Original Article

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TANAFFOS

Asthma Management System in Primary Care Based on Global Initiative for Asthma and Snell's Drug Interaction: Accuracy and Usability

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Background: The two main pillars of asthma management include regular follow-up and using guidelines in the treatment process. Patient portals enable regular follow-up of disease, and guideline-based decision-support-systems can improve the use of guidelines in the treatment process. Based on the Global Initiative for Asthma (GINA) and Snell's drug interaction, asthma management system in primary care (AMSPC) includes the capabilities of both mentioned systems. This system was developed to improve regular follow-up and use GINA in the asthma management process. This study aimed to assess the accuracy and usability of the AMSPC based on the GINA and Snell's drug interaction.

Materials and Methods: To assess the accuracy of the system, kappa test was used to calculate the degree of agreement between the suggestions made by the system and the physician's decision for a total of 64 patients selected through convenience sampling method. To assess usability, the Questionnaire for User Interface Satisfaction (QUIS) was used.

Results: The scores of the Kappa for the agreements between the system and the physician in determining "drug type and dosage", "follow-up time", and "drug interactions" were 0.90, 0.94, and 0.94, respectively. The average score of the QUIS was 8.6 out of 9.

Conclusion: Due to the high accuracy of the system in computerizing the GINA and Snell's drug interaction, as well as its proper usability, it is expected that the system be widely used to improve asthma management and reduce drug interactions.

Key words: Accuracy; Asthma management system; Drug interaction; Global Initiative for Asthma; Primary care; Usability

INTRODUCTION

Asthma is the fifth most common disease in the world, affecting about 300 million people and accounting for 250,000 deaths annually (1, 2). It is a chronic inflammatory disease of the airways which leads to symptoms, such as cough, chest tightness, wheezing, and shortness of breath (3).There is no definitive treatment for asthma, but if it is managed and controlled properly (2, 4) there would be a reduction in the risk of asthma attacks and asthma-related deaths (5, 6). The aim of asthma management is to control and eliminate symptoms of asthma with anti-inflammatory drugs and bronchodilators. Based on the severity of symptoms, asthma is managed at two levels of primary and secondary care provided by general physicians and

asthma and allergy specialists, respectively (5). More than 70% of asthmatic patients are managed at the primary care level; however, in more than half of them, the disease remains uncontrolled (7).

The use of guidelines or expert consensus-based documents for the treatment process and regular follow-up can improve the management of the disease in primary care setting (5, 7). One of the prominent expert consensus-based documents for asthma is the Global Strategy for Asthma Management and Prevention created by the Global Initiative for Asthma (GINA) in 2002, which is updated periodically (5).

Although there are so many guidelines and expert consensus-based documents for asthma drug interactions, Snell's category is the only one that explicitly explains the drug interactions and the ways to manage the side effects (8). Unfortunately, guidelines are rarely adopted by physicians due to the complexity of instructions and the required time for applying them (9). One of the solutions to this problem is to use a guideline-based decision support system (DSS) for each patient without wasting the physician's time. There are several DSSs for managing asthma, but some of them are based on national guidelines and cannot be generalized to other countries (10). Moreover, the guidelines created according to the GINA serve only as a calculator of asthma severity and drug dose but lack electronic medical records and databases (11).

Patient portals can improve a regular follow-up through telecommunication between physicians and patients and provide the possibility of refining medication regimens (8). Most patient portals are web-based; therefore, they would be easily accessible via search engines at any time and from any place, regardless of the type of operating system (12). Many patient portals have improved the regular follow-up and the management of asthmatic patients. This improvement has been more evident among patients with lower socioeconomic status (13).

Computerized information systems are widely used in medicine if they are highly accurate and usable (14, 15). There are several ways to assess the accuracy of these systems. The most common method is comparing their results with the gold standards (16). Although there are various methods to assess the usability of systems, such as rating scales, cognitive walkthrough, heuristic walkthrough, and think aloud testing, the rating scales are more popular due to their low cost and involving users in the usability assessment (15). Accordingly, the present study aimed to assess the accuracy and usability of the asthma management system in primary care (AMSPC) based on the GINA.

MATERIALS AND METHODS

AMSPC was developed at Iran University of Medical Sciences (IUMS) in 2019 to manage mild to moderate stages of asthma. The system uses a workflow-based method and is updated based on new guidelines. The workflow-based method depicts the processes applicable to a particular patient in a way in which all the operations and conditions necessary for their implementation, maps, rules, and resources are carefully defined. It also includes the necessary rules for establishing communication between healthcare organizations (17). In this method, the workflow of the desired guideline (in this study, the GINA and Snell's drug interactions) was first extracted using the Business Process Model and Notation (BPMN), and a conceptual model of the system was created. In the next step, ASP.NET-NVC 2015 and SQL-SERVER 2008 were used to develop the AMSPC. We used Snell's drug interactions because GINA does not cover asthma drug interactions. AMSPC consists of three user interfaces, including a physician, a secretary, and a patient whose relationship is shown in Figure 1. When a patient with asthma (in-person or e-visit) visits the medical center, the secretary fills in the related forms through his/her user interface (Figure 2). Then, the patient is added to the list of the physician's office visits (in the doctor's user interface). The physician can see the patient's medical record in his/her user interface by clicking on the patient's name. She/he obtains the best possible medication history and

data about the patient's condition and enters the information into the AMSPC to get some information about drug type and dosage, drug interactions, as well as the follow-up time. Then, she/he determines the patient's action plan and follow-up time. The patient, on the other hand, would be able to view this action plan and follow-up time in his/her user interface (Figure 3). This process is done in-person at the first visit of the patient, but in other visits, according to the diagnosis of the physician, it can be done electronically (18).

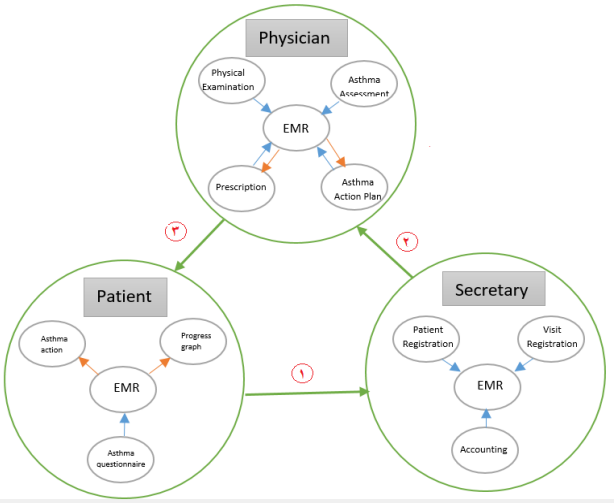

Figure 1. Functions and relationships between the patient, secretary and physician interfaces in the ASMPC

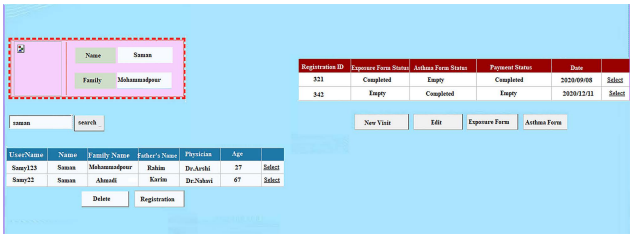

Figure 2. Physician user interface in the AMSPC

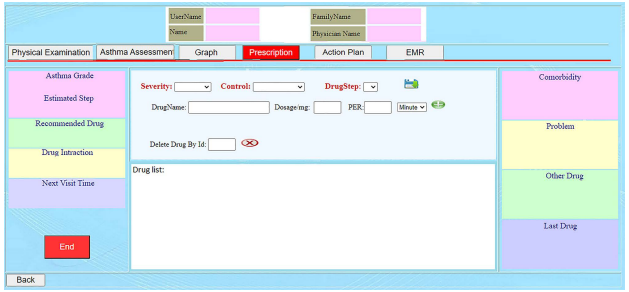

Figure 3. Physician user interface in the AMSPC

The study environment and participants

Accuracy

To determine the sample size, the values of H_0 and H_1 according to Gwet study (19), were specified as 0.8 and 0.6, respectively. The number of categories (k) for the three variables of "drug type and dose", "follow-up time", and "drug interactions" were 8, 4, and 4, respectively. Nevertheless, for more accuracy, the value of "k" was considered 4. Alpha and beta values were considered 0.025 and 0.09, respectively. Finally, the sample size (N=64) was calculated using the PASS.15.0.5 (20). Using the convenience sampling method, 64 asthmatic patients referring to the Asthma and Allergy Clinic of Hazrat-e Rasoul Akram General Hospital in Tehran, Iran were selected as the participants. The inclusion criteria were the definitive diagnosis of asthma and willingness to cooperate in this study.

Usability

Usability assessment was performed by ranking scales method. The participants consisted of physicians, secretaries, and patients in Hazrat-e Rasoul Akram General Hospital. There were 56 participants, including 16 asthma and allergy specialists, eight secretaries, and 32 asthmatic patients. The selected patients were each under the supervision of one of the physicians participating in the study.

Study process

Accuracy

In this study, the physician used the GINA and Snell's drug interactions to manage and treat the patients. She determined "drug type and dosage", "follow-up time", and "drug interactions" and simultaneously registered patients' information in the AMSPC, which independently generated recommendations for "drug type

and dosage", "follow-up time", and "alerted drug interactions". AMSPC was provided to all participants for one week, and each participant used the AMSPC at least once during the study.

Data collection and analysis

Accuracy

Simultaneously with the patient visit, the physician entered the relevant data into AMSPC. Kappa test was used to analyze the collected data and measure the degree of agreement between the suggestions generated by the AMSPC and the physician's decision regarding "drug type and dosage", "follow-up time" and "drug interactions".

Usability

The standard Questionnaire for User Interface Satisfaction (QUIS) version 5.5 was used to collect the data (21). During the data collection process, the secretary, after registering the patient, filled out QUIS and referred the patient to the physician who also filled out QUIS after registering the patient information. Finally, the patient filled out QUIS after observing the doctor's instructions and completing the related forms. Data were analyzed by the Statistical Package for the Social Sciences (SPSS. 22) using descriptive statistics, such as mean, frequency, and frequency percentage.

RESULTS

Accuracy

To assess the accuracy of the AMSPC, the decisions made by the physician were compared with the recommendations of the system (Table 1).

The kappa coefficient for the agreement between the AMSPC and the physician in terms of "drug type and dosage" was 0.9 (Table 2).

The kappa coefficient for the agreement between the AMSPC and the physician in terms of "follow-up time" was 0.941 (Table 3).

The kappa coefficient for the agreement between the AMSPC and the physician in terms of "drug interactions" was 0.94 (Table 4).

Usability

The personal information of the participants assessing the usability of the AMSPC consisted of age, gender, education, computer literacy, and the duration of diagnosis (Table 5).

The average usability scores of the AMSPC were presented separately by the user's role in Table 6. As can be seen, the questions are categorized in five domains of "overall function", "screen", "terms and information", "learnability", and "overall capability". The mean and standard deviation of the overall usability of the AMSPC were 8.51 and 0.57, respectively.

Table 1. Demographic information of the patients

Ages	Illiterate/ Elementary (%)		Diploma (%)		Bachelor's degree and higher (%)		Total	
	Man	Woman	Man	Woman	Man	Woman	Man	Woman
0-4	10 (15.6)	16 (25)	0 (0)	0 (0)	0 (0)	0 (0)	10 (15.6)	16 (25)
5-9	2 (3.1)	3 (4.5)	0 (0)	0 (0)	0 (0)	0 (0)	2 (3.1)	3 (4.5)
10-14	4 (6.2)	2 (3.1)	0 (0)	0 (0)	0 (0)	0 (0)	4 (6.2)	2 (3.1)
15-19	2 (3.1)	2 (3.1)	3 (4.5)	1 (1.5)	0 (0)	0 (0)	5 (7.8)	3 (4.5)
20-29	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.5)	0 (0)	1 (1.5)
30-39	0 (0)	0 (0)	0 (0)	2 (3.1)	0 (0)	1 (1.5)	0 (0)	3 (4.5)
40-49	0 (0)	1(1.5)	2 (3.1)	0 (0)	1 (1.5)	1 (1.5)	3 (4.5)	2 (3.1)
50+	2 (3.1)	5 (7.8)	2 (3.1)	0 (0)	0 (0)	1 (1.5)	4 (6.2)	6 (9.4)
All Ages	20 (31.2)	29 (45.3)	7 (11)	3 (4.5)	1 (1.5)	4 (6.2)	28 (43.7)	36 (56.3)

Table 2. The result of Kappa test for the degree of agreement between the AMSPC and the physician in terms of "type and dose of drug"

		System Drug Type							
		SABA	SABA+ LOW ICS	SABA+LABA +LOW ICS	SABA+ MED ICS	SABA+MED ICS+LABA	Refer to Specialist	Repeat Previous treatment	Total
Physician Drug Type	SABA	2	2	0	0	0	0	0	4
	SABA+LABA	0	0	0	1	0	0	0	1
	SABA+LOW ICS	1	22	2	0	0	0	0	24
	SABA+LABA+LOW ICS	0	0	6	0	0	0	0	6
	SABA+MED ICS	0	0	0	7	0	0	0	7
	SABA+MED ICS+LABA	0	0	0	0	2	0	0	2
	Refer to Specialist	0	0	0	0	0	7	0	7
	Repeat Previous treatment	0	0	0	0	0	0	13	13
	Total	2	24	8	8	2	7	13	64

			Value	Asymp. Std. Error	Approx. T	Approx. Sig.
Measure of Agreement		Kappa	0.900	0.043	14.925	0.000000

Note: SABA: Short-Acting Beta-Agonist; LABA: Long-Acting Beta-Agonist; LOW ICS: LOW Inhaled Corticosteroids.

Table 3. The result of Kappa test for the degree of agreement between the AMSPC and the physician in terms of "follow up time"

			System Follow up Time			
			One Week	One Month	Three Months	Total
Physician Follow Up Time	One Week		3	0	0	3
	One Month		0	25	2	27
	Three Months		0	0	34	34
	Total		3	25	36	64

			Value	Asymp. Std. Error	Approx. T	Approx. Sig.
Measure of Agreement		Kappa	0.941	0.041	8.542	0.000000

Table 4. The result of Kappa test for the degree of agreement between the AMSPC and the physician in terms of “drug interactions”

		System Drug Interaction				
		Non-Interaction	Drug interaction - Avoiding concomitant use- monitor serum Potassium levels	Drug interaction - Risk of exacerbation	Drug interaction - Avoiding concomitant use- monitor serum Potassium levels- Risk of exacerbation	**Total**
Physician Drug Interaction	Non- Interaction	54	1	0	0	55
	Drug interaction - Avoiding concomitant use- monitor serum Potassium levels	0	7	0	0	7
	Drug interaction - Risk of exacerbation	0	0	0	1	1
	Drug interaction - Avoiding concomitant use- monitor serum Potassium levels- Risk of exacerbation	0	0	0	1	1
	Total	54	8	0	2	64

		Value	Asymp. Std. Error	Approx. T	Approx. Sig.
Measure of Agreement	**Kappa**	0.940	0.060	8.987	0.000000

Table 5. The personal information of the participants assessing the usability of the AMSPC

Physicians									
Age		Work experience		Education (%)		Sex (%)		Computer literacy*	
Mean	S.D	Mean	S.D	Expert	Assistant	Male	Female	Mean	S.D
51.12	8.39	9.75	6.28	5 (62.5)	3(37.5)	6(75.0)	2(25.0)	15.5	1.73

Patient										
Age			Education (%)			Sex (%)		Duration of diagnosis**		Computer literacy
Mean	S.D	Illiterate/ Elementary	Diploma	BH and higher		Male	Female	Mean	S.D	Mean	S.D
35	20.02	4 (25.0)	8 (50.0)	4 (25.)		6 (37.5)	10 (62.5)	6.25	4.23	10.25	3.90

Secretary								
Age		Education (%)			Sex (%)		Computer literacy	
Mean	S.D	Diploma	BH	MSc	Male	Female	Mean	S.D
32.5	3.90	0(0.0)	3 (75.0)	1 (25.0)	3(75.0)	1(25.0)	14.5	2.22

* using Computer Literacy And Internet Knowledge Test: 0-13(Not Proficient), 14-17 (Proficient), 18-20 (Highly Proficient).

** The unit of measurement is "Year".

Table 6. The results of the AMSPC assessment using QUIS by question and user role

		Physician		**Secretary**		**Patient**		**Total**	
		Mean ±S.D	**N (%)**	**Mean ±S.D**	**N (%)**	**Mean ±S.D**	**N (%)**	**Mean ±S.D**	**N (%)**
Overall function	Overall system performance	8.63±0.52	16(100)	8.50±0.50	8(100)	8.75±0.46	32(100)	8.65±0.49	56(100)
	System difficulty	8.63±0.74	16(100)	8.50±0.50	8(100)	8.88±0.35	32(100)	8.70±0.54	56(100)
	Feeling about the system	8.13±1.13	16(100)	9.00±0.00	8(100)	8.88±0.35	32(100)	8.60±0.59	56(100)
	General system design	8.25±0.75	16(100)	8.25±0.50	8(100)	8.13±0.83	32(100)	8.20±0.71	56(100)
	Continuous work with the System	8.50±0.57	15(94)	8.00±0.00	8(100)	8.38±0.74	32(100)	8.35±0.52	55(98)
	System configuration	8.00±0.75	16(100)	8.75±0.50	8(100)	8.38±0.74	31(97)	8.30±0.70	55(98)
	Average	**8.35±0.77**	**15.8(99)**	**8.58±0.33**	**8 (100)**	**8.56±0.58**	**31.8(99)**	**8.48±0.56**	**55.6(99)**
Screen	Readability	7.63±0.92	16(100)	7.50±1.00	8(100)	8.50±0.92	32(100)	7.95±0.93	56(100)
	Specific phrases to facilitate tasks	8.38±0.74	16(100)	9.00±0.00	8(100)	9.00±0.00	32(100)	8.75±0.30	56(100)
	Organizing information	8.75±0.46	16(100)	9.00±0.00	8(100)	8.75±0.46	32(100)	8.80±0.39	56(100)
	Sequence of screens	8.75±0.71	16(100)	9.00±0.00	8(100)	8.63±0.74	32(100)	8.75±0.66	56(100)
	Average	**8.38±0.71**	**16(100)**	**8.63±0.25**	**8 (100)**	**8.72±0.53**	**32(100)**	**8.57±0.50**	**56(100)**
Terms and information	Use of terms	7.88±0.64	16(100)	8.75±0.50	8(100)	8.50±1.07	32(100)	8.30±0.78	56(100)
	Relevant terms	8.38±0.74	16(100)	9.00±0.00	8(100)	8.75±0.71	31(97)	8.65±0.58	55(98)
	Location of messages	8.25±0.89	16(100)	8.75±0.50	8(100)	8.88±0.35	32(100)	8.60±0.57	56(100)
	Messaging to record essential data	8.50±0.53	16(100)	8.75±0.50	8(100)	8.88±0.35	32(100)	8.70±0.45	56(100)
	Task completion messaging	8.50±0.76	16(100)	8.75±0.50	8(100)	8.88±0.35	32(100)	8.70±0.45	56(100)
	System error messaging	8.37±0.75	16(100)	9.00±0.00	8(100)	8.88±0.35	32(100)	8.70±0.44	56(100)
	Average	**8.31±0.72**	**16(100)**	**8.88±0.25**	**8 (100)**	**8.79±0.53**	**31.8(99)**	**8.66±0.50**	**55.8(99)**
Learnability	Learning to work with the system	8.88±0.35	14(87)	9.00±0.00	7(87)	9.00±0.00	32(100)	8.95±0.14	53(95)
	Finding properties through trial	8.75±0.71	16(100)	8.75±0.50	8(100)	9.00±0.00	32(100)	8.85±0.38	56(100)
	Memorization of using the system	8.63±0.74	16(100)	8.75±0.50	8(100)	8.88±0.35	30(94)	8.75±0.54	54(96)
	Perform tasks quickly and easily	8.88±0.35	16(100)	9.00±0.00	8(100)	8.75±.071	32(100)	8.85±0.42	56(100)
	On-screen help messages	8.38±0.91	16(100)	8.75±0.50	8(100)	9.00±0.00	32(100)	8.70±0.46	56(100)
	System guide	8.38±0.91	15(94)	8.25±1.25	8(100)	8.75±0.71	32(100)	8.50±0.95	55(98)
	Average	**8.65±0.67**	**15.5(97)**	**8.75±0.50**	**7.8(98)**	**8.90±0.29**	**31.6(99)**	**8.76±0.48**	**55(98)**
Overall capability	System speed	8.38±0.74	16(100)	8.75±0.50	8(100)	9.00±0.00	32(100)	8.70±0.40	56(100)
	System availability	7.88±1.13	16(100)	8.75±0.50	8(100)	9.00±0.00	30(94)	8.50±0.55	54(96)
	Number of system capabilities	8.13±0.99	16(100)	8.50±0.58	8(100)	8.13±1.35	32(100)	8.20±1.05	56(100)
	Ability to correct user errors	8.50±0.76	16(100)	9.00±0.00	8(100)	8.50±0.93	32(100)	8.60±0.68	56(100)
	Design to suit different users	8.13±0.99	16(100)	8.75±0.50	8(100)	8.75±0.46	32(100)	8.50±0.68	56(100)
	Average	**8.20±0.92**	**32(100)**	**8.75±0.42**	**8 (100)**	**8.68±0.55**	**31.6 (99)**	**8.54±0.63**	**55.6(99)**
	Total	8.48±0.56	15.8(99)	8.57±0.50	8(100)	8.66±0.50	31.7(99)	8.51±0.57	55.6(99)

DISCUSSION

Asthma management is the only way to deal with it. However, managing the disease faces many challenges, including inter alia, irregular follow-up, and inappropriate treatment. According to the studies, the development of clinical decision support systems based on national and international guidelines and the provision of telecommunication between physicians and patients can be the best way to eliminate the challenges (10, 13). Therefore, the current study focused on reviewing and assessing AMSPC.

Healthcare applications are developed for the betterment of human life; however, their accuracy is of particular importance (14). In this study, the kappa value for comparing the suggestions by the AMSPC and the physician in terms of "drug type and dosage", "follow-up time", and "drug interactions" was higher than 0.8, which according to Gwet's study, indicates an excellent agreement between the two groups (19).

The results also revealed a 90% agreement between the suggestions made by the AMSPC and the physician in determining "drug type and dosage"; conversely, there was a difference between the two on "drug type and dosage" for five patients. The reason for these differences was that the physician considered the patients' mental state while prescribing the medicine. In other words, the physician did not change medications for those patients whose symptoms got worse due to mental disorders, whereas the system increased the dose of the drug. The guideline-based DSS for the treatment of asthma by Dexheimer et al. was 87% accurate in determining "drug type and dosage". The system error (13%) was investigated and the analysis showed that the comorbidity was not taken into consideration (10). Comorbidities and adherence were considered in the design phase of the AMSPC (18).

There was also a 94% agreement between the suggestions provided by the AMSPC and the physician in determining "follow-up time"; however, a difference was observed in setting "follow-up time" for two patients, that is, the physician set the "follow-up time" earlier than the time suggested by the AMSPC because the physician considered the patients' socio-educational condition. In other words, the physician set "follow-up time" earlier for the patient with lower socio-educational condition.

The results further indicated a 94% agreement between the alerts generated by the AMSPC and the physician's decisions regarding "drug interactions"; nevertheless, there was a difference between the two in finding "drug interactions" for one patient. Namely, the physician did not diagnose "drug interactions" for the patient because she was not aware of the patient's other medications at the time of prescribing.

Due to the value of time in patients' treatment process, healthcare providers do not use any software that causes delays in the process. Therefore, usability is one of the main pillars of clinical software (14). The overall usability score of the AMSPC was 8.61 out of 9. The scores of the five domains, i.e., "overall function", "screen", "terms and information", "learnability", and "overall capability" were 8.5, 8.57, 8.66, 76.8, and 8.54, respectively.

Therefore, the usability of the AMSPC in this study in all domains was at a good level since according to Mohammadpour et al., the results of the QUIS are classified into three categories: bad (0 to 3), moderate (3.1 to 6) and good (6.1 to 9) (18). Similarly, Hasannezhad assessed the usability of their system by using QUIS, which indicated a good usability of the system, except that the values of "overall function" (7.38), "screen" (8.12), "terms and information" (7.9), "learnability" (06.06), and "overall capability" (7.8) were less than the values obtained for the AMSPC. Nevertheless, their system was well used (22).

The main limitation of this study was the patients' limited experience of technology; therefore, they were unable to make optimal use of the system. To solve the problem, the patients received adequate training in several sessions.

CONCLUSION

In conclusion, considering the high accuracy of the AMSPC in computerizing the GINA and its proper

usability, it is expected that the system be widely used and improve asthma management. Furthermore, due to the high ability of the AMSPC in detecting drug interactions, it is expected to reduce drug interactions for asthmatic patients too.

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Declaration of interest

The authors report no conflicts of interest.

REFERENCES

1. Nunes C, Pereira AM, Morais-Almeida M. Asthma costs and social impact. ***Asthma Res Pract*** 2017;3:1.
2. Lundbäck B, Backman H, Lötvall J, Rönmark E. Is asthma prevalence still increasing? ***Expert Rev Respir Med*** 2016;10(1):39-51.
3. O'Byrne PM, Pedersen S, Schatz M, Thoren A, Ekholm E, Carlsson LG, et al. The poorly explored impact of uncontrolled asthma. ***Chest*** 2013;143(2):511-23.
4. Becker AB, Abrams EM. Asthma guidelines: the Global Initiative for Asthma in relation to national guidelines. ***Curr Opin Allergy Clin Immunol*** 2017;17(2):99-103.
5. Global Initiative for Asthma. Global strategy for asthma management and prevention, 2020. [Accessed 2020 Agust 16].
6. Ahmed S, Tamblyn R, Winslade N. Using decision support for population tracking of adherence to recommended asthma guidelines. ***BMJ Open*** 2014;4(3):e003759.
7. Sheehan WJ, Phipatanakul W. Difficult-to-control asthma: epidemiology and its link with environmental factors. ***Curr Opin Allergy Clin Immunol*** 2015;15(5):397-401.
8. Snell NJ. Drug interactions with anti-asthma medication. ***Respir Med*** 1994;88(2):83-8.
9. Wang Z, Norris SL, Bero L. The advantages and limitations of guideline adaptation frameworks. ***Implement Sci*** 2018;13(1):72.
10. Dexheimer JW, Gu L, Guo Y, Johnson LH, Kercsmar C. Design and implementation of the asthma treat smart system in a pediatric institution. ***Knowledge Management & E-Learning: An International Journal*** 2015;7(3):353-66.
11. Gholamzadeh M, Abtahi H, Gharabaghi M, Taleb Z, Amini S. Improving gina adoption by designing a mobile based clinical decision support system. ***Eur Respir J*** 2018;52(Suppl 62): OA1683.
12. Mathe JL. The precise construction of patient protocols: Modeling, simulation and analysis of computer interpretable guidelines. Vanderbilt University; 2012.
13. Apter AJ, Bryant-Stephens T, Perez L, Morales KH, Howell JT, Mullen AN, et al. Patient Portal Usage and Outcomes Among Adult Patients with Uncontrolled Asthma. ***J Allergy Clin Immunol Pract*** 2020;8(3):965-70.
14. Stamelos I, Vlahavas I, Refanidis I, Tsoukiàs A. Knowledge based evaluation of software systems: a case study. ***Information and Software Technology*** 2000;42(5):333-45.
15. Kim HM, Lowery JC, Hamill JB, Wilkins EG. Accuracy of a web-based system for monitoring chronic wounds. ***Telemed J E Health*** 2003;9(2):129-40.
16. Dumas JS, Salzman MC. Usability assessment methods. ***Reviews of human factors and ergonomics*** 2006;2(1):109-40.
17. Panzarasa S, Bellazzi R, Larizza C, Stefanelli M. A careflow management system for chronic patients. ***Stud Health Technol Inform*** 2004;107(Pt 1):673-7.
18. Mohammadpour S. Providing a system for management asthma in primary care [Master thesis]. Tehran: Iran University of Medical Sciences; 2019.
19. Gwet KL. Handbook of inter-rater reliability: The definitive guide to measuring the extent of agreement among raters. Advanced Analytics, LLC; 2014.
20. Flack VF, Afifi AA, Lachenbruch PA, Schouten HJ. Sample size determinations for the two rater kappa statistic. ***Psychometrika*** 1988;53(3):321-5.
21. Alexandru CA. Usability testing and improvement of telemedicine websites. M. Sc. diss. University of Edinburgh. Edinburgh. 2010.
22. Hasannezhad M. Developing a web-based system for self-care management of type 1 diabetes[Master thesis]. Tehran: Iran University of Medical Sciences; 2013.