DOI: 10.1111/jdv.14267 JEADV

ORIGINAL ARTICLE

A proposed scoring system for assessing the severity of actinic keratosis on the head: actinic keratosis area and severity index

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Abstract

Background Actinic keratosis (AK) severity is currently evaluated by subjective assessment of patients.

Objectives To develop and perform an initial pilot validation of a new easy-to-use quantitative tool for assessing AK severity on the head.

Methods The actinic keratosis area and severity index (AKASI) for the head was developed based on a review of other severity scoring systems in dermatology, in particular the psoriasis area and severity index (PASI). Initial validation was performed by 13 physicians assessing AK severity in 18 AK patients and two controls using a physician global assessment (PGA) and AKASI. To determine an AKASI score, the head was divided into four regions (scalp, forehead, left/right cheek ear, chin and nose). In each region, the percentage of the area affected by AKs was estimated, and the severities of three clinical signs of AK were assessed: distribution, erythema and thickness.

Results There was a strong correlation between AKASI and PGA scores (Pearson correlation coefficient: 0.86). AKASI was able to discriminate between different PGA categories: mean (SD) AKASI increased from 2.88 (1.18) for 'light' to 5.33 (1.48) for 'moderate', 8.28 (1.89) for 'severe', and 8.73 (3.03) for 'very severe' PGA classification. The coefficient of variation for AKASI scores was low and relatively constant across all PGA categories.

Conclusions Actinic keratosis area and severity index is proposed as a new quantitative tool for assessing AK severity on the head. It may be useful in the future evaluation of new AK treatments in clinical studies and the management of AK in daily practice.

Received: 23 December 2016; Accepted: 16 February 2017

Conflicts of interest

TD: Lecture fees for Almirall, Biofrontera, Galderma, Leo, Meda, Riemser, Janssen; member of advisory boards for Almirall, Biofrontera, Leo, Meda, Novartis, Riemser, Janssen; unrestricted grant from Meda; GG: Lecture fees from Almirall, Leo, Meda and Novartis; member of advisory boards for Leo and Meda; GM: None; JM: Lecture fees for Almirall, Leo, Meda, ISDIN, Novartis; member of advisory boards for Almirall, Leo, Meda, MSD, Roche, BMS; AS: Lecture fees for Leo, Meda; member of advisory boards for Novartis, Roche, Janssen; AC: None; LS: Lecture fees for Meda, Biofrontera, Galderma, Riemser; GP: Research grant from Meda and Leo; member of advisory boards for Roche, Galderma.

Funding sources

This work was funded by Centroderm GmbH.

*Shared first co-authors who made an equal contribution to the manuscript.

Introduction

Actinic keratosis (AK) is a chronic and recurrent disease caused by long-term sun exposure, which is commonly seen in everyday dermatological practice.[1,2] The prevalence of AK increases with age and is generally higher in men than women.[3] Epidemiological studies have indicated that 40–60% of Australian adults and up to 38% of European adults have AK, and that the prevalence of the disease is rising.[3,4] AKs are regarded as early *in situ* squamous cell carcinoma (SCC).[5] They may progress into invasive SCC via progressive and sequential stages of keratinocyte intraepidermal neoplasia, with more recent evidence showing that AK I lesions are most commonly associated with invasive SCC, suggesting that early AK lesions may also directly transform into invasive disease.[6] The risk of developing SCC rises with an increasing number of AK lesions.[7] As it is not possible to predict when and which AK lesions will transform into invasive SCC, and given that the entire area of sun-exposed skin is affected by both clinical and subclinical disease resulting in field cancerization, current treatment guidelines from the European Dermatology Forum and International League of Dermatological Societies advocate the need to treat all AK lesions and the entire affected field.[8]

The severity of individual clinical AK lesions is commonly graded using clinical and histological classification systems. The clinical classification system of Olsen *et al.*[9] grades AK lesions according to their overall thickness. The histological classification system of Röwert-Huber *et al.*[10] requires a biopsy and assesses lesions according to the extent of atypical keratinocytes in the epidermis. The main limitation of these scoring systems is that they only assess the severity of individual lesions and do not take into consideration the entire area affected by AK. In addition, these scores do not give any information on the risk of AK lesions progressing to invasive SCC. Furthermore, it has recently been shown that these clinical and histological classification systems do not match, with over one-third of lesions clinically classified as very thick and hyperkeratotic (Olsen grade 3) being shown histologically to be mild lesions with atypical keratinocytes limited to the lower third of the epidermis (i.e. AK I).[11]

Clinical studies of new AK therapies typically evaluate their efficacy based on AK lesion counts before and after treatment.[12] The principal limitation of this approach is that in many cases AK lesions do not exist as discrete entities, but may rather coalesce across the affected field making it difficult, even for expert dermatologists, to accurately assess AK lesion numbers.[13]

A new scoring system to quantitatively evaluate the severity of AK across an entire affected area is therefore required. An AK severity scoring system could be used to define treatment goals, to evaluate the efficacy of new AK therapies and to compare the efficacy of different treatments across different clinical studies. The scoring system could also be used to assess the severity of AK in patients seen in the clinical setting, with cut-off thresholds being used to evaluate when to refer patients to specialists. An overall AK severity evaluation could also be used to tailor the support provided to AK patients based on their individual disease needs and circumstances, and to determine whether a treatment has been of benefit or not. Consequently, the aim of this work was to develop and provide an initial pilot validation of a simple, quick and easy-to-use AK area and severity scoring system for potential use both in clinical studies and in clinical practice.

Materials and methods

Development of actinic keratosis area and severity index (AKASI) for the head

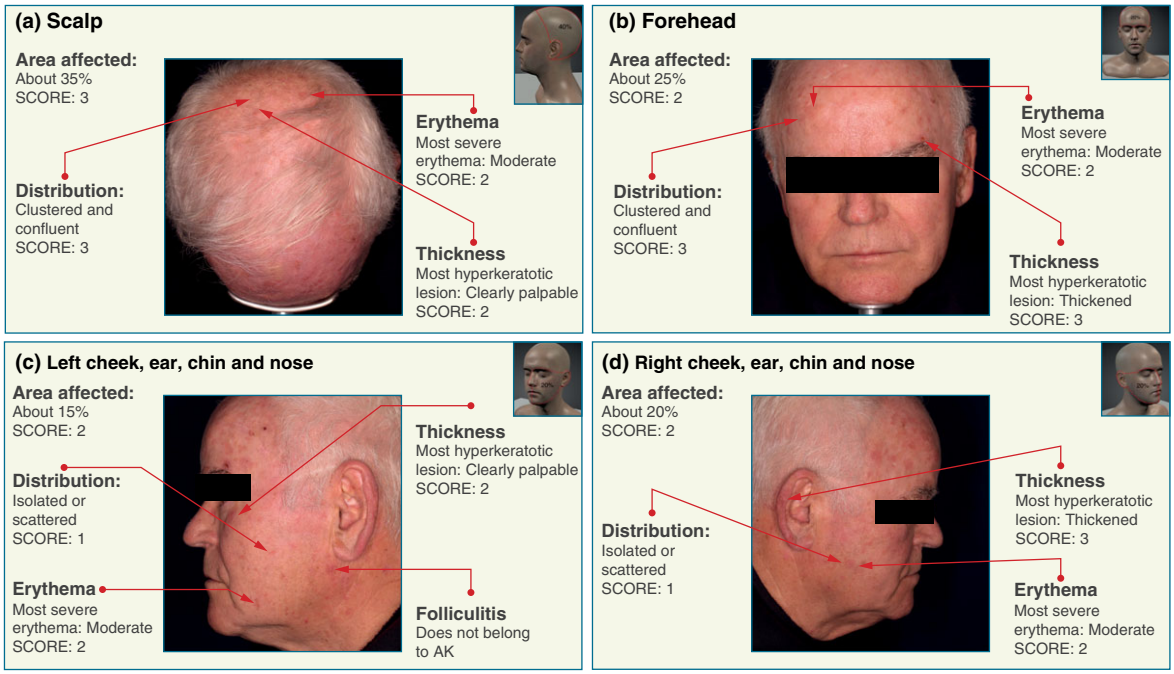
Actinic keratosis area and severity index was developed based on a review of other severity scoring systems in dermatology (e.g. atopic dermatitis,[14] acne,[15,16] psoriasis,[17] vitiligo,[18–20] scleroderma,[21] pemphigus vulgaris,[22] melasma,[23] uriticaria[24]). The authors identified the common characteristics of these scoring systems which typically evaluate the extent of disease, the intensity or morphology of lesions, subjective symptoms and other disease-related factors. Based on this review, the authors considered that the psoriasis area and severity index (PASI) was most suitable for adapting to assess AK severity. PASI takes into account both the extent of disease and the severity of three clinical signs: erythema, induration and desquamation.[17] To develop AKASI, consideration was given to the key factors involved in the clinical presentation of AK that could be used to differentiate between disease severities.

Briefly, for the calculation of an AKASI score (Table 1), the head was divided into four areas, and each region was given a weighting based on its approximate relative size as follows: scalp 40%; forehead 20%; left cheek, ear, chin and nose 20%; right cheek, ear, chin and nose 20%. Each 20% area referred approximately to the size of one open hand. For each region, the percentage of the area affected by AKs (perceived as field cancerization by sight and using touch to feel the skin) was estimated and a numerical value of 0–6 assigned. Then, the severities of three clinical signs of AK (distribution, erythema and thickness) were assessed on a scale from 0 (none) to 4 (maximum), as detailed in Table 1. An AKASI subscore was calculated for each of the four areas of the head, which were then added together to give a total AKASI score for the entire head. Total scores ranged from 0 (no AK) to 18 (AK of the severest possible degree). SCCs, seborrheic keratosis and solar lentigo were not included in the AKASI evaluation. An example of an AKASI calculation is shown in Fig. 1.

Table 1 Actinic keratosis area and severity index (AKASI): Definitions and coefficients/scores for calculation

Head area	**Description**	**Coefficient**
Scalp	Upper part of the forehead, from the detectable/supposed hair-line, parietal and occipital areas = 40% of the total area	×0.4
Forehead	Forehead = 20% of the total area	×0.2
Left face	Including cheek, ear, chin and nose = 20% of the total area	×0.2
Right face	Including cheek, ear, chin and nose = 20% of the total area	×0.2
Area extent		
Parameter	**Description**	**Score**
Extent of sun-damaged skin	Evaluation of sun-damage extent, considering skin alteration characteristic of field cancerization Squamous cell carcinoma, seborrheic keratosis, solar lentigo are excluded	0% = 0 1–9% = 1 10–29% = 2 30–49% = 3 50–69% = 4 70–89% = 5 90–100% = 6
Aspects of AK		
Parameter	**Description**	**Score**
Distribution	***None*** No clinical AKs	0
	Isolated or scattered Isolated or scattered AKs surrounded by apparently normal-looking skin	1
	Clustered Several isolated AKs confined to small clusters up to 25 cm^2	2
	Clustered and confluent AKs insider the cluster (up to 25 cm^2) are coalescing	3
	All confluent Lesions coalescing and not clearly distinguishable across large sun-affected area	4
Erythema†	***None*** No erythema	0
	Slight Light red	1
	Moderate Red, but not deep red	2
	Intense Very red	3
	Very intense Extremely red	4
Thickness‡	***No palpability*** Not detectable by touch	0
	Just palpable Just noticeable by touch	1
	Clearly palpable Easy to detect by touch	2
	Thickened Thick and hyperkeratotic	3
	Very thickened Very thick and hyperkeratotic	4

†Only evaluate erythema related to AK; exclude erythema related to other dermatological conditions such as rosacea or from ongoing AK treatment.
‡Evaluated based on touch.
The head is divided into four areas: scalp, forehead, left and right face. For each region, the percentage of the area affected by sun-damage is estimated, and a score is assigned accordingly; and the distribution of AKs, the intensity of erythema and thickness of the worst visible AK in that area are considered. The sum of AK aspect scores is added to the Area Index and multiplied by the Area Coefficient to obtain a subscore for each area of the head. The sum of the four subscores corresponds to the AKASI (which ranges from 0, no lesion/no sun-damage, to 18, vast sun-damage and severe lesions).



(e) Schematic form - Total score calculation

Area	0%	1-9%	10-29%	30-49%	50-69%	70-89%	90-100%
Score	0	1	2	3	4	5	6

Intensity	Absent	Mild	Moderate	Severe	Very severe
Distribution	None	Isolated or scattered	Clustered	Clustered and confluent	All confluent
Erythema	None	Slight	Moderate	Intense	Very intense
Thickness	No palpability	Just palpable	Clearly palpable	Thickened	Very thickened
Score	**0**	**1**	**2**	**3**	**4**

Score	Scalp	Forehead	Left cheek, ear, chin and nose	Right cheek, ear, chin and nose
D (Distribution)	3	3	1	1
E (Erythema)	2	2	2	2
T (Thickness)	2	3	2	3
Sum of D+ E + T	**7**	**8**	**5**	**6**
% of affected area	35%	25%	15%	20%
Area score	**3**	**2**	**2**	**2**
Subtotal (Sum of D + E T + Area score)	**10**	**10**	**7**	**8**
Area coefficient	x 0.4	x 0.2	x 0.2	x 0.2
Total score	**4.0**	**2.0**	**1.4**	**1.6**
Total AKASI	**9.0**			

Total score range from 0 to 18.

Figure 1 Example patient illustrating the use of AKASI. Clinical photographs of (a) the scalp; (b) forehead; (c) left cheek, ear, chin and nose; (d) right cheek, ear, chin & nose; and (e) completed AKASI. [Correction added on 09 June 2017 after online publication: In section (e), the value for T (Thickness) under "Right cheek, ear, chin and nose" column was previously incorrect and has been corrected in this version]

Pilot validation study

Patients and controls Patients with a clinical diagnosis of AK were randomly selected from the outpatient service of a referral centre for skin disease (Andreas Sygros Hospital, Athens, Greece) over a period of 2 weeks prior to the evaluation day. Patients were eligible for inclusion if they had any AK on their head (face, scalp and ears), regardless of prior treatment.

Control subjects without AK were also recruited from the same outpatient service.

Physicians The physicians who participated in this study were the authors of this manuscript as well as additional physicians recruited from the Athens region. The latter physicians had to be board-certified dermatologists, could work in a hospital or office setting, and included physicians with different expertise in managing patients with AKs.

Study design and evaluations The key objectives of the pilot validation study were to evaluate the correlation of AKASI with a physician global assessment (PGA) of AK, and to determine whether PGA categories can be differentiated by ranges of AKASI scores. The validation study was held at Andreas Sygros Hospital Athens, Greece on 21 May 2016. Ethics approval for the study was obtained from the Scientific and Ethics Committee of Andreas Sygros Hospital.

An initial 30-min training on AKASI was provided by TD, and the physician participants were provided with a handout containing detailed instructions on AKASI (Supporting Information). Patients were assigned to separate examination rooms in the hospital. Physicians were randomly assigned to a starting room and proceeded to examine the individual patients in a predefined room-to-room sequence. The physicians marked case report forms for the PGA score using the following categories: 'None', 'Light', 'Moderate', 'Severe' and 'Very severe'. The same case report forms were used to record scores for each of the components of AKASI.

Statistical analyses

The correlation between AKASI and PGA was evaluated by Pearson correlation coefficient. Correlations between AKASI area subscores and AKASI component subscores with PGA were also calculated. The relationship between AKASI and PGA scores was further explored by plotting AKASI values against each PGA category from each data set and by determining the respective AKASI distribution parameters (mean, median, 0.1 quantile, 0.9 quantile). Means, standard deviations and coefficients of variation for PGA and AKASI were calculated for each patient to examine interrater variation. Statistical analyses were carried out using MS-Access and MS-Excel.

Results

Patients and physicians

Eighteen AK patients [mean age (range): 73 years (60–80); 10 men and eight women] and two controls without AK (62-year-old man and 70-year-old woman) participated in this study. The mean (SD) PGA score was 0.08 (0.27) for the controls and 1.74 (0.80) for the patients. The mean (SD) AKASI score was 0.11 (0.38) for the controls and 4.75 (2.51) for the patients.

In total, 13 physicians participated in this study, including the six authors and seven dermatologists from Athens.

Correlation of AKASI with PGA

The Pearson correlation coefficient for all physicians between AKASI and PGA (0.86) indicates that these measures of AK severity were strongly correlated (Tables 2 and 3). Of the individual areas of the head, the correlation between AKASI and PGA was greatest for the forehead (Pearson correlation coefficient: 0.72) and lowest for the scalp (0.49; Table 2). There was a strong relationship between all of the individual components of AKASI and PGA (distribution: 0.79; erythema: 0.84; thickness: 0.84; area score: 0.79; Table 3). AKASI subscores for the individual areas of the head were only weakly correlated with each other (Pearson correlation coefficient: 0.16–0.55), whereas the correlation between the individual component subscores was higher (0.73–0.86).

As shown in Fig. 2, AKASI was clearly able to discriminate between different PGA categories. The mean (SD) AKASI increased from 2.88 (1.18) for a PGA classification of 'light' to 5.33 (1.48) for a PGA classification of 'moderate', 8.28 (1.89) for a PGA classification of 'severe', and 8.73 (3.03) for a PGA classification of 'very severe'. The coefficient of variation for AKASI scores was low and relatively constant across all PGA categories.

The use of AKASI is illustrated with an example 67-year-old male patient with Fitzpatrick Skin Type II. This patient was judged to have severe AK according to the PGA and had an AKASI score of 9.0 (Fig. 1).

Table 2 Correlation between total AKASI score and subscores for the different regions of the head with PGA

	PGA	Scalp	Forehead	Left face	Right face	AKASI
PGA	1					
Scalp	0.49108	1				
Forehead	0.72090	0.21601	1			
Left face	0.71607	0.17223	0.61271	1		
Right face	0.65218	0.15655	0.47267	0.55136	1	
AKASI	0.86387	0.74171	0.70025	0.69174	0.65170	1

Data are Pearson correlation coefficients.
AKASI, actinic keratosis area and severity index; PGA, physician's global assessment.

Table 3 Correlation of the total AKASI score and its different component subscores with PGA

	PGA	Distribution	Erythema	Thickness	Area	AKASI
PGA	1					
Distribution	0.79052	1				
Erythema	0.84449	0.78854	1			
Thickness	0.84451	0.79248	0.86066	1		
Area	0.78894	0.80723	0.73624	0.73318	1	
AKASI	0.86387	0.87991	0.87008	0.90766	0.89389	1

Data are Pearson correlation coefficients.
AKASI, actinic keratosis area and severity index; PGA, physician's global assessment.

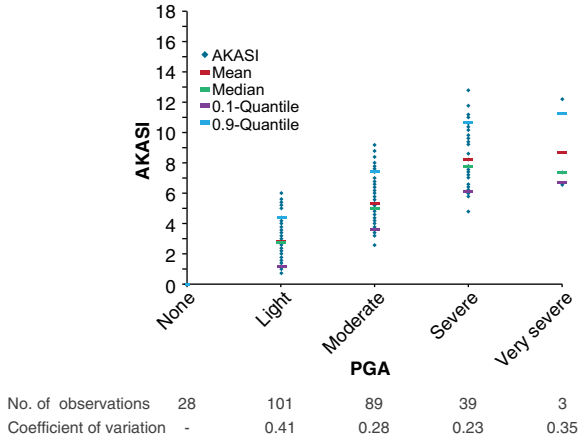


Figure 2 Distribution of AKASI scores vs. PGA categories. AKASI, actinic keratosis area and severity index; PGA, physician's global assessment.

The variations of PGA and AKASI scores for each patient/control in the study are shown in Table S1 in the Supporting Information. For AK patients, the coefficient of variation for PGA (0.46) and AKASI (0.53) scores were similar, as were the coefficients of variation for the controls (3.53 and 3.57, respectively).

Discussion

To our knowledge, the AKASI scoring system presented here represents the first attempt to quantitatively assess the severity of AK across an entire affected field, in this case the head. AKASI addresses the unmet need for a more accurate scoring system to assess the severity of AK, measuring both the area affected by actinic damage and three signs of AK lesions (distribution, erythema and thickness), which were chosen due to their clinical relevance and potential for variation. Four areas of the head (scalp, forehead, left face and right face) were given weighting in the total AKASI score based on their approximate relative sizes. We hope that AKASI will become the standard way of assessing the severity of AK both in clinical studies of new treatments as well as in daily clinical practice.

AKASI was developed based on similar principles to PASI. Both systems take into consideration the extent of disease based on the size of the affected area calculated using the 'rule of nine', as well as the severity of clinical signs which are specific to the respective diseases.[17] The resemblance of AKASI to PASI, a well-established measure which has been used by dermatologists for many years, is a key advantage of our new AK scoring system, which may help to facilitate uptake by practicing dermatologists. Given the small number of AK experts and general dermatologists in this study, it was not possible to meaningfully analyse whether the AKASI scores correlated differently to PGA scores according to the physicians' level of AK expertise. However, we anticipate that dermatologists with differing levels of expertise in diagnosing and treating AK should be able to incorporate the use of AKASI into their daily clinical practice after only 30 min of training using clinical images.

Clinical studies of new AK treatments need to accurately quantify and compare the severity of disease before and after the intervention. The primary endpoint commonly used in investigations of new AK treatments is the complete clearance rate of lesions. Although this end point is easy to measure and detect, and it is often challenging to achieve, may be confounded by the appearance of subclinical lesions during treatment, and most patients and physicians would consider a reduction in lesions as treatment success.[12,25] The disease severity assessment provided by AKASI may be clinically more relevant than assessing whether or not a treatment clears all of a patient's AK lesions.

Other endpoints in clinical studies are based on counting AK lesions before and after treatment. Lesion counting was avoided in the development of AKASI, as it is unreliable and not reproducible,[13,26,27] and does not take into account the disease pathophysiology with actinic damage across the entire sun-exposed area.[28] Lesion counting is particularly challenging in patients with severe photodamage in which contiguous AKs may coalesce into large areas of inflamed and sun-damaged skin.[3] Instead, AKASI assesses the percentage of the head area that is affected by actinic damage, as well as the distribution of AK lesions, with severity defined according to whether the lesions are isolated, clustered or coalescent.

The assessments which a physician needs to make to calculate an AKASI score are easy to learn, simple and quick to perform, and therefore suitable for assessing disease severity in clinical studies and daily practice. Following initial training, we estimate that a physician can complete the AKASI evaluations in 2–5 min. The evaluation involves assessing the thickness of AK lesions by touch, which is important since early AK is sometimes only palpable but not visible. Moreover, the possible different distribution of AK on the left/right facial sides is not influencing the score, as both facial sides are evaluated.

The results of the pilot validation study showed that AKASI and PGA scores were highly correlated. Each of the individual components of AKASI (area, distribution, erythema and thickness) was strongly correlated to PGA. This is encouraging and is in contrast to a comparison of PASI with a PGA, in which the area scores were more highly correlated with PGA than were scores for erythema, induration and desquamation.[29] Of the individual head areas, the correlation of the AKASI subscore for the forehead and PGA was the strongest, and the scalp and PGA were the weakest. The weaker correlation of scalp AKASI subscores and PGA may be because it is more difficult to assess the area affected by AK and the characteristics of AK lesions if they are located between hairs. AKs on the scalp may have been more commonly categorized as 'isolated' rather than 'confluent' decreasing the AKASI score and creating the difference between AKASI and PGA, suggesting that we need to refine the initial training for this area to make the distinction between distribution scores clearer. The pilot validation study results also demonstrate the potential of AKASI scores to classify patients into different categories of AK severity, thereby facilitating the appropriate selection of lesion-versus field-directed treatments.

A limitation of this work was the number of physicians and patients that were used to validate AKASI. Future studies could further validate AKASI in larger populations of patients from different countries with different skin types. Subsequent studies could also include larger numbers of physicians and investigate their opinions on the ease of use of this new AK severity scoring system. AKASI was initially developed for the head area (i.e. face and scalp) because this is where the disease most commonly presents. The AKASI for the head area could be adapted for use on other areas of the body affected by AK such as the limbs and trunk. Moreover, the different area subscores could be separately accounted in clinical trials, in consideration of varying response rates to AK treatments at different anatomical sites and of the targeted anatomical area. Investigations which evaluate the use of AKASI in clinical studies of new therapeutic agents for AK will also be informative. As data on AKASI accumulate, we hope to be able to provide discrete score ranges which correspond to mild, moderate and severe disease, as well as score reductions which constitute a clinically meaningful response, similar to those used for PASI (e.g. PASI 75; PASI 90). AKASI thresholds could be used as inclusion criteria in clinical studies of AK treatments, which would be more precise than using AK lesion counts or Olsen lesion classification. Many clinical studies currently exclude patients with Olsen grade 3 lesions as it is assumed that these have the highest risk of progression to SCC. However, recent evidence shows that only 14% of Olsen grade 3 lesions have severe atypia of the full thickness of the epidermis (i.e. AK III) questioning the relevance of this study exclusion criterion.[11] Anyway, as the severity of AK and actinic damage is dependent on patient's condition, severity threshold should be adapted to target population, that is, immunecompromised patients should be considered 'severe' also for lower scores due to the increased risk to develop SCC.

In conclusion, AKASI is proposed as a new quantitative tool for assessing the severity of AK on the head, which is easy to learn and is anticipated to prove useful in the future evaluation of new AK treatments in clinical studies as well as being of benefit to the diagnosis and management of AK in daily dermatological practice.

Acknowledgements

We thank the Athens AK Study Group for their support in organizing and participating in the validation study. This group includes: A.J. Stratigos, A. Panagiotopoulos, V. Hasapi, A. Befon, I. Potouridou, D. Polydorou, F. Kousta, E. Polychronaki (1st Department of Dermatology-Venereology, University of Athens Medical School, A. Sygros Hospital and State Department of Dermatology-Venereology, A. Sygros Hospital, Athens, Greece); M. Kyriazopoulou (Department of Dermatology, 401 Military Hospital, Athens); M. Kosmadaki, I. Stefanaki, E. Soura, M. Kostaki, F. Chatzinasiou (Office-based dermatologists, affiliated with A. Sygros Hospital, Athens, Greece). Medical writing assistance in the preparation of this manuscript was provided by David Harrison, Medscript Ltd, funded by Centroderm GmbH. We thank Dr. Jürgen Wicht (Schumpeter School of Business and Economics, Bergische Universität Wuppertal) for providing statistical support and Ágota Bartha (Centroderm Clinic, Wuppertal) for assisting in the selection of clinical images and preparation of the training material.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Variation in PGA and AKASI patients vs controls.