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Diabetes care and outcomes for American Indians and Alaska natives in commercial integrated delivery systems: a SUrveillance, PREvention, and ManagEment of Diabetes Mellitus (SUPREME-DM) Study

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ABSTRACT

Objective: To compare cardiovascular disease risk factor testing rates and intermediate outcomes of care between American Indian/Alaska Native (AI/AN) patients with diabetes and non-Hispanic Caucasians enrolled in nine commercial integrated delivery systems in the USA.

Research design and methods: We used modified Poisson regression models to compare the annual testing rates and risk factor control levels for glycated haemoglobin (HbA1c), low-density lipoprotein cholesterol (LDL-C), and systolic blood pressure (SBP); number of unique diabetes drug classes; insulin use; and oral diabetes drug medication adherence between insured AI/AN and non-Hispanic white adults with diabetes aged ≥18 in 2011.

Results: 5831 AI/AN patients (1.8% of the cohort) met inclusion criteria. After adjusting for age, gender, comorbidities, insulin use, and geocoded socioeconomic status, AI/AN patients had similar rates of annual HbA1c, LDL-C, and SBP testing, and LDL-C and SBP control, compared with non-Hispanic Caucasians. However, AI/AN patients were significantly more likely to have HbA1c >9% (>74.9 mmol/mol; RR=1.47, 95% CI 1.38 to 1.58), and significantly less likely to adhere to their oral diabetes medications (RR=0.90, 95% CI 0.88 to 0.93) compared with non-Hispanic Caucasians.

Conclusions: AI/AN patients in commercial integrated delivery systems have similar blood pressure and cholesterol testing and control, but significantly lower rates of HbA1c control and diabetes medication adherence, compared with non-Hispanic Caucasians. As more AI/ANs move to urban and suburban settings, clinicians and health plans should focus on addressing disparities in diabetes care and outcomes in this population.

Key messages

In a large cohort of over 300 000 patients within nine US commercial integrated delivery systems

- American Indian/Alaska Native (AI/AN) patients were significantly more likely to have poor glycated haemoglobin (HbA1c) control compared with non-Hispanic Caucasians.
- AI/AN patients were significantly less likely to adhere to their oral diabetes medications.
- AI/AN patients had similar rates of annual HbA1c, low-density lipoprotein cholesterol (LDL-C), and systolic blood pressure testing, and LDL-C and systolic blood pressure control compared with non-Hispanic Caucasians.

Emerging research questions

- How can we improve diabetes care and outcomes of care for AI/AN patients receiving care outside the Indian Health Service?
- What are the best ways to address disparities in care for AI/AN patients with diabetes in urban and suburban healthcare settings?
- What are the healthcare system-level predictors of high-quality diabetes care for AI/AN patients?

American Indians and Alaska Natives (AI/AN) are more than twice as likely to have diabetes as non-Hispanic Caucasians[1]; the prevalence of diabetes in AI/AN populations has increased by more than 68% since 1994.[2] In addition, up to 30% of AI/AN have prediabetes,[2] or higher-than-normal blood sugar levels associated with increased risk of type 2 diabetes. There are significant disparities in diabetes outcomes for AI/AN patients: for example, the death rate from diabetes in AI/AN patients is 1.6 times higher than in the general population.[3] Cardiovascular disease (CVD), which is strongly associated with diabetes, also is

increasingly common in the AI/AN population.[4 5] The costs of caring for diabetes and its complications are high; a recent study revealed that in one of the Indian Health Services' (IHS) major facilities, 10.9% of its patients with diabetes consumed nearly 38% of the total dollars available to meet the health needs of its entire user population.[6]

Most studies of the care and outcomes for AI/AN patients with diabetes, including CVD risk factor monitoring and levels of control, have been conducted within the IHS. The IHS, a part of the US Department of Health and Human Services, provides health services to approximately 1.9 million AI/AN members of more than 500 federally recognized tribes, and is the primary federal healthcare provider for Indian people.[7] The IHS provides a level of diabetes guideline-concordant care that is comparable to other race/ethnicity groups in general healthcare settings.[8 9]

However, little is known regarding the quality of diabetes care for AI/AN patients seen in other clinical settings. This is especially true with respect to the 60% of AI/ANs who live in non-tribal metropolitan areas.[10] A major exception is a recent report released by the Urban Indian Health Institute that describes trends in diabetes care and clinical outcomes for 3603 AI/AN patients served between 2008 and 2012 by 30 urban Indian health organizations.[11] Using IHS Diabetes Audit data, the report observed a 5% increase over the 5-year period in the percentage of participants with diabetes whose mean blood pressure fell within the range of <130 systolic/<80 diastolic. Similarly, mean low-density lipoprotein cholesterol (LDL-C) decreased 3% over the same timeframe. Unfortunately, these analyses were limited by substantial missing data for select variables, by limited demographic information, by the inability to track individual patients over time, and by the lack of key measures such as medication adherence and other comorbidities.

The purpose of this study is to determine the demographic and clinical characteristics, including rates of CVD risk factor (HbA1c, LDL-C, and systolic blood pressure (SBP)) testing, control, and oral diabetic medication adherence, of AI/ANs with diabetes receiving care from a national research network of commercial integrated delivery systems, and to compare them to their non-Hispanic white counterparts within the same systems.

RESEARCH DESIGN AND METHODS
Study setting and population
The study cohort was drawn from the membership of The SUrveillance PREvention and ManagEment of Diabetes Mellitus (SUPREME-DM) study health systems between 1 January 2011 and 31 December 2011. SUPREME-DM combines patient demographic, healthcare utilization, diagnosis, procedure, medication, and laboratory data from EHR and other clinical and administrative databases of 11 integrated US healthcare systems. Because the SUPREME-DM distributed database (known as the DataLink) represents a

defined population with over one million patients with diabetes, it provides an exceptionally robust, geographic, and race/ethnicity-distributed research resource.[12] The nine SUPREME-DM sites participating in the current study include: HealthPartners (Minnesota), Group Health (Washington), Marshfield Clinic (Wisconsin), and Kaiser Permanente regions in Colorado (KPCO), Northern California (KPNC), Southern California (KPSC), Hawaii (KPHI), Georgia (KPGA), and the Northwest (KPNW). Members in these health plans receive their insurance through commercial group and self-paid plans, and Medicare and Medicaid.

For the current study, patients with diabetes were identified using the SUPREME-DM DataLink, and were included if they were age 18 or older as of 1 January 2011, and had self-identified race/ethnicity as either AI/AN (either as a primary or secondary racial category), or non-Hispanic Caucasian (as their primary racial category).[13] Presence of diabetes was established by: at least one inpatient or two outpatient diagnoses of diabetes (ICD-9-CM 250.xx, 357.2, 366.41, 362.01–362.07) on separate dates no more than 2 years apart; or fasting plasma glucose ≥ 126 mg/dL, random plasma glucose ≥ 200 mg/dL, HbA1c $\geq 6.5\%$ (mmol/mol≥ 47.5); at least two abnormal ambulatory tests were required. Patients with more than a 90-day gap in membership with their health plan in 2011 were excluded.

For the eligible cohort, we used the DataLink to obtain patient demographics, geocoded Census-block group level education and income, and presence of key comorbidities (eg, hypertension, hyperlipidemia, depression, chronic kidney disease, obesity) using the Quan Modified Elixhauser comorbidity index[14] based on ICD-9 codes in the 12 months following the date of diabetes determination. The Quan Modified Elixhauser index is a comprehensive, widely used measure of comorbidity that has been consistently shown to be correlated with healthcare outcomes.[15]

We used the DataLink to determine whether HbA1c and LDL-C tests were performed in 2011 for each patient, and to determine the results of those tests. SBP levels for 2011 were determined using measurements from outpatient visits (excluding those from urgent care and emergency department visits). Our analyses focused on HbA1c, blood pressure, and cholesterol testing and control for patients with diabetes, since these 'ABCs' for controlling CVD risk are widely considered to be the critical elements for reducing CVD-related mortality and morbidity.[16] Risk factor control was calculated based on last measurement in 2011 using cut-off points of HbA1c >9% (>74.9 mmol/mol), LDL-C ≥ 100 mg/dL, and SBP ≥ 130 mm Hg.

We calculated the number of oral diabetes drug classes dispensed, and whether insulin was dispensed, in 2011 using DataLink pharmacy data. To assess adherence to oral diabetes medications, we used pharmacy refill data to determine the cumulative period for which medication was available to the patient, dividing the

number of days for which the patient had the medication by the number of days in the study window for that participant. Adherence ranges from 100% (completely adherent) to 0% (completely non-adherent). We then dichotomized the adherence values, considering ≥80% as a marker of good adherence.[17–19] This adherence threshold has been used in previous studies that examined the relationship between medication adherence and both hospitalizations and mortality rates.[20–22] If a patient was taking more than one antidiabetic medication during 2011, the adherence for each medication was combined into a weighted average based on the number of days the patient had days' supply for each prescription. We restricted our analysis of drug use and medication adherence to the 87% of patients with prescription drug coverage in their health plan in 2011.

Statistical analysis

To compare the CVD risk factor testing, control, and oral diabetes medication adherence between the AI/AN and non-Hispanic white population, we performed seven separate modified Poisson regression models[23] using HbA1c >9%, having no HbA1c test in 2011, LDL-C ≥100, having no LDL-C laboratory test in 2011, SBP ≥130, having no SBP reading in 2011, and oral diabetes medication adherence ≥80% as the respective dichotomous dependent variables, and race/ethnicity as the main independent variable. Modified Poisson regressions directly estimate risk ratios when outcomes are common.[23–25] These models adjusted for age, gender, Quan Modified Elixhauser comorbidity score, duration of diabetes, delivery system site, and geocoded socioeconomic status; the models for HbA1c control and diabetes medication adherence also adjusted for insulin use as a marker for disease severity.[26]

All data analyses were performed with SAS V.9.3. This study was approved by the KPCO Institutional Review Board (IRB) and each participating site either ceded oversight to the KPCO IRB or received approval from their local site IRB.

RESULTS

We identified 328 908 patients in 2011 who self-identified as either AI/AN (n=5831) or non-Hispanic Caucasian (n=323 077; table 1). AI/AN patients were younger (59 vs 64 years, p<0.0001), more likely to be female (52% vs 47%, p<0.0001), had a lower Quan comorbidity score (2.74 vs 2.86, p<0.0001), and resided in geocoded Census block groups with lower income and education levels (p<0.0001).

After adjusting for age, gender, comorbidities, duration of diabetes, insulin use, and geocoded socioeconomic status (table 2), AI/AN patients were significantly more likely to have HbA1c >9% (RR=1.41, 95% CI 1.31 to 1.51) compared with non-Hispanic Caucasians. AI/AN patients were also significantly less likely to be adherent to their oral diabetes medications

(RR=0.90, 95% CI 0.88 to 0.93). AI/AN patients had similar rates of HbA1c, LDL-C, and SBP testing, as well as similar rates of LDL-C and SBP control, compared with non-Hispanic Caucasians. Sensitivity analyses examining the adjusted differences in continuous measures of HbA1c, LDL-C, and SBP in 2011 also showed significantly higher HbA1c levels in AI/AN patients, and no differences in LDL-C and SPB levels, compared with non-Hispanic Caucasians (data not shown). Additional sensitivity analyses including only AI/AN patients who selected AI/AN as their primary racial category in the DataLink, and including drug coverage as a covariate, also showed similar results (data not shown).

DISCUSSION

To the best of our knowledge, this study is the first to examine diabetes care and outcomes in a large, nationally based sample of AI/AN patients receiving care from integrated, commercial delivery systems outside the IHS and its urban affiliates. We found that AI/AN patients were younger, more likely to be female, had fewer comorbidities, and lived in Census block groups with lower socioeconomic status compared with the non-Hispanic Caucasians with diabetes in the same delivery systems. After adjusting for these demographic, socioeconomic, and clinical differences, testing rates and outcomes of care for blood pressure and lipids were similar in both groups. Since the risk for CVD in AI/AN adults with diabetes is up to eight times higher than in the AI/AN population without diabetes,[27] it is encouraging that no disparities were evident in the management of these CVD risk factors in AI/AN patients within these delivery systems.

However, we found that AI/AN patients with diabetes had lower rates of HbA1c control, and lower rates of medication adherence to diabetes-related medications, than non-Hispanic white patients with diabetes. Previous studies have found disparities between non-Hispanic Caucasians and other racial/ethnic groups in the use of prescription medications in patients with diabetes,[28–29] and in HbA1c control.[30–31] While some have suggested that disparities can be ameliorated when healthcare is delivered in a less fragmented, more integrated system of care,[32–33] other studies indicate that disparities in medication use, adherence, and outcomes may persist even within integrated systems.[34–36] By using a large, nationally based sample of AI/AN patients with diabetes in non-IHS healthcare settings, this is the first study to document that such disparities may exist in AI/AN patients receiving care in commercial integrated delivery systems.

Previous studies have suggested that healthcare system-level interventions have the potential to ameliorate racial/ethnic disparities in diabetes medication adherence and outcomes in patients with diabetes.[36–38] As a larger share of the AI/AN population moves to metropolitan areas and receives medical care from commercial health plans, health systems should consider ways to

Table 1 Patient characteristics

Variable	Overall (n=328 908)	Non-Hispanic Caucasian (n=323 077)	American Indian, Alaska Native (n=5831)
Age on 1 January 2011, mean (SD)	64 (13)	64 (13)	59 (13)***
Female (%)	47	47	52***
Census block group: per cent of households with below-poverty level income (%)	8	8	10***
Census block group: per cent of pop age 25+ with high school education at most (%)	39	38	45***
Type of insurance in year 2011 (%)			
Commercial	76	76	80***
Medicaid	2	2	4***
Medicare	17	17	11***
Unknown	5	5	5
Duration of diabetes (in years), mean (SD)	6.86 (3.92)	6.87 (3.92)	6.74 (3.99)*
Quan Modified Elixhauser Comorbidity	2.86 (1.99)	2.86 (2.00)	2.74 (1.91)***
Scale mean (SD)			
Depression (%)	14	14	14
CKD (%)	5	5	4***
Hypertension (%)	58	58	51***
CVD risk factors in year 2011			
HbA1c, mean (SD)	7.2 (1.4)	7.2 (1.4)	7.7 (1.7)***
HbA1c > 9 (%)	9	9	15***
% no HbA1c laboratory test	12	12	13
Number of HbA1c laboratory tests, mean (SD)	1.82 (1.22)	1.82 (1.22)	1.83 (1.23)
LDL, mean (SD)	88 (31)	88 (31)	91 (32)***
LDL <100 (%)	73	74	70***
% no LDL laboratory test	11	11	14***
Number of LDL laboratory tests, mean (SD)	1.52 (1.04)	1.52 (1.04)	1.44 (1.01)***
SBP, mean (SD)	127 (12)	127 (12)	127 (12)
SBP < 130 (%)	58	58	58
% no SBP measurement	5.6	5.6	6.2*
Number of SBP measurements, mean (SD)	5.80 (6.09)	5.80 (6.09)	5.79 (6.01)
Had fill of an oral diabetes drug in 2011† (%)	57	57	62***
Had insulin fill in 2011† (%)	24	24	26***
Diabetes drug classes dispensed, mean (SD)†	1.25 (1.11)	1.24 (1.11)	1.35 (1.10)***
Diabetes drug adherence is ≥80% (%)‡	77	78	68***

*Statistically significant at p<0.05; **p<0.01; ***p<0.001.
†Restricted to patients with drug coverage in year 2011 (n=285 050).
‡Restricted to patients who had two or more fills of an oral diabetes medication in the same drug class in year 2011, and who had drug coverage in year 2011 (n=151 210).
CKD, chronic kidney disease; CVD, cardiovascular disease; HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SBP, systolic blood pressure.

identify system-level barriers and facilitators to medication adherence and HbA1c control in their AI/AN patients with diabetes. These efforts have the potential to address the increased risk of diabetes and CVD risk within AI/ANs.

Limitations to this study include the inability to distinguish between type 1 and type 2 diabetes within the SUPREME-DM population, the potential misclassification of race based on our administrative data, and the potential misclassification of comorbidities based on ICD-9 data alone. In addition, while the SUPREME-DM DataLink includes geocoded data on income and education, it does not have individual patient-level socioeconomic status data; both socioeconomic and cultural factors may contribute to differences in AI/AN population diabetes outcomes compared with those of other racial/ethnic groups. Risk factor control was determined using the last value in the measurement year; while this is consistent with Healthcare Effectiveness Data and Information Set (HEDIS) and other national quality metrics, using one measure may not adequately reflect the variability of these measures. The findings of a study of the insured population in the SUPREME-DM systems may not generalize to the diabetes population in all healthcare systems or to the uninsured, although members of these health plans are diverse and receive their insurance through Medicare and Medicaid as well as through commercial plans. However, as these integrated healthcare systems exemplify care models recommended by recent legislation such as meaningful use of EHR data, primary care medical homes, and integrated care,[39–41] our results provide a critical and timely

Table 2 Estimated ORs and 95% CIs from multivariate models of diabetes care and outcomes

	HbA1c >9%*†§	No HbA1c laboratory test in 2011	LDL≥100†	No LDL laboratory test in 2011	SBP≥130†	No SBP reading in 2011	Diabetes drug adherence ≥80%¶‡
American Indian/ Alaska Native (reference: non-Hispanic Caucasian)	1.41*** (1.31 to 1.51)	0.96 (0.90 to 1.03)	1.03 (0.99 to 1.08)	1.01 (0.94 to 1.08)	1.03 (0.99 to 1.06)	0.92 (0.83 to 1.02)	0.90*** (0.88 to 0.93)

All models control for patient age and gender, geocoded Census Block Group income and education, HMO site, duration of diabetes, and comorbidities using the Quan Modified Elixhauser Comorbidity Scale.
*Statistically significant at p<0.05, **p<0.01, ***p<0.001.
†Restricted to patients with a measurement in year 2011.
‡Model controls for whether patient had a dispensing of insulin in year 2011.
§Model controls for whether patient had a dispensing of an oral diabetes medication in year 2011.
¶Restricted to patients with drug coverage who had two or more dispensings of an oral diabetes medication in the same drug class in year 2011.
LDL, low-density lipoprotein; HbA1c, glycated haemoglobin; SBP, systolic blood pressure.

benchmark for the quality of care for AI/AN patients receiving healthcare outside the IHS.

CONCLUSIONS

AI/AN patients with diabetes in commercial integrated delivery systems have similar blood pressure and cholesterol outcomes, but significantly lower rates of HbA1c control and diabetes medication adherence, compared with non-Hispanic Caucasians. Given that more than half of AI/ANs live and work in urban and suburban settings, clinicians and health plans should focus on health system-level efforts to address disparities in diabetes care and outcomes in this population.

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Supplemental Table: Coefficients from Multivariate Models of the Mean HbA1c, LDL-C, and SBP Levels in 2011

	A1c [1,2,3]	LDL level[1]	SBP≥130[1]
American Indian/ Alaska Native (ref: Non-Hispanic White)	0.23***	0.73	0.29

***Statistically significant at p<0.001

[1]Restricted to patients with a measurement in year 2011

[2]Model controls for whether patient had a dispensing of insulin in year 2011

[3]Model controls for whether patient had a dispensing of an oral diabetes medication in year 2011

Note: All models control for patient age and gender, geocoded Census block group-level education and income, HMO site, duration of diabetes, and comorbidities using the Quan Modified Elixhauser Comorbidity Scale