European Journal of Cancer 117 (2019) 32–40

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.ejcancer.com

Original Research

Opportunities for improving the efficiency of keratinocyte carcinoma care in primary and specialist care: Results from population-based Dutch cohort studies

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Received 4 March 2019; received in revised form 29 April 2019; accepted 4 May 2019
Available online 21 June 2019

KEYWORDS
Keratinocyte carcinoma;
Primary care;
Secondary care;
Diagnosis;
Treatment;
Follow-up visits

Abstract ***Background:*** High incidence rates of keratinocyte carcinoma (KC) in Western countries put pressure on healthcare systems. The aim of this study was to describe clinical practice in order to identify areas for improvement.
Methods: A random selection of patients from the Integrated Primary Care Information database who consulted their general practitioner (GP) for suspicious or confirmed KC (n = 1597) was made in the analysis. For secondary care, 1569 patients with histologically confirmed KC were randomly selected from the Netherlands Cancer Registry. All patients were diagnosed between 2009 and 2013 and followed up until 2016. Details on diagnosis, treatment and care during follow-up were described.
Results: Among 942 patients who consulted their GP, KC was included in the working or differential diagnosis, but two-thirds (629) were not KC. If the GP suspected KC, the GP directly referred to a medical specialist in most cases (548 of 942). In half (470 of 967) of all confirmed KCs, a skin malignancy was not described in the initial working or differential diagnosis of the GP. The medical specialist treated the first primary KC in 86% (1369 of 1596) by excision, 4% (69 of 1596) by Mohs surgery and 10% (158 of 1596) by another treatment. Although follow-up is not recommended for low-risk basal cell carcinoma, 83% (29 of 35) received follow-up care. In contrast, 82% (60 of 73) patients with squamous cell carcinoma received less follow-up than recommended.
Conclusions: Strengthening the diagnostic pathway for KC in primary care and reduction of

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https://doi.org/10.1016/j.ejca.2019.05.010

low-value follow-up visits in secondary care seem potential areas for improving the efficiency of KC care.

1. Introduction

Worldwide, the incidence of keratinocyte cancer (KCs, consisting of basal cell carcinoma [BCC] and cutaneous squamous cell carcinoma [SCC]) is high and still rising [1–3]. More than one-third of patients with KC will develop at least one subsequent KC [4]. These high numbers of KC put pressure on healthcare systems and urges to evaluate current KC care to identify opportunities to improve efficiency of care.

The economic burden of KC is substantial [5–8]. A national skin cancer expenditure analysis in the US showed that $2.5 billion was spent in 2013 on skin cancer–related diagnoses in Medicare patients alone. Half of this spending was attributable to KC [7]. KC ranks as the 5th most expensive cancer to treat among Medicare patients [7], among the highest per head in Australia [5] and among the 5 most costly cancers in the Netherlands [6]. Thus, optimal and efficient healthcare utilisation is of vital importance to maintain a sustainable healthcare system.

In countries like the Netherlands, UK and Australia, the general practitioner (GP) has a gatekeeper function and decides on diagnosis, treatment and referral [9–11]. Despite this gatekeeper function, a primary care guideline for suspicious skin lesions was missing in the Netherlands until 2017. For medical specialists, clinical guidelines were implemented in 2002 (BCC) and 2012 (SCC) [12,13]. In the US and other European countries (e.g. Belgium, Germany), patients have direct access to a dermatologist, which leads to different management strategies, but all require efficient use of healthcare resources [14,15].

The true burden on healthcare systems is difficult to describe because many cancer registries do not register SCC, BCC or multiple KCs. Thus, the incidence and absolute numbers of KCs in a population are often unknown or at best an estimation. Also, complete information on the diagnosis, treatment and follow-up is often not routinely registered. In the Netherlands, both BCC and SCC are registered by the nationwide Netherlands Cancer Registry (NCR). Combined with a detailed Dutch primary care database, this offers a unique opportunity to describe care pathways for patients with KC. The aim of this study was to describe the diagnostic process, treatment and follow-up care of patients with KC in primary and secondary care in the Netherlands, in order to identify opportunities to improve efficiency of care.

2. Methods

2.1. Design

We conducted a multiple database study, based on routinely collected healthcare data in primary care of patients with suspected or confirmed KC (Integrated Primary Care Information [IPCI]) and data of the NCR to describe specialist care. The STROBE and RECORD statements were used for the reporting [16,17].

2.2. Data sources and study population

2.2.1. Study period

In order to assess 5-year follow-up care, we selected patients from 2009 to 2010, and in order to assess recent clinical practice during the first 2 years of diagnosis and treatment, we selected patients from 2012 to 2013. We applied these study periods to both primary and secondary care.

2.2.2. Primary care records: IPCI

The IPCI database is a central research database with a collection of electronic routinely collected patient records from GPs in the Netherlands since 1989 [18].This database contains 2.2 million patient records derived from 575 primary care practices. The selection process is described in detail in the supplementary methods. We included patients with BCC and SCC, who were identified by an algorithm within the study period and who consulted their GP for a (suspected) KC at the first date when the patient was identified by the algorithm or within the preceding year and who met one of the following criteria: KC was suspected by the GP or KC was confirmed by either a pathological report or by a medical specialist. Routinely collected data in the IPCI was used to assess the diagnostic process, treatment patterns and follow-up of patients with BCC/SCC in primary care.

2.2.3. Secondary care records: NCR

The NCR is a nationwide database of histologically confirmed malignancies since 1989 and collects data on all newly diagnosed patients with cancer in the Netherlands. Registration is primarily based on notification by the nationwide network and registry of histopathology and cytopathology (Pathologisch Anatomisch Landelijk Geautomatiseerd Archief [PALGA]) [19]. We aimed to select 1000 patients with BCC and 1000 patients

with SCC, but owing to the extremely time-consuming registration of extra variables for this project, we included 837 patients with BCC and 732 patients with SCC who, in total, had 1731 BCCs and 1293 SCCs. The registration included data on tumour characteristics, treatment and follow-up of KC in secondary care. Follow-up visits were registered for all patients with SCC and a proportion of patients with BCC (550) because the remaining 287 patients with BCC were included in a preliminary project, in which follow-up visits were not registered in detail. High-risk histopathological features of SCC were not included as separate variables as these were not routinely registered in the pathological reports during the study period. However, SCC stage was available, as this was routinely extracted from the medical files by registrars of the NCR.

2.2.3.1. Statistical analysis. The primary objective was to describe current clinical practice. No hypothesis testing and therefore no sample size calculation were performed. Descriptive analyses are described in detail in the supplementary methods and were performed using SPSS 24.0 (SPSS Inc., Chicago, IL, USA) and SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

3.1. Routine GP records: IPCI

We included 787 patients (suspected) with BCC and 810 patients (suspected) with SCC, who consulted their GP for KC (Table 1). This included both patients where the GP suspected KC (942, Table 2), although this was not always confirmed, and patients with confirmed KC (967, Table 3).

3.1.1. Diagnosis

Of all 942 patients with suspected KC, 584 had a suspected BCC and 358 had a suspected SCC (Table 2). In one-third of all 942 suspected KC, a KC diagnosis was confirmed (n = 313, 33%). The most frequent initial policy (n = 548, 58%) was to directly refer a patient to the medical specialist (Table 2).

Of all confirmed BCC, the working or differential diagnosis included BCC in 53% (233 of 436) and another skin malignancy in 8% (37 of 436) (Table 3). Of all confirmed SCC, 15% (80 of 531) of the working or differential diagnosis included SCC and 28% (147 of 531) included another skin malignancy.

Treatment. The GP treated almost a third of suspected KCs (Table 2). In 20% (190 of 942) of suspected KCs, the GP applied a direct excision, without a prior biopsy. The final diagnosis of suspected KC, which were treated with an unrelated topical treatment for KC (e.g. antibacterial, antimycotic ointments), included in 65% (34 of 52) a non-malignant diagnosis and in 35% (18 of 52) a KC (Fig. S1).

The initial policy of the GP for confirmed BCC was a surgical treatment in 13% ((45 + 11) of 436) (Table 3). Confirmed SCCs were initially treated with surgery in 28% ((145 + 3) of 531). Six percent (28 of 436 and 29 of 531) of all confirmed BCCs and SCCs were initially treated with another topical treatment, unrelated to KC.

Follow-up. More than half (56%, 275 of 489) of patients with KC with at least 5-year follow-up did not have any

Table 1
Patient characteristics.

Data source	Primary care		Secondary care	
	Integrated Primary Care Information		The Netherlands Cancer Registry	
Tumour type	BCC	SCC	BCC	SCC
	Number of GP practices: 206	Number of GP practices: 206	Number of hospitals: 5	Number of hospitals: 5
Patients, n	787	810	837	732
BCC/SCC suspected by the GP[a]	584	358	N.A.	N.A.
of which confirmed[b]	233	80	–	–
BCC/SCC (histologically) confirmed[a,b]	436	531	837	732
of which suspected BCC/SCC by the GP	233	80	–	–
Patient characteristics				
Age, mean (SD)	66 (14)	72 (13)	66 (13)	75 (11)
Male, N (%)	356 (45)	413 (51)	398 (48)	435 (59)
History of cutaneous (pre-)malignancies, N (%)				
AK	88 (11)	135 (17)	205 (24)	382 (52)
BCC	77 (10)	45 (6)	139 (17)	107 (15)
SCC	9 (1)	37 (5)	5 (1)	75 (10)

BCC, basal cell carcinoma; SCC, squamous cell carcinoma; KC, keratinocyte carcinoma; GP, general practitioner, AK, actinic keratosis; N.A., not applicable, SD, standard deviation.

[a] Primary care patients can be included in both categories: KC may be included in the working or differential diagnosis and could also have been confirmed.

[b] KC was considered 'confirmed' if the KC was confirmed histopathologically or by correspondence of a medical specialist. All KCs included in the NCR were histologically confirmed.

Table 2
Initial policy of the GP for suspected BCC and SCC.

Initial policy of the GP for suspected BCC and SCC				
		BCC N (%)	SCC N (%)	KC (BCC + SCC) N (%)
Number of patients where the GP suspected BCC or SCC		584	358	942
Confirmed BCC or SCC diagnosis[a]		233 (40)	80 (22)	313 (33)
No treatment		38 (7)	15 (4)	53 (6)
Surgical	Diagnostic biopsy only[b]	24 (4)	11 (3)	35 (4)
	Diagnostic excision (no prior biopsy)	65 (11)	50 (14)	115 (12)
	Excision without histology	2 (0)	1 (0)	3 (0)
	Therapeutic excision (prior biopsy)	10 (2)	4 (1)	14 (1)
Referral	Direct referral	348 (60)	200 (56)	548 (58)
	Referral after diagnostic biopsy	18 (3)	6 (2)	24 (3)
Other treatments[d]	Shave/electrocoagulation	3 (1)	3 (1)	6 (1)
	Cryotherapy	27 (5)	15 (4)	42 (4)
	5-FU	6 (1)	1 (0)	7 (1)
	Other topical treatment[c]	42 (7)	52 (15)	94 (10)
	Unknown	1 (0)	0	1 (0)

KC, keratinocyte carcinoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma; GP, general practitioner; 5-FU, 5-fluoro-uracil.
[a] Confirmed by a pathological report or a letter from a medical specialist.
[b] No further skin cancer treatment or referral.
[c] Other treatment includes oral antibiotics, indifferent topical treatments and salicylic acid.
[d] In only 2% (3 of 150) of all other treatments, a biopsy was taken before applying the treatment.

Table 3
Initial diagnosis and policy of the GP of confirmed BCC and SCC.

Initial diagnosis and policy of the GP of confirmed BCC and SCC				
		BCC N (%)	SCC N (%)	KC (BCC + SCC) N (%)
Number of patients with confirmed BCC or SCC seen by the GP in the last year[a]		436	531	967
Initial diagnosis of the GP				
Working or differential diagnosis	Correct histopathological diagnosis[b]	233 (53)	80 (15)	313 (32)
	Other skin malignancy[c]	37 (8)	147 (28)	184 (19)
	Skin premalignancy[d]	27 (6)	70 (14)	97 (10)
	Other[e]	126 (29)	222 (42)	348 (36)
	Lesion not seen by GP	13 (3)	12 (2)	25 (3)
Initial policy of the GP				
No treatment		1 (0)	0	1 (0)
Surgical	Diagnostic biopsy only[f]	2 (1)	3 (1)	5 (1)
	Diagnostic excision (no prior biopsy)	45 (10)	145 (27)	190 (20)
	Therapeutic excision (prior biopsy)	11 (3)	3 (1)	14 (1)
Referral	Direct referral	302 (69)	295 (56)	497 (51)
	Referral after diagnostic biopsy	35 (8)	19 (4)	54 (6)
Other treatments	Shave/electrocoagulation/curettage	0	1 (0)	1 (0)
	Cryotherapy	8 (2)	19 (4)	27 (3)
	5-FU	1 (0)	1 (0)	2 (0)
	Other topical treatment[g]	28 (6)	29 (6)	57 (6)
	Unknown	3 (1)	16 (3)	19 (2)

KC, keratinocyte carcinoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma; GP, general practitioner; 5-FU, 5-fluoro-uracil.
[a] Confirmed BCC and SCC include all BCCs and SCCs which are confirmed by either histopathological confirmation in the GP record or confirmation of the diagnosis in correspondence from a medical specialist.
[b] BCC included in working or differential diagnosis for confirmed BCC and SCC included in working of differential diagnosis for confirmed SCC.
[c] BCC (for confirmed SCC), SCC (for confirmed BCC), keratoacanthoma, melanoma, skin cancer without further specification.
[d] Actinic keratosis, Morbus Bowen, cornu cutaneum without further specification.
[e] e.g. Eczema, Mycosis, Psoriasis and other cutaneous diagnoses.
[f] No further treatment or referral.
[g] Incl. antimycotic and antibacterial ointments.

GP visit related to cutaneous (pre)malignancies (Table S1). A small proportion (4%, 20 of 489) of patients visited the GP at least annually for cutaneous (pre) malignancies for at least 2 years. Most patients visited the GP for cutaneous (pre)malignancies with irregular intervals (Table S1). The frequency of GP visits related

to cutaneous (pre)malignancies per year is shown in Fig. 1.

3.2. Secondary care records: NCR

Among 837 patients with a histologically confirmed BCC and 732 patients with a histologically confirmed SCC (Table 4), a total number of 1721 BCCs and 1272 SCCs were registered during follow-up (Table S2).

Diagnosis

The diagnostic biopsy rate among medical specialist ranged from 49% (262 of 540 subsequent SCC) to 66% (587 of 884 subsequent BCC) (Table 4).

Treatment

Most patients (~70%) were treated by the dermatologist, followed by the plastic surgeon (~20%) (Table 4). Excision was the most frequent treatment. Subsequent SCCs were more frequently treated with topical treatments or photodynamic therapy because these also included 212 (39%) in situ SCCs (in contrast to the index SCC, which were all invasive SCC). The margins of excised KCs showed no histological clearance in 3% (47 of 1434) of BCCs and in 5% (59 of 1272) of SCCs.

Follow-up

The incidence rate of new KC was high, as ~40% of all patients with KC developed at least 1 subsequent KC (Table 5). Also, half to two-thirds of all patients with KC were diagnosed with actinic keratosis during follow-up.

Of all patients with a low-risk BCC, 83% (29 of 35) received more follow-up visits than most recent guidelines recommend. In contrast, 90% (38 of 42) of all patients with a low-risk SCC received less follow-up visits

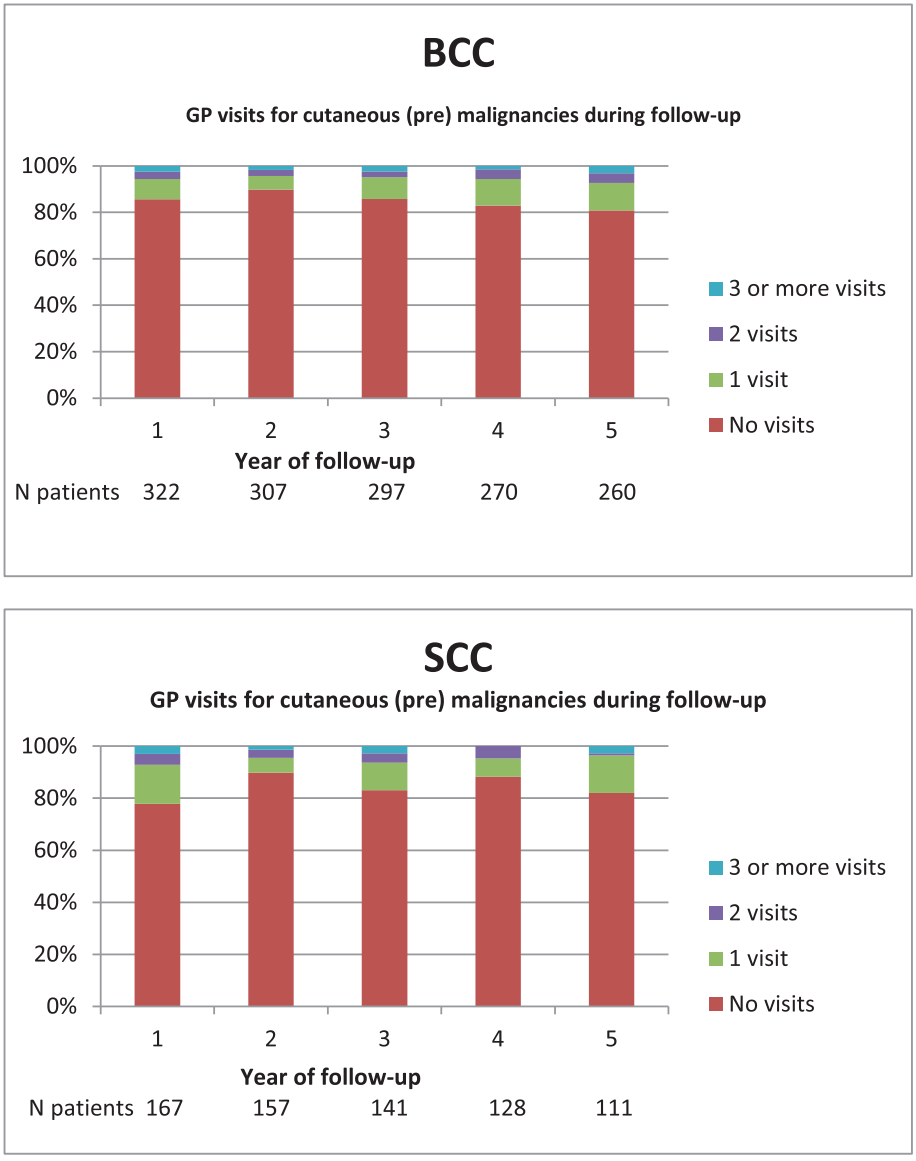

Fig. 1. Cutaneous (pre)malignancy-related GP visits during follow-up of patients with a confirmed BCC or SCC. All patients with confirmed BCC or SCC, who were diagnosed in 2009 or 2010, were included in order to have sufficient follow-up. BCC, basal cell carcinoma; SCC, squamous cell carcinoma; GP, general practitioner.

Table 4
Diagnosis and treatment of BCC and SCC by medical specialists.

	BCC		SCC	
Patients (N)	837		732	
Tumours (N)	1,721[c]		1,272[c]	
	Index BCC	Subsequent BCC[c]	Index SCC	Subsequent SCC[c]
Tumours (N)	837	884	732	540
Treating medical specialist, N (%)				
Dermatologist only	615 (73)	633 (72)	451 (62)	390 (72)
Plastic surgeon only	151 (18)	163 (18)	206 (28)	109 (20)
Other (combination of) treating medical specialist(s)	61 (7)	14 (2)	74 (10)	20 (4)
No treatment/treating medical specialist	10 (1)	74 (8)	1 (0)	21 (4)
Biopsy taken before treatment,[a] N (%)				
No	339 (41)	262 (30)	382 (52)	253 (47)
Yes	491 (59)	587 (66)	342 (47)	262 (49)
Unknown	7 (1)	35 (4)	8 (1)	25 (5)
Type of treatment, N (%)				
Excision	669 (80)	609 (69)	700 (96)	404 (75)
Mohs micrographic surgery	52 (6)	58 (7)	17 (2)	14 (3)
Photodynamic therapy	65 (8)	69 (8)	1 (0)	49 (9)
Topical therapy (5-FU, imiquimod)	14 (2)	57 (6)	1 (0)	25 (5)
Other[b]	25 (3)	77 (9)	11 (2)	43 (8)
No treatment	12 (1)	14 (2)	2 (0)	5 (1)
Unknown	0	0	0	0

BCC, basal cell carcinoma; SCC, squamous cell carcinoma; 5-FU: 5-Fluouracil.
[a] Includes only subsequent BCC and SCC, in order to avoid bias due to missing non-histologically confirmed index tumours.
[b] Other treatments include laser coagulation, curettage and shave, cryosurgery and radiotherapy.
[c] Also includes subsequent BCCs of patients with an index SCC or subsequent SCC or patients with an index BCC.

Table 5
Follow-up of BCC and SCC by medical specialists.

	BCC	SCC
All Patients (N)	550	732
Duration of follow-up, N (%)		
<5 years	312 (57)	498 (68)
≥5 years	238 (43)	234 (32)
AK diagnosis during follow-up, N (%)	249 (45)	495 (68)
BCC or SCC during follow-up, N (%)		
None	335 (61)	433 (59)
<0.5 BCC or SCC per person-year	129 (23)	151 (21)
≥0.5 BCC or SCC per person-year	85 (15)	146 (20)
Unknown	1 (0)	2 (0)
Comparison to the most recent clinical guidelines		
Patients diagnosed in 2013 (N)	271	378
Follow-up visits of low risk tumours[a]		
Patients with a low-risk tumour at the index date (N)	35	42
According to the guidelines[b]	6 (17)	2 (5)
More follow-up	29 (83)	2 (5)
Less follow-up	n.a.	38 (90)
Follow-up visits of high-risk tumours[c]		
Patients with a high-risk tumour at the index date (N)	99	31
According to the guidelines[d]	19 (19)	1 (3)
More follow-up[e]	61 (62)	2 (6)
Less follow-up	19 (19)	22 (71)

BCC, basal cell carcinoma; SCC, squamous cell carcinoma; AK, actinic keratosis.
[a] All low-risk SCC and BCC did not have a history of AK, BCC or SCC and did not develop AK, BCC or SCC during follow-up. Low-risk primary BCC: not in the H-zone, no infiltrative or micronodular BCC, ≤20 mm, no recurrent BCC. Low-risk primary SCC: stage I.
[b] Recommended follow-up for low-risk BCC: none. Recommended follow-up frequency for low-risk SCC: twice per year during year 1 and 2.
[c] High-risk BCC: H-zone, infiltrative/micronodular, >20 mm, recurrent BCC. High-risk SCC: ≥ TNM stage II.
[d] Recommended follow-up frequency for high-risk BCC: annual follow-up visits. Recommended follow-up frequency for high-risk SCC: Year 1: 4 visits, Year 2: 3 visits.
[e] 55% (54 of 99) of high-risk patients with BCC and 58% (18 of 31) of patients with high-risk SCC with more follow-up developed AK, BCC or SCC during follow-up, which contributed to more visits than the guideline.

than recommended. Also, most patients (71%, 22 of 31) with high-risk SCC received less follow-up than recommended. Similar proportions were observed among patients who received follow-up according to the former national BCC and SCC guidelines (Table S3). The frequency of follow-up visits per year of all patients is shown in Figure S2.

4. Discussion

We described care pathways of patients with KC in both primary and secondary care in the Netherlands. We observed in primary care that a skin malignancy is not initially considered in half of all confirmed KCs and that two-thirds of suspected KC lesions were not a skin malignancy. Nevertheless, the majority of suspected KCs were directly referred to the medical specialist and ~5% received a biopsy. In secondary care, the dermatologist was the main treating specialist and in half to two-thirds, a biopsy was available before treatment. In secondary care, low-risk patients with BCC received more follow-up visits than recommended, but almost all patients with SCC (both low- and high-risk SCCs) received less follow-up visits than recommended.

4.1. Diagnosis and treatment of KC in primary care

Ideally, the role of the GP as a gatekeeper in the management of suspicious skin lesions is to control the referral rate and treat low-risk tumours, such as low-risk BCC. The newly introduced (June 2017) clinical guidelines for GPs regarding suspicious cutaneous lesions are based on this principle [20]. Thus, during the study period, the GPs could not rely on guidelines. If the GP suspected KC, the majority of patients were referred to a dermatologist. However, one-third (33%) of suspected KC lesions were skin malignancies, leading to unnecessary referrals. GPs reported a skin malignancy in their initial working or differential diagnosis in approximately half of all confirmed KC cases. The specific diagnosis was correctly predicted for half of all BCCs but only in 15% of all SCCs. This may also explain the relatively high proportion of direct excisions by the GP without prior biopsy of SCCs (27%) compared to BCCs (10%). Furthermore, the relatively fast, often exophytic growth of SCCs may also urge a GP to take more immediate action compared to BCCs.

Overall GPs treated almost a third of all suspected KC lesions, but one-third of those treatments were not primarily directed at KC (e.g. antibacterial and/or antimycotic ointments). This observation suggests that GPs might be more actively involved in skin cancer care and does not necessarily suggest 'mistreatment' but that GPs first pragmatically treated the most likely diagnosis and kept an open mind that the skin lesion might be malignant. The new Dutch primary care and the UK guidelines recommend to directly refer high-risk KC (including all SCCs) and to take a biopsy from other suspected KC [9,10]. If implemented successfully, the increased use of histology will improve appropriate care and clear agreements on referral indications will decrease the surgical treatments of SCC in primary care.

Without proper training, clinical guidelines are insufficient to improve patient care [21]. Although skin-related complaints and referrals to dermatologists are high in primary care [22–24], it is worrisome that dermatology is not required at both the undergraduate and postgraduate training programs of GPs in many European countries [23,25,26]. In Australia, the GP may play a larger role in skin cancer management after receiving extra training and accreditation, so-called GPs with special interest. In the UK, services for the management of low-risk BCCs can be commissioned from accredited GPs with specialist dermatology training who participate in a regular histological accuracy audit [27]. GPs can play a pivotal role in the early detection, diagnosis and management of many skin cancers considering they have had sufficient formal training, time and resources available [28].

4.2. Follow-up of KC in primary care

The variable patterns of follow-up visits in primary care for suspicious cutaneous (pre)malignancies suggest that patients initiate GP visits. A single visit to evaluate treatment and provide instructions for self-examination should be sufficient. UK guidelines on KC also recommend self-examination or follow-up in primary care for primary adequately treated BCCs [10].

4.3. Diagnosis and treatment in secondary care

For BCC, a biopsy is recommended because histological growth patterns guide treatment decisions, unless it concerns a low-risk or multiple BCC. These guidelines seem to be followed because the biopsy rate among BCC (59–66%) was much higher than the proportion of high-risk BCC (17–36%).

The histological clearance rate of excisions was higher for BCC compared to SCC and similar to other studies [29–31]. The discrepancy between BCC and SCC might be explained by suboptimal preoperative margins for SCC, less guideline adherence concerning excision margins, more diagnostic excisions for SCC that are not followed by curative excisions and/or less use of micrographic Mohs surgery for SCC compared to BCC.

4.4. Follow-up in secondary care

Comparable to a preliminary study, patients with BCC received more follow-up than recommended, which is considered a low-value service [32]. Qualitative studies showed that abstaining of follow-up is a shared

responsibility by patients and physicians [33]. In a discrete choice experiment, Dutch patients were willing to receive less (or no) follow-up visits, if they are seen once by the same medical specialist after their treatment and received personalised information regarding their BCC diagnosis, treatment and risk on a subsequent BCC [34]. An intervention study is ongoing in order to determine if the implementation of this strategy leads to a decreased frequency of follow-up visits without reducing the quality of care [33].

In surprising contrast to BCC, patients with SCC received less follow-up than recommended. Although more than 80% of patients with SCC have stage I tumours of which only a very small fraction will develop metastasis [35], the Dutch and European guidelines recommend 5 years of follow-up for all patients with SCC [13,36]. The UK guidelines are less stringent and recommend to discharge low-risk patients with SCC after a single postoperative visit, where instructions for self-examination and prevention are provided, which seems in line with our observations.

4.5. Strengths and limitations

Strengths of this research are that it is the first attempt to assess healthcare utilisation of patients with KC across primary and secondary care in large population-based samples. Multiple databases and additional manual registrations were used to present a comprehensive overview. A limitation is that linkage between the primary and secondary care databases on an individual patient level was not possible. Another limitation is that the primary care database was intended for registration purposes and was not designed for this research. This may have led to missing information. For example, KC may have been included in the working or differential diagnosis, but when this was not registered by the GP, it could not be taken into account.

5. Conclusion

This descriptive study suggests that in primary care, the diagnostic pathway of KC can be improved and that in secondary care there is a need to adhere or reconsider follow-up recommendations. After both this observational research of routinely collected healthcare data and qualitative research including the views and opinions of physicians and patients [33], it is now time to design interventional studies to improve the efficiency of skin cancer care in primary and secondary care.

Conflict of interest statement

None of the authors report any conflict of interest.

Funding

This study was funded by the National Health Care Institute for the Project Sensible Care, the Netherlands, (Zorginstituut Nederland [ZiNL]) for patients with non-melanoma skin cancer and actinic keratosis.

Competing interest

None declared.

Ethical approval

This study was approved by the IPCI Scientific and Ethical Advisory Board (project 1/2016) and the NCR Scientific and Ethics Committee (project K16.029).

External funding

Yes.

Source of funding

National Health Care Institute Netherlands (Zorginstituut Nederland [ZiNL])

Name of the PI

Tamar Nijsten.

Author contributions

L.M.H., T.N. and M.W. helped in study concepts. L.M.H., T.N., M.W., and J.v.d.L. helped in study design. S.v.E. and M.L. helped in data acquisition and quality control of data and algorithms. L.M.H., S.v.E., M.L., J.v.d.L., P.B., T.N. and M.W. helped in data analysis and interpretation, manuscript editing and manuscript review. S.v.E., M.L. and L.M.H. helped in statistical analysis. L.M.H. helped in manuscript preparation.

Acknowledgements

The authors thank the National Health Care Institute Netherlands (Zorginstituut Nederland [ZiNL]) for the financial support of this study. They thank the staff of IPCI, PALGA and the NCR for the data collection. They further thank K. Ramdas for assisting with drafting the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejca.2019.05.010.

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