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ORIGINAL ARTICLE

Evaluation of a 3-year teledermoscopy project in primary healthcare centres in Belgium

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Abstract

Background: With the increasing incidence of skin cancer and limited access to specialised care, teledermoscopy (TDS) may represent a useful triage tool for skin cancer detection.

Objectives: An evaluation of a 3-year TDS project in primary healthcare centres (PHCs) in Belgium (TELESPOT project).

Methods: A total of nine PHCs were trained to use an in-house developed smartphone-based application for macroscopic and dermoscopic acquisition of skin lesions, subsequently analysed independently by two investigators in a tertiary university skin cancer centre. The primary outcome was the proportion of high-priority management (HPM) recommendations. Secondary outcomes included the TDS diagnoses, the quality of image acquisition, the mean time between HPM recommendations and subsequent surgery, the correlation between HPM reports and histopathology after surgery as well as patient and general practitioner satisfaction scores. All the endpoints were compared between the initial year of the TDS project and the subsequent 2-year extension period of the study.

Results: Over 3 years, a total of 478 lesions were analysed in 335 patients: initial phase (105 lesions from 76 patients in six PHCs) and extension phase (373 lesions from 259 patients in nine PHCs). An HPM was recommended in 9.2% (initial and extension phases: 7.6% and 15.7%, respectively). The dermoscopic-histological correlation achieved 84.1%. The median delay between HPM and surgery was 9 days.

Conclusions: This TDS project avoided unnecessary tertiary care visits in about 9 out of 10 cases, increased the HPM by a ninefold in comparison with the conventional care pathway and provided excellent satisfaction levels for PHCs and patients. Long-term participation improved the triage quality for suspect skin lesions by 2.24-fold.

KEYWORDS
melanoma, non-melanoma skin cancer, primary health care, public health, skin cancer, teledermatology, teledermoscopy

INTRODUCTION

The incidence of melanoma (MM) and non-melanoma skin cancer (NMSC) is steadily rising over years,[1–3] and leads to an increased workload for first-line healthcare professionals (FHPs) and dermatologists.[4] Furthermore, the dearth of dermatologists and long waiting times hamper rapid diagnosis and management, with potentially worse prognoses.[4] Triage in primary healthcare centres (PHCs) could be useful, but FHPs often lack faith in their clinical diagnoses.[4] Teledermoscopy (TDS), defined as dermatoscopic images that are analysed at distance using telecommunication technologies, may help to distinguish skin lesions and speed up the management of suspicious lesions.[5] Finally, in terms of public health, early diagnosis followed by appropriate management remains the cornerstone of reduced skin cancer morbidity and mortality.[6]

In 2019, a pilot TDS project (TELESPOT (TELEdermoscopy Smartphone-based Pigmented lesion diagnosis Online Taskforce) was conducted in six PHCs for a 1-year test period in the French-speaking part of Belgium.[7] In contrast to previous dermoscopy studies, the development of our system was based on open-source applications and programs. The main advantages of open-source development are flexibility, sustainability, security and reduced costs.[8] Our application was principally focused on distinguishing benign versus malignant lesions and on prioritising clinical management. After 1 year, the impact on skin cancer care of our TDS referral system was highly appreciated in all PHCs, in good agreement with results from previous reports. Patient and HCP satisfaction rates were not assessed in those studies.[8]

This article resumes the results of the final evaluation of the TELESPOT project after a period of 3 years.

MATERIALS AND METHODS

Ethics

This study was performed in accordance with the Helsinki Convention on Human Rights. The ethics committee and the university hospital legal department approved the project. The patients were informed about all the procedures and all signed the informed consent forms, and authorised the electronic transfer of clinical data and images (Ethics Committee of the CHU, Sart Tilman (707), Avenue de l'Hôpital, Liège, B-4000, Belgium).

Description of the patient care pathway

The PHCs were trained to use the in-house developed system and associated smartphone application. An on-site basic training course reviewed the clinical and dermoscopic appearances of the major benign and malignant skin lesions.[7,8] Once a lesion was considered as suspect, macroscopic and dermoscopic images were acquired and sent for evaluation to a tertiary skin cancer centre (TSCC), rendering within 48 h a recommendation for a low- or high-priority management (LPM or HPM; Figure 1).

Demographics

The following demographic data were recorded for each patient; age and gender, phototype, indoor versus outdoor profession and a personal and familial history of prior skin cancer. The TSCC report included a final diagnosis based on the demographic, macroscopic and dermoscopic images as well as a recommendation for LPM or HPM.

The initial period (phase 1) included acquisitions from six PHCs performed between September 2019 and August 2020. The extension period (phase 2) included data from the six initial PHCs and from three additional PHCs gathered between September 2020 and August 2022.

PHCs were considered as close (<20 km) or distant (≥20 km) to the TSCC and as medium size (<10 general practitioners [GPs]) or large (≥10 GPs). The mean age of the GPs, single or multiple TELESPOT users per PHC and the number of additional teaching visits to the PHCs were recorded.

Outcomes

Comparisons of endpoints were performed between different periods: group 1 = 6 initial PHCs in phase 1,

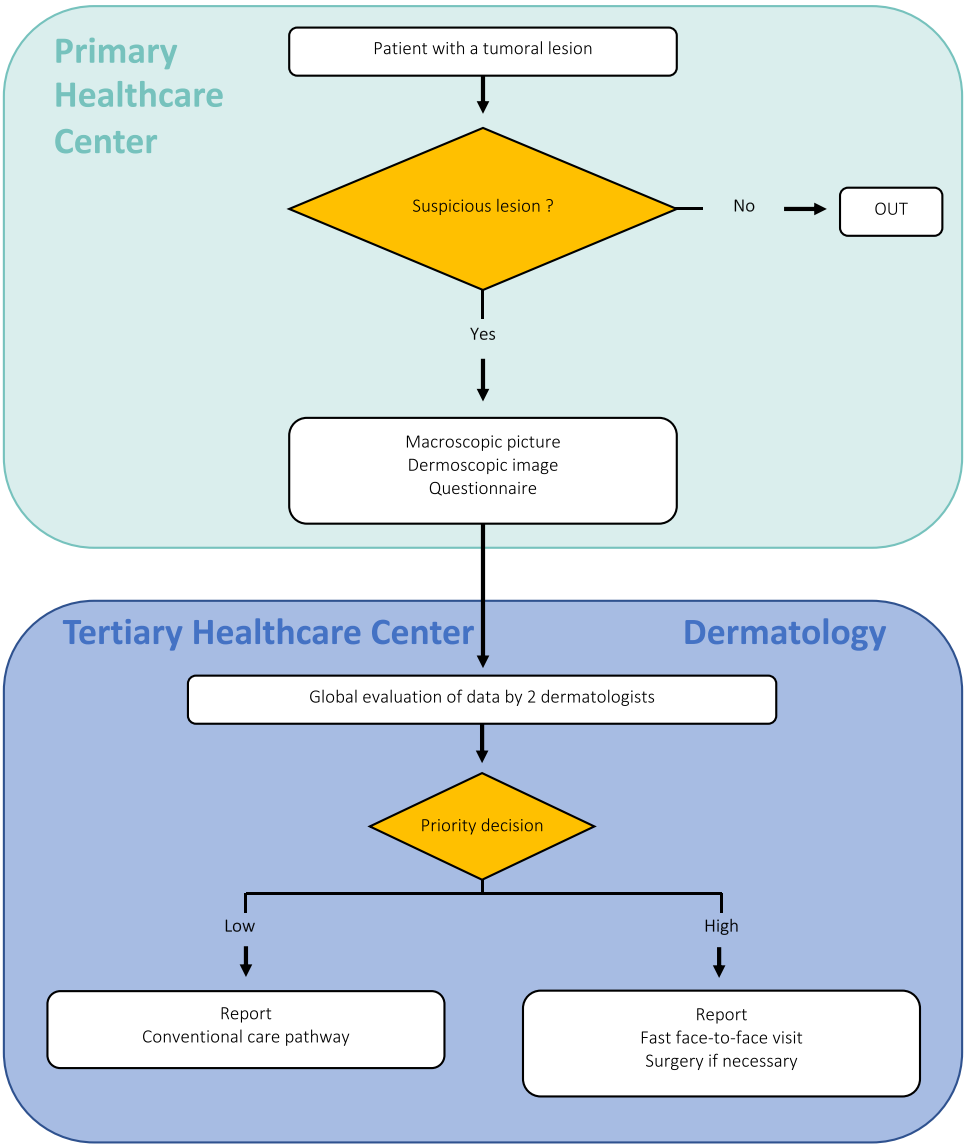

FIGURE 1 Detailed TELESPOT pathway (see: Ref 8).

group 2 = 6 initial PHCs in phase 2, group 3 = 3 additional PHCs in phase 2 and group 4 = all 9 PHCs in phase 2.

The primary outcome was the number of LPM versus HPM recommendations between the four groups.

Secondary outcomes included the percentages of malignant skin lesions among all the recorded lesions, the quality of the acquisition (evaluable or not-evaluable), the mean time between the TSCC report and the surgery for HPM lesions in comparison with a conventional in-house care pathway (mean: 81 days), the correlation between the TSCC report for HPM lesions and their histopathological diagnosis, the localisation of the all the acquired lesions, the duration between the patient's awareness of the lesion and the actual acquisition in the PHC, the number of acquisitions by PHC per season, as well as the patient and GP satisfaction scores, as previously defined. Wherever relevant, the secondary outcomes were compared between the four groups.

Statistical methods

Results are presented as means and standard deviation (SD), quartiles (medians, Q1–Q3) and range (minimum–maximum) for quantitative variables and as frequency tables for qualitative variables. Descriptive statistics as well as comparison between diagnosis and histopathology for HPM lesions are provided on all lesions, in each phase and in each type of PHC in phase 2. The outcomes, that is, nature of the lesion, priority management, repetition and degree of certainty, were analysed

by a repeated logistic model (genmod) accounting for the fact that some PHCs are included in both phases. In the model, the type of PHC (initial PHCs or additional PHCs) and the study phase were considered as fixed effects and PHC as a random effect. Results are considered significant at the 5% uncertainty level ($p < 0.05$). Analyses were performed using the SAS version 9.4.

RESULTS

Patient demographics

Out of the 335 patients, 56.4% were female (mean age: 50.5 years, min: 2, max: 94 years). The median phototype was 3 (min: 1, max: 6). A minority of patients had an outdoor profession (7.8%). A personal history of prior skin cancer was noted in 3% of the patients. Table 1 illustrates the patient demographics according to the four groups.

PHC demographics

In phase 1, all the six enroled PHCs were close to the TSCC and four of the six were considered as large size PHCs. In phase 2, the three additional PHCs were distant to the TSCC and all were considered as medium size PHCs. Individual data of the PHCs are presented in Table 2.

Primary outcome

HPM was recommended in 9.2% of the 478 analysed lesions, corresponding to 13.1% of the total cohort of 335 patients. Table 3 details the comparison of triage among the four groups. The logistic regression model (genmod) with PHC as random effect and, study phase and type of PHC as fixed effects, shows that the probability of classifying a lesion as HPM is lower for additional PHCs ($p = 0.023$). This probability tends to be higher in phase 2 than in phase 1 but not significant ($p = 0.057$; Table 3).

TABLE 1 Demographic data of 335 participation patients.

		Phase 1 Initial PHCs		Phase 2 Initial PHCs		Phase 2 Additional PHCs		Phase 2 All PHCs	
Variable	**Categories**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**
Sex		77		84		176		259	
	Female		52 (67.5)		45 (53.6)		92 (52.3)		137 (52.9)
	Male		25 (32.5)		39 (46.4)		84 (47.7)		122 (47.1)
Phototype		77		84		176		259	
	1		3 (3.9)		3 (3.6)		2 (1.1)		5 (1.9)
	2		30 (39.0)		33 (39.3)		63 (35.8)		96 (37.1)
	3		22 (28.6)		24 (28.6)		102 (58.0)		125 (48.3)
	4		19 (24.7)		21 (25.0)		8 (4.5)		29 (11.2)
	5		1 (1.3)		2 (2.4)		1 (0.6)		3 (1.2)
	6		2 (2.6)		1 (1.2)		0 (0.0)		1 (0.4)
Profession		77		84		176		259	
	Indoor		69 (89.6)		77 (91.7)		165 (93.8)		241 (93.1)
	Outdoor		8 (10.4)		7 (8.3)		11 (6.3)		18 (6.9)
Personal history		77		84		176		259	
	No		75 (97.4)		80 (95.2)		172 (97.7)		251 (96.9)
	Yes		2 (2.6)		4 (4.8)		4 (2.3)		8 (3.1)
Familial history		77		84		176		259	
	No		76 (98.7)		76 (90.5)		169 (96.0)		244 (94.2)
	Yes		1 (1.3)		8 (9.5)		7 (4.0)		15 (5.8)

Abbreviation: PHC, primary healthcare centre.

TABLE 2 PHCs demographic data.

	PHC 1	PHC 2	PHC 3	PHC 4	PHC 5	PHC 6	PHC 7	PHC 8	PHC 9
Distance to tertiary centre (km)	15	13	11	11	10	5	115	113	129
Number of GPs	12	4	12	9	13	35	6	7	5
Mean age of GP (years)	43.3	38.7	45.4	41.6	44.3	48.2	44.8	40.9	37.8
User mode	Multiple	Single	Multiple	Multiple	Multiple	Single	Single	Multiple	Multiple
Additional investigator visits	3	2	1	1	1	2	1	0	0

Abbreviations: GP, general practitioner, km, kilometre; PHC, primary healthcare centre.

TABLE 3 Distribution of HPM versus LPM lesions.

	All lesions		Phase 1 Initial PHCs		Phase 2 Initial PHCs		Phase 2 Additional PHCs		Phase 2 All PHCs	
Variable	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**
Management priority	478		105		115		258		373	
Low		434 (90.8)		97 (92.4)		97 (84.3)		240 (93.0)		337 (90.3)
High		44 (9.2)		8 (7.6)		18 (15.7)		18 (7.0)		36 (9.7)

Note: probability of classifying a lesion as HPM is lower for additional PHCs ($p = 0.023$). This probability tends to be higher in phase 2 than in phase 1 but not significant ($p = 0.057$).

Abbreviations: HPM, high-priority management; LPM, low-priority management; PHC, primary healthcare centre,

Secondary outcomes

Of the 478 TSCC analysed lesions, 84.6% were classified as benign, 3.7% as uncertain and 11.7% as malignant. Table 4 details the comparisons between the four groups. The logistic regression model (genmod) with PHC as random effect and, study phase and type of PHC as fixed effects, reveals that the probability of classifying the lesion as malignant is not related to the type of site (initial PHCs or additional PHCs; $p = 0.64$) nor to the phase ($p = 0.071$) but there is a tendency. Indeed, the probability tends to be higher in phase 2 than in phase 1.

In global, 1.9% of the acquisitions were judged as non-evaluable and repetition of image acquisition was required. Table 5 details the comparison in the four groups. The logistic regression model (genmod) with PHC as random effect and, study phase and type of PHC as fixed effects, shows that the probability of a repeated acquisition is not related to the type of site ($p = 0.14$) nor to the phase ($p = 0.20$).

For the 44 HPM lesions, the mean interval between the TSCC report and surgery was 9 days.

Among the suggested TSCC diagnosis of the 44 HPM lesions, 37 (84.1%) were confirmed by histopathology. The TSCC proposed diagnoses of NMSC were all

TABLE 4 Distribution of benign, malignant and uncertain classification.

	All lesions		Phase 1 Initial PHCs		Phase 2 Initial PHCs		Phase 2 Additional PHCs		Phase 2 All PHCs	
Variable	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**
Nature of the lesion	478		105		115		258		373	
Benign		405 (84.7)		91 (86.7)		92 (80.0)		222 (86.0)		314 (84.2)
Uncertain		18 (3.8)		6 (5.7)		7 (6.1)		5 (1.9)		12 (3.2)
Malignant		55 (11.5)		8 (7.6)		16 (13.9)		31 (12.0)		47 (12.6)
Benign+Uncertain		423 (88.5)		83 (92.4)		99 (86.1)		227 (88.0)		326 (87.4)
Malignant		55 (11.5)		8 (7.6)		16 (13.9)		31 (12.0)		47 (12.6)

Abbreviation: PHC, primary healthcare centre.

TABLE 5 Distribution of repetition.

	All lesions		Phase 1 Initial PHCs		Phase 2 Initial PHCs		Phase 2 Additional PHCs		Phase 2 All PHCs	
Variable	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**	***N***	**Number (%)**
Repetition	478		105		115		258		373	
No		468 (97.9)		102 (97.1)		114 (99.1)		252 (97.7)		366 (98.1)
Yes		10 (2.1)		3 (2.9)		1 (0.9)		6 (2.3)		7 (1.9)

Abbreviation: PHC, primary healthcare centre.

confirmed by histopathology. Among the melanocytic lesions highly suspected of malignancy, 11 of the 18 (61.1%) were diagnosed as melanoma (6 in situ MM, 4 superficial spreading MM and 1 malignant lentigo). The positive predictive value of the TSCC report for HPM lesions was 83.3% (95% confidence interval: 68.6%–93.0%).

The anatomical distribution of all the lesions was as follows: head and neck ($n = 102$; 21.3%), trunk ($n = 102$; 21.3%), upper limbs ($n = 81$; 16.9%), lower limbs ($n = 54$; 11.3%) and genital area ($n = 4$; 0.8%).

The distribution of the interval between the patient's awareness of the lesion and the actual acquisition were: <1 month ($n = 53$; 11.1%), 1–3 months ($n = 73$; 15.3%), 3–6 months ($n = 46$; 9.6%), 6–12 months ($n = 75$; 15.7%) and >12 months ($n = 231$; 48.3%). The proportion of HPM lesions among these intervals were 9.4%, 10.3%, 11.6%, 11.7% and 6.5%, respectively.

TABLE 6 Detailed GP and patient satisfaction scores.

GP satisfaction scores	**Phase 1 ($n = 6$)**	**Phase 2 ($n = 20$)**
The project easily fits into daily practice	8.6	8.9
The acquisition technique is not very time-consuming	9.4	9.6
Satisfaction with the report and advice	9.6	9.5
The project accelerates diagnosis of suspicious skin lesions in my patients	9.0	9.1
The project represents a health benefit for my patients	8.8	8.8
Involvement in skin cancer screening	8.6	8.8
Improving diagnostic competencies in distinguishing benign versus malignant skin lesions	6.8	7.1
More eager to do a complete skin check-up	7.6	7.2
The project adds value to PHC	9.2	8.3
Global satisfaction with the project	9.4	9.7
Patient satisfaction scores	**Phase 1 ($n = 19$)**	**Phase 2 ($n = 64$)**
Comfort with procedure	9.4	9.5
Confidence about this new technology	8.6	8.7
Trust in specialised advice	8.2	8.1
Willingness to repeat the experience	8.8	9.0
Global satisfaction with the project	8.8	8.9

Abbreviations: GP, general practitioner; PHC, primary healthcare centre.

The seasonal distribution of acquisitions was as follows: spring: 39.5%, summer: 27.6%, autumn: 13% and winter: 19.9%.

The global satisfaction score of GPs was 9.4/10 for the initial period and 9.7/10 for the extension period. The global satisfaction score of the patients was 8.8/10 and 8.9/10, respectively (Table 6).

DISCUSSION

The pilot phase of the TELESPOT project showed that this TDS system in PHCs represented a useful triage tool for suspicious skin lesions and permitted to adequately prioritise care management.[8] The extension phase consolidated the anterior results in a larger cohort and longer evaluation period.

In total, an HPM was recommended in 9.2% of the cases. The proportion of HPM was 7.6% during phase 1 versus 9.7% in phase 2. This could indicate a trend towards an improved triage in the PHCs, but this increase was not statistically significant. However, when evaluating the 6 PHCs who participated in both periods, there was a statistically significant improvement in triage (phase 2: 15.7% vs. phase 1: 7.0%: ratio = 2.24). Hence, the PHCs became more performant over time in discriminating the skin lesions.

These results are probably due to at least two factors: The 3-year participation in this project forced the GP to show interest in this type of lesions, probably improving his diagnostic capacities. Furthermore, the feedback of the diagnosis from the tertiary centre, however, without providing the GP with a dermoscopic description of the lesion, also helped them to improve their diagnostic skills. This is probably a type of cognitive intuitive learning process.

The clinical and/or dermoscopic images were judged as non-evaluable in 1.9% of the cases and a second acquisition of the lesion was required. This value lies between two other similar studies, reporting 0.4%[9] and 9.5% as non-evaluable.[10] There was no significant difference in percentages between the three additional PHCs compared to the 6 initial PHCs.

The mean interval between an HPM TSCC report and a visit (and surgery if needed) was 9 days, nine times faster in comparison with the conventional care pathway (median waiting time for a dermatology visit in Belgium: 81 days). This highly significant acceleration of management underlines the efficiency of the TDS system in the fight against skin cancer.

Out of all the lesions recommended for HPM, 84.1% were histopathologically confirmed. All lesions classified as NMSC were histopathologically confirmed. Among the melanocytic lesions highly suspected of malignancy, 61.1% were histopathologically confirmed as MM with more than half (54.5%) as in situ MM. This fact could be explained by the sole participation in the project, increasing awareness, and maybe also by speeding up the delay between the diagnostic suspicion and the factual surgery. However, larger series and longer observations will be required to validate or not this fact. MM represented 2.3% of all analysed lesions and 25% of all the HPM lesions. These data are comparable to other studies.[10] The seven melanocytic lesions clinically and dermatoscopically highly suspected of malignancy comprised, two Spitz nevi, one dysplastic naevus, two congenital nevi, one benign naevus and one seborrhoeic keratosis, as assessed by histology subsequently. Globally, the positive predictive value of the TSCC report for HPM lesions was 83.3% (95% confidence interval: 68.6%–93.0%).

In both periods, it was challenging to observe that 48.3% of the lesions sent in for advice were present for more than 12 months. Only 26.4% were present less than 3 months. No comparable data were available in the other studies.[9,10] This indicates that one out of two individuals are still not aware of the risks of skin cancer and that the sooner the diagnosis is made, the better the prognosis is. In contrast, the message about the link between sun exposure and skin cancer seems better known. Indeed, more than two out of three lesions were acquired during the spring and summer months.[11,12]

The GP and patient satisfaction scores were excellent and maintained stable between phases 1 and 2. These results are well in line with other studies reporting GPs and/or patient satisfaction levels.[13–15] The TDS system confirms its general usefulness, easy implementation and user-friendliness.

The main limitation of a TDS system still remains the initial triage in PHCs. Rare clinical presentations such as amelanotic melanoma are still easily missed.[16] A recent retrospective study compared the initial self-reported referral decisions of GPs before TDS system versus their final self-reported referral decisions after TDS system for skin lesions diagnosed by the teledermatologist (TD) as (pre)malignant or benign.[17] In half of the TDS consultations, GPs adjusted their initial referral decision after TD advice and TD diagnosis. Initially, GPs did not have the intention to refer 56.8% of patients with a malignant TDS diagnosis and 16.0% of patients with a premalignant TD diagnosis but then decided to refer these patients after the TDS consultation.[17] Moreover, GPs adjusted their decision from referral to nonreferral in 74.9% of benign skin lesions.[17]

Another limitation in the evaluation of the TELESPOT project was to not include a control visit for LPM

lesions. However, the high sensitivity and specificity rates of TDS systems were already demonstrated.[4,18] These studies showed no significant difference in sensitivity between in vivo consultations versus TDS referrals, especially in distinguishing a benign versus malignant lesion[18]: the diagnostic accuracy for a primary diagnosis and benign versus malignant triage with TDS were 58.2% (95% CI, 52.3–63.9) and 80.1% (95% CI, 75.0–84.5), respectively. The TELESPOT design better reflects the final aim of TDS in real-life healthcare conditions: reducing unnecessary in vivo visits and accelerating the management of suspicious lesions. A final limitation could be that a TDS system is not fitted for a total body skin examination.[19]

In conclusion, this long-term evaluation indicates the added value of this TDS for PHCs, delivering a high GP and patient satisfaction, an efficient tool for an accelerated management of a suspect lesion and an effective triage as well as avoiding unnecessary patient travel and specialised care visits. In addition, this evaluation showed that long-term participation resulted in a 2.24-fold improved triage quality of the PHCs.

An eventual implementation in national healthcare systems of this kind of project will depend on a series of legal, medical, professional and technical regulations.

AUTHOR CONTRIBUTIONS

All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, taking responsibility for the integrity of the work as a whole, and have all given their final approval for this version to be published. Thomas Damsin and Arjen F. Nikkels both provided significant contributions to the conception and design, the analysis and interpretation of the data and the drafting of the final article and revising it critically for important intellectual content, and the final approval of the version to be published. Gregory Canivet, Pauline Jacquemin, Laurence Seidel, Gilles Absil, Didier Giet and Pierre Gillet critically revised the intellectual content and approved the final version to be published.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data generated or analysed during this study are included in this published article as Supporting Information files.

ETHICS STATEMENT

This study was performed in accordance with the Helsinki Convention on Human Rights. The ethics committee and the university hospital legal department approved the project. All patients in this manuscript have given written informed consent for participation in the study and the use of their deidentified, anonymized, aggregated data and their case details for publication.

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