









## ORIGINAL ARTICLE

# International Skin Imaging Collaboration-Designated Diagnoses (ISIC-DX): Consensus terminology for lesion diagnostic labeling

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**Abstract**

**Background:** A common terminology for diagnosis is critically important for clinical communication, education, research and artificial intelligence. Prevailing lexicons are limited in fully representing skin neoplasms.

**Objectives:** To achieve expert consensus on diagnostic terms for skin neoplasms and their hierarchical mapping.

**Methods:** Diagnostic terms were extracted from textbooks, publications and extant diagnostic codes. Terms were hierarchically mapped to super-categories (e.g. 'benign') and cellular/tissue-differentiation categories (e.g. 'melanocytic'), and appended with pertinent-modifiers and synonyms. These terms were evaluated using a modified-Delphi consensus approach. Experts from the International-Skin-Imaging-Collaboration (ISIC) were surveyed on agreement with terms and their hierarchical mapping; they could suggest modifying, deleting or adding terms. Consensus threshold was >75% for the initial rounds and >50% for the final round.

**Results:** Eighteen experts completed all Delphi rounds. Of 379 terms, 356 (94%) reached consensus in round one. Eleven of 226 (5%) benign-category terms, 6/140 (4%) malignant-category terms and 6/13 (46%) indeterminate-category terms did not reach initial agreement. Following three rounds, final consensus consisted of 362 terms mapped to 3 super-categories and 41 cellular/tissue-differentiation categories.

**Conclusions:** We have created, agreed upon, and made public a taxonomy for skin neoplasms and their hierarchical mapping. Further study will be needed to evaluate the utility and completeness of the lexicon.

## INTRODUCTION

Clinical care requires clear communication between clinicians and pathologists about diagnostic categories that will guide management.<sup>1</sup> To be useful for educational, research and artificial intelligence (AI) training purposes, large skin

imaging data sets need agreed-upon diagnostic labels with a clear-cut hierarchy.<sup>2–8</sup>

The International Skin Imaging Collaboration (ISIC) was established to facilitate use of skin imaging towards reducing mortality and morbidity from skin cancer.<sup>8</sup> A goal of ISIC is to standardize image acquisition, diagnostic labeling, metadata terminology and digital archiving towards

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development of a large image data set for educational and research purposes. Indeed, the ISIC image archive is a growing, open-source repository of skin neoplasms, available for teaching, conducting research and developing AI systems.<sup>9</sup> The ISIC archive has been the source of dermoscopic images for five international grand challenges leading to thousands of technical publications.<sup>4,10,11</sup> To date, ISIC has restricted itself to a dozen diagnostic categories of skin neoplasms. As ISIC archive broadens to represent the full gamut of skin proliferations, we find that prevailing dermatological lexicons are limited in their scope, consistency and granularity.

Herein, we focused on trying to achieve standardized diagnostic labeling of images of skin neoplasms based on correspondence with histopathological terminology. To this end, we have conducted a modified Delphi-consensus predicated on existing diagnostic lexicons and present the resulting taxonomy for broad international use.

## MATERIALS AND METHODS

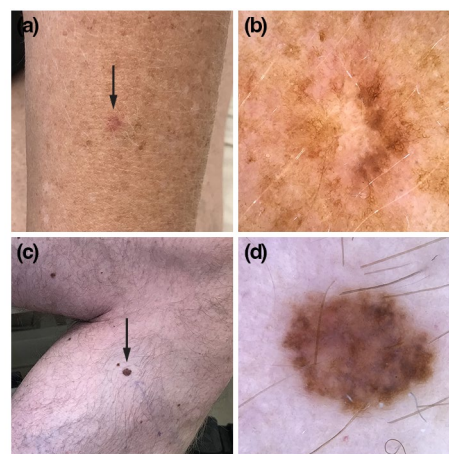
Consistent with previous studies, an institutional review board approval was not applicable to this study, as it included no research subjects<sup>12</sup>; all Delphi members were co-authors. Illustrative clinical images were retrospectively selected from an image database; written informed consent to publication of their case details was obtained from the patients whose images are depicted.

### Study aims and initial development of diagnostic scheme

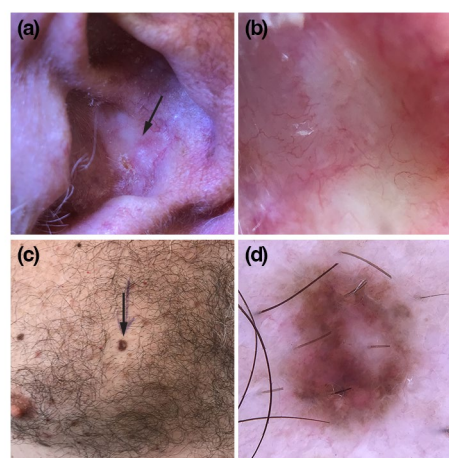
Our plan is to label existing and future ISIC-Archive images with diagnostic terms that most accurately and reproducibly represent the histopathological diagnoses. For each clinical-pathological entity, we sought the best diagnostic term, the pertinent modifiers and commonly used synonyms and the hierarchical mapping of diagnoses.

We began with several premises: (1) focus on neoplasms with few examples of inflammatory processes that may appear in the clinical differential diagnosis of skin lesions, and (2) convergence on agreed-upon diagnostic labels—prioritizing a unique ISIC-designated-diagnosis (ISIC-DX) term for each clinical-pathological entity.

Next, we extracted diagnostic terms from dermatopathology textbooks, scientific literature, online sources and extant diagnostic codes.<sup>13–17</sup> We created a three-tier hierarchy with the top level mapped to a 'benign' (Figure 1), 'malignant' (Figure 2) or 'indeterminate' (Figure 3) super-category.<sup>18–20</sup> Next, each diagnosis was mapped to cellular/tissue differentiation category; these categories were termed based on the cell type (e.g. 'melanocytic') or on the tissue element (e.g. 'vascular' or 'neural') from which the proliferation arises or with which it is closely associated. Synonyms were added to terms, to recognize variable diagnostic designations commonly used for the same entity. Finally, modifiers were



**FIGURE 1** Examples of benign proliferations. (a) Clinical and (b) dermoscopic images of a lesion on the leg histopathologically diagnosed as 'dermatofibroma'. This lesion is classified into super-category 'Benign', cellular/tissue differentiation category. This lesion is classified into super-category 'Benign', cellular/tissue differentiation category 'Soft tissue proliferations – Fibro-histiocytic', diagnostic term 'Dermatofibroma, NOS'. (c) Clinical and (d) dermoscopic images of a lesion on the leg histopathologically diagnosed as 'dysplastic compound nevus'. It is classified into super-category 'Benign', cellular/tissue differentiation category 'Melanocytic proliferations', diagnostic term 'Nevus, Atypical, NOS/Nevus, Dysplastic/Nevus, Clark', with modifier 'Compound'.

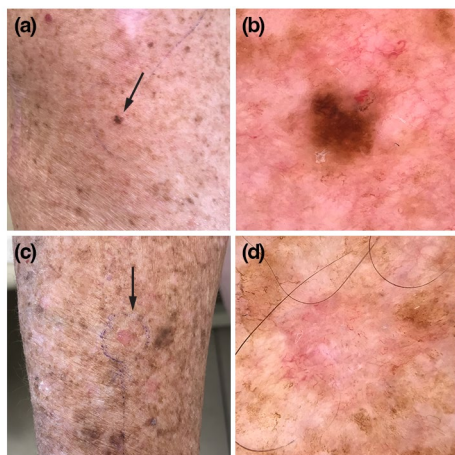


**FIGURE 2** Examples of malignant proliferations. (a) Clinical and (b) dermoscopic images of a lesion on the ear concha histopathologically diagnosed as 'Basal cell carcinoma, sclerosing (morphea) type'. This lesion is classified into super-category 'Malignant', cellular/tissue differentiation category 'Adnexal epithelial proliferations – Follicular', diagnostic term 'Basal cell carcinoma, Sclerosing/morpheaform'. (c) Clinical and (d) dermoscopic images of a lesion on the chest histopathologically diagnosed as 'melanoma 0.5 mm in thickness, without ulceration, and with nevoid features'. It is classified into super-category 'Malignant', cellular/tissue differentiation category 'Melanocytic proliferations (melanoma)', diagnostic term 'Melanoma invasive, Nevoid', with modifiers 'Breslow depth 0.5 mm' and 'non-ulcerated'.

defined as descriptors that allow further sub-categorization of terms, in a manner that is clinically or pathologically meaningful. For example, nevi are often sub-classified by pathologists as 'junctional', 'compound' or 'intradermal'.

## Delphi contributors and rounds

We utilized a modified Delphi method to attain consensus on the terminology lexicon.<sup>21,22</sup> We invited members of ISIC who are dermatologists and dermatopathologists to serve as Delphi experts by sending an email describing the study aims and Delphi methodology and asking recipients to pre-view the study user interface via a 6.5-min tutorial video.<sup>23</sup> Consent to serve as experts in the Delphi process was implied through self-registration and round completion.

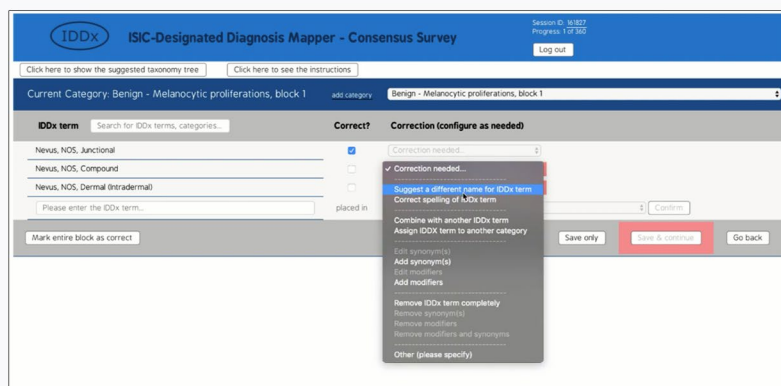


**FIGURE 3** Examples of Indeterminate proliferations. (a) Clinical and (b) dermoscopic images of a lesion on the arm histopathologically diagnosed as 'atypical junctional melanocytic lesion, in favor of melanoma in-situ'. This lesion is classified as super-category 'Indeterminate', cellular/tissue differentiation category 'Melanocytic proliferations', diagnostic term 'Atypical melanocytic neoplasm' with modifiers 'Junctional', 'MPATH III' and 'Histopathological report favours melanoma'. (c) Clinical and (d) dermoscopic images of a lesion on the forearm, whereby the histopathological report described an 'atypical junctional melanocytic hyperplasia on sun-damaged skin, the possibility of a developing melanoma in situ cannot be excluded'. It is classified into super-category 'Indeterminate', cellular/tissue differentiation category 'Melanocytic proliferations', diagnostic term 'Atypical melanocytic neoplasm' with modifiers 'Junctional', 'MPATH III' and 'Histopathological report undecided'.

Contributors were surveyed on basic demographics and could recommend inclusion of additional experts as Delphi members. Contributors who completed all Delphi rounds were offered authorship in the ensuing publication.

In the first Delphi round, contributors were asked to review the entire list of ISIC-DX terms using a web interface (Figure 4). Contributors had to respond to each individual ISIC-DX term by marking the term as 'correct', denoting agreement with the term, its hierarchical mapping and when relevant, its synonyms and modifiers. Alternatively, they could select a modification: (1) suggest a different name for a term or category, (2) correct spelling of the term, (3) combine with another term, (4) assign term to another category in the hierarchical mapping, (5) edit synonyms or modifiers, (6) suggest additional synonyms or modifiers, (7) remove term entirely, (8) remove synonyms or modifiers, and (9) other free text suggestions. In addition, contributors could (1) suggest adding new categories in the hierarchical mapping, and (2) suggest adding new terms. At all times, they could refer to an overview of the entire taxonomy.

Results of the first round were evaluated after all experts submitted their surveys. Threshold for Delphi consensus was set at >75%.<sup>24</sup> A steering committee of three ISIC members (AS, VR and KL) who were not in the Delphi panel reviewed contributors' responses for terms that did not reach consensus and clustered these responses to multiple-choice items. In addition, the committee made majority-vote decisions on suggestions for added terms. These items formed the basis for the second Delphi round survey. Suggestions for new terms were not accepted after round one. At the second round, consensus threshold was retained at >75% for multiple-choice (>2) items, while threshold was set at a majority vote of >50% for items with only two choices. For items that did not reach consensus, we identified the top-two voted choices, for final evaluation at the third Delphi round. At the conclusion of the third round, threshold for consensus was set at a majority vote of >50%. For third round items with tied participant votes, the steering committee made a majority-vote decision. Delphi surveys and participants responses are available in a public repository.<sup>25</sup>



**FIGURE 4** Screenshot of the web interface presented to members in the first Delphi round evaluation. In this exemplary page, Delphi members were presented with a batch of three ISIC-DX terms, Nevus, NOS-junctional, -compound and -dermal. The upper right box shows the hierarchical mapping of the terms to 'benign' super-category and 'melanocytic proliferations' category. Checking the 'correct?' box denoted agreement with the term. Alternatively, they could use a drop-down menu to suggest deleting or modifying the term or its associated mapping.



## Statistical design

Descriptive and relative frequencies were used to describe the survey respondents and the results of the consensus. Measures of central tendency were calculated. Agreement threshold >75% for 18 Delphi members was calculated as  $\geq 14$  consensus votes and >50% as  $\geq 10$  votes.

## RESULTS

### Delphi contributors

Invitations to contribute to the study were sent to 36 clinicians. Of 36 invited, 18 (50%) completed all Delphi rounds (10 dermatologists, four dermato-pathologists and four with a dual certification); five (14%) initially agreed to be Delphi members, but did not complete round I; three (8%) declined and 10 (28%) did not respond.

### Round I

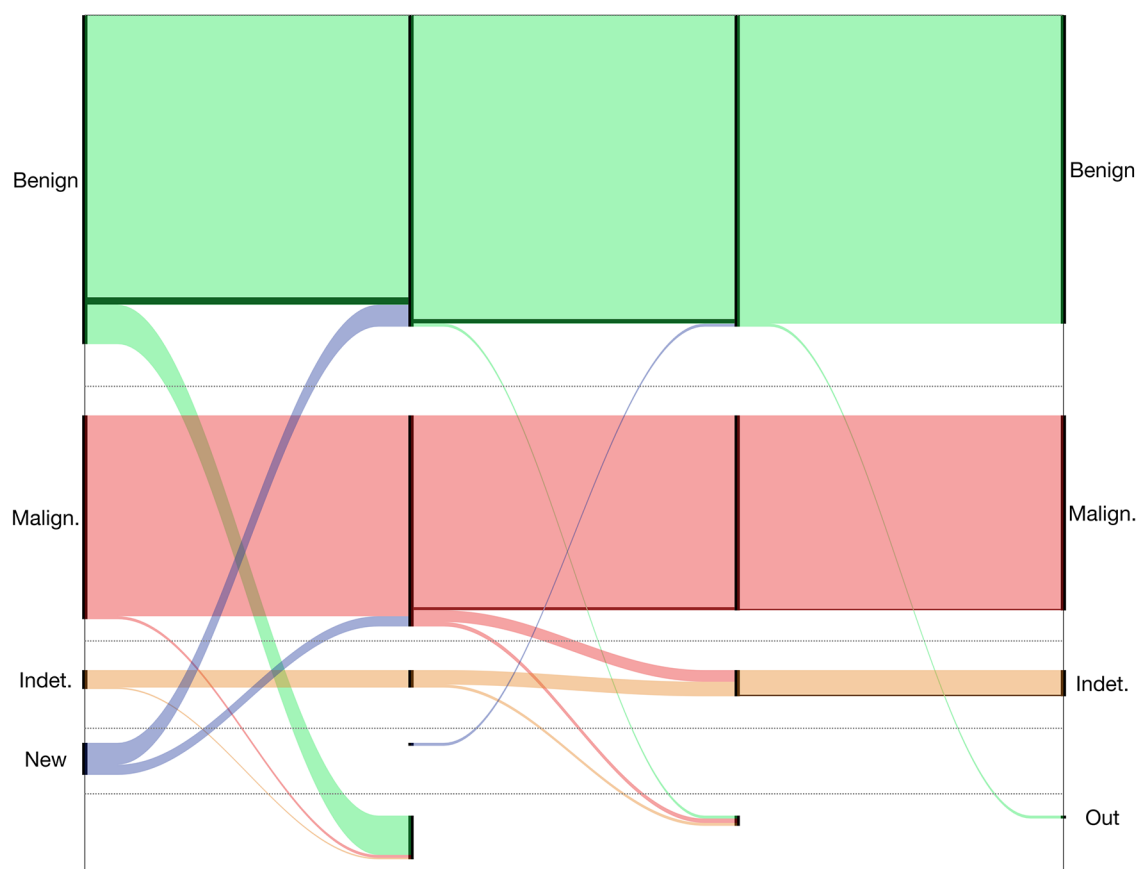
Round I was held between November 2019 and January 2020. Overall, there were 379 ISIC-DX terms (benign = 226,

malignant = 140 and indeterminate = 13). Of 379 terms, 356 (94%) passed the 75% threshold in round I. Twenty-three terms, including 11/226 (5%) benign-category terms, 6/140 (4%) malignant-category terms and 6/13 (46%) indeterminate-category terms, did not reach agreement. These were carried over to round II as 34 items, including ISIC-DX terms ( $n=16$ ), modifiers ( $n=7$ ), synonyms ( $n=8$ ), assignment of terms to another category in the hierarchical mapping ( $n=2$ ) and change of cellular/tissue differentiation category name in the hierarchical mapping ( $n=1$ ). In addition, 29 newly suggested terms were introduced into round II.

Based on the contributor feedback, the steering committee decided to remove the inflammatory ( $n=15$ ) and infectious terms ( $n=12$ ) and focus solely on skin neoplasms. This reduced the total number of approved ISIC-DX terms, at the conclusion of round I, from 356 to 329 terms.

### Round II

Round II was held from August to October 2020. Contributors voted on 63 items carried over from round I. Of 34 items related to existing terms, 22 items (65%) surpassed the agreement threshold, including 6/16 (38%) terms, 7/7 (100%) modifiers, 7/8 (88%) synonyms, 1/2 (50%) for assignment of



**FIGURE 5** Alluvial plot depicting the amendments made in the ISIC-DX taxonomy across the three rounds of Delphi. For example, the green thick curved line shows the fraction of terms from the benign super-category that were eliminated after round I. The two purple thick curved lines on the left shows new terms introduced into the benign (top line) and malignant (bottom line) super-categories following round I.

terms to another category in the hierarchical mapping and 1/1 (100%) for change of cellular/tissue differentiation category name in the hierarchical mapping—under ‘benign’ super-category, ‘deposits’ was renamed ‘exogenous’. In addition, 26 of the 29 (90%) new terms introduced in round II exceeded the agreement threshold. Fourteen multiple-choice items did not reach the agreement threshold; the two terms with the highest number of votes for each item were carried over to Delphi round III. Finally, one binary-choice item—should ‘solar lentigo’ be categorized under ‘flat melanotic pigmentations’ or under ‘epidermal proliferations’—had a tie of votes (9/18 for each option); the steering committee made a majority vote to retain the original classification of ‘solar lentigo’ under ‘epidermal proliferations’, even though some solar lentigines exhibit a measure of melanocytic hyperplasia.

## Round III

Round III was held between February and April 2021. Contributors voted on 14 entities from round II, including existing terms ( $n=10$ ), newly suggested terms ( $n=2$ ), synonyms ( $n=1$ ) and assignment of terms to a category ( $n=1$ ). Of these, 13 items (93%) reached consensus by majority vote.

There was one item—whether to combine ‘Nevus, Atypical, NOS’, ‘Nevus, Dysplastic’ and ‘Nevus, Clark’ into one ISIC-DX, or to Combine ‘Nevus, Atypical, NOS’ and ‘Nevus, Dysplastic’, while deleting ‘Nevus, Clark’—that did not reach consensus because of a tied vote. The steering committee made a majority vote for the former option of combining all three into one term, namely ‘Nevus, Atypical, NOS/ Nevus, Dysplastic/Nevus, Clark’, classified under ‘benign’ ‘melanocytic proliferations’.

In addition, the steering committee added two survey items to maintain consistency of the terminology. First, contributors decided in round II to move the term ‘solar (actinic) cheilitis’ from ‘malignant’ to ‘indeterminate’ super-category. In round III, they were surveyed and confirmed that all ‘solar keratosis’ terms be moved from ‘malignant’ to ‘indeterminate’ super-category, under ‘epidermal proliferations’. Second, contributors decided in round II to delete the term ‘PUVA keratoses’. In round III, they were asked whether the term ‘arsenical keratoses’ should be deleted as well and voted in favour of deletion of this term.

An overview of the amendments made in the ISIC-DX taxonomy across the three rounds of Delphi is depicted (Figure 5). The final consensus list consists of 362 ISIC-DX terms (Appendix S1). The ‘benign’ super-category encompasses 20 categories and 210 terms (Figures 1 and 6); the

<b>Melanocytic proliferations</b> Nevus, NOS, Junctional Nevus, NOS, Compound Nevus, NOS, Dermal (Intradermal) Nevus, Atypical, NOS / Nevus, Dysplastic / Nevus, Clark Nevus, Lentiginous Lentiginous melanocytic proliferation Nevus, Spitz Nevus, Reed Nevus, BAP-1 deficient Nevus, Congenital (per history - present at birth or within 1 year of infancy) Nevus, Congenital pattern (per histopathology) Proliferative nodule in congenital melanocytic nevus (Minimal or no atypia AND no mitotic activity (M/PATH II)) Nevus, Spilus Nevus, Agminated Blue nevus, NOS Blue nevus, Common Blue nevus, Cellular Blue nevus, Epithelioid Blue nevus, Sclerosing Blue nevus, Plaque type Nevus, Deep penetrating Nevus, Combined (details of 2 components to be specified) Nevus, Combined, NOS Nevus, Acral Nevus, Of special anatomic site (e.g. genital, flexural, milium and breast, other) Nevus, Recurrent / persistent Nevus, Halo Nevus, Balloon cell Nevus, Meyerson Lentigo simplex Mongolian spot Nevus of Ota Pigmented epithelioid melanocytoma Dermal melanocytosis, NOS Benign melanocytic proliferations, other (to be specified)	<b>Adnexal epithelial proliferations - Follicular</b> Trichoblastoma, NOS Trichoepithelioma Trichoepithelioma, Desmoplastic Tricholemmoma Tricholemmoma, Desmoplastic Proliferating tricholemmal tumor Folliculosebaceous cystic hamartoma Piloaroma Trichofolliculoma Proliferating tricholemmal tumor Pilar sheath acanthoma Nevus comedonicus Warty dyskeratoma Tumor of follicular infundibulum Panfolliculoma Benign adnexal epithelial proliferations, Follicular or infundibular, other (to be specified)	<b>Soft tissue proliferations - Vascular</b> Hemangioma, NOS Hemangioma, Cherry Hemangioma, Infantile Noninvoluting congenital hemangioma (NCH) Rapidly involuting congenital hemangioma (RICH) Hemangioma, Hobnail Hemangioma, Tufted Glomeruloid hemangioma Acquired elastotic hemangioma Verrucous hemangioma Hemangioma, other (to be specified) Angiokeratoma Pyogenic granuloma Glomus tumor Glomangiomyoma Angioleiomyoma Angiolymphoid hyperplasia with eosinophilia Nevus anemicus Capillary vascular malformation Venous malformation Arterio-venous malformation Lymphangioma (superficial lymphatic malformation) Other vascular or lymphatic malformation / hamartoma (to be specified) Vascular spider Venous lake Telangiectasia Acroangiodermatitis of Mail Benign soft tissue proliferations, Vascular, other (to be specified)	<b>Soft tissue proliferations - Adipocytic</b> Lipoma, NOS Lipoma, Spindle cell / pleomorphic Angiolipoma Fibrolipoma Lipomatous nevus Benign soft tissue proliferations, Adipocytic, other (to be specified)
<b>Flat melanotic pigmentations (not melanocytic nevus)</b> Ink-spot lentigo Mucosal melanotic macule Café au lait macule / patch Ephels	<b>Adnexal epithelial proliferations - Sebaceous</b> Sebaceous hyperplasia Sebaceous adenoma Sebaceoma Nevus sebaceous Fordyce spots Folliculocystoma Trichodroma Benign adnexal epithelial proliferations, Sebaceous, other (to be specified)	<b>Soft tissue proliferations - Fibro-histiocytic</b> Dermatofibroma, NOS Dermatofibroma, Aneurysmal Dermatofibroma, Hemosiderotic Dermatofibroma, Epithelioid Dermatofibroma, Cellular Dermatofibroma, Atypical Dermatofibroma, other (to be specified) Non-Langerhans histiocytosis, NOS Juvenile xanthogranuloma Rosai-Dorfman disease Reticulohistiocytosis Non-Langerhans histiocytosis, other (to be specified) Fibroepithelial polyp Angiofibroma, Facial Angiofibroma, Penile Angiofibroma, Periungual Myxoma, Cutaneous Fibroma, NOS Fibroma, Sclerotic Fibroma, Pleomorphic Fibroma, other (to be specified) Giant cell tumor of the tendon sheath Scar, NOS Scar, Hypertrophic Scar, Keloid Benign soft tissue proliferations, Fibro-histiocytic, other (to be specified)	<b>Soft tissue proliferations - Neural</b> Neuroma, NOS Neuroma, Traumatic Neuroma, Palisaded and encapsulated Neurofibroma, NOS Neurofibroma, Plexiform Granular cell tumor Granular cell tumor, Non-neural Schwannoma Nerve sheath myxoma Perineuroma Benign soft tissue proliferations, Neural, other (to be specified)
<b>Epidermal proliferations</b> Solar lentigo Seborrheic keratosis Seborrheic keratosis, Clonal Lichen planus like keratosis Clear cell acanthoma Large cell acanthoma Porokeratosis Epidermal nevus Epidermolytic acanthoma Acantholytic acanthoma Melanoacanthoma Benign epidermal proliferations, other (to be specified)	<b>Adnexal epithelial proliferations - Apocrine or Eccrine</b> Syringoma Poroma Hidradenoma, Apocrine, NOS Hidradenoma, Apocrine, Predominantly with clear cells Hidradenoma, Poroid Hidradenoma papilliferum Hidradenoma, NOS Syringadenoma Cylindroma Mixed tumor, Apocrine type Mixed tumor, Eccrine type Mixed tumor, NOS Syringocystadenoma papilliferum Apocrine tubular adenoma Syringofibroadenoma Supernumerary nipple Fibroadenoma Myoepithelioma Cystadenoma Benign adnexal epithelial proliferations, Apocrine or Eccrine, other (to be specified)	<b>Soft tissue proliferations - Muscle tissue or myofibroblastic</b> Dermatomyofibroma Smooth muscle hamartoma Pilo leiomyoma Angioleiomyoma Dartic muscle leiomyoma Nodular fasciitis Benign soft tissue proliferations, Myofibroblastic or muscle tissue, other (to be specified)	<b>Soft tissue proliferations - Cartilaginous and ossifying</b> Accessory tragus Extraskeletal chondroma Subungual osteochondroma Osteoma cutis Benign soft tissue proliferations, Cartilaginous and ossifying, other (to be specified)
		<b>Soft tissue proliferations - Myoepithelial</b> Myoepithelioma	<b>Mast cell proliferations</b> Mastocytosis, NOS Mastocytoma, Solitary / unifocal Maculopapular mastocytoma Mastocytosis, Diffuse / multifocal (subtype: Telangiectasia macularis eruptiva perstans, Diffuse cutaneous, other; to be specified) Mast cell proliferation, other (to be specified)
			<b>Langerhans cell proliferations</b> Langerhans cell histiocytosis, NOS Langerhans cell histiocytosis, Solitary / unifocal Langerhans cell histiocytosis, Diffuse / multifocal Langerhans cell histiocytosis, other (to be specified) Indeterminate cell histiocytosis, NOS Erdheim Chester disease Mixed Langerhans cell histiocytosis and Erdheim Chester disease
			<b>Cysts</b> Cyst, NOS Milium Comedo Infundibular / epidermal cyst Trichilemmal / isthmio-catagen / pilar cyst Dilated pore Steatocystoma Digital mucous cyst Benign cyst, other (to be specified)
			<b>Exogenous</b> Tattoo Foreign body granuloma Exogenous, other (to be specified)
			<b>Collision - Only benign proliferations</b> Collision, Only benign proliferations (to be specified)
			<b>Benign - Other</b> Benign, other (or not readily classifiable; to be specified)

**FIGURE 6** Overview of the categories and terms under the ‘benign’ super-category.

‘malignant’ super-category—19 categories and 134 terms (Figures 2 and 7); and the ‘indeterminate’ super-category—2 categories, namely ‘melanocytic proliferations’ and ‘epidermal proliferations’, and 18 terms (Figures 3 and 7).

## DISCUSSION

Herein, we present a Delphi-based, proposed clinical-pathological categorization of skin neoplasms. We share our initial attempt to develop a consensus lexicon designed for use as diagnostic labels for improved clinician communication, education, research and AI training. We also plan to apply this terminology for labeling of the images used in the ISIC Archive.

Our initial strategy was to adopt an existing authoritative taxonomy, however, we found them lacking in scope, granularity and consistency. There have been efforts to standardize diagnostic terminology, including ICD10<sup>26</sup> and SNOMED.<sup>27</sup> Yet, the clinical utility and reproducibility of terms used by these coding systems have been previously called into question.<sup>28–30</sup> For example, among benign melanocytic proliferations, the current Delphi consensus recorded 36 ISIC-DX terms; of these, 26 would not have a distinctive ICD-10 diagnosis, which could detract from the clarity of diagnostic labeling of the ISIC archive. To fill some of these gaps, pathologists have suggested additional

structured reporting schemes, such as the MPATH-Dx and the codes of the College of American Pathologists.<sup>1,31</sup> Indeed, MPATH-Dx provides an encompassing scheme for structured labeling of melanocytic proliferations with associated treatment recommendations.<sup>32–34</sup>

Ideally, all neoplasms could be categorized into benign versus malignant super-categories. In reality, as highlighted by MPATH-Dx, there are many examples of lesions (e.g. ‘Atypical Intraepithelial Melanocytic Proliferation’) for which their malignant versus benign status is debated. However, exclusion of such relevant ‘borderline’ cases from clinical training and education and from AI training risks undermining the diagnostic accuracy of clinicians in daily practice, as well as that of AI systems. Hence, we added an ‘indeterminate’ super-category to the first tier of our hierarchical scheme. Almost half (46%) of the ISIC-DX terms under the ‘indeterminate’ super-category did not reach consensus in the first round of the Delphi, while about 95% of the terms under ‘benign’ and ‘malignant’ super-categories did. This likely reflects clinicians’ ambiguous view of entities whose biological behaviour is still deliberated. While the ‘indeterminate’ super-category initially only included the category ‘melanocytic proliferations’, the consensus panel decided to include all terms related to ‘solar (actinic) keratosis’ under ‘indeterminate’ ‘epidermal proliferations’. This categorization echoes an old literature deliberation on the nature of solar keratosis.<sup>35–37</sup> However,

<b>Melanocytic proliferations</b> Melanoma in situ, NOS Melanoma in situ, Lentigo maligna type / melanoma in situ on chronically sun-exposed skin Melanoma in situ, Acral / acral-lentiginous Melanoma in situ, Mucosal (site to be specified e.g. lip, oral mucosa, genital, other) Melanoma in situ, Superficial spreading Melanoma in situ, Recurrent / persistent Melanoma in situ, associated with a nevus; require to specify nevus type (_____) Melanoma in situ, other (to be specified) Melanoma invasive, NOS Melanoma invasive, Superficial spreading Melanoma invasive, On chronically sun-exposed skin / lentigo maligna melanoma Melanoma invasive, Acral / acral-lentiginous Melanoma invasive, Nodular Melanoma invasive, Desmoplastic (indicate if associated with lentigo maligna) Melanoma invasive, Neurotropic Melanoma invasive, Nevoid Melanoma invasive, Spitzoid (melanoma resembling Spitz nevus / tumor) Melanoma invasive, Pigmented spindle cell nevus like (melanoma resembling Reed nevus) Melanoma invasive, Blue nevus-like (melanoma resembling or originating from a blue nevus) Melanoma invasive, Recurrent / persistent Melanoma invasive, Mucosal (site to be specified e.g. lip, oral mucosa, genital, other) Melanoma invasive, Heavily pigmented (resembling epithelioid blue nevus or melanoma developing in animals) Melanoma invasive, Arising in a congenital nevus Melanoma invasive, Associated with a nevus; require to specify nevus type (_____) Melanoma invasive, other (to be specified) Melanoma metastasis	<b>Epidermal proliferations</b> Squamous cell carcinoma in situ, NOS Squamous cell carcinoma in situ, Bowen's disease Squamous cell carcinoma in situ, other (to be specified) Verrucous carcinoma, Oral florid papillomatosis type Verrucous carcinoma, Carcinoma circuliatum type Verrucous carcinoma, Giant condyloma type Verrucous carcinoma, NOS Bowenoid papulosis Keratoacanthoma Squamous cell carcinoma, invasive, NOS Squamous cell carcinoma, invasive, Keratoacanthoma-type (syn: SCC with keratoacanthoma-features) Squamous cell carcinoma, invasive, Acantholytic Squamous cell carcinoma, invasive, Spindle cell Squamous cell carcinoma, invasive, Verrucous Squamous cell carcinoma, invasive, Adeno-squamous Squamous cell carcinoma, invasive, Clear cell Squamous cell carcinoma, invasive, Sarcomatoid Squamous cell carcinoma, invasive, other (to be specified) <b>Adnexal epithelial proliferations - Follicular</b> Basal cell carcinoma, NOS Basal cell carcinoma, Superficial Basal cell carcinoma, Nodular Basal cell carcinoma, Micronodular Basal cell carcinoma, Infiltrating Basal cell carcinoma, Sclerosing / morpheiform (morpheic) Baso-squamous carcinoma Basal cell carcinoma with adnexal differentiation Basal cell carcinoma with sarcomatoid differentiation Basal cell carcinoma, Fibroepithelial Basal cell carcinoma, Combined subtypes (details of all components to be specified) Basal cell carcinoma, other (to be specified) Matrical / pliomatrical carcinoma Proliferating trichilemmal carcinoma Malignant adnexal epithelial proliferations, Follicular, other (to be specified)	<b>Adnexal epithelial proliferations - Apocrine or Eccrine</b> Paget disease, Mammary Paget disease, Extra-mammary Microcystic adnexal carcinoma Apocrine carcinoma, NOS Tubular carcinoma Malignant mixed tumor Porocarcinoma Hidradenocarcinoma Mucinous carcinoma Digital papillary carcinoma Adenoid cystic carcinoma Adnexal adenocarcinoma arising in association with spiradenoma / cylindroma / spiradenocylindroma Malignant adnexal epithelial proliferations, Apocrine or Eccrine, other (to be specified) <b>Soft tissue proliferations - Vascular</b> Kaposi sarcoma Angiosarcoma cutaneous, Face and scalp of elderly patients Angiosarcoma cutaneous, NOS Angiosarcoma cutaneous, With associated lymphedema Angiosarcoma cutaneous, Post-irradiation Angiosarcoma cutaneous, Epithelioid Malignant glomus tumor Hemangiopericytoma, NOS Hemangiopericytoma, Kaposiform Hemangiopericytoma, other (to be specified) Malignant soft tissue proliferations, Vascular, other (to be specified) <b>Soft tissue proliferations - Fibro-histiocytic</b> Atypical fibroxanthoma Pleomorphic undifferentiated sarcoma Dermatofibrosarcoma protuberans (DFSP) Fibrosarcoma Epithelioid sarcoma Malignant soft tissue proliferations, Fibro-histiocytic, other (to be specified) <b>Soft tissue proliferations - Muscle tissue or myofibroblastic</b> Leiomyosarcoma, Cutaneous Rhabdomyosarcoma, Cutaneous Atypical intradermal smooth muscle tumor Malignant soft tissue proliferations, Muscle tissue, other (to be specified) <b>Soft tissue proliferations - Adipocytic</b> Liposarcoma, Well differentiated Liposarcoma, Undifferentiated Malignant soft tissue proliferations, Adipocytic, other (to be specified)	<b>Soft tissue proliferations - Neural</b> Malignant peripheral nerve sheath tumor Malignant granular cell tumor Malignant soft tissue proliferations, Neural, other (to be specified) <b>Soft tissue proliferations - Cartilaginous and ossifying</b> Extraskeletal osteosarcoma Malignant soft tissue proliferations, Cartilaginous and ossifying, other (to be specified) <b>Soft tissue proliferations - Myoepithelial</b> Myoepithelial sarcoma <b>Soft tissue proliferations - Unknown or other histiogenesis</b> Ewing sarcoma, Primary cutaneous Malignant soft tissue proliferations, Unknown or other histiogenesis, other (to be specified) <b>Merkel cell proliferation</b> Merkel cell carcinoma <b>Lymphocytic proliferations - T-Cell/NK</b> Mycosis fungoides, NOS Mycosis fungoides, Folliculotropic Mycosis fungoides, Pagetoid reticulosis Mycosis fungoides, Granulomatous slack skin Mycosis fungoides, With large cell transformation Sezary syndrome Adult T-cell leukemia / lymphoma Primary cutaneous CD4+ small/medium T-cell lymphoproliferative disorder Primary cutaneous CD30+ lymphoproliferative disease, NOS Primary cutaneous CD30+ lymphoproliferative disease, Cutaneous anaplastic large cell lymphoma Primary cutaneous CD30+ lymphoproliferative disease, Lymphomatoid papulosis Subcutaneous panniculitis-like T-cell lymphoma Extranodal NK/T-cell lymphoma, Nasal type Chronic active EBV infection Primary cutaneous peripheral T-cell lymphoma, Rare subtype, NOS Primary cutaneous peripheral T-cell lymphoma, Rare subtype (to be specified) Primary cutaneous peripheral T-cell lymphoma, NOS Lymphocytic proliferation, T-Cell/NK, other (to be specified) <b>Lymphocytic proliferations - B-Cell</b> Primary cutaneous marginal zone lymphoma Primary cutaneous follicle center lymphoma Primary cutaneous large B-cell lymphoma EBV+ mucocutaneous ulcer (provisional) Intravascular large B-cell lymphoma Lymphocytic proliferation, B-Cell, other (to be specified)
<b>Skin metastasis of internal solid (non-hematological) cancer</b> Skin metastasis of internal solid (non-hematological) cancer (to be specified) <b>Collision - At least one malignant proliferation</b> Collision, At least one malignant proliferation (to be specified) <b>Malignant - Other</b> Malignant, other (or not readily classifiable; to be specified)	<b>Adnexal epithelial proliferations - Sebaceous</b> Sebaceous carcinoma Malignant adnexal epithelial proliferations, Sebaceous, other (to be specified)		
<b>Melanocytic proliferations</b> Atypical intraepithelial melanocytic proliferation (AIMP) Atypical Spitz tumor, Junctional Atypical Spitz tumor, Compound Atypical Spitz tumor, Dermal (intradermal) Atypical pigmented spindle cell tumor Atypical proliferative nodules in congenital melanocytic (Moderate or severe atypia OR mitotic activity) Superficial atypical melanocytic proliferation of uncertain significance (SAMPLUS) Melanocytic tumor of uncertain malignant potential (MEDUMP) Atypical melanocytic neoplasm Indeterminate melanocytic proliferation, other (to be specified)	<b>Epidermal proliferations</b> Solar (actinic) keratosis, NOS Solar (actinic) keratosis, Hypertrophic Solar (actinic) keratosis, Atrophic Solar (actinic) keratosis, Acantholytic Solar (actinic) keratosis, Bowenoid Solar (actinic) keratosis, Lichenoid Solar (actinic) keratosis, other (to be specified) Solar (actinic) cheilitis		

**FIGURE 7** Overview of the categories and terms under the ‘malignant’ (red) and ‘indeterminate’ (brown) super-categories.



inclusion of an entity in the 'indeterminate' category does not imply that these lesions have biological malignant potential, but rather difficulty in placing an entity into benign or malignant category.

The terms 'dysplastic nevus' and 'atypical nevus', whose definitions are varied,<sup>38–42</sup> did not reach consensus by the experts following three Delphi rounds. In the first round 'dysplastic nevus', 'atypical nevus' and 'Clark nevus' were presented as three distinct terms under 'benign' 'melanocytic proliferations'; none surpassed the 75% threshold. Even in round III, the top two options—combine all three terms versus combine only 'atypical nevus' and 'dysplastic nevus'—received a tied vote. Finally, the steering committee, using a simple-majority vote, chose the more inclusive option of combining all three diagnoses to one ISIC-DX term 'Nevus, Atypical, NOS/Nevus, Dysplastic/Nevus, Clark'. This was thought to be the best approach given the overlapping use of the terms in labeling subsets of nevi, while being cognizant that these terms are not strict synonyms.

The proposed lexicon has limitations. First, we chose to restrict the scope of diagnostic terms for practicability. Future efforts may need to specifically enrich image data sets for rare diagnoses, and expand the taxonomy to include inflammatory or infectious disorders. Second, we chose to limit granularity for each diagnosis. While ancillary immunohistochemical and molecular markers may gain importance in distinguishing variants of diagnoses, Delphi members focused on the current clinical relevance of diagnostic entities. Eventually, we anticipate that a more molecularly informed ontology of diagnoses will lead to improved diagnostics labels. Lastly, the lexicon has not been tested prospectively. To understand the completeness, applicability and reproducibility of the taxonomy, we plan to study the prospective labeling of images submitted to the ISIC archive. We anticipate that the terms may need to be periodically updated.

In conclusion, we propose a publicly available, expert consensus-based taxonomy for diagnostic labeling of images of skin neoplasms. The ISIC-DX lexicon may benefit clinical communication, teaching and research and may improve AI training and interpretability. Further study and feedback from the dermatology community will be needed to evaluate the utility and the completeness of the lexicon.

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## CONFLICT OF INTEREST STATEMENT

A Scope—Consulting fees (stated as not relevant for this publication) from Roche Pharmaceuticals (Israel) LTD; Payment or honoraria for lectures, presentations, speakers bureaus, article writing or educational events (stated as not relevant for this publication) from Janssen Israel. RP Braun—Advisory board (stated as not relevant for this publication) from Allmiral. MA Marchetti—Grants from Harry J. Lloyd Charitable Trust—Funding to institution for study unrelated to this work; Payment or honoraria for lectures, presentations, speakers bureaus, article writing or educational events from American Dermoscopy Meeting and Medscape. AA Marghoob—Royalties or licences from Up To Date and Informa publishing; Payment or honoraria for lectures, presentations, speakers bureaus, article writing or educational events from DermLite and FotoFinder; Receipt of equipment, materials, drugs, medical writing, gifts or other services from Heine, DermLite and FotoFinder. HP Soyer—Consulting fees (to institution) from Canfield Scientific Inc, MoleMap Australia Pty Ltd and Blaze Biosciences Inc; Patents planned, issued or pending for Microbiopsy Device; Stock or stock options—Shareholder MoleMap NZ Limited and Shareholder e-dermconsult GmbH. A Stratigos—Payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing or educational events, made to institution, from BMS, Janssen Cilag, Sanofi, Genesis Pharma and Regeneron. L Thomas—Receipt of equipment, materials, drugs, medical writing, gifts or other services, made to institution, from Casio, 3 GEN, Heine, Fotofinder and C-Cube. H Kittler—Royalties or licences from Casio, Heine.

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## DATA AVAILABILITY STATEMENT


The data that supports the findings of this study are available at <https://github.com/neuroelf/dermodelphi>.

## ETHICAL APPROVAL

Consistent with previous studies, an institutional review board approval was not applicable to this study, as it included no research subjects; all Delphi members were co-authors.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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