

# Diabetes Preventive Services and Policy Implications in the U.S.

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**OBJECTIVE** — To investigate whether the patient or physician practice characteristics predict the use of diabetes preventive care services.

**RESEARCH DESIGN AND METHODS** — This was a cross-sectional study of a nationally representative sample of 27,169 adult ambulatory care visits, using the 2007 National Ambulatory Medical Care Survey data. The outcome variable is whether any preventive care services, defined as diagnostic tests (glucose, urinalysis, A1C, and blood pressure) or patient education (diet/nutrition, exercise, and stress management), were ordered/provided. Multivariate analysis was performed to identify independent predictors of diabetes preventive care services, controlling for patient and physician practice characteristics. All analyses were adjusted for the complex survey design and analytic weights.

**RESULTS** — Compared with people without diabetes, diabetic patients were older (63 vs. 53 years;  $P < 0.01$ ) and were more likely to be nonwhite and covered by Medicare insurance. In multivariate analyses, younger patients and the availability of primary care physicians, electronic medical records, and on-site laboratory tests were associated with more effective preventive care services ( $P < 0.05$ ). If physician compensation relied on productivity, preventive care services were less likely (odds ratio 0.4 [95% CI 0.27–0.82 for men and 0.26–0.81 for women]). Although the patterns of patient education and diagnostic testing were similar, the provision of patient education was less likely than that of diagnostic testing.

**CONCLUSIONS** — Primary care physicians and practice features seem to steer diabetes preventive services. Given the time constraints of physicians, strategies to strengthen structural capabilities of primary care practices and enhance partnerships with public health systems on diabetic patient education are recommended.

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**D** iabetes is a common chronic condition and costly disease that demands effective preventive care services (1). In 2007, an estimated 23.6 million people in the U.S. had diabetes (2). Patients with diabetes have an increased risk of morbidity and mortality from several conditions, such as cardiovascular, cerebrovascular, or kidney diseases and heart failure (3–5). Previous studies have shown that interventions or intensive management of glucose and hypertension are likely to reduce the morbidity and mortality of diabetes-related complications (6,7). In addition, economic analysis indicates that mean total costs associated with microvascular complications have almost doubled compared

with those for patients without these complications (1). Thus, both intervention and economic studies suggest the critical importance of providing effective interventions and preventive care services for patients with diabetes. However, underuse of recommended preventive services is reported for people with diabetes (5). Furthermore, it is unclear whether patient or physician practice characteristics predict the use of diabetes preventive services. Given the racial/ethnic differences in mean glucose, diabetes prevalence, and diabetes-related cardiovascular disease (8,9), it is important to identify whether there are disparities in the provision of preventive care services for patients with diabetes.

To our knowledge, no previous study has examined the utilization patterns of preventive care services for patients with diabetes in a national sample of adult ambulatory care visits. Therefore, the newly released data from the 2007 National Ambulatory Medical Care Survey (NAMCS) were selected to investigate the use of diabetes preventive services during routine care for preventing the long-term complications of diabetes. The objective of this analysis was to identify whether patient or physician practice characteristics predict the likelihood of diabetes preventive care services.

## RESEARCH DESIGN AND METHODS

Analyses were conducted for a nationally representative sample of adult ambulatory care visits, using publicly available data from the 2007 NAMCS. The NAMCS is a national survey, with the use of a multistage probability sampling design (10). All ambulatory care visits of office-based physicians were randomly sampled from physician practice settings across the country. Physicians were sampled from one of 112 geographically based probability sampling units in the U.S. (11). NAMCS data on ambulatory care visits contained information about patients, physicians, and practices. The item nonresponse rate is generally  $<5\%$  (11). More details on NAMCS methods were described previously (10,11). The study population consisted of all ambulatory care visits ( $n = 32,778$ ) to physician offices in 2007. Because adult ambulatory care was the focus of this analysis, all patients aged  $\geq 18$  years were included in the study sample ( $n = 27,169$ ). Patients with diabetes ( $n = 3,403$ ) were identified by physicians' answers of "yes" to the survey question "Does patient now have diabetes?" Appropriate institutional review board approval was obtained from the Cleveland State University.

## Independent variables

The categories of race were white (non-Hispanic), African American (non-Hispanic), Hispanic, or other. Insurance type included private insurance, Medicare, Medicaid, self-pay, or other. Records regarding "Has the patient been

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seen in your practice before?" indicated established or new patients. The number of chronic conditions quantified the disease burden. The metropolitan versus rural location of patient residence was identified. Two covariates (educational attainment and median household income) were included in all models because of their significance in previous studies (12,13). The percentage of population in patient's zip code with a bachelor's degree or higher was classified as  $\geq 31.7\%$  vs.  $< 31.7\%$ . Median household income was dichotomized as  $\geq \$52,388$  vs.  $< \$52,388$ .

Primary care physician or a designated provider for the patient was identified by the answer of "yes" to "Are you the patient's primary care physician?" Practice settings included private practice, free-standing clinic, community health center, and other. Physicians were grouped as the owners versus employees or contractors. Electronic medical record (EMR) use was dichotomized as "yes" (partial or all EMR) versus "no." The laboratory testing was performed at the office or off-site. Other covariates regarding factors accounting for the compensation included physician productivity, patient satisfaction, and quality of care and were dichotomized as "yes" or "no."

### Outcome measures

Outcome variables were defined as the use of any diagnostic testing or patient education. Diagnostic tests included glucose, urinalysis, A1C, and blood pressure. Cholesterol was not included, because of the lack of accurate BMI measures among this sample aged  $\geq 18$  years study cohort. Patient education was defined as any counseling on diet/nutrition, exercise, and stress management. Preventive care services were defined as any provision of diagnostic tests or patient education, including glucose, urinalysis, A1C, blood pressure, diet/nutrition, exercise, and stress management. On the basis of data records, three outcome variables were created and dichotomized as "yes" (indicating the provision of one or more diagnostic tests, patient education, and preventive services) versus "no."

### Statistical analysis

The adult ambulatory care visit was the unit of analysis throughout. The NAMCS sampling weights were obtained from the National Center for Health Statistics (11). National estimates of the overall numbers of visits and descriptions for all variables

were obtained by using the weighted measures that accounted for the multi-stage sampling design (10,11). The association among study variables was analyzed and tested with likelihood ratios and/or the adjusted Wald test (14). Three multivariate logistic regression models were constructed for the comparison of diagnostic testing, patient education, and preventive care services among visits. Visits were stratified according to the sex (male or female) of diabetic patients. Patient-level independent variables were age, race, insurance type, residential location, visit status, number of chronic conditions, and time spent with physicians. Physician practice-level independent variables included the physician type, practice setting, ownership, EMR use, and

laboratory testing availability as well as whether physician productivity, patient satisfaction, or quality of care accounted for compensation. Other covariates were socioeconomic indicators of the residential location (educational attainment and median household income in patient's zip code). All statistical analyses were conducted using Stata (version 10; Stata-Corp, College Station, TX). The complex survey design was accounted for in all analyses to ensure proper representation of the study population and to render nationally representative estimates.

**RESULTS**— Patients with diabetes accounted for 12.5% of the total visits (Table 1). In 2007, there were 27,169 (nonweighted) adult visits to physician's

**Table 1—Characteristics of the study sample and physician practice**

Characteristics	Diabetes	Nondiabetes	Total
<i>n</i>	3,403	23,766	27,169
Age (years)*	63.2 $\pm$ 0.4	52.7 $\pm$ 0.5	54.1 $\pm$ 0.5
Female sex (%)*	53.1	62.0	60.8
Race/ethnicity*			
White	68.5	73.2	72.6
African American	13.1	9.9	10.3
Hispanic	13.2	11.1	11.4
Other	5.2	5.6	5.5
Insurance type*			
Private insurance	36.0	52.3	50.2
Medicare	43.1	25.2	27.5
Medicaid	12.0	8.0	8.5
Self-pay	2.8	5.4	5.0
Other	6.1	8.9	8.5
Established patient*	89.1	84.6	85.2
No. of chronic conditions*	2.9 $\pm$ 0.06	0.6 $\pm$ 0.07	0.8 $\pm$ 0.07
Time spent with physician (min)	19.6 $\pm$ 0.5	19.2 $\pm$ 0.3	19.3 $\pm$ 0.3
Nonmetropolitan area	15.8	14.3	14.5
$\geq 32\%$ with a bachelor's degree*	18.3	25.6	24.7
Median household income $\geq \$52,388$ *	19.7	26.9	26.1
Primary care physician*	48.4	35.8	37.4
Practice setting*			
Private practice	88.0	86.1	86.4
Free-standing clinic	5.1	7.1	6.9
Community health center	3.3	2.3	2.4
Other	3.5	4.3	4.2
Owner of practice	69.4	70.0	69.9
Use of EMRs	39.4	35.5	36.0
Laboratory testing in office	51.9	49.2	49.6
Physician productivity in compensation	42.5	39.0	39.4
Patient satisfaction in compensation*	20.7	16.6	17.1
Quality of care in compensation*	23.5	19.7	20.2
Diagnostic testing ordered/provided*	72.3	65.6	66.4
Patient education ordered/provided*	21.8	13.3	14.3
Preventive care services ordered/provided*	75.2	68.3	69.2

Data are means  $\pm$  SE or %. Data were adjusted for the complex survey design and for the person-level analytic weights. Numbers may not add up to 100% because of rounding. \* $P < 0.01$  for the comparisons between patients with and without diabetes.

Table 2—Multivariate analysis of diabetes preventive services for men

Variables	Diagnostic testing	Patient education	Preventive services
Patient characteristics			
Age ≥65 years	0.6 (0.40–1.13)	0.7 (0.49–1.17)	0.5† (0.31–0.93)
Race/ethnicity			
White	1.0	1.0	1.0
African American	0.9 (0.52–1.88)	1.4 (0.84–2.57)	0.9 (0.46–1.89)
Hispanic	0.8 (0.48–1.45)	1.3 (0.92–2.10)	0.7 (0.46–1.34)
Other	0.7 (0.33–1.69)	0.4 (0.16–1.48)	0.6 (0.27–1.34)
Insurance type			
Private insurance	1.0	1.0	1.0
Medicare	1.1 (0.60–1.99)	0.5 (0.33–0.96)*	1.2 (0.73–2.21)
Medicaid	1.4 (0.46–4.62)	1.3 (0.67–2.78)	1.6 (0.54–5.11)
Self-pay	0.7 (0.23–2.13)	1.0 (0.30–3.27)	0.5 (0.19–1.73)
Other	0.8 (0.41–1.50)	1.6 (0.79–3.63)	0.9 (0.49–1.88)
Established patient	0.9 (0.56–1.43)	1.0 (0.64–1.74)	0.9 (0.59–1.56)
No. of chronic conditions	1.5 (1.23–1.71)†	1.3 (1.19–1.47)†	1.4 (1.21–1.74)†
Time spent with physician	1.0 (0.99–1.03)	1.0 (1.00–1.03)†	1.0 (0.99–1.03)
Nonmetropolitan area	0.4 (0.21–0.84)†	0.6 (0.40–1.19)	0.4 (0.20–0.80)†
Physician practice characteristics			
Primary care physician	19.5 (10.76–35.59)†	2.4 (1.50–4.06)†	19.1 (10.31–35.64)†
Practice setting			
Private practice	1.0	1.0	1.0
Free-standing clinic	0.8 (0.26–2.49)	1.1 (0.40–3.42)	0.9 (0.25–3.87)
Community health center	6.0 (1.07–34.42)*	1.0 (0.45–2.58)	11.9 (1.87–75.85)†
Other	0.1 (0.05–0.48)†	0.3 (0.10–1.07)	0.2 (0.06–0.65)†
Owner of practice	0.5 (0.28–1.03)	1.4 (0.92–2.17)	0.6 (0.31–1.17)
Use of electronic medical record	1.9 (1.13–3.44)†	1.9 (1.34–2.86)†	1.9 (1.17–3.09)†
Laboratory testing in-office	4.5 (2.99–6.99)†	1.1 (0.73–1.69)	3.7 (2.43–5.87)†
Physician productivity	0.5 (0.31–0.91)*	0.4 (0.30–0.78)†	0.4 (0.27–0.82)†
Patient satisfaction	2.8 (0.97–8.41)*	2.0 (0.79–5.42)	3.0 (1.08–8.75)*
Quality of care	0.4 (0.15–1.11)	2.3 (0.96–5.61)	0.4 (0.16–1.03)

Data are OR (95% CI). Data were adjusted for the complex survey design and analytic weights. Socioeconomic indicators of educational attainment and household income in zip code areas were included in all models. \* $P < 0.05$ ; † $P < 0.01$ .

offices (799,362,170 weighted visits). Compared with individuals without diabetes, patients with diabetes were older and were more likely to be African American or Hispanic American and covered by Medicare insurance. The average number of chronic conditions was 2.9 for patients with diabetes and 0.6 for other individuals. Based on the zip code, 18.3% of diabetic patients and 25.6% of others resided in areas with ≥32% of the population having a bachelor's or higher degree. Median household income of ≥\$52,388 was 19.7% among diabetic patients and 26.9% in other individuals. Nearly one-half of visits for diabetes and one-third of visits for other conditions were to primary care physicians. The major setting of visits for diabetic and other patients was the private practice. Patient satisfaction or quality of care in compensation was more likely for visits for diabetes than for other visits. Patients with diabetes were more likely than others to have diagnostic tests or patient education.

In multivariate analyses for men (Table 2), patients aged ≥65 years had a lower likelihood of preventive care services. After adjustment for other covariates, race or insurance was not associated with preventive services. The number of chronic conditions predicted a slightly higher likelihood of preventive care. Living in rural areas was associated with a lower likelihood of preventive services. Primary care physicians were associated with a higher likelihood of diagnostic tests (odds ratio [OR] 19.5 [95% CI 10.76–35.59]) or patient education (2.4 [1.50–4.06]). EMR use predicted a higher likelihood of diagnostic tests (1.9 [1.13–3.44]) and patient education (1.9 [1.34–2.86]). On-site laboratory tests were associated with a higher likelihood of diagnostic testing (4.5 [2.99–6.99]). If physician compensation relied on productivity, there was a reduced likelihood of diagnostic testing (0.5 [0.31–0.91]) and patient education (0.4 [0.30–0.78]).

In multivariate models for women

(Table 3), older women were less likely to have diagnostic tests or patient education. The race/ethnicity, payment resources, visit type, and time spent with physicians were not significant predictors of preventive services. The number of chronic conditions was associated with a slightly higher likelihood of patient education. A reduced likelihood of diagnostic testing was predicted by living in rural areas. Primary care physicians were linked with a higher likelihood of diagnostic tests (19.2 [10.20–36.24]) or patient education (2.2 [1.34–3.73]). EMR use was associated with a higher odds of patient education (1.8 [1.22–2.71]). On-site laboratory tests predicted a higher likelihood of diagnostic testing (4.9 [2.95–8.18]). If the productivity accounted for compensation, the odds of preventive services was reduced (0.4 [0.26–0.81]).

**CONCLUSIONS**— Previous studies have reported the underuse of recom-

Table 3—Multivariate analysis of diabetes preventive services for women

Variables	Diagnostic testing	Patient education	Preventive services
Patient characteristics			
Age ≥65 years	0.6 (0.39–0.99)*	0.5 (0.38–0.85)†	0.5 (0.37–0.92)*
Race/ethnicity			
White	1.0	1.0	1.0
African American	0.9 (0.58–1.68)	1.3 (0.74–2.45)	1.0 (0.61–1.64)
Hispanic	1.3 (0.62–2.79)	1.3 (0.88–2.21)	1.3 (0.60–3.11)
Other	1.7 (0.85–3.57)	1.2 (0.62–2.47)	1.4 (0.69–2.84)
Insurance type			
Private insurance	1.0	1.0	1.0
Medicare	1.0 (0.68–1.79)	0.8 (0.52–1.44)	1.0 (0.60–1.88)
Medicaid	1.0 (0.60–1.87)	0.7 (0.38–1.39)	1.1 (0.62–2.07)
Self pay	2.2 (0.71–6.97)	0.6 (0.26–1.80)	2.2 (0.60–8.61)
Other	0.5 (0.22–1.10)	0.9 (0.36–2.48)	0.4 (0.19–1.06)
Established patient	1.2 (0.82–1.81)	1.3 (0.71–2.35)	1.1 (0.79–1.69)
No. of chronic conditions	1.1 (0.95–1.31)	1.1 (1.03–1.36)†	1.1 (0.98–1.34)
Time spent with physician	1.0 (0.98–1.02)	1.0 (0.99–1.02)	1.0 (0.99–1.02)
Nonmetropolitan area	0.5 (0.25–0.97)*	0.6 (0.34–1.15)	0.8 (0.38–1.66)
Physician practice characteristics			
Primary care physician	19.2 (10.20–36.24)†	2.2 (1.34–3.73)†	20.1 (10.77–37.79)†
Practice setting			
Private practice	1.0	1.0	1.0
Free-standing clinic	1.1 (0.54–2.43)	1.1 (0.37–3.50)	1.3 (0.55–3.14)
Community health center	0.8 (0.20–3.66)	1.0 (0.57–1.86)	1.3 (0.28–6.22)
Other	0.2 (0.10–0.77)†	0.1 (0.05–0.60)†	0.3 (0.10–0.87)*
Owner of practice	0.5 (0.28–0.95)*	0.9 (0.59–1.43)	0.5 (0.29–1.01)*
Use of EMRs	1.3 (0.74–2.44)	1.8 (1.22–2.71)†	1.5 (0.88–2.64)
Laboratory testing in office	4.9 (2.95–8.18)†	1.3 (0.90–2.11)	3.8 (2.31–6.38)†
Physician productivity	0.5 (0.29–0.87)†	0.5 (0.35–0.79)†	0.4 (0.26–0.81)†
Patient satisfaction	3.2 (0.85–12.17)	0.9 (0.46–2.11)	2.4 (0.81–7.38)
Quality of care	0.3 (0.11–1.24)	2.0 (1.15–3.80)*	0.4 (0.16–1.32)

Data are OR (95% CI). Data were adjusted for the complex survey design and analytic weights. Socioeconomic indicators of educational attainment and household income in zip code areas were included in all models. \* $P < 0.05$ ; † $P < 0.01$ .

mended preventive care services for patients with diabetes (5,15). This is the first study to provide a national picture of diabetes preventive services in ambulatory care visits. With regard to preventing the long-term complications of diabetes, this analysis indicates the disparities in diabetes preventive care. However, the 2007 NAMCS data suggest that variations in diabetes preventive care are part of a larger pattern of physician practices and not simply the variation of patient race or insurance. The policy implication is to increase the awareness of or training in diabetes preventive care.

Patient-level predictors of diabetes preventive services, such as age or chronic condition, could be explained by physician practices, in response to patient health-related behaviors and the U.S. Preventive Task Force (USPSTF) guidelines (16,17). In terms of practice-level predictors, the 2007 NAMCS data suggest that primary care physicians and practice fea-

tures, i.e., the availability of EMRs and an on-site laboratory, have a significant impact on diabetes preventive care. The finding associated with EMR use is consistent with a recent study in primary care practices. Health services researchers at Harvard Medical School examined the association between the performance and structural capabilities of 412 primary care practices (18). They reported that EMR use was linked with a higher performance across multiple Healthcare Effectiveness Data and Information Set measures (18). This study extends those findings to the performance of diabetes preventive services. In addition, this study identified a significant link between an on-site laboratory and the likelihood of diagnostic testing. The policy implication that the availability of EMR systems and a laboratory facility has a positive impact on diabetes preventive services is obvious. These results indicate a great opportunity to strengthen structural capabilities of

primary care practices to improve diabetes management.

Strengthening structural capabilities of primary care practices is important, because most diabetic patients receive routine care from primary care providers. Existing variations in primary care practices include settings, sizes, and the availability of EMRs or an on-site laboratory. For example, a rural setting and small size may limit the financial ability of physician practices to expand structural capabilities for better performance compared with large practices. It is unrealistic to expect primary care physicians on their own to realize successful implementation and use of EMR systems (19). Nevertheless, small or rural practices play an irreplaceable role in serving their related populations and are an integral part of the system. Furthermore, the cost-effectiveness of preventive care for diabetic patients is largely determined by long-term health benefits rather than the cost of im-



proving system performance (20). Thus, systematic strategies are pivotal for implementing accurate EMR systems across primary care practices for achieving more efficient diabetes preventive care.

Physician compensation based on the productivity or quantitative patient management is identified as a striking barrier to preventive care. Unfortunately, primary care physicians have been managing more preventive care items (21). An examination of the required time for a primary care physician to provide recommended preventive services suggests that time constraints have limited the ability of physicians to comply with the recommendations (22). In this study we found that patient education was performed eight times less than diagnostic tests. Furthermore, patients  $\geq 65$  years are less likely to receive preventive care. Thus, competing demands on physician's time may have compromised recommended preventive services for vulnerable diabetic patients with complex conditions. The policy implication regarding the necessity of strategic partnerships for diabetes management and preventing the long-term complications is clear.

This study was limited by the drawbacks of survey data. First, NAMCS measurements were largely based on reports by physicians and their staff for individual visits. One previous study suggested that physician self-reports overestimate the visit duration (23). However, the possibility and consequence of the busiest physicians being less likely to participate in surveys should be considered. A recent study by researchers at Northwestern University reported that the majority of physician-documented medical records were accurate (24). The strength of this analysis is examining patient- and physician practice-level independent predictors of diabetes preventive care, while adjusting for the visit duration.

Second, the NAMCS data are limited to national-level information on ambulatory encounters or non-hospital-based physician office visits. Current findings do not apply to other types of visits, such as visits to hospital outpatient and emergency departments. In addition, the survey may be susceptible to recall and sampling bias. Nevertheless, NAMCS data provide a representative national picture regarding the nature of ambulatory care in the U.S. Therefore, the extent of comprehensiveness in diabetes preventive care for broad population groups in

the U.S. is adequately represented by NAMCS measures.

Finally, NAMCS measures include services that are ordered or provided but contain no data on the USPSTF rating of "A" or "B" grade preventive services. Therefore, a complete comparison of each preventive service between what is recommended and what is delivered is not possible. Previous comparisons with direct observation measures of patient visits suggest that NAMCS data are more accurate for diagnostic procedures than for behavioral counseling; thus, patient education may be underestimated (23). To minimize potential bias, this study was designed to identify patient- and physician practice-level independent predictors of diabetes preventive services, rather than a report of each preventive care item ordered/provided. We suspect that if more accurate measures of preventive services ordered versus provided were available, the currently identified picture of less than comprehensive diabetes preventive care may be more dramatic.

Given the disparities identified in diabetes preventive care services, more analyses are needed to examine the degree of preventive care for the vulnerable older population. Meanwhile, this study establishes evidence for national primary care policy to move beyond its historical focus on providers and individuals. Improving primary care infrastructure is necessary to meet projected increases in work volume, driven by the aging population, as well as medical knowledge and technology advancement. This improvement is important because system changes are more effective than patient- and physician practice-level education or training in improving diabetes preventive services. Recommended changes are to establish policies and provide support for implementing effective EMR systems that convene multiple stakeholders, aligning with the needs of diabetes care management to prevent long-term complications (25). Achieving cost-effective quality of diabetes preventive care seems to be sufficient justification for strengthening strategic partnerships and structural capabilities of primary care practices.

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X.H. was responsible for the study concept and design, researched and analyzed data, wrote the manuscript, and reviewed/edited the manuscript.

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