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Retrospective Analysis of the Repeat Prescribing Pattern for Diabetic Patients Consuming Insulin

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Abstract

Introduction: People with chronic diseases need to regularly visit the doctor to renew their prescriptions, which cause more cost and discomfort for patients. Designing a repeat prescription system can be helpful. However, it needs knowledge about the prescription repeat profile for the intended disease. This study aimed to evaluate the repeat pattern of outpatient prescriptions for diabetic patients consuming insulin.

Methods: In this cross-sectional study, prescriptions written between 2013 to 2021 for 200 diabetic patients were evaluated in Hamadan, Iran. Data on total number of regimens and prescriptions, type of prescribed insulins in each regimen, intervals between prescriptions, duration of regimen consumption, and number and type of changes made between two regimens underwent descriptive statistical analysis.

Results: 10148 prescriptions –belonged to 200 patients (121 males and 79 females)- were examined. The average prescriptions number for a person was 2.65 ± 1.21 and the mean interval between two prescriptions was 1.71 ± 0.80 months. The highest number of medication regimens experienced by the cases was six. The most frequent changes made in insulin regimen were deletion and addition as well as addition itself.

Conclusion: It seems that currently, in terms of patient referrals for repeated insulin prescriptions for diabetic patients, doctors have moved to some extent towards eliminating unnecessary referrals. However, if higher efficiency of this process is intended, designing a system considering clinical status of each patient seems necessary. Artificial intelligence and machine learning may be helpful to this end.

Keywords: Diabetes, Insulin, Repeat Prescription, Health Costs, Prescription Refill

1. Introduction

Diabetes mellitus (DM), is a group of prevalent hormonal disorders marked by consistently elevated levels of glucose in the bloodstream. The condition arises from insufficient insulin production by the pancreas or inadequate response of the insulin receptors to the insulin produced. This disease can be inherited or acquired [1]. In 2019, there were 463 million people living with diabetes worldwide, making up approximately 8.8% of the adult population. Type 2 DM accounted for about 90% of all diagnosed cases [2]. The prevalence of this disease continues to rise, particularly in low-and middle-income countries [3]. DM ranks as the seventh leading cause of death worldwide [4], and its healthcare expenditure is estimated to reach USD 760 billion per year [5]. Considering that long-term health conditions exert a significant burden on health systems [6], finding effective approaches to improve the efficiency of their treatments can be of significant value to achieve saving. One of the potential sources of wastage may be the non-optimal time interval between two consecutive doctor visits to repeat prescriptions; multiple studies have investigated the expenses linked to dispensing prescriptions for either longer (3 months) or shorter (1 month) durations [7-11]. In general, some findings indicated that shorter prescriptions were associated to decreased wastage of the medicines. However, other adverse consequences usually outweighed these savings; these consequences included: increased costs of transaction, administrative burden on general practitioners and pharmacy dispensing [11, 12], patient expenses by making frequent visits to the pharmacist [11], and decreased medication adherence and patient satisfaction [13, 14]. There is substantial variation in prescription lengths across different countries and even within the same country. For instance, thyroid prescriptions can range from 28 days in France to 6 months in Australia [15]. In the Canadian province of Quebec, prescription durations across all therapeutic areas were approximately half the duration of those in the rest of Canada [16]. Then, various studies are needed to provide enough knowledge about the profile of prescription repeat in different disease and societies. Considering that frequent need to visit the doctor has potential to reduce patient medication adherence in chronic diseases

considerations, effort to understand the profile of the repeat prescription in various chronic diseases is valuable. DM is one of the relatively high prevalent long term illnesses that weak medication adherence can lead remarkable challenges for both patients and health systems. Therefore, the present study was dedicated to investigate the pattern of prescription repetition in patients with DM.

2. Methods and Materials

2.1 Data Collection

This cross-sectional study was conducted among patients with diabetes mellitus admitting to outpatient diabetes clinics of Hamedan, Iran from 2013 to 2021. Considering the need for access to the prescriptions data, among this population, individuals with Salamat Health Insurance were selected as participants. The inclusion criteria encompassed access to diabetes prescription data, passing at least 3 years after the diagnosis and starting the treatment for DM, and having at least 5 insulin prescriptions during the study period. Finally, a total of 200 participants entered the study and their demographic data and information about their insulin prescriptions during the study period were extracted. These data included age, sex, the first and last prescription date, total number of regimens and prescriptions, type of prescribed insulins in each regimen, intervals between prescriptions, and duration of regimen consumption.

2.2 Statistical Analysis

Descriptive statistics including mean ± standard deviation (SD), frequency, and percentage were used in this study. Study variables including age, sex, total number of regimens and prescriptions, type of prescribed insulins in each regimen, intervals between prescriptions, duration of regimen consumption, number and type of changes made between two regimens were evaluated descriptively. Statistical analysis was done using SPSS software (Statistical Package for the Social Sciences, version 16.0, SPSS Inc., Chicago, III, USA).

2.3 Ethical Considerations

The study was approved by the Ethics Committee of the Hamadan University of Medical Sciences, Hamadan, Iran (ID: IR.UMSHA.REC.1400.063) and were in accordance with 1964 Helsinki declaration and its later revisions.

3. Results and discussion

3.1 Results

Table 1: Descriptive statistics of patients' age and prescribed regimens

	Age	Total prescriptions	Total regimens
Mean (months)	58.62	50.74	2.65
Standard deviation	13.29	19.58	1.21
Median	60.00	50.74	2.50
Minimum	15	16	1
Maximum	86	107	6

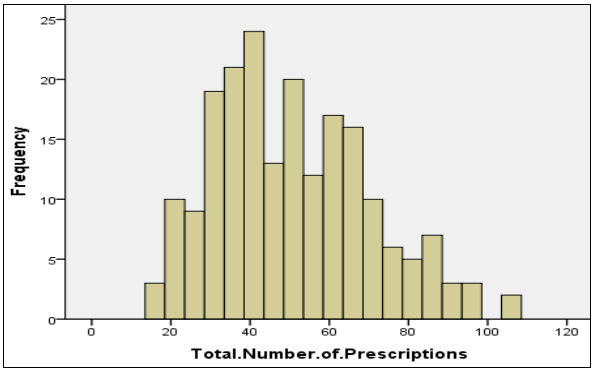


Fig 1: Distribution of total number of prescriptions

Table 2: Frequency of prescribed regimens among all the participants

	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5	Reg 6	Total
Glargine & Aspart	51	42	19	19	1		**132**
Aspart	44	39	16	2			**101**
Glargine	40	20	22	3	4		**89**
Biphasic	3		2				**5**
Aspartmix	2	40	29	18	4	2	**95**
Glargine & Apidra		7	4	2			**13**
Aspart, NPH[a] & Reg[b]		4					**4**
Glargine, NPH & Reg	3						**3**
Detemir	3		2	3			**8**
Glargine, NPH & Reg, Aspart		2					**2**
Aspart & Detemir			2	3	3		**8**
Aspart mix, NPH & Reg				2			**2**
Total	**140**	**160**	**96**	**52**	**12**	**2**	**462**

a: Neutral Protamine Hagedorn insulin, b: Regular insulin

Table 3: Frequency of prescribed regimens according to duration of action

	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5	Reg 6	Total
Rapid	44	39	16	2			**101**
Long	40	23	24	6	4		**97**
Short & intermediate	62	2	6		1		**71**
Rapid & long	51	49	25	24	4		**153**
Rapid & intermediate	3	40	29	18	4	2	**96**
Short & intermediate & long		2					**2**
Short & intermediate & rapid		5		2			**7**
Short & intermediate & rapid & long		2					**2**
Total	**200**	**162**	**100**	**52**	**13**	**2**	**529**

10148 prescriptions obtained from 200 individual patients were assessed. Table 1 summarizes the cases' characteristics. 121 cases (60.5%) were women and 79 (39.5%) were men. The result of the Shapiro-Wilks test showed that the age distribution of the samples was not normal (P<0.001). The average age was 58.62 ± 13.29. The average number of prescriptions for a patient was 50.74 ±

19.58 and its minimum and maximum were 16 and 107 (Fig 1). The mean number of medication regimens for one participating individual was 2.65 ± 1.207, with the highest and lowest number of 6 and 1. Out of 200 participants, 38 cases (19.0%) experienced one treatment regimen, 62 individuals (31.0%) received two treatment regimens, 48 patients (24.0%) received three treatment regimens, 39 individuals (19.5%) received four treatment regimens, 11 individuals (5.5%) received five treatment regimens, and 2 ones (1.0%) experienced six treatment regimens. Table 2 shows the frequency of the prescribed regimens by the number of regimen. Table 3 demonstrates the frequency of prescribed regimens according to duration of action.

Table 4: Descriptive data of intervals between the repeated prescriptions for every regimen

Regimen	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Number	182	161	98	52	13	2
Mean (months)	1.78	1.61	1.78	1.63	1.85	2.00
Standard deviation	0.955	0.662	0.819	0.658	0.689	0.000
Median	2.00	2.00	2.00	2.00	2.00	2.00
Minimum	1	1	1	1	1	2
Maximum	7	5	5	3	3	2

Table 4 demonstrates the descriptive data of time intervals between the repeated prescriptions for every regimen. The average interval between two prescriptions was 1.71 ± 0.81 months. The minimum and maximum time intervals between two prescriptions were 1 and 7 months, respectively. Kruskal-wallis test revealed no significant differences between first and other next regimens regarding the time interval between two consequent prescriptions (p-value= 0.494). Considering the very low frequency of the regimens 5 and 6, these groups were not included in this comparison, to avoid misleading result.

Table 5: Descriptive statistics of treatment duration in different treatment regimens

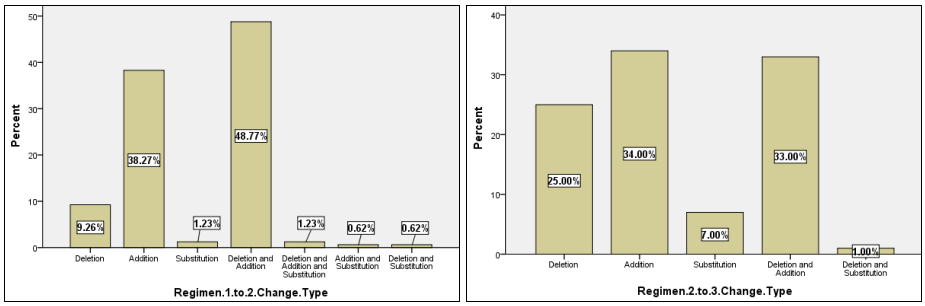
Regimen	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Number	182	161	98	52	13	2
Mean (months)	30.92	31.69	26.30	25.83	18.23	10.00
Standard deviation	26.047	22.181	17.355	19.105	12.775	8.485
Median	27.50	29.00	23.00	18.00	20.00	10.00
Minimum	2	2	3	3	2	4
Maximum	132	118	80	72	45	16

Table 5 summarizes the duration that repeat prescription has been continued for every regimen. The average duration of using a treatment regimen was 29.34 ± 22.50 months. The minimum and maximum duration of using a treatment regimen was 2 and 132 months, respectively.

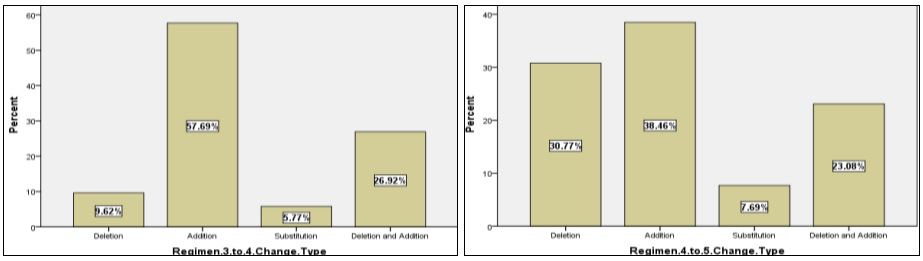
Table 6: Descriptive statistics of number of changes made in regimens prescriptions

	Regimens 1-2	Regimens 2-3	Regimens 3-4	Regimens 4-5	Regimens 5-6
Number	162	100	52	13	2
Mean (months)	2.09	1.62	1.62	1.77	3.00
Standard deviation	1.152	0.885	1.013	1.013	0.000
Median	2.00	1.00	1.00	1.00	3.00
Minimum	1	1	1	1	3
Maximum	4	4	4	4	3

Descriptive statistics related to the number of changes implemented in the prescriptions can be observed in table 6. The average number of changes implemented in the treatment regimen was 1.87 ± 1.1. The minimum and maximum number of changes were 1 and 4. The mean number of changes made from regimens 1 to 2, 2 to 3, 3 to 4, 4 to 5, and 5 to 6 was 2.09 ± 1.15, 1.62 ± 0.88, 1.62 ± 1.01, 1.77 ± 1.01, and 3.00 ± 0.00, respectively. Out of 162 implemented changes between first and second regimens, 79 cases (48.8%) were related to addition and deletion, 62 cases (38.3%) were related to addition, 15 cases (9.3%) were related to deletion, 2 cases (1.2%) were related to within-group substitution, 2 cases (1.2%) were related to deletion, addition, and within-group substitution, 1 case (0.6%) was related to addition and within-group substitution, and 1 case (0.6%) was related to deletion and within-group substitution Also, of 100 implemented changes between second and third regimens, 34 cases (34.0%) were related to addition, 33 cases (33.0%) were related to addition and deletion, 25 cases (25.0%) were related to deletion, 7 cases (7.0%) were related to within-group substitution, and 1 case (1.0%) was related to deletion and within-group substitution. There were 52 implemented changes between third and fourth regimens, of which 30 cases (57.7%) were related to addition, 14 cases (26.9%) were related to addition and deletion, 5 cases (9.6%) were related to deletion, and 3 cases (5.8%) were related to within-group substitution. Furthermore, out of 13 implemented changes between fourth and fifth regimens, 5 cases (38.5%) were related to addition, 4 cases (30.8%) of deletion, 3 cases (23.1%) of deletion and addition, and 1 case (7.7%) of intra-group substitution. Finally, of 2 implemented changes between fifth and sixth regimens, both cases (100%) involved deletion and addition (Fig 2).



A B



C D

Fig 2: Frequency of type of changes made between two consecutive regimens. A: between first and second regimens; B: between second and third regimens; C: between third and fourth regimens. D: between fourth and fifth regimens

Fig 3 demonstrates the frequency of regimen types by regimen sequence. Since the frequency of the patients experiencing the fifth and sixth regimen were very low, these two were not included in this figure.

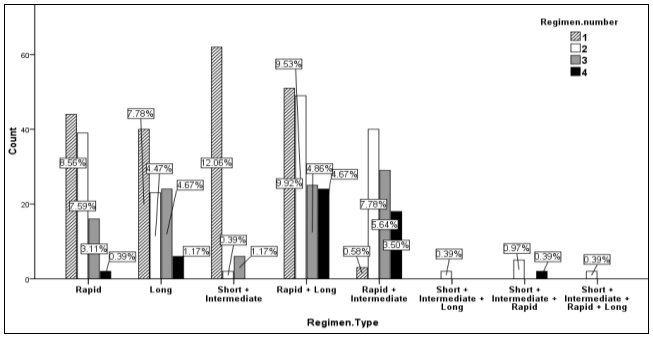


Fig 3: Frequency of regimen types by regimen sequence

3.2 Discussion

The significance of establishing suitable timeframes for diabetic patients to revisit their healthcare providers and receive insulin regimens is crucial. This issue not only affects patient adherence to the treatment regimen but also holds economic significance for both patients and insurance organizations. This saving can be achieve both directly- by reducing the cost of doctor visit- and indirectly; the study conducted by Sokol, *et al.* [17] demonstrated that patients who comply with the prescribed medications, witness a significant cost reduction in their treatment.

In the present study the pattern of prescription repetition was investigated among diabetic persons receiving insulin treatment. According to our results, the average number of prescription repetitions per person during the study period was 74.50, with the minimum and maximum numbers of prescriptions being 16 and 107, respectively. Notably, more than 70% of the study participants had three or fewer prescribed regimens. The study findings showed no significant differences between first and other regimens regarding the time interval between two consequent prescriptions. These findings can be justified by considering the needed time and regimen switches to achieve the appropriate insulin type and optimal dosage in some patients.

More practically discussing the findings of the present study, it can be found that prescriptions are generally prescribed for longer durations until the second or third treatment regimen. Conversely, for patients that their medication regimen needs more than three times of change, shorter interval between the doctor's visit is inevitable, leading in higher healthcare costs.

Multiple studies have shown the positive correlation between the prescription repeat interval and patient adherence, in chronic diseases. For instance, Martin, *et al.* [18] showed that 3-month repeat prescriptions, in contrast to monthly prescriptions, significantly enhanced patient adherence to the treatment regimen. Additionally, a number of other observational studies demonstrated that a longer duration between prescription refills is accompanied by a noticeable decrease in the overall financial costs. These findings highlight the potential cost-saving advantages associated with the integration of longer time intervals between doctors' visits to repeat the same prescriptions [7, 19]. On the other hand, some researches comparing long-term and short-term treatment regimens in chronic diseases showed that while prescribing medications for an extended period reduces some costs, it also leads to an increase in medication wastage [11, 15, 20, 21].

In our study, the most prevalent changes occurred among the treatment regimens were additions, and deletion concomitant with addition. Regarding the number of the changes, until the third treatment regimen, the average number of changes decreased. However, after the third regimen, the average number of changes increased. This reminds that although the goal of reducing the need for prescriptions changes and doctors' visits in chronic diseases results in cost reduction, solely focus on this aspect is not possible, and the patients' clinical status should be considered. This brings to mind the potential benefits of using the individualized medicine approach for designing future systems.

The present study suffers from a limitation; because of the lack of access to the data on patients' concomitant diseases and clinical variables, it was not possible to examine the relationship between these variables and the pattern of prescriptions change. Therefore, this matter was not included in the objectives of this study.

4. Conclusion

According to the results, it seems that in the studied population, physicians and patients have already moved toward optimizing visits in terms of patient referrals to repeat prescriptions for diabetes medication. However, it is still possible to benefit from more efficiency of repeat prescriptions (referrals). This aim can be achieved by defining the right system for repeat prescription. Applying artificial intelligence and data science might be useful to better perception of the related profiles, which in turn is crucial for designing an appropriate system for repeat prescription.

5. Acknowledgement
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6. Conflict of interests
The authors declare no conflict of interests.

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