Registered Nurse Staffing and the Management of Patients with Type 2 Diabetes within Primary Care: A Cross-Sectional Linkage Study

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Abstract

Background: As the organization of primary care continues to evolve towards more interdisciplinary team structures, demonstrating effectiveness of care delivery is becoming important, particularly for non-physician providers. Nurses are the most common non-physician provider within primary care. Previous research in acute care has demonstrated positive associations between high nurse-to-patient ratios and patient outcomes. The effect of nurse staffing on patient care has not been systematically explored in the primary care setting.

Methods: This study utilized nurse staffing data acquired through a cross-sectional survey of Family Health Teams and patient data from the Canadian Primary Care Sentinel Surveillance Network in south eastern Ontario to explore relationships between the presence of Registered Nurses and clinical outcomes in patients with Type 2 diabetes.

Results: 86.7% of practices had ≥1 Registered Nurse. The presence of ≥ 1 Registered Nurse in a Family Health Team was associated with increased odds of patients with diabetes having their hemoglobin A1c, fasting plasma glucose, blood pressure, and low-density lipoprotein cholesterol measurements on-target. Practices with the lowest ratios of diabetic patients-per-Registered Nurse had a significantly greater proportion of patients who had hemoglobin A1C and fasting plasma glucose measurements on-target compared to practices with the highest ratios of diabetic patients-per-Registered Nurse.

Interpretation: This study demonstrated the ability to link nurse staffing data acquired through an organizational survey to patient data within the Canadian Primary Care Sentinel Surveillance Network. The findings suggest that Registered Nurse staffing within primary care practice teams contributes to better diabetic care, as measured by diabetes management indicators.

Comment [JL1]: Modified wording within abstract

Introduction

Within Ontario, there are currently close to 200 Family Health Teams (FHTs) ~~in Ontario~~ that deliver comprehensive care using a team structure that often includes physicians and nurses (1,2). The presence of nursing providers varies across FHTs, providing an opportunity to explore the impact of this variation on the management of patients with chronic conditions, such as Type 2 diabetes. Furthermore, within Canada, nurses form the largest healthcare provider group within all sectors of care (3). The increasing demand for professional and financial accountability results in the need for nurses being able to demonstrate the effects of their care on patient and system outcomes (4). As the organization of primary care services moves further towards interdisciplinary models of care, demonstrating the unique contribution of providers within these models is particularly important for nurses employed within this setting (5–7). To date, the contribution of nurse staffing to clinical or patient outcomes has been primarily explored within acute care, and has focused on examining the relationship between staffing-levels and patient safety outcomes, such as the occurrence of adverse events (4,8,9). Within acute care, reduced adverse events were significantly associated with a higher number of hours of care delivered by Registered Nurses (RNs) (8,9). In contrast, few studies have examined the relationship between primary care nurses and patient outcomes, and information about the number of nurses required to meet the increasing demands for primary care services in Canada is lacking (7,10). This is particularly true for RNs, who comprise the largest group of nursing providers within primary care (11). Most studies do not distinguish between regulatory designations, or focus on Nurse Practitioners (NPs). ~~Reports from~~ Canadian studies utilizing chart abstraction data~~,~~ found that the number of nurses in a primary care practice was independently and positively associated with health promotion (12), and the presence of a NP was associated with improved chronic disease prevention and management (13,14). In a cross-sectional study in the United Kingdom, higher

RN staffing-levels were significantly associated with improved performance of chronic disease care and decreased hospital admissions related to asthma and chronic obstructive pulmonary disease (15).

There is national and international recognition of the paucity of knowledge on how RNs contribute to the delivery of high-quality care in primary care settings (16,17). ~~The College of Family Physicians of Canada (2007) believe access to care and wait-times can be reduced through the collaboration of physicians and RNs in primary care (18).~~ Therefore, the purpose of this study was to examine the relationship between primary care delivery models that incorporate RNs and clinical outcomes in patients with Type 2 diabetes. This study also sought to determine the feasibility of linking organizational-level survey data to patient health data (organized at a provider-level) stored within a large administrative database. Type 2 diabetes was the focus given its high and increasing prevalence in the Canadian population (18), as well as the important role ~~and that~~ nurses can play ~~an important role~~ in the prevention and management of diabetes complications.

Methods

Design

A cross-sectional linkage study was performed to explore associations between FHT models of care that have the presence/absence of RNs and clinical outcomes of patients with Type 2 diabetes in south eastern Ontario. Data on primary care practice nurse staffing-levels acquired from a cross-sectional organizational survey were linked with patient data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN). The study was reviewed for ethical compliance by the Queen's University Faculty of Health Sciences Research Ethics Board.

Patient sample

The patient sample was drawn from CPCSSN. CPCSSN is a chronic disease electronic medical record (EMR) surveillance system that seeks to improve the effectiveness and efficiency of primary healthcare delivery, and to improve patient and system outcomes across the country by creating a platform for research, surveillance and education. It is currently comprised of eleven Practice Based Research Networks across Canada, including one that is located in eastern Ontario. CPCSSN provides access to EMR data collected from patients affected by various chronic diseases, including diabetes (19,20). The present sample ~~(n=6673)~~ is comprised of individuals with diabetes in the CPCSSN database, between the ages of 18-100, and who had ≥ 1 primary care encounter between April 1, 2013 and March 31, 2014. A CPCSSN diagnosis of diabetes includes the presence of the following elements within a patient's personal EMR: existence of an ICD-9 billing data code 250.X indicating a diagnosis of diabetes mellitus, medications that are specifically used for managing diabetes, and laboratory test results that align with a diagnosis of diabetes (i.e. hemoglobin A1c > 7.0%, fasting plasma glucose ≥ 7.0 mmol/L). This diagnostic algorithm has a sensitivity of 95.6% and specificity of 97.1% (21). The study used the 12-month observation period recommended by the Canadian Diabetes Association (2013) to measure quality of care indicators (22). No distinction was made between Type 1 and Type 2 diabetes. However, given that over 90% of Canadians who have diabetes have Type 2 diabetes, the majority of the sample would be expected to have Type 2 diabetes (18,23,24).

Setting

At the time of study completion there were 15 FHTs located within the south eastern Ontario Local Health Integration Network (25), including 9 that participated in the Eastern Ontario Network of CPCSSN. Each practice location affiliated with these 9 FHTs that contributed data to CPCSSN during the index year (i.e. April 1, 2013-March 31, 2014) was invited to participate in this study. Given that an aspect of this study was to determine the

feasibility of conducting the linkage between cross-sectional organizational-level data and patient data housed with CPCSSN, only practices affiliated with the Eastern Ontario Network of CPCSSN were sampled. ~~In total, 8 FHT sites with a total of 15 affiliated practice locations met these criteria and completed the organizational-level survey.~~

Sources of data

Patient variables.

Patient-level data was obtained from CPCSSN. The CPCSSN database has been assessed for quality issues and disease diagnoses have been validated using chart abstractions (26). The demographic and clinical characteristics included were: age, sex, and number of comorbidities. The outcome measures related to diabetes management explored included: hemoglobin A1c (HbA1c), fasting plasma glucose (FPG), blood pressure (BP), low-density lipoprotein cholesterol (LDL-C), and urine albumin creatinine ratio (UACR). According to the Canadian Diabetes Association (2013), the following targets have been established to reduce the risk of developing microvascular or macrovascular complications associated with diabetes: HbA1c $\leq$ 7.0%, FPG < 7.0 mmol/L, BP < 130/80 mmHg, LDL-C $\leq$ 2.0 mmol/L, and UACR < 2.0 mg/mmol, and each of these diabetes indicators should be measured at least once annually (22).

Organizational variables.

Organizational data was obtained from a cross-sectional survey that employed a modified version of the "Measuring Organizational Attributes of Primary Health Care Survey" (27). An item on the questionnaire asked respondents to provide physician and nursing staffing data about their practice. Specifically, the respondents were asked about the number of physicians and number of nurses who worked within their practice. The main exposure variable was the presence/absence of $\geq$ 1 RN at the FHT practice locations. This dichotomized characteristic was

used previously in a study exploring the associations between nurse staffing and chronic disease management in primary care (14).

Linkage of data sources

Data was linked at the organizational-level using a unique site identifier maintained by CPCSSN. To enable the linkage, CPCSSN provided the study authors with a document containing a list of practice locations affiliated with each of the participating FHT sites (n=8) that included the corresponding codes for providers delivering care at each practice location. Each participating practice location (n=15) was then assigned a code that matched the codes assigned to each completed organizational survey. These practice location codes corresponded to the provider identification codes of each included patient encounter to determine which practice location each patient encounter occurred at.

Statistical analysis

Data analysis was conducted using SPSS Version 22 (Armonk, NY: IBM Corp). Demographic characteristics of the patients were described using descriptive statistics. One-way ANOVA was used to explore differences in patients' age across practice locations. All other patient demographic variables and outcome variables were compared across practice locations using χ^2 analysis. To explore variability in diabetes management across practice locations, the percentage of patients with diabetes who had each diabetes management test completed and the percentage of patients who had each diabetes management test on-target within the defined index year was determined.

Logistic regression models were built using a traditional epidemiological paradigm with a backwards elimination procedure. The exposure variable in each model was the presence/absence of ≥ 1 RN in the practice. Outcome variables were dichotomized into on/off-

target for each of the diabetes management indicators. Three dichotomous covariates that can influence the effectiveness of Type 2 diabetes management (22) were included in the modelling: sex, age (< age 65 or older), and comorbidity (none or ≥ 1 additional chronic condition). Using a backwards elimination strategy, an assessment of modification was performed ($p<0.05$), followed by an assessment for confounding (i.e. changed the parameter estimate by >10%). No patient variables either modified or confounded the relationships.

Lastly, we explored the effect of the ratio of diabetic patients-to-RNs. This ratio was categorized into quartiles and associations between the quartiles and diabetes outcome indicators were explored using one-way ANOVA. Quartiles were calculated based on number of diabetic patients-per-RN (displayed in Table 1). The lowest diabetic patient-to-RN ratio (Q1) was defined as practices with less than 90 diabetic patients-per-RN (n=3). Four practices had 91-152 diabetic patients-per-RN (Q2), whereas Q3 contained those practices with 152-310 diabetic patients-per-RN (n=3), and Q4 was defined as practices with greater than 311 diabetic patients-per-RN (n=3). Statistical significance was inferred when $p<0.05$.

Results

Within CPCSSN, 6673 patients met the inclusion criteria and were included in the analysis. With respect to the primary care organizations, ~~In total,~~ 8 FHT sites with a total of 15 affiliated practice locations ~~met these criteria and~~ completed the organizational-level survey.

A profile of provider and patient characteristics across all practice locations is located in Table 1. The average age of patients was 65.1 years (standard deviation (SD) 14.0, range 62.4-67.3), and significant differences in the average age of patients were noted across practices ($p<0.05$). N~~Nearly~~ early 87% of practices had ≥ 1 RN (average of 2.5 per practice, range 0-6) and the ratio of diabetic patients-per-RN ranged from 43 to 405 across practice locations. -

The percentage of patients at each FHT practice location that a ~~had each~~ diabetes management test completed and on-target are displayed in Table 2. Overall, BP measurements were completed for 85% of diabetic patients (range~~,~~ 47.7-96.6%). Management indicators that had the greatest percentage of patients meeting recommended targets were: HbA1c (58.3%, range 44.6%-69.7%) and LDL-C (57.6%, range 32.3%-70.8%).

~~Furthermore,~~ FHT models of care that had ≥ 1 RN were more likely to have ~~significantly associated with increased odds of~~ patients with the ~~within a practice having the f~~following management indicators on-target (Table 3): BP (OR 1.51, 95% Confidence Interval (CI) 1.27-1.81), LDL-C (OR 1.46, 95% CI 1.19-1.79), HbA1c (OR 1.43, 95% CI 1.20-1.69), and FPG (OR 1.35, 95% CI 1.08-1.68). These observed relationships were independent of patient characteristics ~~characteristics~~. In addition, FHT models of care with fewer diabetic patients-per-RN were also associated with improved diabetes outcomes (Table 4). A significantly greater percentage of patients in practices with less than 90 diabetic patients-per-RN met recommended targets for HbA1c and FPG in comparison to practices with greater than 311 diabetic patients-per-RN ($p<0.01$ and $p=0.03$, respectively).

Interpretation

Main Findings

This study sought to explore whether variations of RN staffing across FHT practice locations ~~with RNs present~~ influenced ~~are associated with~~ the management of patients with Type 2 diabetes, as measured by diabetes outcome indicators. The findings from this study indicated that there are considerable variations across FHTs in terms of the percentage of patients with diabetes who have the recommended diabetes management tests completed and on-target. Across all practice locations, nearly half of patients that had the recommended diabetes management

tests completed did not have their measurements on-target. The observed variability in the percentage of patients with diabetes measurements on-target across FHT practices was associated with the presence of RN providers.

Explanation of Findings

The low percentages of patients having recommended diabetes management tests completed and on-target is supported by existing literature. A population-based study conducted in eastern Ontario explored HbA1c testing and reported that 58% of individuals with diabetes received recommended HbA1c testing, and of those tested, less than 50% had HbA1c levels on-target (28,29). Nurses across all regulatory designations are extensively involved in chronic disease management activities (12,13,30–38). However, few studies have specifically explored whether the presence of RNs within interdisciplinary primary care models are associated with improved chronic disease management. The positive relationships between the presence of RNs in FHTs and clinical outcomes of patients with diabetes are consistent with studies conducted in other countries (15,39). Similar findings have also been reported outside of primary care, and within other disciplines. In a systematic review in the United States, a greater number of RNs in acute care was significantly associated with reduced adverse events and shorter lengths of stay (8). Smaller patient-to-physician ratios have also been associated with improved diabetic care (14). Although it may not be surprising that better care is associated with smaller patient-to-provider ratios, demonstrating this relationship quantitatively using large datasets is important to help inform policy-makers making decisions regarding primary healthcare reform.

Limitations

Low rates of diabetes test completion could be a result of providers incorrectly or not documenting care in the patient's EMR. Furthermore, we were unable to determine whether the

low percentage of test completion was a result of providers not ordering the test or a patient's decision to not undergo recommended testing. In addition, the sample used in this study (n=15 FHT practices) may not be representative of other FHTs in Ontario and we were unable to determine how practices that participated in the survey differed from those that did not. Given that the unit of analysis in this study was the practice location and was quite small, the number of covariates explored in the logistic regression models had to be carefully considered. Although patient characteristics that can affect the management of Type 2 diabetes, such as age, sex, and presence of additional chronic conditions, were explored as covariates in the logistic regression model, future studies that are larger in nature should explore whether other patient, provider, and organizational variables affect the observed relationships between FHT models incorporating RN providers and diabetic patient outcomes. For instance, provider variables, such as years of experience, and organizational variables, such as the presence of other healthcare providers (e.g. physicians, nurse practitioners) should be taken into consideration. Furthermore, the study was limited by having only a couple of practices without RNs (n=2). As well, there was the risk for an inflated family wise error rate as each analysis was conducted using a significance level of 0.05. Therefore, further investigation is required to acquire a better sense of diabetes management in primary care practices with varying degrees of RN support. Also, unlike physicians, RNs do not have unique identification codes to use in EMRs, and therefore it was not possible to determine whether patients in practices had any direct contact with the various nursing providers included in the study (i.e. the specific roles of nurses were not be evaluated).

Conclusions and Future Directions

This study addressed an important gap in the literature with respect to understanding how RNs affect patient care within the primary care setting. ~~This~~ It is also the first known study to utilize CPCSSN to explore relationships between FHT models of care employing RN providers

and Type 2 diabetes management indicators in Canada. Previous studies exploring the relationship between organizational characteristics, such as nursing human resources, have mostly relied on patient data obtained from chart abstraction. Furthermore, this study demonstrated that organizational data available at a practice location-level can be feasibly linked to patient data with the CPCSSN, which is organized at a site-level. The establishment of this linkage is important for future studies exploring the heterogeneity in organizational attributes across primary care practice locations. Importantly, the ability to explore relationships between nurse staffing and diabetes management indicators using a large administrative database is a vital step towards demonstrating nurses' added value within primary care in Canada. In particular, a direction for future research includes exploring how nursing roles/activities affect the management of Type 2 diabetes within the primary care setting.

Type 2 diabetes is increasingly being managed within primary care using interdisciplinary team structures, such as FHTs (40,41). This study provides valuable information about the impact of FHT models of care that employ RNs on the quality of care of patients living with diabetes. These findings provide a foundation for further exploration of the effectiveness of the nursing role within primary care. Future studies should explore whether the observed relationship between RN presence and diabetic care is attenuated when organizational factors, including other members of the primary care team, are taken into consideration. In the future it will also be important to conduct larger studies of a similar nature to better understand which attributes of different models of care best support the management of patients with chronic diseases, such as Type 2 diabetes.

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Table 1: Patient and provider profile across practice locations

Practice ID	# of diabetic patients	Providers			Patients				
		# of GPs	# of RNs	# of diabetic patients per RN	Sex		Mean Age (SD)	≥ 65 years n (%)	≥ 1 Comorbidity n (%)
					Male n (%)	Female n (%)			
All Practices	6673				3415 (51.2)	3258 (48.8)	65.1 (14.0)	3690 (55.3)	4734 (70.9)
1	735	5	1	295	352 (47.9)	383 (52.1)	62.4 (14.1)*	335 (45.6)	507 (69.0)
2	295	2	0	-	158 (53.6)	137 (46.4)	63.2 (14.9)‡	144 (48.8)	212 (71.9)
3	315	4	3	69	155 (49.2)	160 (50.8)	67.3 (14.5)	190 (60.3)	264 (83.8)
4	208	8	2	405	91 (43.8)	117 (56.3)	65.5 (13.1)	129 (62.0)	196 (94.2)
5	809	2	1	392	457 (56.5)	352 (43.5)	66.2 (13.0)	493 (60.9)	375 (46.4)
6	392	7	4	136	233 (59.4)	159 (40.6)	66.0 (13.2)	234 (59.7)	334 (85.2)
7	542	8	6	139	251 (46.3)	291 (53.7)	63.8 (14.0)‡	277 (51.1)	417 (76.9)
8	832	2	2	324	447 (53.7)	385 (46.3)	67.0 (14.5)	499 (60.0)	627 (75.4)
9	647	5	2	96	282 (43.6)	365 (56.4)	62.5 (14.0)*	305 (47.1)	332 (51.3)
10	191	6	2	152	80 (41.9)	111 (58.1)	64.7 (14.4)	94 (49.2)	141 (73.8)
11	304	2	4	43	172 (56.6)	132 (43.4)	66.4 (13.4)	183 (60.2)	235 (77.3)
12	170	5	0	-	86 (50.6)	84 (49.4)	68.5 (12.8)	112 (65.9)	143 (84.1)
13	448	13	6	84	233 (52.0)	215 (48.0)	63.7 (14.0)†	237 (52.9)	353 (78.8)
14	504	4	1	281	266 (52.8)	238 (47.2)	66.0 (13.4)	292 (57.9)	432 (85.7)
15	281	18	4	184	152 (54.1)	129 (45.9)	66.2 (13.8)	166 (59.1)	166 (59.1)

Note: GPs=General Practitioners, RNs=Registered Nurses

*$p<0.05$ compared to Location ID 3, 5, 6, 8, 11, 12, 14, 15

‡$p<0.05$ compared to Location ID 3, 8, 12

†$p<0.05$ compared to Location ID 8, 12

Table 2: Diabetes management test completion and on-target (n=6673), **n (%)**

Practice ID	HbA1c		FPG		BP		LDL-C		UACR	
	Completed[a]	On-target[b]	Completed[a]	On-target[b]	Completed[a]	On-target[b]	Completed[a]	On-target[b]	Completed[a]	On-target[b]
All	4592 (68.8)	2676 (58.3)	3245 (48.6)	1524 (47.0)	5645 (84.6)	2109 (37.4)	3893 (58.3)	2240 (57.6)	2075 (31.1)	939 (45.3)
1	592 (80.5)	340 (57.4)	353 (48.0)	164 (46.5)	710 (96.6)	225 (31.7)	478 (65.0)	251 (52.5)	329 (44.8)	156 (47.4)
2	235 (79.7)	129 (54.9)	112 (38.0)	54 (48.2)	284 (96.3)	94 (33.1)	194 (65.8)	109 (56.2)	136 (46.1)	69 (50.7)
3	274 (87.0)	154 (56.2)	252 (80.0)	112 (44.4)	284 (90.2)	124 (43.7)	235 (74.6)	131 (55.7)	156 (49.5)	82 (52.6)
4	99 (47.6)	69 (69.7)	153 (73.6)	109 (71.2)	200 (96.2)	70 (35.0)	158 (76.0)	51 (32.3)	47 (22.6)	27 (57.4)
5	96 (11.9)	47 (49.0)	84 (10.4)	35 (41.7)	671 (82.9)	215 (32.0)	77 (9.5)	36 (46.8)	29 (3.6)	19 (65.5)
6	349 (89.0)	193 (55.3)	280 (71.4)	115 (41.1)	366 (93.4)	232 (63.4)	309 (78.8)	208 (67.3)	179 (45.7)	84 (46.9)
7	432 (79.7)	267 (61.8)	241 (44.5)	109 (45.2)	409 (75.5)	192 (46.9)	334 (61.6)	223 (66.8)	164 (30.3)	56 (34.1)
8	706 (84.9)	471 (66.7)	645 (77.5)	332 (51.5)	736 (88.5)	318 (43.2)	609 (73.2)	384 (63.1)	356 (42.8)	159 (44.7)
9	375 (58.0)	197 (52.5)	406 (62.8)	208 (51.2)	475 (73.4)	128 (26.9)	373 (57.7)	168 (45.0)	188 (29.1)	52 (27.7)
10	157 (82.2)	100 (63.7)	144 (75.4)	60 (41.7)	170 (89.0)	66 (38.8)	132 (69.1)	76 (57.6)	64 (33.5)	29 (45.3)
11	213 (70.1)	95 (44.6)	198 (65.1)	71 (35.9)	201 (66.1)	92 (45.8)	204 (67.1)	116 (56.9)	105 (34.5)	51 (48.6)
12	131 (77.1)	77 (58.8)	31 (18.2)	16 (51.6)	144 (84.7)	76 (52.8)	101 (59.4)	78 (77.2)	14 (8.2)	8 (57.1)
13	326 (72.8)	150 (46.0)	109 (24.3)	34 (31.2)	377 (84.2)	69 (18.3)	179 (40.0)	73 (40.8)	71 (15.8)	31 (43.7)
14	373 (74.0)	231 (61.9)	126 (25.0)	52 (41.3)	484 (96.0)	148 (30.6)	291 (57.7)	183 (62.9)	172 (34.1)	84 (48.8)
15	234 (83.3)	156 (66.7)	111 (39.5)	53 (47.7)	134 (47.7)	60 (44.8)	216 (76.9)	153 (70.8)	65 (23.1)	32 (49.2)

Note: HbA1c=Glycated Hemoglobin, FPG=Fasting Blood Glucose, BP=Blood Pressure, LDL-C=Low-Density Lipoprotein Cholesterol, UACR=Urine Albumin Creatinine Ratio

[a]$\chi 2$ $p<0.001$; significant differences in percentage of pts who had each test completed across practice locations

[b]$\chi 2$ $p<0.001$; significant differences in percentage of pts who had each indicator on-target across practice locations

Table 3: Patients that had diabetes management outcome indicators on-target at practices with or without the presence of RNs

	On-Target				
	HbA1c	**FPG**	**BP**	**LDL-C**	**UACR**
Total # Patients, n	2676	1524	2109	2240	939
Registered Nurse, n (%)					
Yes, ≥1	2372 (59.4)	1378 (47.8)	1916 (38.4)	2036 (58.6)	826 (44.7)
No	304 (50.7)	146 (40.4)	193 (29.2)	204 (49.3)	113 (49.8)
OR	1.43	1.35	1.51	1.46	0.815
95% CI	1.20, 1.69	1.08, 1.68	1.27, 1.81	1.19, 1.79	0.62, 1.07
P Value	≤0.001	<0.01	≤0.001	≤0.001	0.15

Note: HbA1c=Glycated Hemoglobin, FPG=Fasting Blood Glucose, BP=Blood Pressure, LDL-C=Low-Density Lipoprotein Cholesterol, UACR=Urine Albumin Creatinine Ratio, OR=Odds Ratio, CI=Confidence Interval

Table 4. Comparison of on-target diabetes management outcome indicators across quartiles of diabetic patients per registered nurse

	On-Target				
	HbA1c	**FPG**	**BP**	**LDL-C**	**UACR**
Total # Patients within Practices with ≥1 RN, n	2372	1378	1916	2036	826
Diabetic Patients per RN (Quartiles[a]), n (%)					
Q1: < 90	744 (31.4)*	346 (25.1)*	552 (28.8)	611 (30.0)	204 (24.7)
Q2: 91-152	906 (38.2)	567 (41.1)	635 (33.1)	751 (36.9)	366 (44.3)
Q3: 152-310	482 (20.3)	315 (22.9)*	282 (14.7)†	430 (21.1)*	153 (18.5)
Q4: > 311	240 (10.1)	150 (10.9)	447 (23.3)	244 (12.0)	103 (12.5)
F Test	4.02	2.94	9.27	2.95	2.46
P Value	<0.01	0.03	<0.01	0.03	0.06

Note: HbA1c=Glycated Hemoglobin, FPG=Fasting Blood Glucose, BP=Blood Pressure, LDL-C=Low-Density Lipoprotein Cholesterol, UACR=Urine Albumin Creatinine Ratio

[a] Quartiles are calculated based on # of diabetic patients per RN (displayed in Table 1).
[*]Significantly different compared to Q4 ($p<0.05$) (ANOVA)
[†]Significantly different compared to all other quartiles ($p<0.05$) (ANOVA)

Checklist of recommendations for reporting of observational studies using the STROBE guidelines

	Item No	Recommendation	Reported
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Abstract
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction
Objectives	3	State specific objectives, including any pre-specified hypotheses	Introduction
Methods			
Study design	4	Present key elements of study design early in the paper	Methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Methods
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Methods
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Methods
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Methods, Supplement Tables 3, 4
Bias	9	Describe any efforts to address potential sources of bias	Discussion
Study size	10	Explain how the study size was arrived at	Methods, based on availability of the data
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Methods

Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Methods
		(b) Describe any methods used to examine subgroups and interactions	Not Applicable
		(c) Explain how missing data were addressed	Not Applicable
		(d) If applicable, explain how loss to follow-up was addressed	Not Applicable
		(e) Describe any sensitivity analyses	Results
Results			
Participants	13	(a) Report numbers of individuals at each stage of study—e.g. numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed	Results, Figure 1, 2
		(b) Give reasons for non-participation at each stage	Methods, Figure 1, 2
		(c) Consider use of a flow diagram	Figure 1, 2
Descriptive data	14	(a) Give characteristics of study participants (e.g. demographic, clinical, social) and information on exposures and potential confounders	Results, Table 1, Supplement Table 6
		(b) Indicate number of participants with missing data for each variable of interest	Results
		(c) Summarize follow-up time (e.g. average and total amount)	Results
Outcome data	15	Report numbers of outcome events or summary measures over time	Results
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g. 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Results, Table 2
		(b) Report category boundaries when continuous variables were categorized	Table 1, Supplement Table 6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Results, Table 2
Other analyses	17	Report other analyses done—e.g. analyses of subgroups and interactions, and sensitivity analyses	Results, Supplement Tables 7, 8, 9, 10
Discussion			
Key results	18	Summarize key results with reference to study objectives	Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Discussion

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion
Generalizability	21	Discuss the generalizability (external validity) of the study results	Discussion
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Disclosures