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Original Article

Knowledge Acquisition for Diagnosis of Skin Diseases as an Initial Platform for an Expert System

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Abstract

Background: The diagnosis of skin diseases, especially in patients suffering from more than one disease or having similar symptoms, is very complex and access to the knowledge of skin diseases makes the design of an expert system easier. This research aimed to design a knowledge base used for diagnosis of complex skin diseases, selected by experts.

Methods: This applied developmental research was conducted in 2015. The study population included 10 dermatologists of Razi Hospital, affiliated to Tehran University of Medical Sciences. Data collection was conducted through a questionnaire and a checklist. The questionnaire had face and content validity and was based on Likert scale according to the twelfth chapter of the International Classification of Diseases (Tenth revision). The questionnaires were administered to participants and collected after completion. A checklist of knowledge acquisition was designed for each disease based on the semiology book of skin diseases with "agree-disagree" options and completed by interviews. Signs and symptoms had an agreement with at least 70% of the experts, and symptoms that were added according to the experts' proposal entered the checklist and was given to experts for consensus in future evaluations. The software used in this research was Clementine and its statistical method used was Stata. The data were analyzed using SPSS, 16.

Results: The diseases including pemphigus vulgaris, lichen planus, basal cell carcinoma, melanoma, and scabies were selected to design the expert system. Confirmed signs and symptoms of the diseases selected by the experts included 106 causes.

Conclusion: The choice of the selected diseases needed by specialists in the knowledge system is a very vital component needed in designing the expert knowledge base system to meet international standards based on international classification and according to the needs of specialists.

Keywords: Skin diseases, Knowledge acquisition, Knowledge base

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Introduction

The skin is one of the largest organs of the body with the functions of protection of the body against diseases, the sense of touching, and regulation of the body's temperature (1). Many skin diseases are caused by other diseases of the body, such as internal diseases, systemic diseases like hepatitis and cancer, psychological stress or infectious and parasitic diseases (2). Thus, skin references are high frequent as more than 10 percent of outpatient visits include skin disorders in the United States of America. Globally, skin diseases have a high burden among non-lethal diseases, thus directing global health strategies for the prevention and treatment of skin diseases into innovative and comprehensive ways of delivering their services (3, 4). The diagnosis of skin diseases, especially in patients presenting with more than one disease or similar symptoms, is very complex; in this case, access to a wide range of knowledge of skin diseases is required. Also in cases or areas where access to a physician or specialist is not possible, an expert system with transferred physician's knowledge can be effective as a help for patients' diagnosis and treatment (5). Many expert systems have already been designed to detect various diseases (6-8). In Iran, an expert system for the diagnosis of leukemia was provided, using the vp-expert shell, in which the needed knowledge to diagnose and recommend treatment has been stored as rules that can give relatively reliable diagnosis and treatment recommendations (9). In the design of an expert system, the phase of expert knowledge acquisition

and detailed design of knowledge base is an essential step in building knowledge-based systems. Various methods have been introduced for the acquisition of knowledge. Acquisition of knowledge from textbooks, reliable websites, standard questionnaires, and experts' opinion are the common methods of obtaining the experts' knowledge for designing a knowledge base (10). Therefore, as the first step in designing an expert system is knowledge acquisition and knowledge base design, this study aimed to design a knowledge base to identify complex skin diseases selected by experts, in order to integrate the system capabilities and medical experts' knowledge to take a major step forward in the early and precise diagnosis of diseases and as a result improve the quality of life of patients suffering from skin diseases and the provided care.

Methods

This applied developmental research was conducted in 2015 to design software that will provide expert knowledge-based information on the diagnosis of skin diseases. The research context was Razi Specialized Dermatology Hospital, affiliated to Tehran University of Medical Sciences. The study population was made up of 10 specialists in dermatology from the faculty members with a minimum of 10 years of occupational experience who were recruited purposefully. The

Table 1: Frequency of symptoms and diagnosis expert opinion "Pemphigus Vulgaris"

Stage	Type information	Expert opinions(N=10) / Factor	Agree		Adverse		Approve/ Reject
			Number	Percent	Number	Percent	
Stage 1	Identifying information	Age♦	2	0.2	8	0.8	Reject
		Occupation♦	2	0.2	8	0.8	Reject
		Marriage♦	0	0	10	100	Reject
		Sex♦	0	0	10	100	Reject
		Race ♦	0	0	10	100	Reject
	Medical history	History of the underlying disease ♦	0	0	10	100	Reject
		History of the same skin disease in the family♦	2	0.2	8	0.8	Reject
		History of drug use♦	1	0.1	9	0.9	Reject
	Clinical findings	Irritation and pain of mucosal	8	0.8	2	0.2	Approve
		Dysphagia or pain on swallowing food	9	0.9	1	0.1	Approve
		Nasal bleeding	8	0.8	2	0.2	Approve
		Odynophagia	8	0.8	2	0.2	Approve
		Red Eyes	8	0.8	2	0.2	Approve
		Skin sores and Blister	9	0.9	1	0.1	Approve
		Erosions of the mucosal membranes	10	100	0	0	Approve
		Skin blister	9	0.9	1	0.1	Approve
		Skin ulcer and erosions	10	100	0	0	Approve
		Wet lesion	10	100	0	0	Approve
		Involvement of the skin and mucosa	10	100	0	0	Approve
		Local involvement	10	100	0	0	Approve
		Occurrence on the head and neck and seborrheic areas	9	0.9	1	0.1	Approve
		Painful oral erosions with subsequent involvement of the entire body	8	0.8	2	0.2	Approve
		Loose and fragile blisters on the normal skin without erythema	10	100	0	0	Approve
		Nikolsky sign	10	100	0	0	Approve
		Oral lesions	10	100	0	0	Approve
Stage2	Clinical findings	Vesicle*	9	0.9	1	0.1	Approve
		Infected lesions*	10	100	0	0	Approve
		Blister*	10	100	0	0	Approve
		Mucosal lesions(reticular white lines-ulceration-erosions)*	9	0.9	1	0.1	Approve
		Post inflammatory pigmentation*	9	0.9	1	0.1	Approve

Signs of vesicles, lesions of the mucosa (white reticulo-ultrasound-erosion lines), the presence of post-healing pigmentation with an abundance of 9 comments, and infectious and bile secretion lesions with the number of 10 consensus views marked as starred were added to the table. Items marked with the ♦ mark are excluded from the list based on expert opinion

Table 2: Frequency of symptoms and diagnosis expert opinion "Basal cell carcinoma"

Stage	Type information	Expert opinions(N=10) Factor		Agree		Adverse		Approve /Reject
				Number	Percent	Number	Percent	
Stage 1	Identifying information	Age♦		0	0	10	100	Reject
		Occupation♦		2	0.2	8	0.8	Reject
		Sex♦		0	0	10	100	Reject
		Province Location♦		2	0.2	8	0.8	Reject
		Race ♦		0	0	10	100	Reject
		Skin Color, hair color, eyes color, skin types	Fair skin♦	1	0.1	9	0.9	Reject
			Red hair♦	1	0.1	9	0.9	Reject
			Furkle face♦	1	0.1	9	0.9	Reject
			Skin type ♦	0	0	10	100	Reject
	Medical history	History of prolonged exposure to the sun		10	100	0	0	Approve
		History of tanning		8	0.8	2	0.2	Approve
		History of frequent sunburn		9	0.9	1	0.1	Approve
		History of phototherapy		9	0.9	1	0.1	Approve
		History of radiotherapy		8	0.8	2	0.2	Approve
		History of exposure to chemical substances		8	0.8	2	0.2	Approve
	Clinical findings	Papules or nodules with prominent telangiectasias and pearl		9	0.9	1	0.1	Approve
		Ulcerated or bleeding lesion		10	100	0	0	Approve
		Pigmented lesion		10	100	0	0	Approve
		Erythematous Plaque or macula		10	100	0	0	Approve
		Sclerotic plaque		10	100	0	0	Approve
Stage2	Clinical findings	History of genetic diseases such as Xeroderma Pigmentosa*		10	100	0	0	Approve
		Patient's complaint of the skin ulcer*		10	100	0	0	Approve
		History of the change in color or increase in the size of the mole*		10	100	0	0	Approve
		Black or brown or nodules with irregular margins and multiple color*		10	100	0	0	Approve
		Hemorrhagic nodule or tumor*		10	100	0	0	Approve
		Brown-black plaque with irregular color and bonder on the face and sun damage skin*		10	100	0	0	Approve
		Lymphadenopathy*		10	100	0	0	Approve

Factors related to clinical signs of congenital diseases such as Xeroderma Pigmentosa, complaints from a wounded skin lesions, patient complaining of discolouration or increased size of the macula / plaque or papule / black-brown brown nodule with irregular color and irregular borderline, tumor / Blubber or ulcerative nodule, brown / black / black plaque with irregular color and irregular border on the face of the skin and Sundamage skin, lymphadenopathy with 10 distinct stars marked as starred were added to the table. Items marked with the ♦ mark are excluded from the list based on expert opinion.

research was conducted in two stages: 1- Identification of complex diseases by experts, and 2- Determination of clinical symptoms and the diagnosis of these diseases. Data collection was conducted through a questionnaire and a checklist. In the first stage, a questionnaire was designed according to chapter 12 of the tenth edition of the International Classification of Diseases book to "determine the selected complex diseases". The questionnaire included 72 skin diseases designed based on the Likert scale with options ranging from "very high", "important", "very important", "moderately important", "little important", to "very little important" while another section was designed for experts' proposals of other skin diseases that were not mentioned in the questionnaire. The questionnaires were sent to the experts and collected after completion. During the completion of the questionnaire, any questions arising from the respondents were answered. Since the questionnaire was based on chapter 12 of the International Classification of Diseases book, it had face and content validity. In the second stage, to "acquire experts' knowledge to determine clinical signs and diagnosis of complex diseases", we designed a checklist based on the semiology book of Dermatology (2, 11-13). The checklist included signs, symptoms, and clinical findings for each disease with "agree-disagree" options that were completed by interview using the Delphi technique. Symptoms with agreement of at least 70 percent of experts and

Table 3: Frequency of symptoms and diagnosis expert opinion "Lichen Planus"

Stage	Type information	Expert opinions(N=10) Factor	Agree		Adverse		Approve /Reject
			Number	Percent	Number	Percent	
Stage1	Identifying information	Age♦	0	0	10	100	Reject
		Occupation♦	1	0.1	9	0.9	Reject
		Marriage♦	0	0	10	100	Reject
		Sex♦	2	0.2	8	0.8	Reject
		Race♦	0	0	10	100	Reject
	Medical history	History of the same skin disease in the family♦	2	0.2	8	0.8	Reject
		A history of hepatitis B or C♦	2	0.2	8	0.8	Reject
		History of previous Lichen Planus ♦	3	0.3	7	0.7	Reject
		History of drug use♦	2	0.2	8	0.8	Reject
	Clinical findings	Distribution of the lesions	9	0.9	1	0.1	Approve
		Appearance of skin lesions(itchy and purple's papules-polygonal-flat)	10	100	0	0	Approve
		Wickham strrae	10	100	0	0	Approve
		Blister	10	100	0	0	Approve
		Mucosal lesions(reticular white lines-ulceration-erosions)	10	100	0	0	Approve
		Scaring hair loss	10	100	0	0	Approve
		Nail changes	10	100	0	0	Approve
		Post inflammatory pigmentation	10	100	0	0	Approve
		Itchy lesions	10	100	0	0	Approve
		Irritation and pain of mucosal	10	100	0	0	Approve
		Skin sores and Blister	10	100	0	0	Approve
		Erosions of the mucosal membranes	10	100	0	0	Approve
		Skin blister	10	100	0	0	Approve
		Skin sores and Blister	10	100	0	0	Approve
Stage2	Clinical findings	Involvement of the skin and mucosa*	9	0.9	1	0.1	Approve
		Local Involvement *	10	100	0	0	Approve
		Painful oral erosions with subsequent involvement of the entire body*	8	0.8	2	0.2	Approve
		Itching*	10	100	0	0	Approve
		Symmetric lesions*	10	100	0	0	Approve
		Papules*	8	0.8	2	0.2	Approve
		Nodules*	10	100	0	0	Approve
		Eczematous lesion*	9	0.9	1	0.1	Approve
		Excoriated lesions*	7	0.7	3	0.3	Approve
		Oral lesions*	10	100	0	0	Approve

Factors related to clinical signs include topical, itching, sympathetic lesions, nodules, and oral lesions with a frequency of 10 votes, skin and mucous membranes, and exacerbations of lesions with an abundance of 9 votes, starting with painful erosion and then total involvement Body and papule, with an abundance of 8 votes in favor, Excoriated wastes were added to the table with a score of 7 votes, marked as starred. Items marked with the ♦ mark are excluded from the list based on expert opinion

signs added at each stage to experts' proposal were included in the checklist and given to experts for further evaluation. Consensus was reached after double checking the checklist and repeating the interviews.

Results

Results showed that of the 10 skin experts, 5 were women (50%) and 5 men (50%). Five of them were professors, 2 associate professors, and 3 assistants.

The results of the first stage, i.e. "determining the selected complex diseases", indicated that pemphigus vulgaris with a frequency of 10 options of very high importance, basal cell carcinoma and lichen planus with a frequency of 8 options of very high importance, melanoma with a frequency of 7 options of very high importance, and scabies with a frequency of 7 options of very high importance were included as complex diseases according to the experts' opinion that was needed to design an expert system for diagnosis. Thus, diseases including pemphigus vulgaris, lichen planus, basal cell carcinoma, melanoma, and scabies

were selected to design the expert system.

The results of the second stage, i.e. "acquiring experts' knowledge to determine clinical signs and diagnosis of complex diseases", showed that, regarding symptoms and diagnosis of "pemphigus vulgaris", the most clinical signs were agreed with a frequency of 10 agreed opinions as infectious secreting lesion and blister (Table 1).

Regarding symptoms and diagnosis of "basal cell carcinoma", the most clinical symptoms for diagnosis was the history of congenital diseases such as Xeroderma Pigmentosa, patient's complaint of wounded skin lesion, patient's complaint of discoloration or increase in the size of the mole, macule/plaques or papules/brown-black nodules with irregular color and borders, tumor/ulcerated or hemorrhagic nodules, macule/brown-black plaque with irregular color and borders in face, sun damaged skin, and lymphadenopathy with a frequency of 10 agreed opinions (Table 2).

Regarding symptoms and diagnosis of "lichen planus", the highest frequency was local onset, itching, symmetrical lesions, nodules, and oral lesions with 10 agreed opinions (Table 3). Also, regarding symptoms and diagnosis of "melanoma", the highest frequency was the history of chemical contact with a frequency of 10 agreed opinions (Table 4).

Regarding symptoms and diagnosis of "scabies",

Table 4: Frequency of symptoms and diagnosis expert opinion "Malignant Melanoma"

Stage	Type information	Expert opinions(N=10) Factor		Agree		Adverse		Approve/ Reject
				Number	Percent	Number	Percent	
Stage 1	Identifying information	Age♦		0	0	10	100	Reject
		Occupation♦		2	0.2	8	0.8	Reject
		sex♦		0	0	10	100	Reject
		Province Location♦		2	0.2	8	0.8	Reject
		Race ♦		0	0	10	100	Reject
		Skin color, hair color, eyes color, skin types	Fair skin♦	1	0.1	9	0.9	Reject
			Red hair♦	1	0.1	9	0.9	Reject
			Furkle face♦	1	0.1	9	0.9	Reject
			Skin type♦	0	0	10	100	Reject
	Medical history	History of prolonged exposure to the sun		10	100	0	0	Approve
		History of tanning		8	0.8	2	0.2	Approve
		History of frequent sunburn		9	0.9	1	0.1	Approve
		Family history of atypical(dysplastic)moles or melanoma		9	0.9	1	0.1	Approve
		History of genetic diseases such as Xeroderma Pigmentosa		9	0.9	1	0.1	Approve
		History of multiple moles		9	0.9	1	0.1	Approve
		Family history of melanoma		9	0.9	1	0.1	Approve
		History of phototherapy		9	0.9	1	0.1	
Stage2	Medical history	History of radiotherapy*		9	0.9	1	0.1	Approve
		History of exposure to chemical substances*		10	100	0	0	Approve
Stage1	Clinical complaints	Patient's complaint of the skin ulcer		10	100	0	0	Approve
		History of the change in color or increase in the size of the mole		10	100	0	0	Approve
	Clinical findings	Black or brown or nodules with irregular margins and multiple color		10	100	0	0	Approve
		Hemorrhagic nodule or tumor		10	100	0	0	Approve
		Brown-black plaque with irregular color and bonder on the face and sun damage skin		10	100	0	0	Approve
		Pigmented bands of nails		10	100	0	0	Approve
		Hutchinson's sign		10	100	0	0	Approve
Stage2	Clinical findings	Lymphadenopathy*		8	0.8	2	0.2	Approve
		Ulcerated or bleeding lesion*		9	0.9	1	0.1	Approve
		Pigmented lesion*		7	0.7	3	0.3	Approve

Factors related to clinical signs of history of contact with chemicals with an abundance of 10 comments, a history of radiotherapy, and ulcerative or bleeding lesion with an abundance of 9 comments, lymphadenopathy with an abundance of 8 comments, pigmented lesion with an abundance of 7 agreeable views marked as starred have been added to the table. Items marked with the ♦ mark are excluded from the list based on expert opinion.

the most frequent factor was related to secreting lesion with a frequency of 10 agreed opinions (Table 5). Finally, a general list of signs and symptoms of the diseases selected by experts was prepared including

Table 5: Frequency of symptoms and diagnosis expert opinion "scabies"

Stage	Type information		Expert opinions(n=10) Factor	Agree		Adverse		Approve/ Reject
				Number	Percent	Number	Percent	
Stage1	Identifying information		Age♦	0	0	10	100	Reject
			Occupation♦	1	0.1	9	0.9	Reject
			Marriage♦	0	0	10	100	Reject
			Sex♦	1	0.1	9	0.9	Reject
			Race ♦	0	0	10	100	Reject
	Medical history		History of Recent travel	10	100	0	0	Approve
			History of imprisonment	8	0.8	2	0.2	Approve
			History of Recent itching in other family	8	0.8	2	0.2	Approve
	Clinical complaints		Itching	9	0.9	1	0.1	Approve
			Itching worsens at night	10	100	0	0	Approve
			Itching worsens with heat and hot baths	10	100	0	0	Approve
	Clinical findings	Primary	Symmetric lesions	10	100	0	0	Approve
			Presence of skin barrow	10	100	0	0	Approve
			Vesicle	10	100	0	0	Approve
			Papules	10	100	0	0	Approve
			Nodules	10	100	0	0	Approve
		Secondary	Pustule	10	100	0	0	Approve
			Eczematous lesion	10	100	0	0	Approve
			Contact dermatitis	10	100	0	0	Approve
			Infected lesions	10	100	0	0	Approve
			Excoriated lesions	10	100	0	0	Approve
	Diagnostic methods		Barrow with undulating lines 1-10 mm long in the area between the fingers and wrist	10	100	0	0	Approve
			Find vesicle between the fingers, wrist and hand sides	10	100	0	0	Approve
Stage2	Clinical findings		Skin ulcer and erosions*	9	0.9	1	0.1	Approve
			Wet lesion*	10	100	0	0	Approve
			Itchy lesions*	9	0.9	1	0.1	Approve
			Lymphadenopathy*	8	0.8	2	0.2	Approve

Factors related to clinical signs (scar tissue with 10 concordant lesions, skin lesions and erosion, and pruritus lesions with an abundance of 9 comments, lymphadenopathy with a frequency of 8 consensus views marked as starred were added to the table. The ♦ marked has been removed from the list, according to experts

Table 6: The list of Approved signs and symptoms of skin diseases selected by experts

Row	Sign	Row	Sign
1	History of prolonged exposure to the sun	54	Contact dermatitis
2	History of tanning	55	Infected lesions
3	History of frequent sunburn	56	Excoriated lesions
4	History of phototherapy	57	Barrow with undulating lines 1-10 mm long in the area between the fingers and wrist
5	History of radiotherapy	58	Find vesicle between the fingers, wrist and hand sides
6	History of exposure to chemical substances	59	Skin ulcer and erosions
7	Papules or nodules with prominent telangiectasia and pearl	60	Wet lesion
8	Ulcerated or bleeding lesion	61	Itchy lesions
9	Pigmented lesion	62	Lymphadenopathy
10	Erythematous Plaque or macula	63	Distribution of the lesions
11	Sclerotic plaque	64	Appearance of skin lesions(itchy and purple's papules-polygonal-flat)

12	History of genetic diseases such as Xeroderma Pigmentosa	65	Wickham strrae
13	Patient's complaint of the skin ulcer	66	Blister
14	History of the change in color or increase in the size of the mole	67	Mucosal lesions(reticular white lines-ulceration-erosions)
15	Black or brown or nodules with irregular margins and multiple color	68	Scaring hair loss
16	Hemorrhagic nodule or tumor	69	Nail changes
17	Brown-black plaque with irregular color and bonder on the face and sun damage skin	70	Post inflammatory pigmentation
18	Lymphadenopathy	71	Itchy lesions
19	Irritation and pain of mucosal	72	Irritation and pain of mucosal
20	Dysphagia or pain on swallowing food	73	Skin sores and Blister
21	Nasal bleeding	74	Erosions of the mucosal membranes
22	Odynophagia	75	Skin blister
23	Red Eyes	76	Skin sores and Blister
24	Skin sores and Blister	77	Involvement of the skin and mucosa
25	Erosions of the mucosal membranes	78	Local involvement
26	Skin blister	79	Painful oral erosions with subsequent involvement of the entire body
27	Skin ulcer and erosions	80	Itching
28	Wet lesion	81	Symmetric lesions
29	Involvement of the skin and mucosa	82	Papules
30	Local involvement	83	Nodules
31	Occurrence on the head and neck and seborrheic areas	84	Eczematous lesion
32	Painful oral erosions with subsequent involvement of the entire body	85	Excoriated lesions
33	Loose and fragile blisters on the normal skin without erythema	86	Oral lesions
34	Nikolsky sign	87	History of prolonged exposure to the sun
35	Oral lesions	88	History of tanning
36	Vesicle	89	History of frequent sunburn
37	Infected lesions	90	Family history of atypical(dysplastic)moles or melanoma
38	Blister	91	History of genetic diseases such as Xeroderma Pigmentosa
39	Mucosal lesions(reticular white lines-ulceration-erosions)	92	History of multiple moles
40	Post inflammatory pigmentation	93	Family history of melanoma
41	History of recent travel	94	Patient's complaint of the skin ulcer
42	History of imprisonment	95	History of the change in color or increase in the size of the mole
43	History of itching in other members of the family	96	Black or brown or nodules with irregular margins and multiple color
44	Itching	97	Hemorrhagic nodule or tumor
45	Itching worsens at night	98	Brown-black plaque with irregular color and bonder on the face and sun damage skin
46	Itching worsens with heat and hot baths	99	Pigmented bands of nails
47	Symmetric lesions	100	Hutchinson's sign
48	Presence of skin barrow	101	Lymphadenopathy
49	Vesicle	102	History of phototherapy
50	Papules	103	History of Radiotherapy
51	Nodules	104	History of exposure to chemical substances
52	Pustule	105	Ulcerated or bleeding lesion
53	Eczematous lesion	106	Pigmented lesion

A complete list of all the symptoms and symptoms of the 5 illnesses selected by the experts in general, including 106 causes.

106 causes (Table 6).

Discussion

The results show that designing an expert system is essential for pemphigus vulgaris, basal cell carcinoma, lichen planus, melanoma, and scabies due to the complexity in diagnosing these diseases, according to the experts' opinions. The results of other studies have shown that the specialists' opinions were often not considered in disease selection for the expert system. As Nasser and Akilla (2008) designed an expert system to diagnose 9 skin diseases (5), Guvenir and Emeksizb (2000) designed an expert system to diagnose erythematous-squamous (14). AbuNaser and AbuZeitar (2008) designed an expert system to diagnose 4 ocular diseases (6). Alhaji (2012) designed an expert system to detect 10 neurological diseases (15). In none of these studies, the selection criteria for disease(s) were mentioned that is incompatible with the current research. In all these studies, the importance of the selected diseases has been emphasized, but the cause and selection of diseases were not mentioned because the diseases were selected based on the researchers' taste, while one of the main reasons for designing the expert system is based on the specialists' needs. Regarding the fact that considering disease selection is important in the design of an expert system, the main approach in the current study was diseases selected by experts and, therefore, the disease selection, according to an international classification (classified skin diseases in the twelfth chapter of the International classification of diseases book) and experts' need was the strength of this study.

The results of the second phase of the research, i.e. "determining clinical signs and diagnosis of the selected diseases", based on the semiology book of skin diseases, reliable skin websites with Delphi technique and preparation of a checklist and completing it by experts and their consensus resulted in a total of 106 symptoms for the diagnosis of the selected diseases. Saudi and Ali (2014) used Burkit's mouth medical books, reliable websites, and consensus of experts in designing the knowledge base of the expert system for diagnosis and management of oral ulcers (16). Zarandi and colleagues designed a fuzzy system of asthma diagnosis using necessity assessment of variables effective in disease diagnosis through interviews with experts and scientific resources (17), which is consistent with the current research in terms of method, while in some studies interviews with experts have only been used, like Seto et al. (2012) that used interviews with experts to design a knowledge base for monitoring cardiac patients (18) and Chu and Hwang (2008) who used Delphi technique to obtain information from experts in their study (19). Also, some resources have only used web resources, such as Patra and colleagues (2010) that designed an expert system to diagnose human diseases by obtaining the required information in the data acquisition phase from reliable databases and reference websites (20).

Some studies have also used a questionnaire, such as the Bucur and colleagues (2014) who used the psychometric questionnaire in assessing the expert system that determines the level of stress in children before dental administrations (21). Also, Toki et al. (2012) used a questionnaire in the design of online knowledge base expert system for evaluation of speech disorders in children (22), Maizels and Wolfe (2008) in the study of "expert system for diagnosis of headache" (23), and Doniz et al. (2007) in their study (1).

In the present study, 106 clinical symptoms were obtained for 5 complex skin diseases, according to the experts' opinions. In designing an expert system which will be used in diagnosis and treatment, extracting and determining the signs and symptoms of the diseases in question are key and important steps. Alhaji (2012) presented 73 common causes and symptoms with 71 causes in the study of 10 neurological diseases (15). Alotaiby (2012) designed a table including 57 causes of diseases related to chemical threats with their common symptoms (24). The mentioned researches have extracted all the symptoms of the assessed diseases. The current study also attempted to extract the common symptoms (Table 6). Given the importance of these cases, the current study used them and it is recommended that the experts' opinions and extraction of common symptoms should be taken into account in designing a detailed expert system.

Conclusion

As the expert system knowledge base is considered as the heart of the system, its detailed design is important. The choice of the selected diseases needed by specialists for designing the expert system knowledge base based on an international classification system and paying attention to the specialists' needs are necessary for designing a system.

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