

Response rate

Pilot phase: 39 questionnaires were returned either at the conference of teaching doctors or by post within two weeks.

Definite dispatch: The questionnaire was sent successfully to 1212 GPs in the Canton of Zurich. 77 questionnaires were returned as undeliverable by the post. Of the 1212 GPs, 502 answered the questionnaire. The response rate was 41.4%. Of the 502 who answered, 28 responded that they did not work as GP and 13 responded that they were retired. We could therefore incorporate 461 completed questionnaires into the analysis.

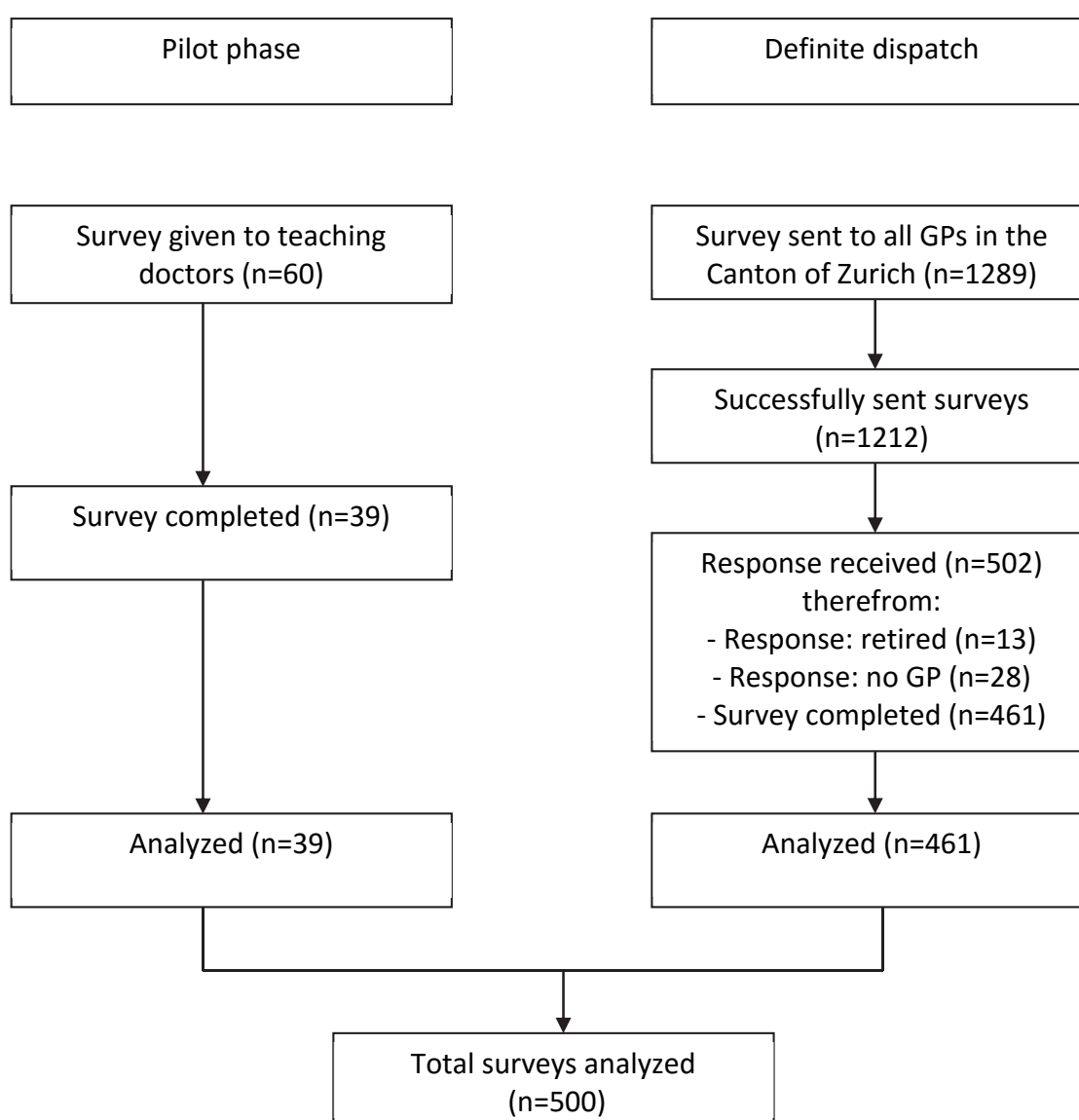


Fig. 1: Flow diagram of the study

As **Fig. 1** shows, both questionnaires from the pilot phase and those from the definite dispatch, which equal a total of 500 questionnaires, were incorporated into the final analysis.

Demographic data

Of the GPs, 350 (70.0%) were male, 150 (30.0%) were female. The average age of the GPs was 54.1 years (SD 9.0), with ages ranging from 31 to 82. The number of years since the establishment of the practices ranged from 0 to 54 years, with an average of 17.1 years (SD 10.2). 347 (69.4%) of the practices were classified as “urban”, 152 (30.4%) as “rural”. 50 (10.0%) of the GPs had a work quota of less than 50%, 135 (27.0%) worked 50-80% and 311 (62.2%) had a quota of more than 80%.

Further education and minor dermatologic surgery in private practice

167 (33.4%) of the GPs indicated that they had received further education on dermatology, while 330 (66.0%) responded that they had not. 296 (59.2%) GPs responded that they perform minor dermatologic surgery in their practice, while 201 (40.2%) responded that they do not.

Frequency in daily practice

116 (23.2%) GPs responded that they are consulted by patients with malignant suspicious skin lesions daily or at least once a week. Further 174 (34.8%) indicated that they advise patients with malignant suspicious skin lesions at least once a month. In total, 290 (58.0%) GPs saw patients with malignant suspicious skin lesions at least once a month, 198 (39.6%) GPs less than once a month.

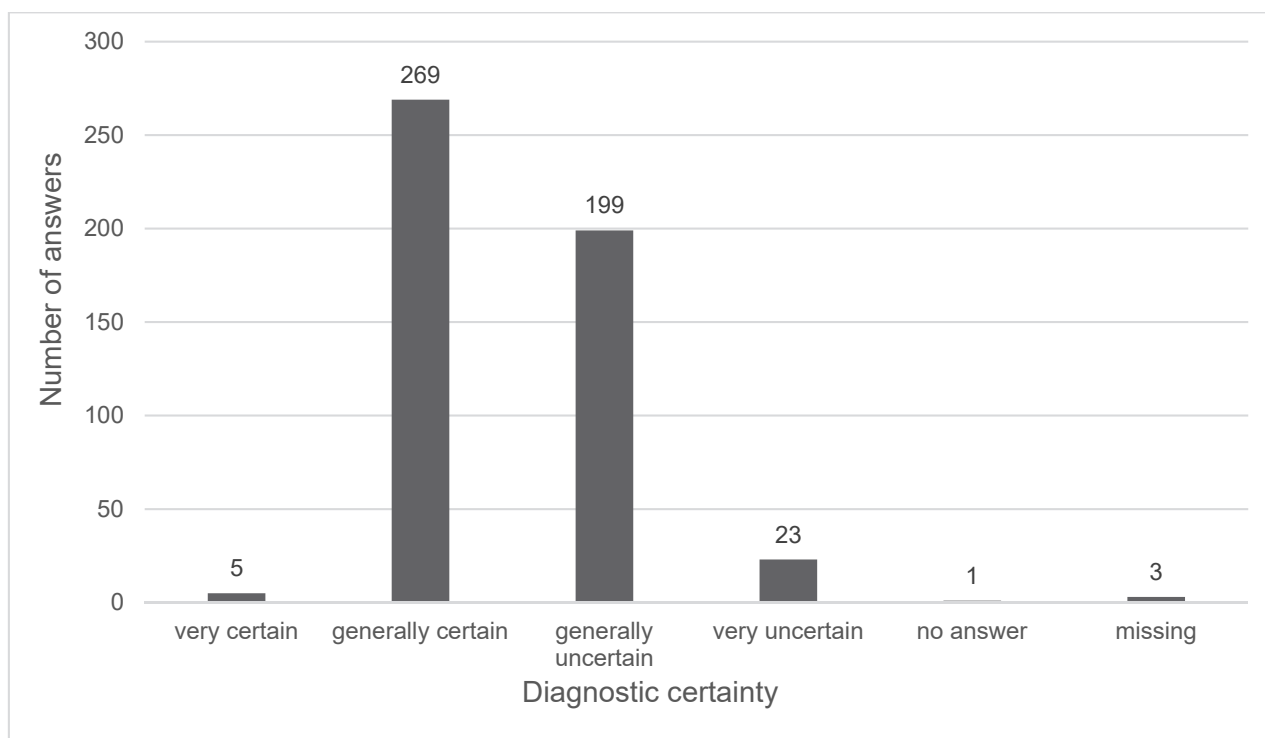


Fig. 2: Subjective diagnostic certainty regarding malignant suspicious skin lesions

Diagnostic certainty and need of further education

As shown in **Fig. 2**, 5 (1.0%) GPs feel “very certain” of their diagnosis of malignant suspicious skin lesions. 269 (53.8%) were “generally certain”, 199 (39.8%) were “generally uncertain” and 23 (4.6%) were “very uncertain”. 294 (58.8%) indicated that they had difficulty diagnosing melanoma, 220 (44.0%) indicated difficulty diagnosing spinocellular carcinoma and 131 (79.0%) had difficulty diagnosing basal cell carcinoma. As shown in **Fig. 3**, 395 (79.0%) GPs indicated in our questionnaire that they felt they needed further education regarding skin cancer (159 (31.8%) answered “yes” and 236 (47.5%) answered “generally yes”). 94 (18.8%) GPs indicated that they had no need of further education regarding skin cancer.

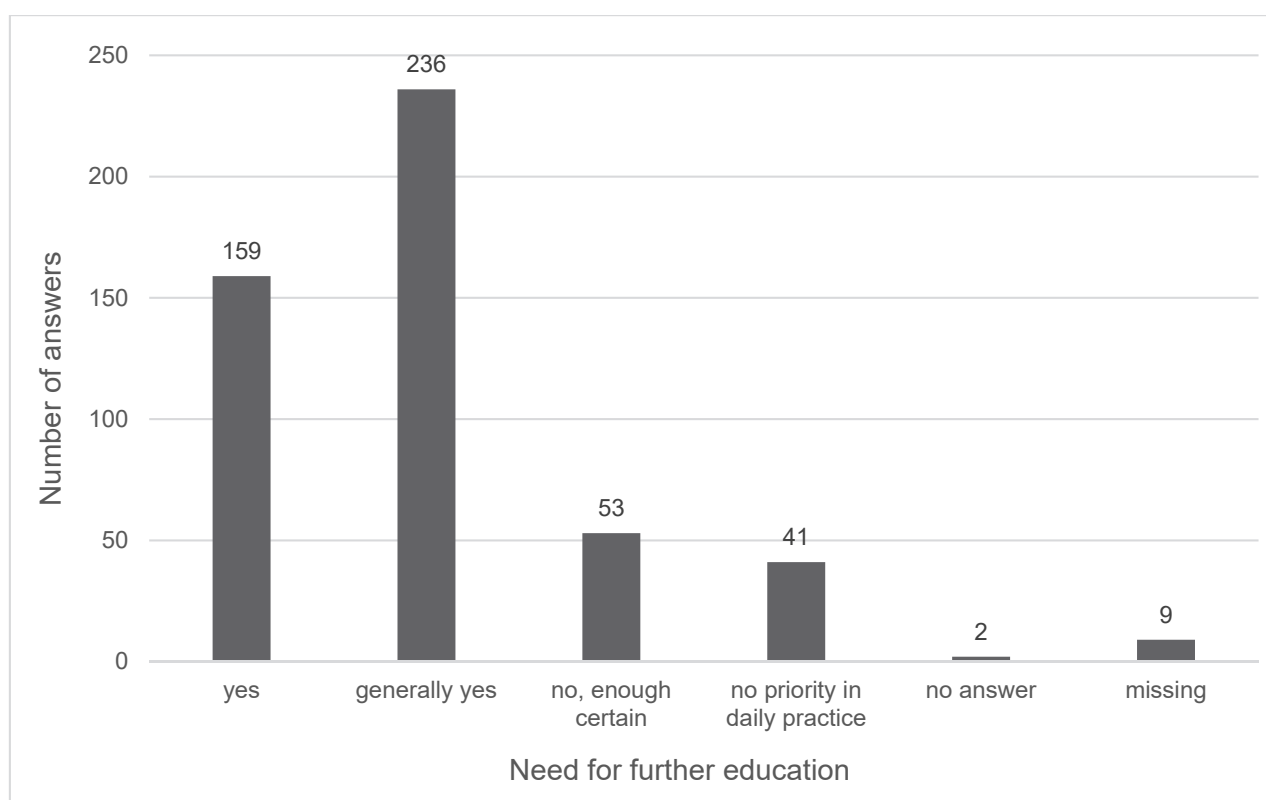


Fig. 3: Need for further education regarding skin cancer

Handling of malignant suspicious skin lesions

50 (10.0%) GPs indicated that, with patients with malignant suspicious skin lesions, they only examined the individual lesion. 196 (39.2%) said that they examined the individual lesion as well as performing a total body examination. 226 (45.2%) said that they did not examine these patients themselves, but referred them directly to a dermatologist. Of the 246 GPs who examined the malignant suspicious skin lesions of their patients, 157 (63.8%) performed the excision of the lesion themselves, while 63 (25.6%) referred their patients to a dermatologist or surgeon for excision.

Influence factors on the need of further education

As shown in **Tab. 2**, the correlation analysis shows several statistically significant, yet weak correlations between the examined influence factors, even after the Bonferroni correction. There were positive correlations between the factor “certainty” and the factors “age”, “experience”, “work quota”, “education” and “frequency”. Urban practices saw significantly less dermatologic problems compared to rural practices. The urban location of the practice and the subjective diagnostic certainty were independent and significant factors associated with less need of further education (adjusted OR 0.42 or 0.40). Work quotas higher than 50% showed a higher need of further education (**Tab. 3**).

	Sex	Age	Experience	Urban	Work quota	Education	Frequency	Certainty
Sex	1.00							
Age	-0.25**	1.00						
Experience	-0.26**	0.89**	1.00					
Urban	0.16**	-0.03	-0.03	1.00				
Work quota	-0.46**	0.11*	0.08	-0.09	1.00			
Education	-0.04	0.13*	0.16**	-0.06	0.08	1.00		
Frequency	-0.21**	-0.01	0.03	-0.15**	0.18**	0.10*	1.00	
Certainty	-0.21**	0.21**	0.24**	-0.09	0.24**	0.29**	0.22**	1.00

Tab. 2: Spearman correlation coefficient for the possible influence factors.

(* $p < 0.05$ without Bonferroni correction; # $p < 0.05$ with Bonferroni correction)

Need for further education	OR (unadjusted)	p-value	OR (adjusted)	p-value
Sex (Ref.= male)	1.14	0.605	1.13	0.713
Age (years)	0.98	0.100	1.02	0.597
Experience (years)	0.98	0.108	0.97	0.291
Urban (Ref.= rural)	0.44	0.004	0.42	0.006
Work quota 50-80% (Ref. <50%)	2.20	0.048	2.84	0.019
Work quota >80% (Ref. <50%)	1.67	0.138	2.32	0.050
Education	1.10	0.699	1.38	0.240
Frequency (Ref.= monthly/less)	1.04	0.889	1.09	0.784
Certainty (Ref.= generally/very uncertain)	0.45	0.003	0.40	0.002

Tab. 3: Unadjusted and adjusted odds ratios (OR) resulting from the bivariate and multiple logistic regression analyses: The need for further education remained significant associated with the factors “urban” “work quota 50-80%» and “certainty”.

Discussion

Main findings

Almost 80% of the GPs indicated a need of further education regarding skin cancer. This need of further education was influenced by the subjective diagnostic certainty, the location of the practice and the work quota. GPs in urban areas and with higher diagnostic certainty had less need of further education regarding skin cancer, while GPs with higher work quotas did have a higher need of further education.

Frequency of skin cancer in daily primary care, diagnostic certainty and need of further education

More than half of the GPs were consulted at least once a month on malignant suspicious skin lesions; around a quarter were consulted weekly. An earlier Swiss study [13] showed that skin or skin conditions were the fifth commonest reason for consulting a doctor, after musculoskeletal, cardiovascular, respiratory and endocrinal reasons. A study conducted in Scotland found skin conditions in 9% of consultations, over 11% of which concerned skin tumors [14].

Although more than half of the GPs surveyed felt certain in their diagnosis of malignant suspicious skin lesions, 80% indicated that they felt they needed further education regarding skin cancer. Especially the diagnosis of melanoma was judged as difficult by 60% of the GPs questioned. It has been difficult for GPs to receive further education on skin cancer during their vocational training, due to the lack of positions in dermatology open to prospective GPs. This was also shown in our survey: only around a third of the surveyed GPs indicated that they had deepened their knowledge of dermatology during vocational training.

With the new general practitioners' curricula [15], individual trainee doctors do have the possibility to spend a half-yearly rotation in dermatology and so receive broader education on dermatology. These rotational positions are filled years in advance, which shows that they are in great demand. Our study showed that the frequent occurrence of the topic in primary care is clearly disproportionate to the amount of available further education regarding skin cancer. This imbalance is being addressed by the establishment of rotational positions in dermatology for future GPs. However, for practicing GPs, there should be more education available in the fields of skin cancer diagnosis and the management of malignant suspicious skin lesions.

Influence factors on the need of further education

The correlation analysis showed that older GPs were subjectively more certain of their diagnosis the longer they had been in practice, the higher their work quota, the more training they had received and the more often the subject was raised in their practice. GPs in urban areas saw fewer patients with malignant suspicious skin lesions. The number of GPs with further education on dermatology rose with the number of years of practical experience.

The multiple logistical regression analysis showed that an urban location of the private practice was directly linked to a lower need of further education. Because the specialist density in urban

areas is higher than in rural areas, it is possible that GPs refer their patients to a dermatologist more often, or that patients with suspicious skin lesions seek a dermatologist directly. The relative frequency of the topic in daily practice was lower in urban areas; therefore, it was discussed less in consultations, leading to a lower need of further education regarding skin cancer in practices in urban areas.

Higher work quotas tended to be associated with a higher need of further education. This could be explained by the fact that GPs with lower work quotas encountered the topic less often in their consultations and that the topic is therefore less relevant than to GPs with higher work quotas. It is also possible that, because lower work quotas also mean less capacity for further education, the further education would be focused on more relevant and frequently occurring topics.

Also noticeable was the trend towards less need of further education, the higher GPs subjectively rated their diagnostic certainty. The GPs' subjective certainty on a medical problem was possibly one of the criteria whereby the need of further education was prioritized, in cases of limited resources for further education. The further-education-effect was greater in topics not prioritized by GPs, compared to preferred topics, as shown in a study by Sibley et al. [16].

Our cross-sectional analysis could not fully assess whether the lower need of further education was influenced by "avoidance behavior" or by greater certainty in the handling of malignant suspicious skin lesions.

Strengths and limitations

The response rate of 41.4% was higher than is usually expected in surveys of GPs [17]. Due to the relatively high amount of undeliverable questionnaires, it must be assumed that we did not reach all GPs in the Canton of Zurich. It should also be emphasized that, for example, diagnostic certainty and need of further education were not measured objectively, but were rated subjectively by the participants.

Conclusion

It could be shown that GPs in the Canton of Zurich are faced with patients with malignant suspicious skin lesions relatively often, and that, despite relatively high subjective diagnostic certainty, there is a clear demand for further education regarding skin cancer.

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Chapter 3

*“minSKIN” - does a multifaceted intervention improve the competence in the diagnosis of skin cancer by general practitioners?
Study protocol for a randomized controlled trial.*

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T. Rosemann
R. Tandjung
R. P. Braun

Abstract

Background

In Switzerland, skin cancer is one of the most common neoplasms. Melanoma is the most aggressive one and can be lethal if not detected and removed on time. Nonmelanoma skin cancer is more frequent as melanoma; it is seldom lethal but can disfigure patients in advanced stages. General practitioners (GPs) are often faced with suspicious skin lesions of their patients.

Methods/Design

Design: Randomized controlled trial (RCT).

Population: 60 GPs, randomized into intervention group and control group.

Intervention: GPs get a Lumio loupe, a digital camera and continuous feedback based on pictures of skin lesions they send to the dermatologist.

Primary outcome: Competence in the diagnosis of skin cancer by GPs, measured as the percentage of correctly classified pictures of skin lesions.

Measurements: At baseline, and prior to any intervention (T0), GPs will be asked to rate 36 pictures of skin lesions according to their likelihood of malignancy on a visual analogue scale (VAS). After a full day training course with both groups (T1) and after one year of continuous feedback (T2) with the intervention group, we will repeat the picture scoring session with both groups, using new pictures.

Discussion

We want to determine whether a multifaceted intervention (including technical equipment and a continuous feedback on skin lesions) leads to an improved competence in the diagnosis of skin cancer by GPs. This study addresses the hypothesis that an additional feedback loop, based on pictures performed in daily practice by GPs is superior to a simple educational intervention regarding diagnostic competence. We expect an improvement of the competence in skin cancer diagnosis by GPs in both groups after the full day training course. Beside this immediate effect, we also expect a long term effect in the intervention group because of the continuous problem based feedback.

Background

Skin cancer is one of the most common neoplasms in Switzerland [1] and in Central Europe Switzerland is one of the countries with the highest prevalence of melanoma [2].

There are three main types of skin cancer: basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and melanoma. Within skin cancers, melanoma is the most aggressive one and can be lethal if not detected and removed on time. It is responsible for more than 90% of all skin cancer related deaths. The lifetime risk for melanomas in Switzerland for newborns of the year 2000 is estimated to be 1:80 [3], there are currently approximately 1900 new cases of melanoma per year in Switzerland [1] and the rate of incidence continuously increases. Due to a lack of adequate therapies for metastatic melanoma, the best management option currently remains early diagnosis and prompt surgical excision of the primary cancer. If diagnosed and treated at early stages most melanoma can be cured.

BCC and SCC (summarized as nonmelanoma skin cancer, NMSC) are more frequent than melanoma; they are less dangerous because they rarely spread in the body. Due to their high incidence, their aggressive, destructive growth pattern and their tendency to recur after treatment, the morbidity and costs related to these cancers are very high [4].

Due to the rapidly rising incidence of skin cancer, GPs are more and more faced with suspicious skin lesions in their patients. Appropriate knowledge and continuous training about suspicious skin lesions are crucial to handle these lesions correctly. An important condition for an optimal patient care is the collaboration of GPs with dermatologists in a multidisciplinary treatment team [5].

Methods/Design

Hypothesis

A multifaceted intervention including technical equipment and a continuous feedback (provided by a dermatologist) leads to an improved competence in the diagnosis of skin cancer by GPs.

Study design

This study is a (prospective) randomized, two-armed study; randomized and controlled at the GP level. The intervention includes a Lumio loupe (magnifying glass with integrated polarized light source allowing subsurface examination), a digital camera and continuous feedback on all pictures of skin lesions the GP sends to the dermatologist.

Primary outcome

Competence in the diagnosis of skin cancer by GPs, measured as the percentage of correctly classified pictures of skin lesions.

Inclusion criteria for general practitioners

All GPs in the Canton of Zurich will be invited to join the study by postal letters and information sessions provided by members of the study center. 60 GPs are projected to be part of the study. Any general practitioner who provides basic medical care with a workload of at least 20 hours per week, who does not plan to retire or to move away during the study period is entitled to participate in the study.

Procedure of the study

The procedure of the study is summarized in **Fig. 1**.

Both groups

At baseline, and prior to any intervention (T0), the GPs will be asked to rate 36 pictures of skin lesions according to their likelihood of malignancy on a VAS. After a full day training course with both groups (T1) and after one year of continuous feedback (T2) with the intervention group, we will repeat the picture scoring session with both groups.

Intervention group

After the initial picture scoring sessions and the full day training course, every GP will receive a Lumio loupe (magnifying glass with integrated polarized light source allowing subsurface examination) and a digital camera. During his normal consultations, the GP takes pictures with the digital camera of those skin lesions he wants to get feedback on. The pictures are made anonymous and sent by e-mail to an address, specially created for this study. Alternatively, the memory cards with the pictures will be sent once per week to the study center.

Based on those pictures, a continuous problem based feedback and teaching to the GPs will be conducted. As kind of reminder, every GP will receive a monthly update on the study, including the number of pictures he sent to the dermatologist compared to the number of pictures sent by the other GPs in the intervention group.

We will not change the current health care practice for the patients; malignant suspicious lesions will be removed immediately. In case of an additional teledermatological diagnosis “malignant suspicious”, the GP will be informed directly and has to contact the patient immediately to prevent a delay in excision and further treatment.

Control group

GPs in the control group also join the initial picture scoring sessions and the full day training course, but they will receive neither the technical equipment nor the continuous feedback until the end of the study. After the end of our measurements, GPs in the control group will also receive the Lumio loupe, the camera and the possibility to send pictures of skin lesions for teledermatological assessment.

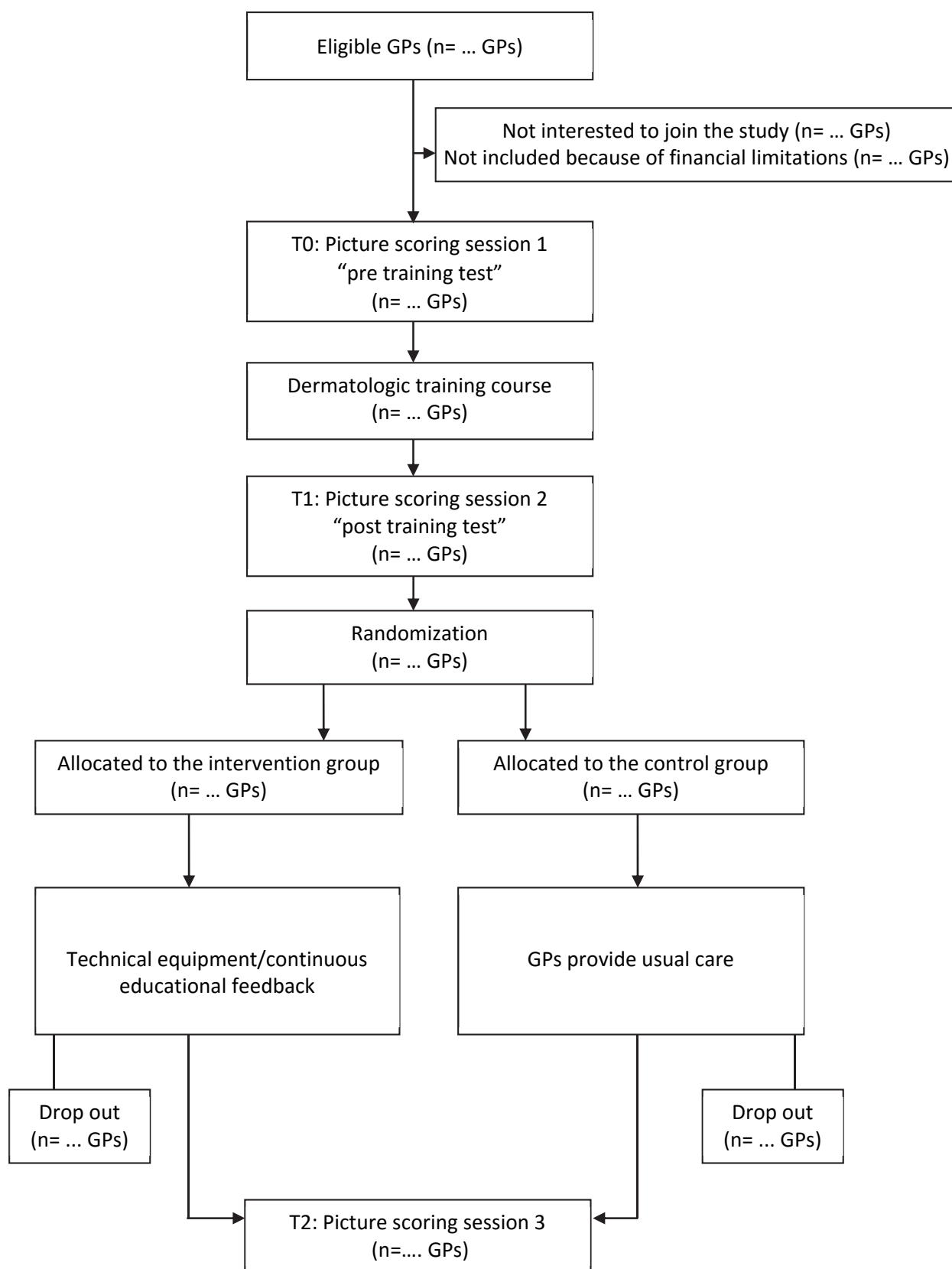


Fig. 1: Study design

Sample size

The power calculation was based on data from previous studies, as e.g. Gerbert et al. [6] who showed that the improvement in correct answers with an educational intervention could be about 13-36%. Due to the continuous feedback via teledermatology we assume this effect even to be greater.

Based on these assumptions, a power of 80% and a significance level of 5% (alpha error) the sample size has to be 53 GPs. With a dropout rate of 10% we concluded that 60 GPs would be necessary.

Randomization and blinding

Randomization (intervention group or control group) will take place at the GP level and will be carried out centrally by the study center. After the initial picture scoring sessions and the full day training course, we will draw up a randomization list by computer (ralloc command of Stata software for Windows, Version 11). Blinding of the GPs is not possible.

Training course

The GPs in both groups will receive a full day training course on skin cancer diagnosis which is going to be organized by Prof. Braun and his collaborators from the Department of Dermatology of the UniversityHospital Zurich. This training course will contain structured lectures and interactive problem based teaching.

Time frame

The time frame of our study is shown in **Fig. 2**. The study is intended to last around 16 months from which the intervention with the continuous feedback will last 12 months.

Data collection

For this study we will develop a pool of 108 example cases (pictures of skin lesions we know the diagnosis, supplemented with short histories), 36 cases at a high difficulty level, 36 cases at a medium difficulty level and 36 cases at a low difficulty level. The levels of difficulty will be defined by two dermatologists independently. For each of the three picture scoring sessions (at T0, T1 and T2), we will randomly allocate 36 cases (12 at each level of difficulty). This random distribution will be made prior to the start of the study to assure an equal difficulty of each picture scoring session. With the scoring session prior and after the intervention, we measure the competence in skin cancer diagnosis of all participating GPs. We will record the percentage of correct diagnoses made on the basis of pictures with a short history. The GPs will have to score the likelihood of malignancy on a VAS («very unlikely” to “very likely”).

From photographed patients in the GPs' practices of the intervention group, we will record some demographic and clinical information (age, sex, skin type, parts of the body that were examined and the histology of skin lesions that were excised). All patient data are made anonymous and the encoding list is kept by the GP.

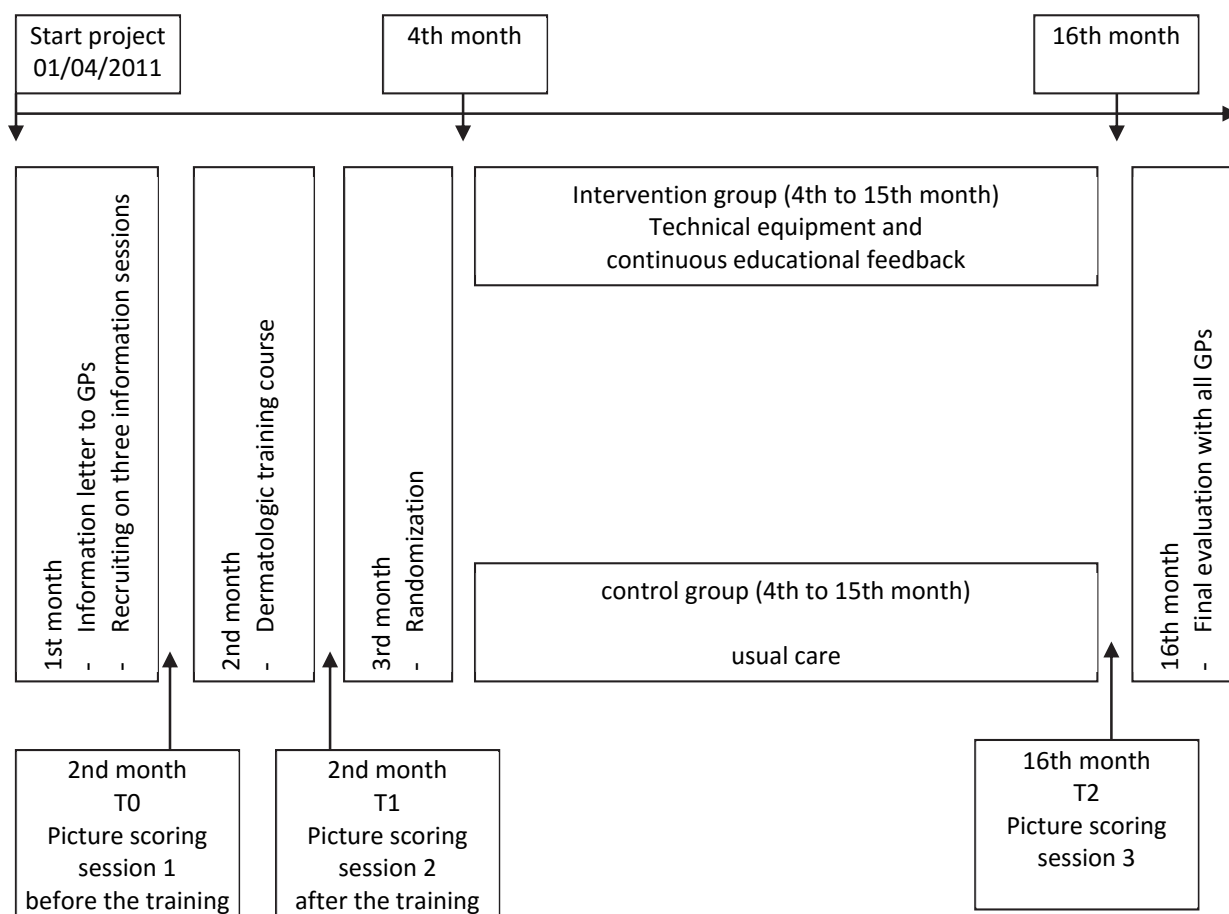


Fig. 2: Time frame

Analysis

Prior to the start of the study, the pictures will be categorized by two dermatologists independently into three different levels of difficulty (low, medium or high level of difficulty). For every level of difficulty, a cut-off on the VAS will be defined previously to determine the correctness of the answers. This allows analyzing the answers corrected for the difficulty of the pictures.

The Chi-square test will be used for the primary outcome. The presentation of the data will follow the CONSORT-recommendations for reporting results of randomized controlled trials [7].

Ethical principles

The study is being conducted in accordance with medical professional codex and the Helsinki Declaration as of 1996 as well as Data Security Laws and Good Clinical Practice criteria (GCP). Study participation of GPs and patients is voluntary and can be cancelled at any time without provision of reasons. The study protocol will be registered at a trial register (current-controlled-trials) and the study protocol will be published in an open access journal, to be accessible for everybody.

GP and patient informed consent

Previous to study participation GPs receive written and spoken information about the content and extent of the planned study. In case of acceptance they sign the informed consent form. Written informed consent will also be obtained from patients prior to take pictures of one of their skin lesions. In case of study discontinuation all material will be destroyed or the GPs and patients will be asked if they approve existing material for analysis in the study.

Vote of the ethics committee (KEK-ZH-Nr. 2010-0384/5)

The study protocol has been approved by the ethics committee of Zurich. A written and unrestricted positive vote of the ethics committee was recorded on the 1st of March 2011.

Data security and disclosure of original documents

The GP and patient names, pictures of skin lesions and all other confidential information fall under medical confidentiality rules and are treated according to appropriate Federal Data Security Laws. All study related data and documents are stored on a protected central server of the University of Zurich. Only direct members of the internal study team can access the respective files. Intermediate and final reports are stored at the Institute of Primary Care and at the Department of Dermatology at the Zurich UniversityHospital (USZ).

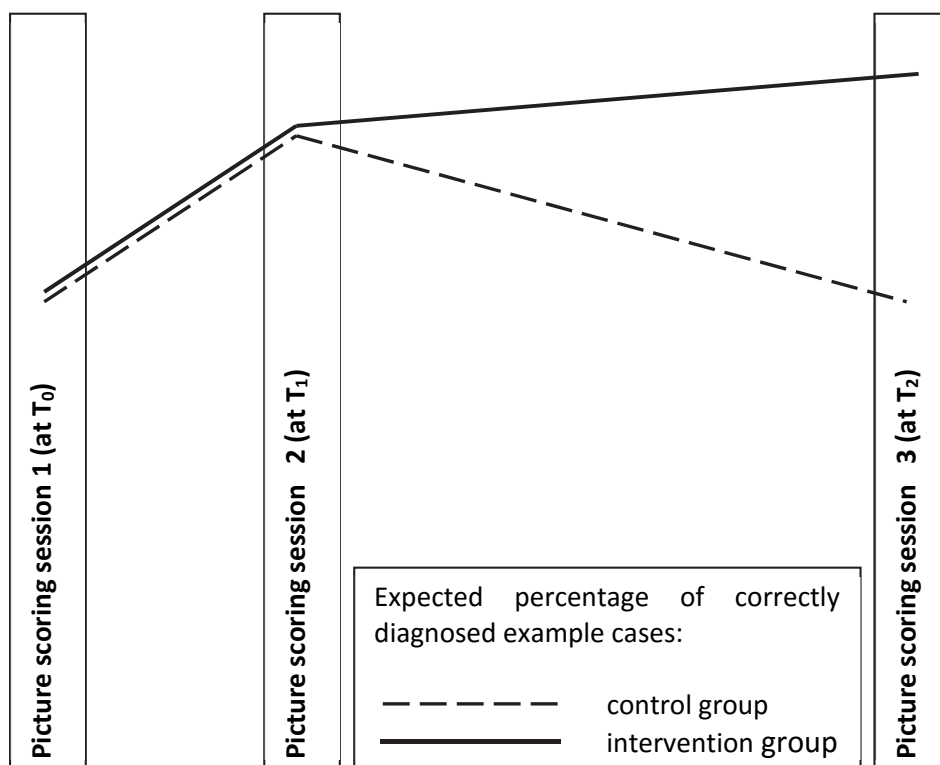


Fig. 3: Expected results

Discussion

As shown in **Fig. 3** we expect an improvement of the competence in skin cancer diagnosis after the full day training course at T1 compared to T0 in both groups. This improvement will probably fade away in the control group after one year. It is known from different studies [8,9] that the effect of a continuing medical education (CME) is superior to the effect of single interventions. Therefore, we expect at T2 a significant difference in the competence in the diagnosis of skin cancer between the intervention group and the control group. We even expect that in the intervention group, GPs will score better at T2 than they did at T1, this would show the effect of the continuous problem based teaching.

Limitations of the study

With our study, we do not investigate the influence of our intervention on the mortality caused by skin cancers. Additionally, blinding of GPs is not possible.

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Chapter 4

*Diagnostic competence of Swiss general practitioners
in skin cancer.*

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Abstract

Questions under study

In Switzerland, skin cancer is one of the most prevalent neoplasms. General practitioners (GPs) are often faced with suspicious skin lesions in their patients. The aim of our study was to assess GPs' competence to diagnose skin cancer and to examine whether this can be improved by a one-day dermatologic education program.

Methods

Study design: Pre / post-intervention study.

Study population: 78 GPs in the Canton of Zurich.

Intervention: A one-day dermatologic education program provided by a dermatologist.

Measurements: Before (T0) and after (T1) the dermatologic education program, GPs were asked to rate pictures (with a short history) of skin lesions on a visual analogue scale according to their likelihood of malignancy.

Analysis: Non-parametric paired Wilcoxon signed rank test was used to compare the sum score of correctly classified skin lesions at T0 and T1.

Results

At T0 GPs classified 63.9% lesions correctly (benign: 51.2%; malignant: 76.6%), while at T1 these figures increased to 75.1% (benign: 67.6%; malignant: 82.7%).

Conclusion

A one-day dermatologic education program led to improvements in GPs' diagnostic competence in skin cancer, but there remained room for further improvement.

Background and questions under study

Skin cancer is one of the most common neoplasms in Switzerland [1] and its prevalence is high compared to other countries in Europe [2–5]. Forsea et al. [6] estimated that Switzerland has the highest melanoma incidence in Europe with 19.2 cases per 100,000 residents (compared for example with Germany with around 12 cases per 100,000 residents or Austria with under 8 cases per 100,000 residents). Melanoma is responsible for more than 90% of all skin cancer related deaths. The melanoma lifetime risk at birth in the year 2000 was estimated to be 1:80 in Switzerland [7, 8]. There are currently approximately 1,900 new cases of melanoma per year in Switzerland [1] and the incidence continuously increases. Melanoma is the fourth most frequent cancer in Switzerland in men as well as in women [9]. For men, only prostate cancer, lung/bronchus/trachea cancer and colorectal cancer have a higher incidence than melanoma; for women only breast cancer, colorectal cancer and lung/bronchus/trachea cancer have a higher incidence than melanoma [9]. Potential determinants of this increase in Switzerland are the more frequently intermittent sun exposure for fashion [10] and during recreation as well as a higher detection rate because increasing numbers of nevi get excised and histologically examined [1, 11]. One third of Swiss patients with melanoma is less than 50 years old: melanoma is one of the most frequent cancer diagnoses in young adults [1]. Due to a lack of adequate therapies for metastatic melanoma, the best management option remains early diagnosis and prompt surgical excision of the primary cancer.

Non-melanoma skin cancers (NMSC) including basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) are more frequent than melanoma. They are, from a clinical point of view, less aggressive because of their low metastatic potential, but due to their high incidence, local destructive growth pattern, and their tendency to recur after treatment, the morbidity and cost related to these cancers are very high [12].

Due to the rapidly rising incidence of skin cancer and the rising awareness of the topic in patients, GPs are more and more faced with suspicious skin lesions in their patients, they are usually the first contact person to examine and potentially refer patients to dermatologists. Appropriate knowledge and a high diagnostic competence are crucial in handling suspicious skin lesions correctly. During medical school there is no specific skin cancer training at this point in time. Research data on the dermatological diagnostic competence of GPs in Switzerland is lacking, but clinical experience suggests that diagnosis of skin cancer in primary care may be suboptimal. Embedded in an on-going broader project called “minSKIN” [13] this study aimed to assess GPs’ competence to diagnose skin cancer and to determine whether it was increased by a one-day dermatologic education program.

Design and methods

Study design

This is a pre / post-intervention study.

Study population

All of the around 1000 GPs in the Canton of Zurich [14] were invited to take part in the study by an advertisement, by postal letters and information sessions provided by members of the study center. Any general practitioner who provided primary medical care with a workload of at least 20 hours per week, who did not plan to retire or to move away during the study period was entitled to participate in the study. Finally, 78 GPs were included in our study. All of these 78 GPs later joined the RCT called “minSKIN” after our one-day education program [13]. The participating GPs did not receive financial compensation.

Intervention: dermatologic education program

The dermatologic education program was embedded in a randomized-controlled study with GPs [13]. The GPs received a full day dermatologic training course, organized by a dermatologist of the UniversityHospital Zurich. This training contained lectures about current epidemiology of skin cancer in Switzerland, background information on melanoma, basal cell carcinoma and squamous cell carcinoma, diagnosis and differential diagnosis of skin cancer, strategies to handle with suspicious skin lesions and interactive case discussions for the three main types of skin cancer.

Measurements

For the study, we developed a pool of total 108 case-vignettes of skin lesions with a short history and known histology (benign: 54; malignant: 54), 36 cases at a high difficulty level, 36 cases at a medium difficulty level and 36 at a low difficulty level. The benign case-vignettes included the diagnoses: nevi, dysplastic nevi, seborrheic keratosis, angioma and other benign lesions. The malignant case-vignettes included the diagnoses: BCC, SCC, melanoma, M. Bowen, keratoacanthoma and other malignant lesions. The pictures had to be of good quality (in focus etc.) and the diagnoses had to be histologically proven. They were randomly chosen from an image collection of the Clinic of Dermatology at the UniversityHospital Zurich. The levels of difficulty were independently defined by two dermatologists prior to the start of the study.

As primary outcome, we defined the competence in the diagnosis of skin cancer by GPs, measured as the percentage of correctly classified pictures of skin lesions. Prior to the start of the study, we randomly allocated 36 of the clinical case-vignettes (12 at each level of difficulty) for each picture scoring session to assure an equal difficulty of the sessions. Before (T0) and after (T1) the dermatologic education program, the GPs were asked to rate these pictures of skin lesions according to their likelihood of malignancy on a visual analogue scale (VAS) with length 100 mm.

Visual analogue scales were chosen for measurements because they are easy to handle and well known in the study population. Furthermore, they more strongly reflect diagnostic uncertainty in every day's clinic than a dichotomous outcome.

Picture category	Cut-off on the VAS
Malignant lesion, high level of difficulty	70mm
Malignant lesion, medium level of difficulty	75mm
Malignant lesion, low level of difficulty	80mm
Benign lesion, high level of difficulty	30mm
Benign lesion, medium level of difficulty	25mm
Benign lesion, low level of difficulty	20mm

Tab. 1: Cut-offs on the VAS, depending on the difficulty of the pictures

Data analysis

For each level of difficulty, a cut-off on the VAS was defined prior to analysis in order to dichotomize the GPs' judgment into correct or false as compared with the histology results. These cut-offs are displayed in **Tab. 1**, an example for the interpretation of a malignant lesion picture and different levels of difficulty is shown in **Fig. 1**. We used a statistical test procedure that took into account dependencies in the data: assessment of 36 pictures per participating GP for each moment in time (T0 and T1). For each of the 78 GPs, we summed up the number of "correctly" classified skin lesion pictures according to the above described dichotomization and obtained a score ranging from 0 (no correctly classified picture) to 36 pictures (all pictures correctly classified), at time T0 and T1.

Example for the interpretation (picture with a malignant lesion):

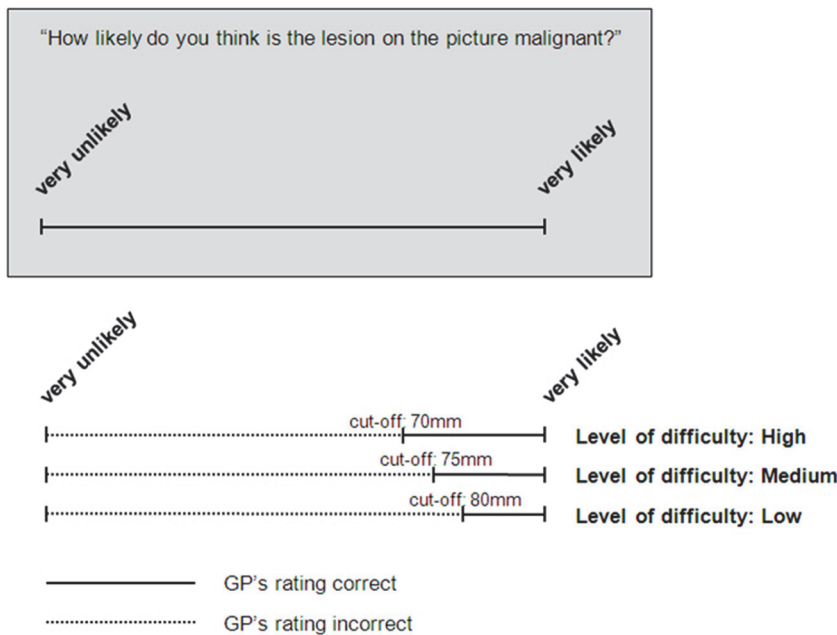


Fig. 1: Example of the interpretation (picture with a malignant lesion).

We then compared these two vectors of length 78 with a non-parametric paired Wilcoxon signed rank test. Significance level was set at 5%. For descriptive measures, we call “sensitivity” the malignant lesions («disease”) that were correctly classified as malignant and “specificity” the benign lesions («no disease”) that were correctly classified as benign.

Ethical principles

The study was embedded in a broader project called “minSKIN” [13], which was approved by the ethics committee of Zurich (KEK-ZH-Nr. 2010-0384/5) and which has been registered at a trial register (current-controlled-trials: ISRCTN29854485).

Results

Main results

Before the dermatologic education program (at T0) GPs classified total 63.9% of the lesions correctly (51.2% of benign lesions and 76.6% of malignant lesions). After the dermatologic education program (at T1) corresponding values significantly increased to total 75.1% (67.6% for benign lesions and 82.7% for malignant lesions).

Gender (n=78)	
Male	56 (71.8%)
Female	22 (28.2%)
Age (n=77)	
<= 40 years	9 (11.7%)
41- 50 years	29 (37.7%)
>= 51 years	39 (50.6%)
Years in practice (n=77)	
<= 10 years	35 (45.5%)
11 - 20 years	21 (27.3%)
>= 21 years	21 (27.3%)
Workload (n=77)	
Fulltime	43 (55.8%)
Part-time	34 (44.2%)
Practice type (n=77)	
Single handed	24 (31.2%)
Double handed	20 (26.0%)
Group practice	33 (42.9%)
Additional training in dermatology (n=77)	
Yes	14 (18.2%)
No	63 (81.8%)

Tab. 2: Demographic data of the participating GPs.

Participants

Due to the high interest from the GPs during recruitment, more than the initially planned number of 60 GPs wanted to take part in the study, so we were finally able to include 78 GPs. All GPs

completed the pre-intervention picture scoring session at T0 as well as the post-intervention picture scoring session at T1. One GP did not provide information about his or her demographic data. The mean age of the participating GPs was 50.9 years with a range from 34 to 75 years. As shown in **Tab. 2**, 71.8% of the GPs were male and 28.2% female. 55.8% worked fulltime while 44.2% worked part-time. 31.2% worked in a single handed practice, 26.0% in a double handed practice and 42.9% in a group practice with three or more physicians. 18.2% of the participating GPs stated that they have had additional dermatologic training while 81.8% did not. Compared to all GPs in the Canton of Zurich [14], our study population was slightly younger. Furthermore, we had rather more male GPs in the study population compared to all GPs in the Canton of Zurich.

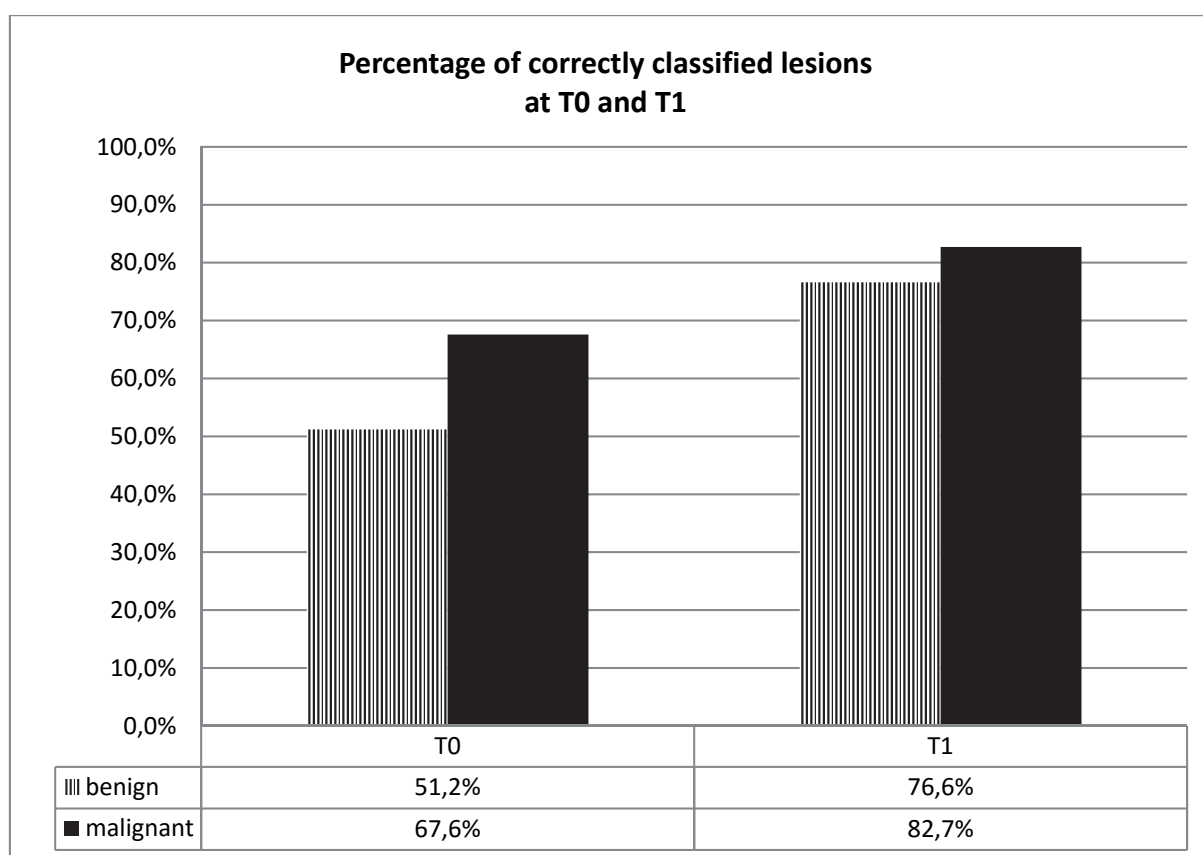


Fig. 2: Percentage of correctly classified skin lesions before (T0) and after (T1) the one-day dermatologic education program.

Results from the picture scoring sessions

As shown in **Fig. 2**, GPs classified 51.2% of benign and 76.6% of malignant lesions correctly before any intervention (at T0). After the dermatologic education program (at T1) GPs classified 67.6% of benign and 82.7% of malignant lesions correctly. The increase in the percentage points of correctly classified skin lesions was 16.4% for benign lesions and 6.1% for malignant lesions. With our dermatologic education program, GPs' sensitivity increased from 76.6% to 82.7% without any loss in specificity.

We calculated the sum score as number of correctly classified pictures per participating GP before and after the intervention. The paired Wilcoxon signed rank test showed a significant increase of the sum score after the intervention ($p < 0.001$).

It could be argued that the cut-offs based on the pre-specified levels of difficulty were arbitrary. In a secondary analysis we re-evaluated the outcome of the participating GPs with respect to difficulty level of the pictures and without the pre-defined cut-offs, the results can be found in **Fig. 3**. It turns out that with increasing level of difficulty, the mean outcome clearly deviates further from 100 for the malignant pictures. For benign pictures, the increasing deviation from 0 was clear at T0 but inconsistent at T1. Corresponding interquartile ranges increase for both malignant pictures at T0 and T1 and benign pictures at T0 with increasing difficulty, indicating increasing uncertainty of the participants. These findings support and justify our original assumptions.

As also shown in **Fig. 3**, the mean VAS values shift from T0 to T1 nearer to 100 (for malignant lesions) or nearer to 0 respectively (for benign lesions) and the interquartile ranges were reduced (except for low difficulty benign lesions) from T0 to T1.

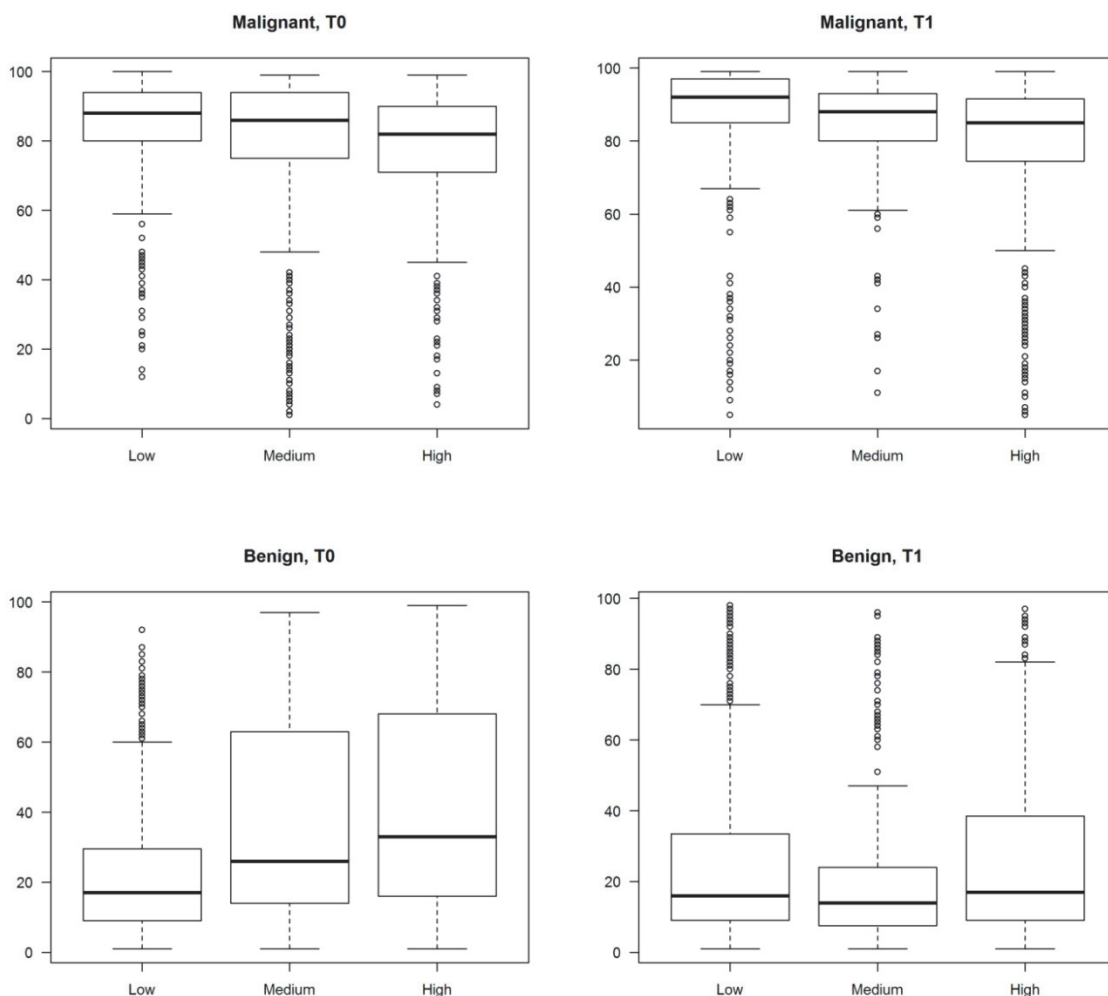


Fig. 3: Outcomes by the difficulty level of the pictures and without the pre-defined cut-offs.

Discussion

The diagnostic competence of the GPs' in our study was relatively high at baseline, compared to GPs in other studies [15–21]. Nevertheless, after our one-day dermatologic education program, the GPs significantly increased their diagnostic competence in skin cancer regarding lesions' dignity.

At baseline, GPs scored a higher proportion of malignant lesions correctly than benign lesions. This may reflect a GPs' "fear of missing" of a suspicious skin lesion. From a clinical point of view, it is less severe to overrate a benign lesion as malignant than to underrate a malignant lesion as benign because of the lack of therapeutic options for a metastatic melanoma for example. On the other hand, inadequate diagnosis of benign lesions may increase distress in patients and use of healthcare services at the expense of other, clinically potentially more effective services. It is therefore also important to reduce the number of inappropriately diagnosed benign skin lesions. The effect of our dermatologic education program demonstrated a higher impact when diagnosing benign lesions as compared to malignant lesions, implying that it is feasible to enhance diagnostic competence.

In **Fig. 3**, the shift of the mean VAS values from T0 to T1 displayed the effect of our dermatologic education program on the GPs' diagnostic competence. The reduction of the interquartile ranges from T0 to T1 may indicate an increasing dermatological diagnostic security in the participating physicians. This reduction can especially be seen in two subgroups: benign lesions at a medium difficulty level and benign lesions at a high difficulty level. This may indicate that a dermatologic education program could lead to a reduction of unnecessarily removed benign skin lesions without affecting the removal rate of malignant skin lesions. A reduction of unnecessarily removed benign skin lesions can have a considerable impact on health care costs.

Because the recruiting procedure was done partially by an advertisement in a GP journal, we are not able to give a numerical amount of the response rate. However, the GPs' interest to participate in this study was considerably higher than in our previous comparable projects. Due to this high interest, we were able to include many more GPs than initially planned. From our point of view, this interest shows the importance and frequency of patients with suspicious skin lesions in daily practice and the GPs' relative uncertainty on how to handle all these patients. During their vocational training, most of the GPs did not attend further dermatological training until now, because it was almost impossible to get short-term positions in a dermatological institution as GP trainee.

Limitations and strengths

With this study setting, we were not able to evaluate the long-term effect of our intervention. Because we did not ask for specific diagnoses but for their likelihood of malignancy, it may be that GPs' diagnostic competence was overestimated. Nevertheless, from the clinical point of view, the very specific diagnosis is less important for the GP because he acts mainly as first contact person

for further referral. Furthermore, the pool of our case-vignettes did not reflect the distribution of malignant skin cancer in primary care, so the pre-test probability for a malignant lesion in our study was much higher than in “real life”. As an additional weakness, we did not ask for the clinical procedure (excision yes/no) of the lesions, but just for their likelihood of malignancy. Aside from these limitations, we had a relatively high number of GPs participating in this study. Furthermore, by discriminating the skin cancer example cases into three levels of difficulty, we used a very advanced approach in the picture scoring session, considering the heterogeneity of skin lesions.

Conclusion

With a one-day dermatologic education program, GPs’ diagnostic competence in skin cancer can be significantly increased. Taking into account the high interest of GPs in the topic and considering the effect of our intervention, skin cancer diagnostic skills should be integrated more often into GPs’ continuing medical education.

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Chapter 5

A multifaceted intervention: no increase in general practitioners' competence to diagnose skin cancer (minSKIN) - randomized controlled trial.

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Abstract

Background

General practitioners (GPs) play crucial roles in early detection of skin cancer. A pilot-study found a positive short-term effect of a 1-day dermatologic education program on GPs' diagnostic competence.

Objective

To determine effects of a multifaceted intervention, including technical equipment and continuing feedback by a dermatologist, on GPs' diagnostic skills regarding skin cancer.

Methods

Randomized controlled trial with 78 GPs of the Canton of Zurich, Switzerland.

Intervention: GPs in intervention group received a 1-day training, a Lumio© (magnifying glass with polarized light, 3Gen), a Nikon digital camera and – during 1 year – feedback on skin lesion pictures sent to the dermatologist. GPs in control group only received the 1-day training.

Main outcome and measures: Primary outcome: structured assessment of GP's diagnostic skills in correctly diagnosing images of skin lesions regarding skin cancer. At baseline prior to intervention (T0), after the full-day training course in both groups (T1), and after 1 year of continuing feedback (T2) to the intervention group. Measures: Non-parametric unpaired (Wilcoxon–Mann–Whitney) tests were used to compare numbers of correctly classified skin lesions between both groups at T2 and for the change between T1 and T2.

Results

At T0, both groups classified a median of 23 skin lesions of the 36 images correctly. This value rose to 28 for both groups at T1 and fell to 24 for both groups at T2. No difference between control and intervention group at T2. Furthermore, we compared differences in the sum scores per GP between T1 and T2 for each group. Also in this comparison, no difference between control and intervention group was found.

Conclusion and relevance

No long-term effect of the multifaceted intervention was found on the competence to diagnose skin cancer by GPs. The positive short-term effect of the 1-day dermatologic education program did not persist over 12 months.

Introduction

There are three main types of skin cancer: melanoma, basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). BCC and SCC are summarized as non-melanoma skin cancer (NMSC). The limited therapeutic options for a metastatic melanoma highlight the importance of early diagnosis and immediate surgical removal. NMSC are clinically less aggressive than melanoma but, due to their higher incidence, their local destructive growth pattern and their tendency to recur, their morbidity and health care costs are also high [1]. The increasing incidence of skin cancer [2, 3] and the rising risk awareness of patients contribute to the fact that general practitioners (GPs) are more and more faced with both malignant and benign skin lesions in their patients. To properly manage these lesions, GPs need a high dermatological diagnostic competence and appropriate knowledge about skin cancer [4].

The best way to optimize professional behaviors of physicians is the focus of a large body of scientific research. Nevertheless, the way to provide continuing medical education (CME) remains unclear, particularly regarding its long-term effectiveness [5–12]. Evidence suggests that repeated CME activities are superior to single educational sessions regarding the GPs' knowledge acquisition [6–8, 10, 11]. Several studies [13–16] have investigated the effect of CME on GPs' knowledge about skin cancer as well as their diagnostic skills and they found a positive effect. Furthermore, it seems that the combination of CME with other strategies contribute to its effectiveness [8, 10, 17]. For instance, teledermatology uses telecommunication technologies for the exchange of medical information like videos or skin pictures over distance. Several studies [18–26] on teledermatology found that the remote diagnosis of skin lesions can be a viable alternative to a face-to-face consultation, and thus facilitate the early detection of skin cancer.

The aim of this study was to determine whether a CME for GPs, combined with the provision of technical equipment for teledermatology and continuing feedback on skin lesions, led to a long-term improvement of the competence in the diagnosis of skin cancer in GPs.

Materials and methods

Design

We conducted a randomized controlled trial with a multifaceted dermatological educational intervention in primary care in Switzerland. The study was conducted in accordance with the medical professional codex and the 1996 Helsinki Declaration as well as Data Security Laws and Good Clinical Practice criteria. The study was registered at a trial register (ISRCTN29854485) and the study protocol was published [27]. The study was approved and accepted by the ethics committee of Zurich (KEK-ZH-Nr-201 0-0384/5). Before participation, GPs and patients gave written informed consent.

Setting

As shown in **Fig. 1**, we conducted three image scoring sessions: at T0 (baseline, prior to any intervention), T1 (after a full-day training course with both groups) and T2 (after 1 year of continuing feedback with the intervention group). After T1, the GPs were randomized into an intervention group and a control group. Blinding of the GPs was not possible.

During the 1-year feedback period, the GPs in the intervention group took pictures of those patients' skin lesions they wanted to get feedback on. The skin lesion pictures were made anonymous and sent to the study center to receive continuing feedback by the study dermatologist; dermatologists provided feedback within 2-3 working days. The GPs in the control group provided usual care. As an incentive for the intervention group, the GPs could keep the Lumio© magnifying glass and the camera if they remained in the study until the end. As an incentive for the control group, the Lumio© and the camera were given to the GPs as a gift after the end of the study and the GPs were invited to send skin lesion pictures for teledermatological assessment during 1 year after the end of the study.

Sample

Seventy-eight GPs from the Canton of Zurich, Switzerland participated in the study. Any GP from the Canton of Zurich who provided primary medical care with a workload of at least 20 h/week and who did not plan to retire or to move away during the study period was entitled to participate in the study.

Dermatological educational intervention

General practitioners in the intervention group received a one-day training, a Lumio© (magnifying glass with integrated polarized light source allowing subsurface skin examination, 3Gen), a Nikon digital camera and – during 1 year – feedback on skin lesion pictures sent to the dermatologist. GPs in the control group only received the one-day training.

Outcome

The primary outcome was a structured assessment of GP's diagnostic skills in correctly diagnosing images of skin lesions regarding skin cancer. For practical reasons, it was not feasible to include patients. A pool of 108 case vignettes (images of skin lesions with known histology, supplemented with short histories) was carefully developed: 36 cases with high diagnostic difficulty, 36 cases with medium difficulty and 36 cases with low difficulty. The levels of difficulty were defined by two dermatologists independently prior to the start of the study.

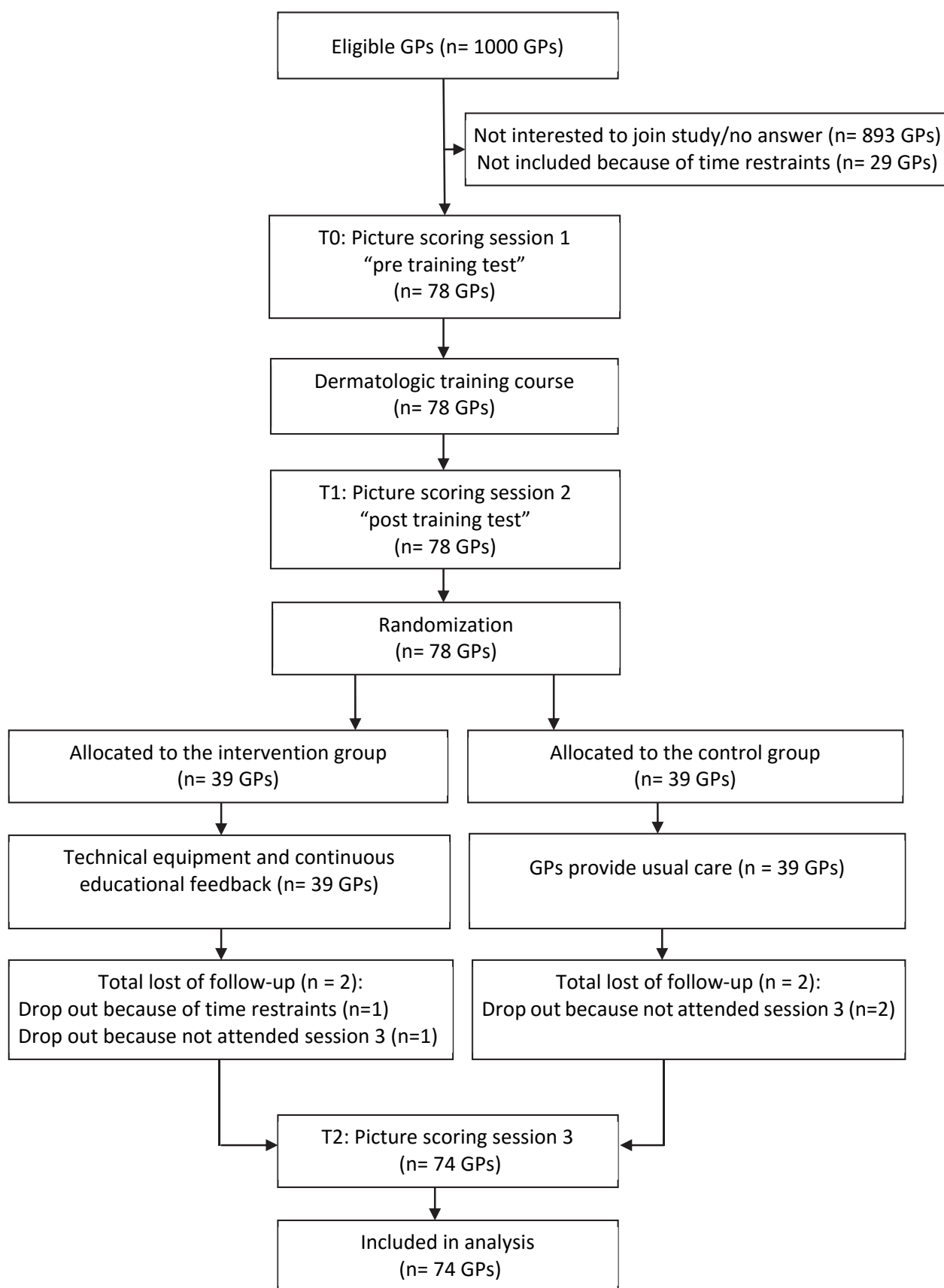


Fig. 1: Flow chart of the study design: 78 GPs participated in the study, 74 GPs completed all three image scoring tests.

Thirty-six case vignettes (18 malignant and 18 benign; 12 at each level of difficulty) were randomly allocated to each of the three image scoring sessions and the GPs rated these lesions' likelihood of malignancy on a visual analogue scale (VAS) of 100 mm, from 'very unlikely' (0 mm) to 'very likely' (100 mm). Taking into account the different levels of diagnostic difficulty (high/medium/low) for both dignities, we pre-defined the following cut-offs on the VAS for a correct classification: ≥ 70 mm (high), ≥ 75 mm (medium), and ≥ 80 mm (low) for malignant lesions, and ≤ 30 mm (high), ≤ 25 mm (medium) and ≤ 20 mm (low) for benign lesions. For post hoc analyses, the outcomes were analyzed without the pre-defined cut-offs, but using deviance scores, defined as the difference of the GPs' image ratings to 0 mm (for benign case vignettes) or to 100 mm (for malignant case vignettes), respectively. **Fig. 2** shows two examples of vignettes presented at the final image scoring session.



Fig. 2: Two examples of vignettes presented at the final image scoring session.

(a and b) A malignant melanoma (rated as high diagnostic difficulty), 17 (45.9%) of the intervention group and 13 (35.1%) of the control group rated this vignette correctly ($p = 0.334$).

(c) A benign lesion (rated as medium diagnostic difficulty), 33 (89.2%) of the intervention group and 32 (86.5%) of the control group rated the vignette correctly ($p = 0.722$).

Data analysis

A descriptive approach using box plots as well as non-parametric unpaired (Wilcoxon–Mann–Whitney) tests were used to compare the number of correctly classified skin lesions per participant between both groups at T2. Paired tests were used to compare the change between T1 and T2 in the intervention and the control group.

For more detailed information about the methods and design of the study, we refer to the study protocol [27].

Results

Main results

Overall, we found no effect of the multifaceted dermatological education on GPs' competence to diagnose skin cancer. As shown in **Fig. 3**, at T0 both groups classified a median of 23 skin lesions correctly. This value rose to 28 for both groups at T1 and fell to 24 again for both groups at T2. No difference was found between the control and intervention group at T2 ($P = 0.377$).

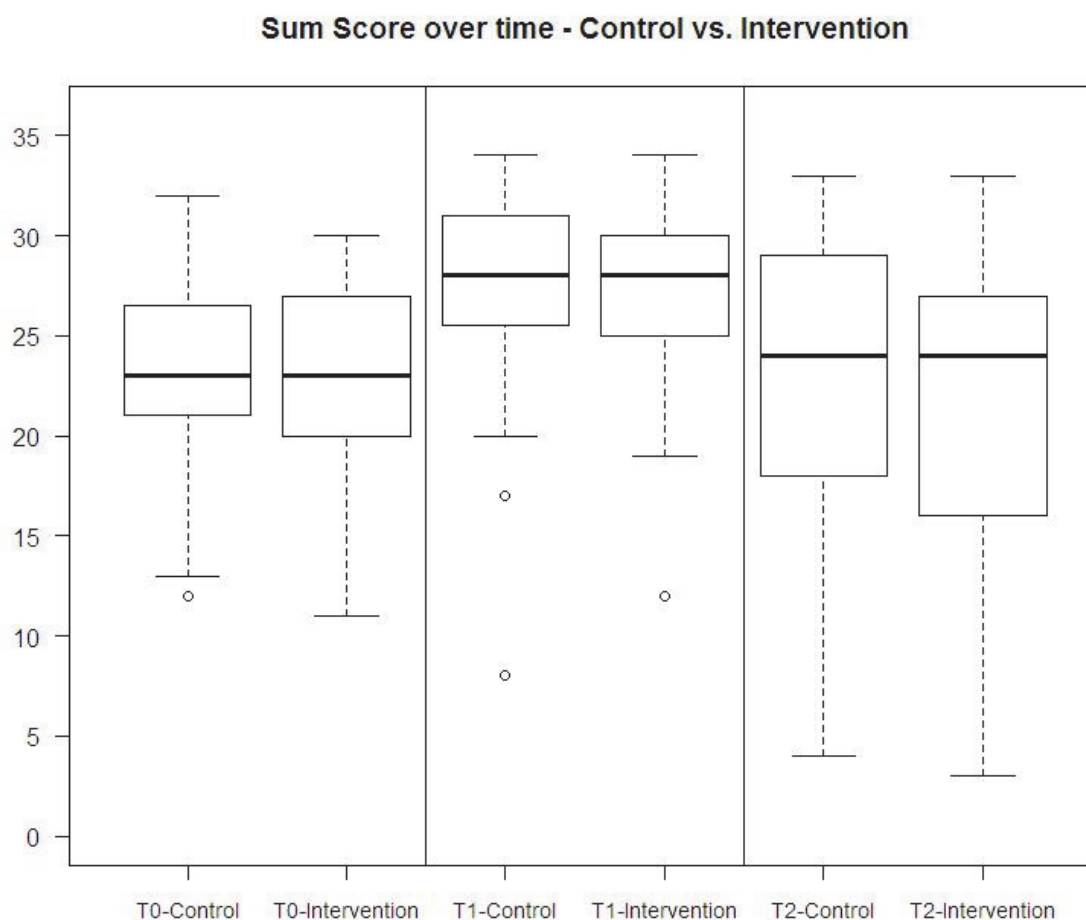


Fig. 3: Number of correctly classified skin lesions at T0, T1 and T2, control group vs. intervention group. No significant difference between the control and the intervention group at T2 ($p=0.377$).

As shown in **Tab. 1**, from T1 to T2, the majority of the GPs worsened their test score, without difference between the intervention and control group. Furthermore, we compared the differences in the sum scores per GP between T1 and T2 for each group. Also in this comparison, no difference between the control and intervention group was found ($P=0.512$).

Comparison between:	Score increased (No. of GPs)	Score decreased (No. of GPs)	Score remained the same (No. of GPs)
T0 / T1	Total: 67/78 (85.9%)	Total: 9/78 (11.5%)	Total: 2/78 (2.6%)
T1 / T2	Total: 10/74 (13.5%) Intervention: 5/37 Control: 5/37	59/74 (79.7%) Intervention: 30/37 Control: 29/37	5/74 (6.8%) Intervention: 2/37 Control: 3/37

Tab. 1: Number of GPs that improved and worsened their test score, comparison between T0/T1 and T1/T2. Between T0 and T1, the majority of the GPs improved their test score while between T1 and T2, the majority of the GPs worsened their test score.

Participants

As shown in **Fig. 1**, around 1000 GPs were eligible for our study. After the announcement, 107 GPs were interested to participate in the study, but 29 could not join because of time constraints. Of the 78 study participants, 39 were randomized into the control group and the intervention group, respectively.

The image scoring tests one and two were completed by all 78 GPs, while the image scoring test three was completed by 74 GPs. One GP in the intervention group left the study during the 1-year feedback phase because of time constraints. Two GPs in the control group and one GP in the intervention group did not attend the image scoring test three.

The mean age of participants was 50.9 years with a range from 34 to 75 years, 71.8% were male and 28.2% female. For more information about the participants' demographical data, we refer to the publication of the baseline data [28].

Transferred pictures

During the 12-month study period, a total number of 982 skin lesion pictures were transferred to the study center by the 39 GPs in the intervention group. The range of transferred pictures by GP varied from zero pictures to 91 pictures (mean 25.2 pictures).

Post hoc analyses

To eliminate a possible systematic error because of the arbitrary chosen cut-offs, we re-analyzed the outcomes at T2 without the pre-defined cut-offs, but using deviance scores, defined as the difference of the GPs' image ratings to 0 mm (for benign case vignettes) or to 100 mm (for malignant case vignettes), respectively. The results are shown in **Fig. 4**: Also in this secondary analysis, we found no difference between the control and the intervention group ($p = 0.453$).

The number of skin lesion pictures varied considerably between the GPs (zero to 91 pictures). To investigate the influence of the number of transmitted skin lesion pictures, we conducted a post hoc regression analysis with the participants of the intervention group. No relationship between the number of transferred skin lesion pictures and the sum score in the tests was found ($p = 0.142$). The fit of this regression model was low with an $R^2 = 0.061$.

Discussion

The purpose of this study was to assess if GPs' competence to diagnose skin cancer can be increased by a multifaceted dermatological educational intervention including technical equipment and continuing feedback. In contrast to our hypothesis, we found no significant difference between the control and the intervention group after our dermatological educational intervention. A previously found effect of a 1-day dermatologic education program [28] was not sustained over the investigated period of 12 months. Here, we will elaborate on the potential reasons for the absence of long-term effects.

Boxplot of deviance score at T2 - Control vs. Intervention

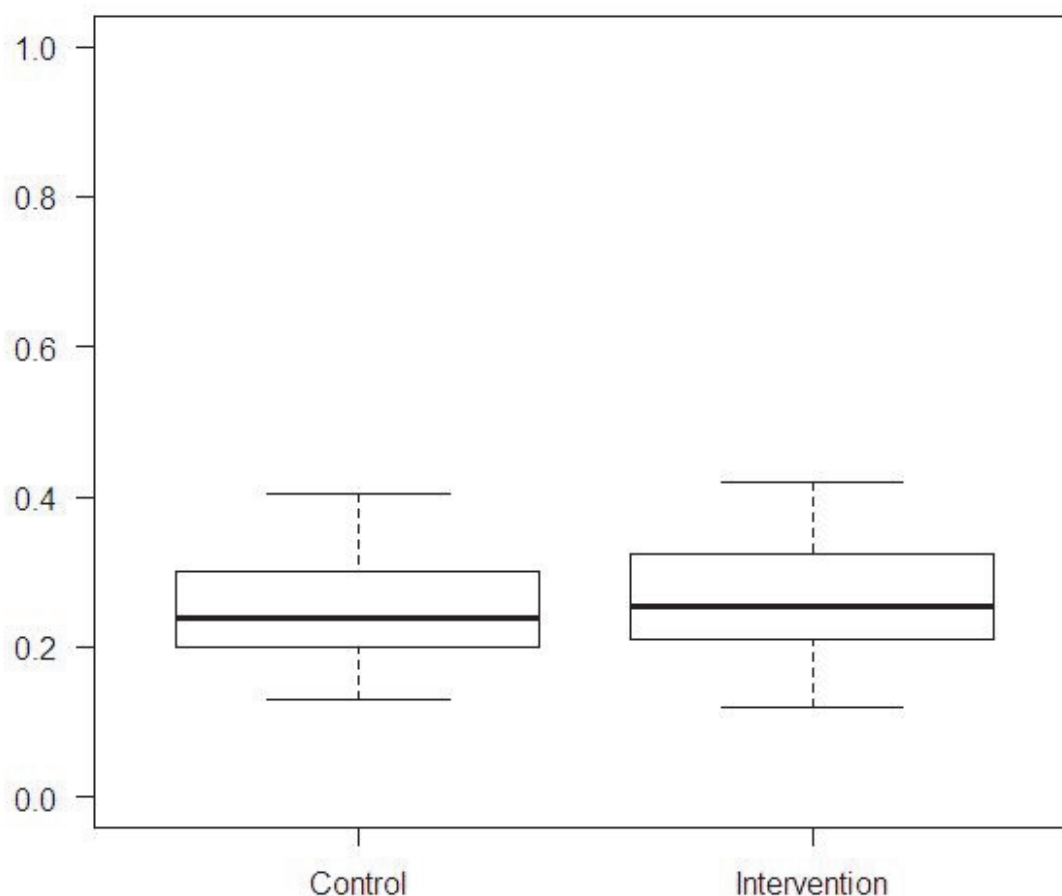


Fig. 4: Deviance score of control and the intervention group at T2. Deviance scores were defined as the difference of the general practitioners image ratings to 0mm (for benign case vignettes) or to 100mm (for malignant case vignettes), respectively. No significant difference between the two groups ($p=0.453$).

First, as Ivers et al. [12] found in the updated Cochrane review about audit and feedback, 'audit and feedback may be most effective when the health professionals are not performing well to start out with'. In our study, GPs had a relatively good performance at start. Other studies addressing the diagnostic competence of GPs [13–15, 29–31] reported pre-intervention rates of correctly diagnosed skin lesions of 43–57%. In contrast to these values, the GPs in our study scored with 75.1% relatively high at T1 – our dermatological educational intervention may therefore not have been effective.

Second, as different authors [7, 10, 32, 33] stated, activation of learners is one of the most important factors for an optimal learning effect. Activation can be reached for example by interactive discussion and reflection of themes or by using didactical tools like quizzes or tests. The

feedback service in our dermatological educational intervention did not fulfil this: The GPs' role within the feedback service was quite passive; they were neither provided with the possibility of an interactive case discussion with the dermatologist nor obliged to take an active decision whether a skin lesion was malignant or benign. They were able to delegate the responsibility for the decision about the dignity of the skin lesions to the dermatologist. This could have led to a quite passive attitude of the GP, knowing that the dermatologists acted as 'safety net'. It could also explain why the effect of the 1-day dermatological educational in the first phase of the minSKIN project [28] was clearly measurable because there, several interactive case discussion sessions and tests were provided.

Third, a problem could be that the all-over frequency of transferred pictures (and received feedback) was quite low with a mean of 25 pictures per GP during the 12-month study period. Because of this rather low-caseload in daily practice, the GPs were maybe not frequently enough faced with the topic to achieve a measurable learning effect. In our post hoc regression analysis, we could not show any influence of the number of transferred pictures on the test results, but it is possible that higher degree of density is needed to achieve optimal effects. Unfortunately, no data is available to estimate the needed number of items to receive a learning effect.

Fourth, our dermatological educational intervention may have been not sufficiently multifaceted. We combined technical equipment with feedback but not with written or virtual additional education material. Bordage et al. [6] suggested the use of multimedia CME interventions in preference to single-medium interventions. Other studies highlighted different facets of multimodal interventions and found positive effects. Youl et al. [16] investigated the effect of a 6-month educational program composed of a paper-based self-paced education module and feedback on GPs diagnostic accuracy for excised lesions and found a positive effect on GPs' malignant/benign excision rate. Gerbert et al. [14] combined face-to-face feedback with a seminar and a booklet and found a positive effect.

In further research, the possibility for direct discussion of skin lesions between the GP and the dermatologist should be considered to activate the GPs and to achieve a measurable learning effect. In addition, an intervention should be enriched with additional learning material like booklets or video-learning tools.

There are some limitations in our study. We did not ask for specific diagnoses but for their likelihood of malignancy, what may lead to a general overestimation of GPs' diagnostic competence. In addition, the pool of our case vignettes did not reflect the distribution of malignant skin cancer in primary care, so the pre-test probability for a malignant lesion in our study was much higher than in 'real life'.

In conclusion, a long-term and multifaceted dermatological educational intervention showed no effect on GPs' competence to diagnose skin cancer. As a short training course led to a significant increase in the diagnostic competence in the short run, skin cancer CMEs for GPs may be best formatted as short courses, which should be repeated or refreshed periodically because the learning effect faded away over time.

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Chapter 6

*Feasibility and diagnostic accuracy of
teledermatology in Swiss primary care:
process analysis of a randomized controlled trial.*

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N. Kleiner
M. Wensing
T. Rosemann
R. P. Braun
O. Senn

Abstract

Rationale, aim and objective

To test feasibility and diagnostic accuracy of dermatologist's feedback based on digital images of skin lesions collected in Swiss primary care.

Methods

This was a process analysis of a randomized controlled trial, conducted in 2011/2012. 30 of 78 general practitioners (GPs) were randomized to an intervention, which included dermatologist's feedback on digital images of skin lesions. Feedback was categorized into four categories: (1) no further investigation; (2) clinical observation; (3) biopsy; and (4) other. Histologic findings were allocated to the same categories. Feasibility was measured in the perspective of GPs concerning technical handling and of dermatologists as proportion of images usable for feedback. Diagnostic accuracy was measured as proportion of malignant histology of the first three feedback groups. No long-term data was collected.

Results

981 images of skin lesions were collected, two were not eligible due to low quality of images. The majority of GPs (77.8%) reported no problem with the procedure. 207 images were in feedback category 1, 353 in 2, 360 in 3 and 59 in 4. A total of 236 histologic tests were collected. Three cases in category 1 indicated malignancy (1 melanoma). 201 of category 3 received a biopsy; where in 91 (45.3%) malignancy was confirmed.

Conclusion

Teledermatology with digital images taken in primary care was feasible from a GP and from a specialist perspective. However, diagnostic appropriateness regarding avoidance of specialist care and possible missed skin cancer raises concerns. These results therefore question a promotion of teledermatology in clinical routine.

Background and questions under study

The incidence of skin cancer, especially malignant melanoma, is rising. Switzerland is among the countries with the highest incidence [1]. Early diagnosis especially in malignant melanoma has major impact on mortality [2]. General practitioners (GPs) are often faced with skin lesions, but do not feel confident evaluating them [3]. In case a skin lesion remains unclear, often a referral to a dermatologist is necessary, being associated with long waiting periods and uncertainties for patients. In Switzerland, many dermatologists report a capacity limit. Instruments for a safe and efficient handling of suspicious skin lesions would be helpful to reduce dermatologists' workload. An alternative diagnostic pathway should fulfil several criteria: An easily implementable procedure in daily practice; no expensive infrastructure and low costs. Furthermore, the diagnostic procedure should be accurate and safe.

With the broad use of computer technology and the availability of digital cameras, technical investments for teledermatology are low but little is known about the feasibility in Swiss primary care. Our study was embedded in a randomized controlled trial called minSKIN (does a multifaceted intervention improve the competence in the diagnosis of skin cancer by general practitioners?) [4]. This study tested a multifaceted intervention, which included the possibility to send in digital images of skin lesions in order to get a feedback from a dermatologist. Teledermatology – the use of technology to obtain a diagnosis without the direct contact to a dermatologist – has so far produced inconclusive results. Several studies show positive effects on earlier referrals to dermatologists and earlier diagnosis of melanoma [5–7]. On the other hand, a systematic review showed inferiority of teledermatology to clinical dermatology [8].

The aim of this study was to examine the feasibility and diagnostic accuracy of a teledermatological approach by using digital images of skin lesions in Swiss primary care.

Methods

The study is a process analysis of a randomized controlled trial [4]. The main results are reported elsewhere [9], and showed no effect on diagnostic competency of GPs in the intervention group compared to GPs in the control group. In this trial, 78 GPs participated and half of them were randomized into an intervention group. During the study period from June 2011 to May 2012, the GPs of the intervention group (n = 39) were instructed to send digital images of skin lesions of their patient to a dermatologist. Based on data of the patient (sex, age, number of nevi (more or less than 100), skin photo type, family history and personal history of skin cancer, changes of the skin lesion within the last 4 weeks) and images of the lesion the dermatologist provided a feedback to the GP. For the feedback, we used a store and forward procedure: images were taken during the consultations, mailed to the study center later and feedback of dermatologists was provided within 1–3 days. No live feedback of a dermatologist was offered.

All participants received a Nikon® P7000 camera Zurich, Switzerland. We used a standardized camera to achieve equal image quality; this camera was chosen because images obtained high quality of both overview and macro images without additional technical material necessary. The image size was preset at a resolution of 2592 × 1944 dpi in the automatic camera mode; this size allowed both a good quality of the images and handling by standard email programs. GPs were instructed to take an overview image, where the body region and the surroundings of the lesion could be seen and a lesion with closer focus (an automatic macro modus of the camera).

All images were then sent together with data of the patients to the study center to the Institute of Primary Care in Zurich. The data were merged at the study center to a standardized form and then sent to a dermatologist. The images were assessed by one dermatologist. Two dermatologists participated in this study, both were senior dermatologists and very experienced in the assessment of skin lesions. The dermatologist then added their feedback and recommendation for the further management. GPs were asked to base their decision for further diagnostic procedures independent of the dermatologist's recommendation.

We collected data on all skin lesions sent to the study center, including the feedback of the dermatologists given to the GPs. We grouped the feedbacks into four different groups: (1) no further steps necessary; (2) clinical observation, meaning a clinical control was recommended within 3 to 6 months; (3) excision/ biopsy or referral to a dermatologist recommended; and (4) other feedback (such as microbiological workup, specific pharmacological skin treatment, etc.). GPs were free to decide – independently of the feedback they received by the dermatologists – to obtain a biopsy. In case of an excision or a biopsy, GPs were asked to send the histologic results to the study center.

To compare with the gold standard of histological exam, we only included the study cases that had both clinical and histological data. We compared diagnoses and categories (malignant/ benign) lesion to the management. We categorized actinic keratosis, Morbus Bowen, dysplastic nevus, lentigo maligna, squamous cell carcinoma, basal cell carcinoma, malignant melanoma and keratoacanthoma as malignant. Into the category 'other', we categorized acanthopapilloma, lentigo solaris or different feedbacks (such as: mycological exam recommended).

Assessment of feasibility

This assessment was based on two measurements, involving GPs and dermatologists. After the termination of the study, we asked the GPs of the intervention group about organizational issues of our study. Among organizational issues, we asked four questions about the use of a smartphone alternatively to the digital camera, technical problems with the camera, problems with the transmission of the images or with the process of sending patient information together with images to the study center. GPs were asked to rate these items on a Likert scale (1 = strongly disagree to 6 = strongly agree). In addition, we noted the proportion of images with sufficient quality that allowed a feedback as reported by dermatologists.

Diagnostic accuracy

The feedback categories 1 and 2 can be handled in primary care and therefore can potentially avoid specialist involvement. We measured diagnostic accuracy first as the number of possible avoided dermatological consultations and as proportion of dermatologist-reported malignancies in the first three feedback groups.

Data analysis

We used descriptive statistics to analyze subgroups. Data are presented in absolute numbers (frequencies) and percentages.

Ethical principles

The study was embedded in a broader project called ‘minSKIN’ [4,10], which was approved by the ethics committee of the Canton of Zurich (KEK-ZH-Nr. 2010-0384/5) and which has been registered at a trial register (current-controlled-trials: ISRCTN29854485). All data were handled confidentially; data on patients were coded and anonymized; and only the GPs could identify the patient.

Results

Feasibility

Twenty-seven (69.2%) of the 39 GPs of the intervention group participated in the feedback survey. Overall, the GPs were very happy with the camera and the procedure of handling the images and the clinical information; details are listed in **Tab. 1**. During this study period, a total of 981 skin lesions were photographed and sent to the study center by 38 GPs (1–91 images overall, median 21 images). The images of two skin lesions were of a too low quality and could not be assessed by dermatologists; therefore, 979 lesions got a feedback report.

Item in questionnaire	Likert Scale Category					
	1 (strongly disagree)	2	3	4	5	6 (strongly agree)
The use of a smartphone e.g. iPhone® to take a picture of skin lesions would have been easier	59.3%	22.2%	11.1%	3.7%	0	3.7%
I had technical difficulties with the handling of the digital camera.	40.7%	29.6%	11.1%	3.7%	11.1%	3.7%
I had difficulties with the process of transmitting the images to the study center	63.0%	14.8%	11.1%	7.4%	3.7%	0%
The process of handling the information together with the images could be optimized	44.4%	44.4%	3.7%	7.4%	0%	0%

Tab. 1: Feasibility in the perspective of GPs. 27 of the 38 GPs who have sent images to the study center, participated in this survey.

Diagnostic accuracy

These feedback reports were categorized into following four groups: 207 (21.1%) category 1 (no further steps necessary), 353 (36.1%) in category 2 (clinical observation recommended), 360 (36.8%) in category 3 (excision, biopsy or dermatologic referral) and 59 (6.0%) had other feedbacks (category 4).

We sorted histological findings into the categories of dermatologists' feedback. In the feedback group 1 (no further steps necessary), 10 out of 207 received a histological exam and in three cases, histology was malignant (including one melanoma). In the feedback 2 group (clinical observation), 24 out of 353 were biopsied, nine were malignant (all of them non-melanoma skin cancer). Two hundred one of 360 of the third feedback group received a biopsy. Ninety-one (45.3%) of these biopsies were malignant, including five melanomas. In feedback 4, one of the 59 participants received a biopsy, which was benign. This results into a total of 236 histologic findings (94 malignant). The histological diagnoses are listed in **Tab. 2**. For the 236 cases with histological findings, demographics and clinical data were available and as follows: mean 58.9 (SD 17.8) age (years), 127 male (53.8%), previous history of skin cancer 18 (7.6%), family history of skin cancer 21 (8.9%). **Fig. 1** shows an overview of the number of skin lesions sent to the study center and the further management, as well as the number of histological findings within each feedback group.

Histological Diagnosis	N	%	Feedback 1: No further steps necessary	Feedback 2: Clinical observation recommended	Feedback 3: Excision, biopsy or dermatologic referral	Feedback 4: Other feedbacks
Basal cell carcinoma	50	21.2	1	1	48	0
Seborrheic keratosis	44	18.6	3	7	34	0
Naevus	37	15.7	4	5	28	0
Dysplastic naevus	20	8.5	1	6	13	0
Actinic keratosis	14	5.9	0	1	12	1
Fibroma / Histiocytoma	9	3.8	0	0	9	0
Squamous cell carcinoma	7	3.0	0	1	6	0
Acanthopapilloma	7	3.0	0	0	7	0
Melanoma	6	2.5	1	0	5	0
Morbus Bowen	5	2.1	0	0	5	0
Haemangioma	4	1.7	0	0	4	0
Lentigo solaris	3	1.3	0	0	3	0
Keratoacanthoma	1	0.4	0	0	1	0
Lentigo maligna	1	0.4	0	0	1	0
Other	28	11.9	0	3	25	0

Tab. 2: Diagnoses of the skin lesions, where a histological investigation was ordered. Figures indicate absolute numbers (N) and % of total (n=236). The distribution into the four feedback categories is shown with absolute numbers of each histological finding.

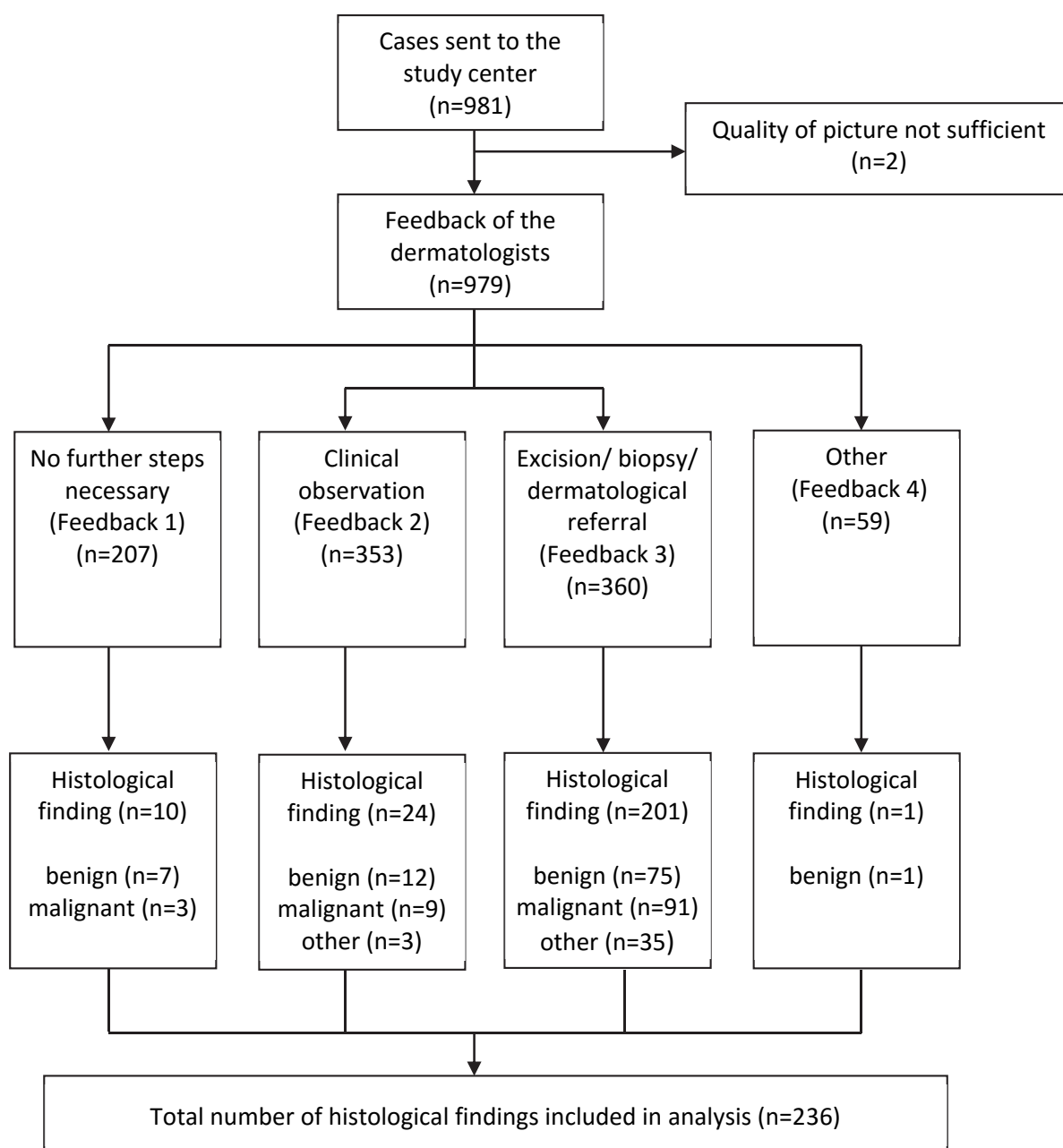


Fig. 1: 981 skin lesions were sent to the study center, 979 could be assessed by dermatologists. The 979 cases were allocated to four feedback groups, Feedback 1 (no further investigation necessary), Feedback 2 (clinical observation), Feedback 3 (excision, biopsy or dermatological referral recommended), Feedback 4 (other, such as e.g. mycological investigation recommended). Overall 236 biopsies or excisions were taken; we categorized the histology into benign, malignant and other (such as recommendation for mycological or microbiological investigation). These histologies were allocated to the four categories.

Discussion

In our study, we have chosen inexpensive and almost ubiquitous available technical equipment. The GPs using the intervention for 1 year reported good acceptance of the process and high feasibility concerning technical aspects, which included data on patients together with an overview and a macro image. The quality of the images was high; overall, only two out of 981 images had to be excluded because of low quality, which made a dermatologist's feedback impossible. In a similar procedure of an Australian study published in 2004, in 16%, additional photographs were requested because of inadequate image quality [11]. The technical progress of digital cameras is most likely to be responsible for our excellent result. Therefore, we conclude that feasibility in sense of technical and organizational features is given.

There are different rationales to implement teledermatology. While in some countries such as Australia or the United States, the distances from a patient to dermatologist might be the main aim [6,11], in Switzerland, the waiting time for a dermatologic consultation and possible diagnostic delay has higher priority. Therefore, a main focus should be the avoidance of unnecessary consultations with dermatologists. In our study sample, the proportion of lesions where a clinical observation or a biopsy was recommended was high and in only 21.1% of the lesions, no further step was recommended and another consultation could be avoided. A systematic review concerning the use of teledermatology [8] found that the range of avoided visits ranged from 12.8% to 72%.

Nevertheless, our results mainly raise safety concerns. In case of feedback category 1 (no further observation or investigation needed), it is absolutely crucial not to miss a malignancy. In our study, we specifically asked the GPs to proceed based on their clinical experience. In 10 patients, biopsy was initiated by GPs; in three cases, this led to a diagnosis of skin cancer, including one case of malignant melanoma, despite the feedback of the dermatologist. Three missed cases out of the 207 lesions in the feedback 1 category (1.5%) may be considered as safe if teledermatology and GP's clinical skills are combined. However, in this group, only 10 histology lesions were ordered, the histological findings of the remaining 197 are unknown, and therefore, a clear safety statement on this procedure cannot be given.

Our results are limited by the fact that we did not collect long-term data on the further management and outcomes of the skin lesions. Also, not all lesions – especially in the feedback group 1 – included in the trial were further investigated by a histological test, and consequently, accuracy for these lesions could not be measured. Still, two major concerns arise from our small study sample: safety concerns and the rather small number of avoided specialists' visit. We were not able to conduct a cost-effectiveness study, but with the small amount of the skin lesions needing no further diagnostics and the additional workload with the teledermatoscopy, the effect might be small.

A possible solution could be the introduction of teledermatoscopy, which was shown to be feasible and inter-rater agreement was high [12–14]. One study [15] in the Netherlands tested teledermatoscopy in a primary care setting. Images were taken by GPs and sent to dermatologists. This study still had limitations. Accuracy and inter-observer reliability was still low concerning further management, and was higher in images with better quality. With improvements in technology and lower costs of the additional infrastructure, an additional implementation of teledermatoscopy could ameliorate the process, but this should be tested in a daily clinical setting.

Strengths and limitations

We present data from a randomized controlled trial with skin lesions presented in primary care and observed by dermatologist. Data were prospectively collected, and in our analysis, we only used skin lesion that were confirmed by a histological investigation, which still is the gold standard to assess dignity of skin lesions. Our study protocol did not include a biopsy for all skin lesions that were presented in our study; we therefore are not able to conclude how many situations of the skin lesion that did not get a biopsy, the teledermatological diagnosis or management were correct. We furthermore did not collect data concerning the further management such as referrals to dermatologists and we therefore do not know what, for example, happened to the patients where a biopsy was recommended but where a histology was not sent to the study center. Nevertheless, we think that with almost a quarter of the lesions with a histologic workup, our study did allow a critical scope at the value of teledermatologic investigation in primary care.

Conclusion

Teledermatology with digital images taken in primary care was feasible from a GP and from a specialist perspective. However, diagnostic appropriateness regarding avoidance of specialist care and possible missed skin cancer and in particular melanoma raises concerns. These results therefore question a promotion of teledermatology in clinical routine.

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Chapter 7

*The role of skin self-examination at the
Swiss skin cancer day.*

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Abstract

Background

The rising incidence of melanoma - Switzerland has the highest incidence in Europe - is a major public health challenge. Swiss dermatologist introduced the "Swiss Skin Cancer Day" (SSCD) in 2006, which provides skin cancer screening at no costs. The aim of the study was to describe the participating subjects and their motivation and investigate factors influencing the probability of a clinical diagnosis of skin malignancy.

Methods

150 dermatologists were involved in the SSCD in May 2012. Dermatologists were not remunerated. Participants had the opportunity to show a single skin lesion to a dermatologist at no cost. A questionnaire for each participating subject collected data about subjects' age, sex, risk factors and reason for encounter; furthermore the dermatologist noted down clinical diagnosis and further management. We used descriptive statistics to report characteristics of participants and skin lesions. We built two multiple logistic regression models, one regarding the clinical diagnosis of skin malignancy and one regarding the further management.

Results

5266 subjects (55.6% female) were assessed; in 308 (5.8%) participants a clinical diagnosis of skin malignancy was found. In 1732 participants (32.9%) a clinical follow up or an excision was recommended. In the multiple logistic regression model age, sex, skin phototype and the reason for participation at the SSCD were found as significant risk factors regarding the clinical diagnosis of skin malignancy. Participants with skin cancer risk factors were more likely to get a clinical follow up recommended even if the clinical diagnosis was benign.

Conclusion

A self-perceived suspicious lesion was the strongest predictor for a clinical diagnosis of skin malignancy at the SSCD. This suggests that skin self-examination might also work in general population. Future research should focus on better access to a specialist in case a suspicious skin lesion was discovered. Safety and quality of the SSCD should be further investigated, especially concerning the discrepancy between the low number of malignant lesions and the high quantity of participants where further clinical examinations or interventions were recommended.

Background

The rising incidence of melanoma over the past decades is a major public health challenge [1,2]. Switzerland (26.8 cases per 100,000 in male and 25.4 in female population; European age-standardized rates) is among the countries with the highest incidence [3]. Clinical examination of skin does not require expensive technical equipment and early detection of melanoma has a huge impact on prognosis [4], thus cutaneous melanoma seems to be prone to preventive services.

While screening in high-risk patients was shown to reduce mortality and to be cost-effective [5,6], the evidence on effectiveness of screening program in general population remains inconclusive [7-12]. German studies on a pilot in Schleswig-Holstein and a consecutively introduced nationwide screening program produced promising results [10, 13, 14]. Compared to the pre-screening era the mortality of melanoma was reduced (from 1.9/100,000 to 1.0 in men and from 1.4 to 0.7 in women), while the mortality was stable in four adjacent regions. Studies about the role of skin self-examination (SSE) produced promising results: some studies showed that SSE reduces tumor thickness and melanoma incidence in high-risk patients [15-18].

The Swiss healthcare system has no mandatory gate keeping system. Dermatologists are working in outpatient clinics as well as in private practices. Even though many patients choose an insurance model without gatekeeping, a direct consultation with a dermatologist is hardly possible and a referral from primary care physicians is usually mandatory. Therefore, a suspicious lesion in SSE might have unnecessary barriers with a contact to a primary care physician and a possible secondary referral to a dermatologist, since many primary care physicians also feel rather insecure concerning the diagnosis of melanoma [19].

Switzerland lacks a nationally coordinated cancer screening strategy, some prevention investigation such as a colonoscopy screening after the age of 50 have recently been taken in the remuneration scheme of insurance companies. A general skin cancer screening has not been implemented so far, but local campaigns started in the late 80ies. The evaluation of a skin cancer campaign in the year 2000 showed an important role of such campaigns in the early detection of melanoma [20]. In 2006 a national and annual prevention program was introduced, when Switzerland joined the European prevention campaign "Euromelanoma Day", where nowadays dermatologists of over 20 European countries participate. The prevention campaign contains both: a public health information campaign through mass media about sun protection and the importance of an early detection of melanoma and a special event, where anyone can participate and will be examined by participating dermatologists for free [21-23]. In Switzerland the prevention campaign is called "Swiss Skin Cancer Day" (SSCD). Nowadays, the SSCD is a multifaceted campaign with different activities, such as public lectures about skin cancer, risk factors for melanoma and the importance of an early detection of melanoma; a media campaign concerning the importance of sun protection and several other public events. The main focus is on primary prevention, but among these activities an opportunity of a free single skin lesion check is offered to the public, which has to effects: 1) raising awareness for the importance of primary

prevention concerning skin cancer and 2) a possible early detection of skin cancer (secondary prevention). In times of scarce health professionals and rising health care costs an implementation of a general screening program might not be feasible. Therefore, an event such as the “Swiss Skin Cancer Day”, “Euromelanoma Day” or “Melanoma Monday” in the US might also be effective [21,24-27].

However, two facts might limit the effect of such an event: During the SSCD resources do not allow a full body exam or the standardized use of dermoscopy, but only an investigation of a single lesion. And second, prevention campaigns are likely to reach a younger and more health-conscious population and therefore might not aim at the population most likely to profit [28, 29]. Former SSCD participants stated different reasons for their participation: while some subjects had a specific lesion they wanted to show to a dermatologist, others just wanted to use the opportunity of a free skin check-up.

The aim of the study was to describe the participating subjects and their motivation and investigate factors influencing the probability of a suspicion of malignancy.

Methods

Swiss skin cancer day

Among the activities of the SSCD, on special scheduled slots dermatologists in private practices as well as outpatient clinics offer the possibility to evaluate skin lesions of participants. Dermatologists in private practices and Clinics of Dermatology had the freedom to participate or not; participation was not remunerated. On three afternoons in May 2012 (7th, 9th and 12th) over 150 dermatologists in the French and German speaking parts of Switzerland offered such opportunities, all ten dermatology clinics and 63 (out of 384) dermatologists in private practice contributed to the SSCD 2012. For the patients, participation was free of charge and no special appointment was necessary. Participants had the possibility to show a single skin lesion only; the logistic challenges – mainly time constraints – did not allow a full body scan. A dermoscopic investigation was allowed, although not standardized and due to time constraints not routinely offered and not documented.

Assessment instruments

We created a paper-based questionnaire collecting anonymous data about patient characteristics (sex, age, nationality), main reason for participation on the SSCD (specific lesion vs. general check-up vs. skin cancer of friends), risk factors (Fitzpatrick phototype, over 100 nevi, skin cancer in family), and clinical diagnosis based on the examination and recommendation for further management. The further management was categorized into three domains: 1) no further step necessary 2) clinical observation and 3) excision or biopsy recommended. The questionnaire was completely filled by the participating dermatologists. Data management was centrally organized

at the Institute of Primary Care of the University Hospital Zurich. A questionnaire is provided in Additional file 1. We considered lentigo maligna, melanoma, basal cell carcinoma, squamous cell carcinoma and “other malignant diagnosis” as malignant.

Statistics

We used descriptive statistics to report characteristics of participants and skin lesions. To compare male and female participants we used chi-square testing regarding the participants’ characteristics. We created a multiple logistic regression to assess participants’ characteristics (age, sex, reason for participation, more than 100 naevi, skin phototype and family skin cancer history) associated with a higher risk of a clinical diagnosis of skin malignancy. Since we were specifically interested whether self-screening was efficient, we created a dichotomous variable (1 = self-perceived lesion, 0 = all other). We performed analyses using Stata® Version 12.1 (Stata Corporation, College Station, TX 77845, USA, www.stata.com). We regarded a $p < 0.01$ as statistical significant.

We created a second multiple regression model concerning further management. We excluded the participants with clinical malignant diagnosis. We grouped the participants where a biopsy or excision and where a clinical observation was recommended (biopsy or clinical observation necessary = 1, no further investigation necessary = 0). Number of nevi, skin photo type, positive family history and age were included in the regression model as influence factors.

Ethics approval

Under current ethical guidelines of the Swiss Academy of Medical Sciences [30] this study collecting completely anonymous data did not need formal ethical approval. Data was treated confidentially. On a general information letter of the SSCD activities participants were informed that data collected would be analyzed in anonymized form.

Results

During the three afternoons in May 2012, a total of 5266 subjects were screened (44.4% male, 55.6% female), the average age was 51.2 years (SD 19.27) for male, and 48.1 years (SD 18.47) for female subjects ($p = 0.224$). The prevalence of skin types was: Type I 323 (6.1%), Type II 2354 (44.7%), Type III 1734 (33.0%), Type IV 257 (4.9%), Type V 45 (0.9%), Type VI 7 (0.1%), 546 entries were missing. In the estimation of nevi 4090 (77.7%) had less than 100 naevi, 613 (11.6%) more than 100; 563 data are missing. 379 (7.2%) have a family history of skin cancer. We asked subjects for their reason to participate. The majority of 3178 subjects (60.4%) declared that they wanted to use the possibility of a free check-up of the skin. 1530 (29.1%) were using the possibility to show a self-perceived suspicious skin lesion, 87 (1.7%) had skin cancer cases in their entourage, 276 (5.25%) were sent by their partners, 188 (3.6%) stated different or no reasons. In **Tab. 1** the risk factors are listed in female and male participants.

	Female	Male	Significance Level
Age in years (mean, SD)	48.1 (18.47)	51.2 (19.27)	p=0.224
Skin Phototype (%)			P<0.001
I	8.37	4.89	
II	51.22	48.18	
III	33.92	40.40	
IV	5.25	5.71	
V	1.06	0.77	
VI	0.19	0.05	
More than 100 naevi (%)	11.31	15.23	p<0.001
Family history of skin cancer (%)	8.27	5.87	p=0.001
Reason for participation (%)			p<0.001
Checkup	63.15	57.03	
Suspicious skin lesion	29.47	28.62	
Skin cancer of friends	1.54	1.75	
Sent by partner	9.55	1.81	
other	3.26	3.83	

Tab. 1: Characteristics of female and male participants. Numbers indicated age in years and all other variable indicate frequencies in percentage of all female or male participants respectively. We used chi square testing to compare the characteristics between male and female participants.

In these 5266 subjects a total of 308 lesions had a clinical diagnosis of skin malignancy: 38 were suspicious for lentigo maligna, 34 for melanoma, 173 for basal cell carcinoma, 32 for squamous cell carcinoma and in 31 cases another malignant lesion was suspected, details of clinically diagnoses are shown in **Tab 2**. In 3386 subjects (64.3%) no further investigations were deemed required (= shown skin lesion not suspicious for skin malignancy); in 968 (18.4%) a clinical follow-up assessment and in 764 (14.5%) an excision or biopsy was recommended.

Clinical Classification	N	%
Dermal nevus	1541	29.26%
Seborrheic wart	1224	23.24%
Angioma	324	6.15%
other, benign	818	15.53%
Actinic keratosis	426	8.09%
Atypic naevus	450	8.55%
Lentigo maligna	38	0.72%
Melanoma	34	0.65%
Basal cell carcinoma	173	3.29%
Squamous cell carcinoma	32	0.61%
Other, malignant	31	0.59%
Not stated	175	3.32%
Total	5266	100%

Tab. 2: Clinical Classification of shown lesions. For every participant only one lesion was documented.

Detailed results of the multiple logistic regression model concerning the probability of a clinical malignant diagnosis are shown in **Tab. 3**. We found significant influencing factors were age, sex, reason for participation and skin photo type.

	Odds ratio	Standard error	Significance level
Sex	0.691	0.098	0.009
Age	1.049	0.005	<0.001
Number of Naevi	1.170	0.261	0.482
Skin Phototype	0.629	0.066	<0.001
Reason for participation	1.658	0.235	<0.001
Family History	0.637	0.225	0.201

Tab. 3: Multiple logistic regression analysis regarding influential factors concerning clinical malignancy. Categories, reference is indicated by a * (Sex 0=male*, 1=female; age in years, 1=*; Number of Naevi 0=less than 100*, 1= more than 100; skin phototype Fitzpatrick types 1*-6; reason for participation 1=self-perceived skin abnormality 0=free skin checkup* and other reasons; family history 1=positive family history for skin cancer, *0= no skin cancer in family). Participants with missing data were excluded from this analysis, a total of 4360 entries could be included in this model, R2 of this model=0.11

The results of the second multiple regression model concerning further need of investigation (either biopsy/excision or clinical control) is shown in **Tab. 4**. Participants with more than 100 nevi and a positive family history were more likely to get a recommendation for further investigations. To assess the risk factors where dermatologists recommended further management even though the clinical diagnosis was benign, we created a multiple regression model.

	Odds ratio	Standard error	Significance level
Number of naevi	3.583	0.354	<0.001
Family history	1.406	0.191	0.012
Skin phototype	0.803	0.040	<0.001
Age	1.014	0.002	<0.001

Tab. 4: Influence factors where further management was recommended despite a benign clinical skin lesion. Reference is indicated with * (Naevi: *0=less than 100 Naevi, 1=more than 100 Naevi; Family history of skin cancer *0=no, 1=positive family history; skin phototype according to phototype 1 as reference; age in years). Participants with clinical malignant diagnosis or missing data were excluded from the analysis. 4062 entries were included in this model; R2 of this model was 0.0493.

Discussion

The attendance at the SSCD to show a self-perceived suspicious skin lesion was the strongest predictor in our multiple regression model (OR 1.6) for a clinical diagnosis of skin malignancy. The national skin cancer campaign aims at raising awareness for skin cancer, promoting sun protection and emphasizing the importance of early detection. This aim alone might already legitimate a prevention campaign such as the SSCD. An easy access to a specialist in case of a self-perceived

abnormality of a skin lesion might therefore be very helpful. Still whether SSCD is the right instrument is questionable, doubts on safety and quality regarding a single-lesion examination and no routine use of dermoscopy remain and needs to be assessed in future SSCD campaigns.

The uncertainty and limitations of the SSCD might also be reflected in the discrepancy between the number of clinical malignant diagnoses (5.8%) and the number of participants, where a further workup (clinical observation or excision/biopsy) was recommended (32.9%). We investigated possible reasons for this discrepancy in our multiple regression model; participants with risk factors were more likely to get a recommendation for further workup, which could be explained by the context of the SSCD, since participants were only allowed to show one skin lesion. While this skin lesion was possibly benign, the dermatologists nevertheless could have recommended a dermatological consultation since he was not able to conduct a complete dermatological workup. This could raise awareness concerning the risk factors for skin cancer and the importance of regular control in participants with more risk factors, but the direct benefit of the skin lesion screening remains questionable. For clinics and private practices, the event might also be an incentive to attract future patients and therefore be a useful public relations event; in case of a clinical uncertainty this might also contribute to recommend a clinical follow up rather than a reassurance. Former studies have shown skin self-examination (SSE) to be effective in high-risk patients [15-18]. Our study suggests SSE might also work in a general population. From a health services perspective this results implies further research should focus on possibilities to allow an easier access to a specialist, in case of self-perceived skin lesion, especially outside such events. This also might reduce system delay from diagnosis to treatment [31].

Our analysis concerning clinical diagnosis of skin malignancy revealed an unexpected result regarding a positive family history of skin cancer as a risk factor. Participants with a positive family history had a lower risk of a clinical diagnosis of skin malignancy than participants without. Even though this result was statistically not significant in our multiple logistic regression model, this finding raises some questions about the study population. In our study 7.2% stated to have a family history for skin cancer. In the evaluation of the Italian Euromelanoma campaign in the years 2005–2007 7% of the participants recalled a history of skin cancer and 5.2% of melanoma in a family member [25]. The percentage was higher in the Swedish Euromelanoma population, where 14.8% indicated a family history of melanoma [24]; in the Swedish Euromelanoma population the skin phototype were 32.9% with type II and 58.3% type III skin phototype, compared to 44.7% type II and 33.0% type III in our population. One possible reason for this finding could therefore be an incomplete reporting of family history in the participants' questionnaire and the result might be biased. Another reason could be that persons with family history were possibly already under regular skin control and therefore did not participate at the SSCD.

Strength and limitations

In our study with the complete dataset on subjects participating on the “Swiss Skin Cancer Day” in 2012, we could show that SSE seems to ameliorate effectiveness of screening and raise the detection rate of clinical diagnoses of skin malignancies. These results are limited by the fact than only single lesions were assessed during the event. Furthermore, in our study we were only able to include clinical diagnosis and could not confirm the diagnoses either by dermoscopy or histological findings, this could possibly lead to an over-diagnosis. Also recommendations for a clinical control and/or an excision of the skin lesions were in very high, we do not know what the reasons are for that high number and how many patients really participated in a follow up.

Conclusion

A self-perceived suspicious lesion was the strongest predictor for a clinical diagnosis of skin malignancy at the SSCD. This suggests that skin self-examination might also work in general population. Future research should focus on better access to a specialist in case a suspicious skin lesion was discovered. Safety and quality of the SSCD should be further investigated, especially concerning the discrepancy between the low number of malignant lesions and the high quantity of participants where further clinical examinations or interventions were recommended.

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Chapter 8

General discussion

General discussion

Introduction

The rising incidence of skin cancer, especially melanoma, is a major public health challenge. The melanoma detection rate rose over the last decades, which resulted in a higher number of diagnoses, especially of early diagnoses. Changes in life styles (work indoor, leisure outdoor) increased the risk of intermittent exposure to high doses of UVR, which is suspected to be the main risk factor for melanoma. Given their central role in the healthcare system, GPs are more and more faced with suspicious skin lesions in their patients.

In collaboration with the Department of Dermatology of the University Hospital Zurich, we elaborated a multifaceted education program for GPs to improve their competence in the diagnosis of skin cancer. The main question of this PhD thesis was to investigate the feasibility and effect of dermatological education on GP's competence to diagnose skin cancer.

Summary of the main findings

- The self-reported need for dermatological education programs was high in the population of GPs in the Canton of Zurich.
- A teledermatologic service with digital images taken by GPs was feasible from the specialist and from the GP perspective.
- A short (one-day) educational program improved GPs' diagnostic competence in skin cancer, but the effect did not persist over time.
- A multifaceted intervention over one year did not improve GPs' diagnostic competence in skin cancer.
- Skin self-examination performed by patients might be helpful in diagnosing skin cancer: a self-perceived suspicious skin lesion was the strongest predictor for the diagnosis of skin cancer at the Swiss skin cancer day.

Skin cancer in primary care

In Switzerland, even though there is no mandatory gate keeping system with GPs as gatekeeper, a direct consultation with a dermatologist is hardly possible because of a relative shortage of dermatologists. In addition, more and more patients choose voluntarily an insurance model with their GP as gatekeeper. Such insurance models give the patients financial advantages; they have to pay less for their health insurance.

These characteristics of the Swiss health care system, combined with the rising incidence of skin cancer, lead to the situation that in most of the cases, GPs are the first contact person for patients with a suspicious skin lesion. As we showed in our survey (chapter 2), almost 60% of GPs see patients with suspicious skin lesions at least once a month. Nevertheless, many GPs felt uncertain in the assessment of such skin lesions and almost 80% claimed the need for dermatological education programs.

The relatively high frequency of skin conditions in daily practice was also confirmed by an earlier Swiss study which showed that the fifth commonest reason for consulting the GP was because of skin conditions [1]. Another study, conducted in Scotland, found skin conditions in 9% of all consultations, over 11% of these skin consultations concerned skin tumors [2].

Grange et al. [3] found in a study conducted in France that GPs play a key role in the detection of melanoma. Nevertheless, they also found that melanomas detected by GPs have often a relatively high Breslow index. They concluded that training of GPs in skin cancer diagnosis “should help to improve early detection of melanoma”.

Beside the results of our survey, also the above-average motivation of the GPs to join the randomized controlled trial showed the interest in the topic (107 of the 1000 eligible GPs wanted to participate in our study). In former research projects, we had very often fewer interested GPs than study places. However, in the minSKIN trial we had many more GPs who wanted to join the study than available study places. As written in the protocol, we planned the study with 60 GPs. Because of the enormous interest from the GPs, we were finally able to include 78 GPs. This interest clearly shows the importance and frequency of the topic in daily practice and that the GPs are relative uncertain about the handling of such patients.

In summary, our project showed as well as earlier studies that the high frequency of the topic in primary care is clearly disproportionate to the amount of available further dermatological education. Especially for practicing GPs, more offers for further education on the fields of skin cancer diagnosis and the management of malignant suspicious skin lesions should be available.

Continuing medical education

Continuing medical education (CME) is defined as the further professional education after the exam as specialist (e.g. for primary care). New knowledge and new skills arise fast in modern medicine. To keep their knowledge up-to-date, continuing medical education (CME) is important for medical doctors of all specialties. Nevertheless, the optimal way to provide effective CME remains unclear. Above all, the long-term-effectiveness has been investigated, but results remain inconclusive [4-11]. It seems that repeated CME activities are superior to single interventions [5-7, 9, 11] and that the combination of CME with other strategies (for instance teledermatology) contributes to its effectiveness [7, 9, 12].

In Switzerland, GPs have to attend 80 hours of CME per year, 30 hours self-study and 50 hours officially accredited by their professional association. GPs are free to choice the topics and the form of their CME. As we showed in our survey (chapter 2), CME about skin cancer is of high interest for

GPs. This is caused by the relatively high frequency of the topic in daily practice combined with very few opportunities to get further education on dermatology during the vocational training. With our minSKIN study project, we met exactly this request for further dermatological education. However, it has to be stated that Sibley found already in 1982 [13] in a randomized controlled trial about continuing medical education with GPs that “when the topics were of relatively great interest to the physicians, the control group (...) showed as much improvement as did the study group.» Concerning topics that were not preferentially chosen, an improvement and a difference between study and control group was found. Additionally, Ivers et al. [4] found in the updated Cochrane review about audit and feedback that “audit and feedback may be most effective when health professionals are not performing well to start out with”. However, it is conceivable that GPs chose mainly topics for their CME that they are especially interested and that they already know a lot about it.

Concerning the education form and modus, different studies [5, 14-16] found that CME is generally more effective when it is multifaceted, active and repetitive. Activation is seen as one of the most important factors to obtain a learning effect [6, 7, 17, 18]. Didactical tools like quizzes/tests or interactive discussion and reflection can help to activate learners. However, it is not clear what the optimal frequency and composition would be to receive a positive long-term-effect of CME.

In the minSKIN study, we tried to combine some of these important CME aspects into a multifaceted intervention consisting of teledermatological tools and a new cooperation between GPs and dermatologists. Furthermore, it was crucial that the intervention could be implemented in daily practice without extensive time consumption or high costs.

Teledermatology

Different reasons are thinkable to implement teledermatology in primary care. In large countries like Australia or the United States, the distances from the patients to the next available dermatologist might be the most important reason [19, 20]. In Switzerland however, there is very often a long waiting time to get a consultation with a dermatologist what leads to a diagnostic delay which can be crucial in cases of melanoma. Therefore, the avoidance of unnecessary consultations with dermatologists is in Switzerland the main aim of teledermatology.

In chapter 6, we investigated the feasibility of a teledermatological service in primary care. This could avoid unnecessary consultations with dermatologists. We showed that from the GP perspective as well as from the dermatologist perspective, such a service was feasible and highly accepted. We could not find major problems in the technical handling of the teledermatology-equipment. Also concerning the quality of the photos, no problems were reported as only 2 of 981 pictures were of too low quality for a teledermatological assessment.

The analysis of the diagnostic accuracy however raised concerns about the safety of the procedure. We found three cases of malignancy (one of them a melanoma) in the feedback category “no further steps necessary”. These results question the safety of this teledermatological procedure in

daily practice. Further research about the safety of teledermatology in this setting should be conducted before general promotion of teledermatology in daily practice.

In contrast to our finding, several other studies [21-25] showed that teleconsultations of either clinical or dermatoscopic images have a comparable diagnostic accuracy like face-to-face consultations with a dermatologist. However, most of these studies did not have the histological biopsy as gold standard but the dermatologists' assessment in a face-to-face consultation with the patient. From a clinical point of view, the most important question for the GPs is if they have to provide any further diagnostic assessment with the patient. As they cannot refer every patient with a suspicious skin lesion, they have to triage which patients need to be seen by a dermatologist. For this triage, teledermatology may be a helpful tool.

Boyce et al. [21] showed already in 2011 that patients were able to take pictures of suspicious skin lesion even with a simple mobile-phone camera that are of such good quality that a dermatological assessment was comparable with a face-to-face consultation. With the technical progress, the remote assessment of suspicious skin lesion by mobile-phone is *from the technical point of view* a viable alternative to face-to-face consultations with a dermatologist. Beside the advantages of such a low-threshold service, it has to be considered that the patient-centered approach to suspicious skin lesions runs the risk of missing lesions because of the limited experience of GPs in assessing all skin lesions on their body.

Furthermore, patients may have a "false sense of security" and neglect a consultation with the GP or dermatologist for a whole-body examination. Therefore, such a service should not be a complete alternative to face-to-face consultations but a complementary approach.

Possible reasons for lack of effect of our multifaceted intervention

There are different possible reasons for the missing long-term effect of our intervention.

CME seems to be most effective when the participants start with a low level of knowledge or skills [4]. However, the performance of the GPs in our study was already relatively high before any intervention, so there did not remain much space for improvement. A possible reason for this high performance at the beginning of the study could be a classical selection bias: it is conceivable that the GPs who wanted to join our study were over-average interested and motivated in skin cancer diagnostics and therefore performed better than the average of the Swiss GPs.

As described above, activation of learners is crucial to obtain a learning effect. Within the one-day training course, there were different components of activation: GPs had to fill in tests and there was plenty of time for interactive discussion of skin cancer cases. However, during the one-year education phase with continuing feedback, there was no possibility for an interactive discussion between the GP and the dermatologist. Also in-between tests or learning controls were not performed. Therefore, it is conceivable that the whole intervention was too passive to obtain a learning effect.

As another aspect of the missing activation, it is possible that because the GPs were not obliged to take an active decision about the dignity of the photographed skin lesion, they delegated the responsibility about the decision to the dermatologist. So the GPs were in a rather passive role, knowing the dermatologist would act as their “safety net”.

Another problem of the one-year education phase could be the total amount of transferred pictures. With a mean number of 25 transferred pictures during 12 months, on average one feedback every two weeks was provided. Even if the post-hoc regression analysis did not show any effect of the number of transferred pictures on the test results, it is conceivable that we did not reach the critical minimum of pictures to see a measurable effect.

Additionally, our intervention may not have been sufficiently multifaceted. We used technical equipment for teledermatology, as well as a feedback service, but we did not use additional education material like written information or online-tools.

Public health aspect of a skin cancer day

Chapters 2-6 of this thesis focused on a practice-based approach of skin cancer diagnostics. This approach requires that patients with suspicious skin lesions actively go to their GP. Another approach (exemplarily described in chapter 7) is the population-based approach, for example with public health campaigns like a skin cancer day. While screening in high-risk patients was shown to reduce mortality and to be cost-effective [26, 27], evidence for comprehensive skin cancer screening in general population is inconclusive [28-33].

However, in chapter 7, we showed that a self-perceived suspicious skin lesion was a strong predictor for the clinical diagnosis of skin malignancy at the skin cancer day. So, self-examination of the skin might also work in general populations. Nevertheless, the known selection bias of such public health campaigns as well as a possible harmful effect of prevention campaigns are limiting factors for their promotion. An interesting record for such a harmful effect was published by Autier et al. [34] who showed that the use of higher SPF sunscreen led to an increased duration sun exposition.

As general limitation of prevention campaigns is the fact that they often reach not exactly the population which would profit the most of the medical information or adaption of the behavior. The effect of screening and prevention would usually be the most effective one in persons at high risk. Very often, the persons that attend such prevention campaigns, are already well-informed about the relevant topic or at least above-average interested in their health status.

Another limitation of the Swiss skin cancer day is that dermatologists do (because of time restraints) not provide a whole-body examination but assess just one or two single lesions that are appraised to be suspicious by the patient. It is clear that in the framework of such a prevention campaign, not more time per patient is available. This comes with the risk of harm because the patients have a “false sense of security” after having a short-consultation with a campaign dermatologist and neglect the possibility that another lesion than the one he showed could be malignant. A clear advantage of prevention campaign like the Swiss skin cancer day are the low-

threshold and that they strengthen the role of the patients as they have to actively go there and present a skin lesion.

In conclusion, it could be said that prevention campaigns like the Swiss skin cancer day are one of different components in the effort against skin cancer. They just should not stand alone, but complementary to teledermatology for example.

Strengths and limitations

We had several limitations of our intervention study. One main limitation was for sure that we did not assess the final clinical relevant outcomes like mortality or excision rate, but a surrogate by creating artificial skin cancer case vignettes (but with known histology). We used this more indirect measure to assess our hypothesis because the local ethics committee had safety concerns if we would have made measurements directly in daily practice.

Blinding of the GPs was not possible in the intervention study what could have caused a “side-effect” in the sense that also GPs in the control group were more aware and more interested in the topic during our study phase. However, this fact is of no importance because the diagnostic performance in both groups was decreasing during our one-year study period.

In the picture scoring tests of our intervention study, we did not ask for diagnoses but just for the likelihood of malignancy of the case vignettes. This may have led to a general overestimation of GPs’ diagnostic competence. Nevertheless, from the clinical point of view, the diagnosis is for the GP much less important than the differentiation between benign and malignant. In addition, the composition of the case vignettes pool did not reflect the real distribution of skin malignancies in primary care. This resulted in a much higher pre-test probability for a malignant lesion in our study than in “real life”. As strength of the picture scoring tests, we considered the heterogeneity of real skin lesions by discriminating the case vignettes into three levels of difficulty.

Another limitation of our intervention study design was, that we performed in the intervention study simple photo documentation teledermatology and did not work with teledermatoscopy, so a certain amount of pictures was not conclusively assessed; patients had to be referred to a dermatologist for further assessment of the skin lesion. We decided to work with simple teledermatology and not teledermatoscopy because of limited financial resources. In future projects, the investment in more advanced technical equipment and their appropriate instructions could be worthwhile.

Implications for practice and for further research

In conclusion, it can be said that research in the field of skin cancer diagnostics in primary care is of high interest. Further research should be encouraged, but we found some crucial points to consider.

GPs are highly interested in further education regarding skin cancer

As we found in our survey (chapter 2), there is a clear self-reported need for GPs to attend further education programs regarding skin cancer. Also the fact that we had many more interested GPs than available study places in the intervention study was an indication for the enormous interest of the GPs in the topic. It can be critically questioned if we reached with our intervention study (chapters 3-6) the adequate GP population for a skin cancer education program. As discussed above, the effect of CME is the highest if the topic is a non-favorite topic of the participants and if they perform rather low at the beginning of the education. It is thinkable that we mainly had GPs in our intervention study who were highly interested in the topic and therefore performing above average. This hypothesis could be confirmed by the very high test score of the GPs in our baseline test before any intervention (chapter 4) and may also explain the missing effect of the one-year education program (chapter 5).

It is challenging to perform a study with a low prevalence topic in primary care

The origin of our project was that dermatologists from the University Hospital Zurich asked for collaboration. They saw numerous thick melanomas in their consultations in patients who periodically attended their GP and the melanomas could and should have been noticed by the GPs. Because the thickness of a melanoma is absolutely crucial for the patients' prognosis, all effort has to be put in early diagnosis. We first planned to perform a study with a primary clinical endpoint (excision rate of malignant to benign skin lesions), but the local ethics committee did not permit this approach. Furthermore, melanomas have a very low prevalence in primary care, even if suspicious skin lesions are quite often. So we changed the methods and used a surrogate as outcome (correctly diagnosed skin cancer cases in an image test). This problem of the low prevalence could also be a reason for the missing measurable effect of the intervention; it is thinkable that our methods were not adequate for the setting. Further research in this field should consider the low prevalence in a more differentiated way.

Skin cancer education events with GPs should be short but repetitive

The results from our intervention study indicated that an education program over one year did not have an effect on the diagnostic competence of GPs regarding skin cancer, as discussed above. Nevertheless, we were able to show that it could be more reasonable to focus on short trainings, illustrated by the fact that our one-day training course had a clearly measurable effect on GPs' competence to diagnose skin cancer. If such short-term education is provided, it has to be repeated periodically to refresh the learning effect because in our test after one year, the learning effect faded away (chapter 5).

Activation of learners is crucial in any education program or event

As one of the possible reasons for the missing effect of our education program, we identified a possible lack of activation of the GPs. The feedback service did maybe not stimulate the GP enough

to reflect about the lesion he photographed. So the provided one-way diagnosis may be a helpful service for the GPs, but it cannot be expected to have a learning effect. For future GP education on this field, a more interactive approach could be promising. If a multifaceted approach is chosen, components like booklets or online-learning tools should be implemented.

Implementation of a teledermatological feedback-service in primary care is feasible

In chapter 6, we could clearly show that from a technical point of view, the implementation of a teledermatological feedback service in primary care is technically feasible and highly accepted from the GPs' and the specialists' point of view. Regarding the appropriateness of the diagnosis however, there were important concerns because of three missed skin cancer cases and question the promotion of teledermatological services in clinical routine. Further research is needed to ensure evidence for or against teledermatology in GPs' daily practice.

Skin self-examination might work in general population

Beside the GP centered approach of our intervention study, we also tested a population/patient centered approach (chapter 7). With the very low-threshold service of dermatologists' consultation for free during the Swiss skin cancer day, there are different positive effects possible. On one hand, because of the high popularity and the numerous advertisements of the Swiss skin cancer day, the awareness regarding skin cancer and melanoma is increasing. On the other hand, we were able to show that a self-perceived suspicious skin lesion was a predictor for clinical diagnosis of skin cancer. These patients would maybe not go to their GP or to a dermatologist, but profit from the offer of such a free consultation during a prevention campaign. As limitation, as discussed above, it has to be considered that with prevention campaigns in general, very often not persons at high risk for any disease are addressed, but persons with high healthy concerns or with already high awareness for the relevant disease.

Conclusion

The main motivation of dermatologists regarding melanoma is the reduction of mortality caused by melanoma. Among other possible approaches, this can be reached by the promotion of early diagnosis as well as the reduction of incidence. With our project, we aimed on one hand to support GPs by increasing their diagnostic competence in skin cancer. If the GPs would increase their diagnostic competence, more melanomas could be diagnosed in an early stage and with lower Breslow thickness, what would have an enormous positive effect on the patients' prognosis. On the other hand, with events like the Swiss skin cancer day, the awareness in the general population regarding skin cancer, especially melanoma, should be increased what also could lead to earlier consultations and earlier diagnosis of suspicious skin lesions. In summary, this thesis promoted secondary prevention in skin cancer in primary care. The most effective way to reduce the incidence of melanomas is primary prevention with adequate sun protection behavior, what is not discussed in this thesis but should be considered for future skin cancer projects.

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Summary

Chapter 1

Over the past decades, the incidence of skin cancer (especially melanoma) was rising. Switzerland and the Netherlands are two of the countries with the highest incidence of melanoma in Europe. This rising incidence connected with a higher awareness of patients leads to the fact that GPs are more and more faced with suspicious skin lesions in their patients. As first contact person for examination and referral to a dermatologist, GPs knowledge and diagnostic competence regarding skin cancer are crucial. The aims of this thesis were 1) to record the situation for GPs in the Canton of Zurich regarding the relevance of skin cancer in their daily practice, 2) to investigate the feasibility and effects of dermatological education on GP's competence to diagnose skin cancer and 3) to explore the role of skin self-examination for a clinical diagnosis of skin malignancy.

Chapter 2

The aim of chapter 2 was to assess the frequency of patients with suspicious skin lesions in daily primary care. Furthermore, we asked the general practitioners (GPs) for their diagnostic certainty and the need of further education on skin cancer. We conducted a survey with 1212 GPs in the canton of Zurich. The data were analyzed with descriptive statistics, followed by a regression analysis investigating possible influence factors on the need for further education. We found that GPs saw relatively often patients with suspicious skin lesions (23,2% of the GPs daily/weekly, another 34,8% monthly). Despite their self-reported high diagnostic certainty, there was a clear need for further education on skin cancer (79,0% of the GPs affirmed). This need was lower in urban GPs and in GPs with higher diagnostic certainty.

Chapter 3

Chapter 3 is the study protocol for the minSKIN trial (presented in chapters 4 and 5). The protocol was published in advance and the trial was registered at a trial registration (Trial registration: ISRCTN29854485). As in Switzerland skin cancer is one of the most common neoplasms; we planned a study about this topic in collaboration with a dermatological clinic. The design of the study was a randomized controlled trial (RCT) with a planned population of 60 general practitioners (GPs). This study addressed the hypothesis that a long term multifaceted intervention with GPs is superior to a simple educational intervention regarding diagnostic competence. We expected an improvement of the competence in skin cancer diagnosis by GPs in both groups after the full day training course. Beside this immediate effect, we also expected a long term effect in the intervention group because of a continuous problem based feedback.

Chapter 4

The aim of chapter 4 was to assess general practitioners' (GPs) competence to diagnose skin cancer and to examine whether this can be improved by a one-day dermatologic education program. The study design was a pre- / post-intervention study. 78 GPs in the Canton of Zurich, Switzerland joined the study. The intervention consisted of a one-day dermatologic education program

provided by a dermatologist. Before (T0) and after (T1) the dermatologic education program, GPs were asked to rate pictures (with a short history) of skin lesions on a visual analogue scale according to their likelihood of malignancy. We used non-parametric paired Wilcoxon signed rank test to compare the sum score of correctly classified skin lesions at T0 and T1. As result, we found that at T0 GPs classified 63.9% lesions correctly (benign: 51.2%; malignant: 76.6%), while at T1 these figures increased to 75.1% (benign: 67.6%; malignant: 82.7%). We could show that a one-day dermatologic education program led to improvements in GPs' diagnostic competence in skin cancer.

Chapter 5

The aim of chapter 5 was to investigate the effect of a multifaceted intervention (including technical equipment and continuing feedback by a dermatologist) on general practitioners (GPs') diagnostic competence in skin cancer. The design of the study was a randomized controlled trial. 78 GPs of the Canton of Zurich, Switzerland joined the study and were randomized into an intervention group and a control group. The GPs in intervention group received a 1-day training, a Lumio© (magnifying glass with polarized light, 3Gen), a Nikon digital camera and - during 1 year - feedback on skin lesion pictures sent to the dermatologist. GPs in control group only received the 1-day training. As primary outcome, we assessed GP's diagnostic competence in correctly diagnosing images of skin lesions regarding skin cancer at T0 (prior to any intervention), at T1 (after the full-day training course) and at T2 (after 1 year of continuing feedback). Non-parametric unpaired tests were used to compare numbers of correctly classified skin lesions between both groups at T2 and for the change between T1 and T2. We found that at T0, both groups classified a median of 23 of 36 images correctly. This value rose to 28 for both groups at T1 and fell to 24 for both groups at T2. No difference between the control and the intervention group was found at T2. In conclusion, we did not find any long-term effect of the multifaceted intervention on the competence to diagnose skin cancer by GPs. The positive short-term effect of the 1-day dermatologic education program did not persist over 12 months.

Chapter 6

The aim of chapter 6 was to test the feasibility and the diagnostic accuracy of dermatologist's feedback based on digital images of skin lesions collected in Swiss primary care. This was a process analysis of the randomized controlled trial presented in chapter 5. The GPs in the intervention group of the "minSKIN" trial received dermatologist's feedback. This feedback was categorized into the following categories: (1) no further investigation, (2) clinical observation, (3) biopsy and (4) other. Histologic findings were allocated to the same categories. Feasibility was measured in the perspective of GPs (concerning technical handling) and of dermatologists (proportion of images usable for feedback). Diagnostic accuracy was measured as proportion of malignant histology of the first three feedback groups. A total of 981 images of skin lesions were collected, two images were not eligible due to the low quality of the images. The majority of GPs (77.8%) reported no

problems with the procedure. 207 images were in feedback category 1, 353 in 2, 360 in 3 and 59 in 4. A total of 236 histologic tests were collected. Three cases in category 1 indicated malignancy (1 melanoma). 201 of category 3 received a biopsy; where in 91 (45.3%) malignancy was confirmed. In conclusion, we showed that teledermatology with digital images taken in primary care was feasible from a GP and from a specialist perspective. However, diagnostic appropriateness regarding avoidance of specialist care and possible missed skin cancer raises concerns. These results therefore question a promotion of teledermatology in clinical routine.

Chapter 7

Swiss dermatologist introduced the “Swiss Skin Cancer Day” (SSCD), which provides skin cancer screening at no costs. The aim of chapter 7 was to describe the participating subjects and their motivation and investigate factors influencing the probability of a clinical diagnosis of skin malignancy. 150 dermatologists were involved in the SSCD in May 2012. Dermatologists were not remunerated. Participants had the opportunity to show a single skin lesion to a dermatologist at no cost. A questionnaire for each participating subject collected data about subjects' age, sex, risk factors and reason for encounter; furthermore the dermatologist noted down clinical diagnosis and further management. We used descriptive statistics to report characteristics of participants and skin lesions and two multiple logistic regression models, one regarding the clinical diagnosis of skin malignancy and one regarding the further management. 5266 subjects (55.6% female) were assessed; in 308 (5.8%) participants a clinical diagnosis of skin malignancy was found. In 1732 participants (32.9%) a clinical follow up or an excision was recommended. In the multiple logistic regression model age, sex, skin phototype and the reason for participation at the SSCD were found as significant risk factors regarding the clinical diagnosis of a skin malignancy. Participants with skin cancer risk factors were more likely to get a clinical follow up recommended even if the clinical diagnosis was benign. In conclusion, we found that a self-perceived suspicious lesion was the strongest predictor for a clinical diagnosis of skin malignancy at the SSCD.

Chapter 8

In collaboration with the Department of Dermatology of the University Hospital Zurich, we elaborated a multifaceted education program for GPs to improve their competence in the diagnosis of skin cancer. We found that first, the self-reported need for dermatological education programs was high in the population of GPs in the Canton of Zurich. Second, a teledermatologic service with digital images taken by GPs was feasible from the specialist and from the GP perspective. Third, a short (one-day) educational program improved GPs' diagnostic competence in skin cancer, but the effect did not persist over time. Fourth, a multifaceted intervention over one year did not improve GPs' diagnostic competence in skin cancer. Fifth, skin self-examination performed by patients might be helpful in diagnosing skin cancer: a self-perceived suspicious skin lesion was the strongest predictor for the diagnosis of skin cancer at the Swiss skin cancer day.

Samenvatting

Hoofdstuk 1

In de afgelopen decennia is het aantal gevallen van huidkanker (vooral melanomen) gestegen. Zwitserland en Nederland zijn twee van de landen in Europa waar melanomen het vaakst voorkomen. Dit toegenomen aantal gecombineerd met een toegenomen bewustzijn van patiënten leiden tot het feit dat huisartsen steeds vaker geconfronteerd worden met verdachte huidvlekken bij hun patiënten. Als eerste aanspreekpunt voor onderzoek en verwijzing naar een dermatoloog is het cruciaal dat de huisarts over kennis en diagnostische vaardigheden beschikt omtrent huidkanker. De doelstellingen van dit proefschrift waren: 1) meten van de situatie bij huisartsen in het kanton Zürich met betrekking tot het voorkomen van huidkanker in hun dagelijkse praktijk; 2) de haalbaarheid en effecten te onderzoeken van dermatologische scholing op de vaardigheid van de huisarts om huidkanker te diagnosticeren; 3) de zinvolheid van zelfonderzoek van de huid voor een klinische diagnose van onregelmatigheden van de huid.

Hoofdstuk 2

Het doel van hoofdstuk 2 was het vaststellen van de frequentie van patiënten met verdachte huidvlekken in de dagelijkse eerstelijnszorg. Verder hebben we huisartsen gevraagd naar de zekerheid van hun diagnostiek en de behoefte aan verdere scholing in huidkanker. We voerden een vragenlijstonderzoek uit onder 1212 huisartsen in het kanton Zürich. De data werden geanalyseerd door middel van beschrijvende statistiek, gevolgd door een regressie analyse om mogelijke factoren die van invloed zijn op de behoefte aan scholing verder te onderzoeken. We vonden dat huisartsen relatief vaak patiënten zagen met verdachte vlekken op de huid (23.2% van de huisartsen dagelijks/wekelijks, 34.8% maandelijks). Ondanks de door hen zelf gerapporteerde zekerheid van hun diagnostiek was er een duidelijke behoefte aan verdere scholing in huidkanker (79% van de huisartsen bevestigde dit). Deze behoefte was lager in stedelijke gebieden en bij huisartsen met een hogere mate van zekerheid bij hun diagnose.

Hoofdstuk 3

Hoofdstuk 3 is het studieprotocol voor het minSKIN onderzoek (gepresenteerd in hoofdstukken 4 en 5). De opzet van het onderzoek was een gerandomiseerde, gecontroleerde studie (RCT) met een geplande onderzoeksgroep van 60 huisartsen. In het protocol zijn het ontwerp, de methoden en de geplande analyses beschreven. De studie test de hypothese dat een langdurige, samengestelde interventie gericht op huisartsen meer effect heeft dan een eenvoudige educatie interventie gericht op diagnostische competentie. Wij verwachtten een verbetering van de diagnostische competentie bij huidkanker in beide groepen na een training van een dag. Naast dit directe effect verwachtten wij op langere termijn een effect in de interventiegroep doordat hierin continue feedback werd gegeven.

Hoofdstuk 4

In hoofdstuk 4 was het de bedoeling om de deskundigheid voor het stellen van de diagnose huidkanker te beoordelen en te onderzoeken of dit verbeterd kan worden door een eendaags dermatologie scholingsprogramma. De onderzoeksopzet bestond uit een interventie met voor- en nameting. 78 huisartsen in het kanton Zürich, Zwitserland deden mee aan het onderzoek. De interventie bestond uit een eendaags scholingsprogramma over dermatologie, gegeven door een dermatoloog. Voor (T0) en na (T1) het scholingsprogramma werd aan de huisartsen gevraagd om foto's van huidvlekken te beoordelen (met een korte historie) volgens hun inschatting van kanker op een visuele analoge schaal. We gebruikten een Wilcoxon test om de somscore te vergelijken van correct geclassificeerde huidvlekken bij T0 en T1. Als resultaat vonden we dat bij de T0-meting 63.9% van de huisartsen de huidvlekken correct classificeerden (goedaardig: 51.2%, kwaadaardig 76.6%), terwijl bij T1 deze cijfers toenamen tot 75.1% (goedaardig: 67.6%, kwaadaardig 82.7%). We konden aantonen dat een eendaags scholingsprogramma leidde tot verbetering in de diagnostische competentie voor huidkanker bij huisartsen.

Hoofdstuk 5

In hoofdstuk 5 onderzochten we het effect van een meervoudige interventie (inclusief technische uitrusting en continue feedback door een dermatoloog) op de diagnostische vaardigheid van huisartsen voor het stellen van de diagnose huidkanker. Het ontwerp van de studie was een gerandomiseerde gecontroleerde studie. 78 huisartsen in het kanton Zürich deden mee aan de studie en werden verdeeld over een interventie- en een controlegroep. De interventiegroep ontving een eendaagse scholing a Lumio (vergrootglas met gepolariseerd licht), een Nikon digitale camera en gedurende 1 jaar feedback op foto's van huidvlekken die aan de dermatoloog werden gezonden. Huisartsen in de controlegroep kregen alleen een eendaagse scholing. Als primaire uitkomstmaat toetsten we de bekwaamheid van huisartsen van het correct diagnosticeren van foto's van huidvlekken betreffende huidkanker bij T0 (voorafgaand aan enige interventie), bij T1 (na de eendaagse scholing) en bij T2 (na 1 jaar van continue feedback). Non-parametrische niet-gepaarde testen werden gebruikt om de aantallen correct geclassificeerde huidvlekken tussen beide groepen bij T2 te vergelijken met de verandering tussen T1 en T2. We vonden dat bij T0 beide groepen een mediaan van 23 van de 36 foto's correct classificeerden. Dit cijfer steeg naar 28 voor beide groepen bij T1 en nam af naar 24 voor beide groepen bij T2. Er werden geen verschillen gevonden tussen de controle- en de interventiegroep bij T2. Concluderend: we hebben geen lange termijn effect gevonden van de meervoudige interventie op de deskundigheid van het diagnosticeren van huidkanker door huisartsen. Het positieve effect op korte termijn van het eendaags scholingsprogramma hield niet stand na 12 maanden.

Hoofdstuk 6

Het doel van hoofdstuk 6 was het testen van de haalbaarheid en de diagnostische nauwkeurigheid van de feedback van de dermatoloog, gebaseerd op digitale foto's van huidvlekken, verzameld in de Zwitserse eerstelijnszorg. Dit was een procesanalyse van de gerandomiseerde gecontroleerde studie, gepresenteerd in hoofdstuk 5. De huisartsen in de interventiegroep van de "minSKIN" studie ontvingen feedback van een dermatoloog. Deze feedback was onderverdeeld in de volgende categorieën: 1) geen verder onderzoek; 2) klinische observatie; 3) biopsie en 4) anders. Histologische bevindingen werden toegewezen aan dezelfde categorieën. Haalbaarheid werd gemeten vanuit het perspectief van de huisartsen (betreffende technische behandeling) en van dermatologen (gedeelte van foto's dat bruikbaar is voor feedback). Diagnostische nauwkeurigheid werd gemeten als het aandeel kwaadaardige weefseltypen gevonden in de eerste 3 feedbackgroepen. Een totaal van 981 foto's van huidvlekken werd verzameld, twee foto's waren niet bruikbaar vanwege de slechte kwaliteit. De meerderheid van de huisartsen (77.8%) gaf aan geen problemen te hebben met deze procedure. 207 foto's behoorden tot feedbackcategorie 1, 353 tot categorie 2, 360 in categorie 3 en 59 in categorie 4. Een totaal van 236 histologische beoordelingen werd verzameld. Drie gevallen in categorie 1, werden gekenmerkt als kwaadaardig (1 melanoom). Een aantal van 201 in categorie 3 kreeg een biopsie waarvan 91 gevallen (45.3%) als kwaadaardig werden gekenmerkt. We hebben aangetoond dat teledermatologie (dermatologie op afstand) met digitale foto's genomen in de eerstelijns haalbaar was vanuit het perspectief van de huisarts en van de specialist. Echter de diagnostische opbrengst bij vermindering van specialistische zorg en mogelijk gemiste huidkanker baren zorgen. Deze resultaten roepen vragen op bij het bevorderen van teledermatologie in de klinische routine.

Hoofdstuk 7

Zwitserse dermatologen introduceerden de "Zwitserse huidkanker dag" (SSCD), waar gratis huidkanker screening werd aangeboden. Het doel van hoofdstuk 7 was om de deelnemers en hun motivatie te beschrijven en factoren te onderzoeken die invloed hebben op de waarschijnlijkheid van een klinische diagnose van kwaadaardige huid. 150 dermatologen waren betrokken bij de SSCD in mei 2012.

Dermatologen ontvingen geen vergoeding. Deelnemers hadden de mogelijkheid een huidvlek aan een dermatoloog te laten zien zonder kosten. Middels een vragenlijst voor elke deelnemer werden gegevens verzameld over leeftijd en sekse van de deelnemers, risicofactoren en redenen van deelname; verder noteerde de dermatoloog de klinische diagnose en de verdere behandeling. We gebruikten beschrijvende statistiek om kenmerken van de deelnemers en de huidvlekken te rapporteren en 2 multiple regressie modellen. Een betreffende de klinische diagnose van de kwaadaardige huid en een betreffende de verdere behandeling. 5266 personen (55.6% vrouwen) werden beoordeeld; bij 308 (5.8%) deelnemers werd een klinische diagnose van kwaadaardige huid gevonden. Bij 1732 deelnemers (32.9%) werd een klinische follow-up of een verwijdering van de tumor aanbevolen. Bij het multiple regressie model werden leeftijd, sekse, huid, type foto en

de reden van deelname aan de SSCD gevonden als significante risicofactoren betreffende de klinische diagnose van kwaadaardige huid. Deelnemers met risico op huidkanker werd eerder een klinische follow-up aanbevolen, ook al was de diagnose goedaardig. Concluderend vonden we dat een zelf ervaren verdachte huidvlek de sterkste voorspeller was voor een klinische diagnose van kwaadaardige huid bij de SSCD.

Hoofdstuk 8

In samenwerking met de afdeling Dermatologie van het University Hospital Zürich hebben we een veelzijdig scholingsprogramma voor huisartsen uitgewerkt om hun bekwaamheid in het diagnosticeren van huidkanker te verbeteren. Allereerst vonden we dat de zelf gerapporteerde behoefte aan dermatologische scholing hoog was bij de populatie van huisartsen in het kanton Zürich. Ten tweede was een teledermatologische service met digitale foto's genomen door de huisarts toepasbaar vanuit het perspectief van de specialist en van de huisarts. Ten derde verbeterde een kort (eendaags) scholingsprogramma de bekwaamheid van de huisarts om de diagnose huidkanker te stellen, maar het effect hield geen stand. Ten vierde verbeterde een meervoudige interventie gedurende een jaar de diagnostische bekwaamheid van de huisartsen niet. Ten vijfde: zelfonderzoek van de huid, gedaan door de patiënten was de sterkste voorspeller van de diagnose huidkanker op de Zwitserse huidkanker dag.

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Curriculum vitae

Nina Badertscher was born on 21st February 1980 in Zurich, Switzerland. She grew up in Volketswil, a small village beside Zurich, where she attended primary school. Secondary school, she attended in the city of Zurich and finished with the Matura (final exams at the end of the secondary school) in 2001.

From 2001 to 2008 she studied medicine at the University of Zurich. She graduated in 2008 and received her promotion in medical sciences (Dr. med.) from the University of Zurich in 2009.

First practical experience, she gained in 2009 as assistant physician in a primary care practice in Roggwil, Switzerland. From 2009 to 2010 she worked as resident physician in the Department of Surgery at the regional hospital Uster, Switzerland.

From 2010 to 2015, she worked as research associate at the Institute of Primary Care of the University Hospital Zurich. During her position as research assistant and PhD student at the Institute of Primary Care, she attended several research related training courses in Switzerland, Germany, Belgium and the Netherlands. The courses included statistics, quantitative and qualitative data analysis, dermatology, good clinical practice, scientific writing, methodology in survey research and systematic reviews. From 2012 onwards, her scientific research projects were methodically supported by Michel Wensing.

Since Summer 2015, she works as lecturer in basic medical education and as member of the academic advisory board at a private business and medical school in Zurich.

Nina is married since 2009 with Matthias Badertscher and has two children, a girl called Mia (born in 2012) and a boy called Elia (born in 2014).

