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Original Article

Effects of routinely collected health information system variables on the readmission of patients with type 2 diabetes

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الملخص

أهداف البحث: استكشاف العلاقة بين متغيرات نظام المعلومات الصحية التي يتم جمعها بشكل روتيني وإعادة إدخال مرضى السكري من النوع الثاني إلى المستشفى في غضون ٣٠ يوما.

طرق البحث: أجريت هذه الدراسة بأثر رجعي في مستشفى الملك فهد الجامعي، الخبر، المملكة العربية السعودية. وشملت العينة جميع مرضى السكري من النوع الثاني الذين تم إدخالهم إلى المستشفى من يناير ٢٠١٦ إلى نوفمبر ٢٠١٦. وتم الحصول على بيانات الدراسة من نظام المعلومات الصحي بمستشفى الملك فهد الجامعي. تم تحليل ارتباط إعادة إدخال مرضى سكري من النوع الثاني ومتغيرات نظام المعلومات الصحية التي يتم جمعها بشكل روتيني مثل الخصائص السكانية، ونوع داء السكري، ومدة إقامة المريض بالمستشفى، ونوع خروج المريض من المستشفى.

النتائج: بلغ العدد الإجمالي للحالات التي تفي بمعايير الإدراج في الدراسة ٤٩٧. تم إعادة قبول ٣١ حالة (٦.٢٪) من أصل ٤٩٧ في غضون ٣٠ يوما. توصلت الدراسة إلى أن داء السكري من النوع الثاني هو المتغير الوحيد الذي وجد أنه مرتبط بإعادة إدخال المرضى إلى المستشفى في غضون ٣٠ يوما من بين المتغيرات التي تم وضعها في نموذج الانحدار اللوجستي، وكان المتغيرين الوحيدين هما نوع داء السكري ونوع الخروج من المستشفى.

الاستنتاجات: بشكل عام، وُجد أن المتغيرات الديموغرافية والتشخيصية والإدارية التي تم جمعها بشكل روتيني هي مؤشرات ضعيفة لإعادة الدخول

للمستشفى خلال ٣٠ يوما لمرضى السكري من النوع ٢ في المركز الذي تمت دراسته. ومع ذلك، فإن المتغيرات المهمة الوحيدة في التنبؤ بإعادة الدخول لمدة ٣٠ يوما كانت نوع داء السكري ونوع الخروج من المستشفى. للعمل على تحديد مؤشرات إعادة الدخول للمستشفى، يوصى بإضافة الوزن والطول إلى متغيرات نظام المعلومات الصحية التي يتم جمعها بشكل روتيني ونوصي الدراسات المستقبلية بأن تتضمن بيانات لعدة سنوات أو تجمع البيانات من عدة مستشفيات.

الكلمات المفتاحية: إعادة دخول؛ نظام المعلومات الصحية؛ داء السكري من النوع الثاني؛ جودة الخدمات الصحية؛ مدة إقامة المريض

Abstract

Objectives: This research explores the association between variables routinely collected in a health information system and the readmission of patients with type 2 diabetes within 30 days of discharge.

Methods: This retrospective cohort study was conducted at King Fahd Hospital of the University (KFHU) in Al-Khobar, KSA. The study population comprised patients with type 2 diabetes who were admitted to the hospital from January 2016 to November 2016. Data were obtained from the hospital's information system at KFHU. The association between the readmission of patients with type 2 diabetes and routinely collected health information system variables such as demographics, type of diabetes, length of stay, and discharge type were analyzed.

Results: A total of 497 cases met the inclusion criteria. Of these, 31 (6.2%) cases were readmitted within 30 days. Type 2 diabetes was the only variable found to be significantly associated with readmission within 30 days $(\chi^2 (1, N = 497) = 6.116, p = 0.0134)$. Diabetes type $(p = 0.0133)$ and discharge type $(p = 0.0403)$ were the

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only variables that displayed significance utilizing a logistic regression model.

Conclusion: Overall, the routinely collected demographic, diagnostic, and administrative variables were found to be poor predictors of 30-day readmission for type 2 diabetes at the institution studied. Nonetheless, the only significant variables in the prediction of 30-day readmission were diabetes type and discharge type. To determine the predictors of readmission, it is recommended that future studies include height and weight to the routinely collected health information system variables. We also suggest that future studies be based on data collected over several years or on pooled data collected from several hospitals.

Introduction

The ability to study hospital readmission within 30 days is advantageous for several reasons. First, it can serve as a measure of the quality of health care received. The assumption is that if health care is inadequate, or if a surgery is not properly done, then chances of the patient returning to the hospital within a month are high. However, readmission is not always a sign of inadequate care. Instead, readmission could serve as an indicator of quality in some instances.[1,2] Second, readmission can serve as a measure of the risk for hospital-acquired infections. If a hospital is not fully compliant with infection control standards, the chances of obtaining a hospital-acquired infection increases with the length of stay.[3–5] Readmission has been shown to be directly related to cumulative length of stay within a given period. Third, it has implications for reimbursement.[3] When reimbursement rates are related to the number of visits, payers are keen to reduce readmission rates.[1,6] Fourth, readmission is related to resource consumption.[6] For these reasons and others, readmission within 30 days is a serious metric that is worthy of investigation.

Diabetes is one of the many risk factors that contribute to increased readmission rates. Complications from diabetes were found to be among the 10 highest causes of public health readmission in the world.[7] In 2010, diabetes was ranked as the 17th most frequently treated condition and 29th among the conditions that most frequently led to hospital readmission in the United States (US).[8]

In the Arabian Gulf countries, and in KSA in particular, diabetes rates are very high and have been increasing rapidly over the past decade.[9] Hospital resource consumption related to diabetes has also been high.[1,6,10] However, only a few studies have focused on either readmission in general or readmission among patients with diabetes in KSA. One

study published in 2012 found that the readmission rate of patients with diabetes in the Eastern region of KSA was 5.2%.[11]

There are several reported risk factors of readmission among patients with diabetes. A systematic review and a meta-analysis study both found significant associations between the 30-day unplanned hospital readmission of patients with diabetes and their gender, race, age, affordability of medical insurance, comorbidities, and length of stay.[7] Some of these factors were also reported in a retrospective cohort study based on 1,080,580 admissions in the US. The study found that patients with diabetes mellitus were more likely to be readmitted than other patients, and they had longer lengths of hospital stay. The study results also indicated a significant association between the readmission of diabetes mellitus patients and other factors such as demographics, source of admission, comorbidities, and infectious complications.[4]

The risk factors for the readmission of patients with diabetes reported in the literature are inconsistent. However, the most commonly reported risk factors include gender, race, comorbidity, diabetes complications, source of admission, and length of stay.[7] Identifying the common risk factors for the readmission of patients with diabetes is important in predicting readmission and designing evidence-based interventions for reducing readmission rate. Routine health information systems (RHIS) help in identifying factors associated with higher risks for hospital readmission. RHIS are defined as "the ongoing data collection of health status, health interventions, and health resources for decision making".[12] The quality of RHIS is essential in improving health outcomes and the efficiency of healthcare services.[13] An adequate RHIS can help decision makers reduce unnecessary hospitalization of diabetic patients through adequate and consistent documentation of data that enables the accurate identification of the risk factors for readmission.[13]

The aim of this study was to explore the effects of routinely collected variables in a health information system on the readmission of patients with type 2 diabetes mellitus. The findings of this study could help in developing a clinical model for the quick prediction of readmission based on a minimum number of parameters.

Material and Methods

This retrospective cohort study was conducted at King Fahd Hospital of the University (KFHU). In 1982, this 600-bed hospital was established in Al-Khobar city in Eastern KSA.[14] Permission to obtain the data was requested from the hospital record management. The study population consisted of patients with type 2 diabetes mellitus who were admitted to the hospital from January to November 2016. The time period of the study was short because conducting research was a component required for students to graduate, and extending the study window was not possible. Pediatric patients 13 years old or younger were excluded from the study as they are rarely diagnosed with type 2 diabetes mellitus.[15] In addition, gestational diabetes cases, deceasead patients, and those who were admitted in December 2016 were excluded.

The study investigated the association between rates of readmission within 30 days (dependent variable) and health

information routinely collected from the KFUH information system (HIS). These variables included demographic variables, such as age, gender, region of residence, and nationality. They also included diagnostic variables, type of diabetes, and the administrative variables of length of stay (LOS) and discharge type. Data were obtained from the HIS of the KFHU for all patients with type 2 diabetes mellitus without (ICD 9: 250.00, 250.02) and with (ICD 9: 250.60, 250.50, 250.40, 250.42, 250.20, 250.12, 250.80, 250.10, 250.70) complications.

The data were organized, coded, and rearranged using Excel and analyzed with MedCalc. Frequency tables were compiled using descriptive statistics. A chi square test was used to examine the associations between variables, and a multiple logistic regression was fitted to the data using readmission status (0 for not readmitted; 1 for readmitted) as the dependent variable.

Results

A total of 497 cases met the inclusion criteria. The distribution of the study population is shown in Table 1. The population was almost divided equally between males and females. Over 90% of the cases included individuals over 40 years. Over three quarters were Saudis, and approximately 80% lived within the contiguous cities of Al-Khobar, Dammam, and Dhahran. In approximately 80% of the study sample, type 2 diabetes mellitus was controlled. In more than 80% of the sample, the length of stay was less than 10 days, and in more than 90% of the sample, discharge was planned. Of the 497 cases, 31 (6.2%) were readmitted within 30 days.

The readmission rates based on the variables are shown in Table 2. The readmission rate was higher in males (6.4%) than in females (6.0%). The highest readmission rate was in unplanned discharge (13.2%), followed by type 2 diabetes mellitus with complications (12.1%). All other readmission rates were less than 10%.

The associations between the variables and readmission within 30 days are shown in Table 3. Among the associations, the only significant association was between

Table 1: Distribution of variables in the study population of patients with diabetes, 2016.

Variable	n (%)
Gender	
Male	249 (50.1%)
Female	248 (49.9%)
Total	497
Age (years)	
14−29	15 (3.0%)
30−39	32 (6.4%)
40−49	88 (17.7%)
50+	362 (72.8%)
Total	497
Region	
Khobar/Dammam/Dhahran	391 (78.7%)
Other areas	106 (21.3%)
Total	497
Nationality	
Saudi	385 (77.5%)
Non-Saudi	112 (22.5%)
Total	497
Type II diabetes	
Without complication (controlled)	398 (80.1%)
With complication	99 (19.9%)
Total	497
Length of Stay (days)	
1−4	293 (59.0%)
5−9	120 (24.1%)
10+	84 (16.9%)
Total	497
Discharge type	
Planned	459 (92.4%)
Unplanned	38 (7.6%)
Total	497
Readmission	
Hospitalised within 30 days	31 (6.2%)
Not hospitalised within 30 days	466 (93.8%)
Total	497

Table 2: Rates for readmission within 30 days for patients with diabetes, 2016.

Variable	Not readmitted within 30 days	Readmitted within 30 days	Readmission rate
Gender			
Male	233	16	6.4%
Female	233	15	6.0%
Total	466	31	
Age			
14−29	14	1	6.7%
30−39	29	3	9.4%
40−49	82	6	6.8%
50+	341	21	5.8%
Total	466	31	
Region			
Khobar/ Dammam/ Dhahran	368	23	5.9%
Other areas	98	8	7.5%
Total	466	31	
Nationality			
Saudi	360	25	6.5%
Non-Saudi	106	6	5.4%
Total	466	31	
Type II diabetes			
Without complication (controlled)	379	19	4.8%
With complication	87	12	12.1%
Total	466	31	
LOS			
1−4	276	17	5.8%
5−9	113	7	5.8%
10+	77	7	8.3%
Total	466	31	
Discharge type			
Planned	433	26	5.7%
Unplanned	33	5	13.2%
Total	466	31	

Table 3: Association between hospital system variables and readmission within 30 days, 2016.

Variable	Not readmitted within 30 days	Readmitted within 30 days	Total	Chi square value (DF)	p-value
Gender					
Male	233	16	249 (50.1%)		
Female	233	15	248 (49.9%)	0 (1)	0.9908
Total	466	31	497		
Age (years)					
14−29	14	1	15 (3.0%)		
30−39	29	3	32 (6.4%)	0.713 (3)	0.8704
40−49	82	6	88 (17.7%)		
50+	341	21	362 (72.8%)		
Total	466	31	497		
Region					
Khobar/Dammam/Dhahran	368	23	391 (78.7%)		
Other areas	98	8	106 (21.3%)	0.162 (1)	0.6875
Total	466	31	497		
Nationality					
Saudi	360	25	385 (77.5%)		
Non-Saudi	106	6	112 (22.5%)	0.047 (1)	0.8292
Total	466	31	497		
Type II diabetes					
Without complication (controlled)	379	19	398 (80.1%)		
With complication	87	12	99 (19.9%)	6.116 (1)	0.0134
Total	466	31	497		
LOS (days)					
1−4	276	17	293 (59.0%)		
5−9	113	7	120 (24.1%)	0.759 (2)	0.6841
10+	77	7	84 (16.9%)		
Total	466	31	497		
Discharge type					
Planned	433	26	459 (92.4%)		
Unplanned	33	5	38 (7.6%)	2.21 (1)	0.1371
Total	466	31	497		

Table 4: Logistic regression model results of predicting readmission within 30 days using routine hospital system variables, 2016.

Overall Model Fit	
Null model −2 Log Likelihood	232.05
Full model −2 Log Likelihood	221.406
Chi-squared	10.644
DF	10
Significance level	P = 0.3859

Coefficients and Standard Errors			
Variable	Coefficient	Std. Error	P
Sex (females)	−0.055585	0.38386	0.8849
Age (30−39)	0.57453	1.22753	0.6398
Age (40−49)	0.46707	1.14991	0.6846
Age (50+)	0.27035	1.09814	0.8055
Residence (others)	0.28339	0.44349	0.5228
Nationality (non-Saudi)	−0.14916	0.48078	0.7564
Diabetes type (with complication)	1.03377	0.41742	0.0133
LOS (5−9)	−0.11913	0.47928	0.8037
LOS (10+)	0.056387	0.49243	0.9088
Discharge type (unplanned)	1.12098	0.54657	0.0403
Constant	−3.4364		

Odds Ratios and 95% Confidence Intervals		
Variable	Odds ratio	95% CI
Sex (females)	0.9459	0.4458 to 2.0073
Age (30−39)	1.7763	0.1602 to 19.6974

Table 4 (*continued*)

Odds Ratios and 95% Confidence Intervals		
Variable	Odds ratio	95% CI
Age (40−49)	1.5953	0.1675 to 15.1939
Age (50+)	1.3104	0.1523 to 11.2764
Residence (others)	1.3276	0.5566 to 3.1665
Nationality (non-Saudi)	0.8614	0.3357 to 2.2104
Diabetes type (with complication)	2.8116	1.2406 to 6.3720
LOS (5−9)	0.8877	0.3470 to 2.2711
LOS (10+)	1.058	0.4030 to 2.7775
Discharge type (unplanned)	3.0678	1.0509 to 8.9554

type 2 diabetes mellitus and readmission within 30 days (χ^2 (1, $N = 497$) = 6.116, $p = 0.0134$). The associations between readmission within 30 days and all other variables were not significant at the 0.05 level.

The results of the logistic regression model are shown in Table 4. Overall, the results were not significant (χ^2 (10, $N = 497$) = 10.644, $p = 0.3859$). Among the variables fitted in the model, the only significant ones were diabetes type (p = 0.0133) and discharge type (p = 0.0403).

Discussion

Our study focused on patients with type 2 diabetes mellitus who attended the KFHU during 2016. Our study population was predominantly Saudi and consisted of equal numbers of males and females who were over 40 years old and who lived in the three contiguous cities of Al-Khobar, Dammam, and Dhahran. The results of the study showed that the readmission rate of patients with type 2 diabetes mellitus during 2016 was 6.2%. The readmission rates were the highest in unplanned discharges (13.2%) and those who experienced complications related to type 2 diabetes mellitus (12.1%). Among the routinely collected variables in the HIS used in this study, only type 2 diabetes mellitus had a significant association with readmission within 30 days. The results of the multiple logistic regression model were not significant.

Higher rates of 30-day readmission among patients with diabetes mellitus (26.4%) compared to those without diabetes mellitus (22.6%) were also reported in one study conducted in the US that included a total of 7763 admissions.[6] Modifiable and non-modifiable risk factors for readmission were found among patients with diabetes. The identification and evaluation of these risk factors could help healthcare organizations develop appropriate interventions to reduce 30-day hospital readmission rates. Although diabetes is a non-modifiable risk factor for 30-day readmission, an effective strategy to mitigate risk of readmission is to provide diabetes education to inpatients. A number of studies found that this strategy significantly reduced the risk of 30-day readmission.[16−18]

The results of this study have several implications. The first is that because unplanned admission is associated with readmission, patients should be educated about this possibility during the admission process. The second implication is that patients with type 2 diabetes mellitus complications have high readmission rates, which should be considered when planning resources for such patients at their first admission. The third implication is that the scope of variables routinely collected in the HIS variables should be increased to include height and weight so that the BMI of each patient could be calculated and recorded at each visit. BMI is a potential risk factor for the readmission of patients with type 2 diabetes mellitus.[19] In developing countries, incomplete, inaccurate, and inconsistent data are key quality issues in routine HIS.[13,20] Poor data quality in routine HISs hinders the identification of important risk factors and thus limits the health organization's ability to predict readmission among patients with type 2 diabetes mellitus. Additionally, one hospital could not find significant predictors related to the routine health information system variables considered. Therefore, further studies should either consider readmission data collected over several years in the same hospital or utilize pooled data collected from several hospitals.

One limitation of this study is that the patients in the study sample could have been readmitted to other hospitals; thus, the readmission rates in this study do not necessarily reflect the actual number of patients who were readmitted during the study period. Another limitation is other factors that may have affected the readmission rates but were not captured in the HIS, such as height and weight, which are required to calculate the BMI.

Conclusion

The main aim of this study was to explore the relationship between routine HIS variables and the readmission rates of patients with type 2 diabetes mellitus. The study found that the only variable affecting readmission rates was type 2 mellitus diabetes. The other variables had no significant relationship with readmission rates. The study also found that readmission rate was the highest among patients with type 2 diabetes mellitus with unplanned discharge.

Recommendations

The findings of this study should be included in the health education programs at the hospital. For further work on determining the predictors of readmission, we recommend that weight and height be added to the variables routinely collected in the HIS. We also recommend that future studies be based on data collected over several years or utilize pooled data collected from several hospitals.

Source of funding

Conflict of interest

The authors have no conflicts of interest to declare.

Ethical approval

Ethical approval for this study was received from the Institutional Review Board (IRB) of Imam Abdulrahman Bin Faisal University (Ref: IRB-UGS-2017-03-068).

Authors' contributions

SMB supervised the research, re-analyzed the data, and re-wrote the project. ABA, AJA, and HHA worked on project proposal, literature review, initial analysis and initial write-up. HAD co-supervised the project and worked on the literature review. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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