Glycemic Control and Health Disparities in Older Ethnically Diverse Underserved Adults With Diabetes

Five-year results from the Informatics for Diabetes Education and Telemedicine (IDEATel) study

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OBJECTIVE—The Informatics for Diabetes Education and Telemedicine (IDEATel) project randomized ethnically diverse underserved older adults with diabetes to a telemedicine intervention or usual care. Intervention participants had lower A1C levels over 5 years. New analyses were performed to help better understand this difference.

RESEARCH DESIGN AND METHODS—IDEATel randomized Medicare beneficiaries with diabetes (n = 1,665) to receive home video visits with a diabetes educator and upload glucose levels every 4–6 weeks or usual care (2000–2007). Annual measurements included BMI, A1C (primary outcome), and completion of questionnaires. Mixed-model analyses were performed using random effects to adjust for clustering within primary care physicians.

RESULTS—At baseline, A1C levels (mean ± SD) were 7.02 ± 1.25% in non-Hispanic whites (n = 821), 7.58 ± 1.78% in non-Hispanic blacks (n = 248), and 7.79 ± 1.68% in Hispanics (n = 585). Over time, lower A1C levels were associated with more glucose uploads (P = 0.02) and female sex (P = 0.002). Blacks, Hispanics, and insulin-users had higher A1C levels than non-Hispanic whites ($P < 0.0001$). BMI was not associated with A1C levels. Blacks and Hispanics had significantly fewer uploads than non-Hispanic whites over time. Hispanics had the highest baseline A1C levels and showed the greatest improvement in the intervention, but, unlike non-Hispanic whites, Hispanics did not achieve A1C levels <7.0% at 5 years.

CONCLUSIONS—Racial/ethnic disparities were observed in this cohort of underserved older adults with diabetes. The IDEATel telemedicine intervention was associated with improvement in glycemic control, particularly in Hispanics, who had the highest baseline A1C levels, suggesting that telemedicine has the potential to help reduce disparities in diabetes management.

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The prevalence of diabetes is highest in older adults and higher in Hispanics and non-Hispanic blacks (blacks) than in non-Hispanic whites (whites) (1,2). A greater proportion of whites achieve good glycemic control (A1C <7.0%) than blacks or Hispanics (2,3). The development of diabetes-related complications is related to glycemic control (4). Poor access to care, particularly for underserved populations, is a barrier to improving outcomes. Telemedicine has the potential to help overcome this barrier.

The Informatics for Diabetes Education and Telemedicine (IDEATel) project, a large, randomized trial that examined the effectiveness of telemedicine in diabetes management, is unique in that it followed, for 5 years, ethnically diverse older adults (n = 1,665) living in underserved areas (5–7). This target population was chosen because it was considered to have the greatest need for intervention using telemedicine. Intention-to-treat models showed that the telemedicine group compared with usual care had lower A1C levels (P = 0.001); mean ± SE A1C levels (adjusted for clustering and heterogeneous variances) in usual care versus intervention groups were 7.45 ± 0.06 and 7.43 ± 0.05% at baseline and 7.38 ± 0.06 and 7.09 ± 0.06% after 5 years (7). In this article, we examine factors associated with improvement in A1C and the relative effectiveness of the intervention in the context of decreasing health disparities among ethnically diverse groups.

RESEARCH DESIGN AND METHODS

—Participants (n = 1,665) were Medicare beneficiaries with diabetes living in federally designated Medically Underserved or Health Professional Shortage Areas, fluent in English or Spanish, who provided informed consent. Exclusions included moderate or severe cognitive impairment and severe comorbid conditions (5). Participants in the usual care (n = 821) and telemedicine intervention (n = 844) groups were similar at baseline in race/ethnicity (~50% white, 15% black, 35% Hispanic), age at randomization (mean 71 years), BMI (mean 32 kg/m^2), sex (63% female), married/living with significant other (41%), education (10 years), and duration of diabetes (11 years). Recruitment details (Consolidated Standards of Reporting Trials [CONSORT] Statement) have been published (7).

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Study design

Subjects were randomized within primary care provider (PCP) practices to the telemedicine group or usual care between 2000 and 2002, with participation from 2000 to 2007 (5). Telemedicine subjects received a home telemedicine unit to videoconference with a diabetes educator every 4–6 weeks for self-management education, review of transmitted home blood glucose and blood pressure measurements, individualized goal-setting, and access to educational web pages created by the American Diabetes Association in English and Spanish (5–8). The target A1C was ≤7.0% except for participants with significant reduced life expectancy and/or severe hypoglycemic unawareness, for whom the target was ≤8.0%. The intervention used bilingual educators at Columbia University in New York City (urban subjects) and educators at the State University of New York (SUNY) Upstate Medical University in Syracuse (rural subjects). Diabetes educators, supervised by an endocrinologist, made recommendations to PCPs for therapy changes.

Measures

Participants had annual assessments by personnel blinded to intervention status. Assessments included A1C (primary outcome), BMI, urine microalbumin-to-creatinine ratio, and completion of the SHORT-Comprehensive Assessment and Referral Evaluation depression scale (9,10), Charlson Comorbidity Index (11), Lubben Social Network scale (12), and general health short form (SF-12). A1C levels were performed by the Medstar Laboratory (Washington, DC) using boronate affinity chromatography (Primus CLC 385).

Analyses

A1C levels were first analyzed for each racial/ethnic group using the model previously described (7). Nonlinear models with quadratic [group × $(\text{time})^2$] (time-centered) and/or exponential ($e^{-\text{time}}$) terms to model nonlinearity with a first-order auto-regressive covariance structure was used for this analyses (SAS Proc Mixed), adjusted for clustering and heterogeneous variances. A1C was also predicted with the ethnic/racial groups entered as covariates along with number of glucose uploads, female sex, insulin use, oral hypoglycemic agent (OHA) use, education, dual Medicare/Medicaid eligibility, and BMI. The number of glucose uploads, insulin use, OHA use, and BMI were treated as time-varying covariates. Whites were used as the reference group for ethnicity. Usual care participants were assigned a value of zero for number of glucose uploads.

For intervention group participants, the number of glucose uploads was computed using the midpoint between annual assessment dates. "Baseline" refers to the first 6 months of participant enrollment and "year 1" refers to the 6 months before and the six months after the participants' year 1 visit date. SAS Proc Mixed was used to predict number of glucose uploads, adjusting for clustering within PCP. A compound symmetry covariance structure was used. Log time [log(time + 0.01)] was included to model the rapid increase in the number of glucose uploads. Only telemedicine intervention group participants were included in the analyses of glucose uploads (n = 844).

RESULTS—Baseline characteristics by race/ethnicity are shown in Table 1. A higher proportion of whites were male and married/living with a significant other; this group was older, more highly educated, and had higher BMI levels and lower A1C levels than the other racial/ethnic groups. Hispanics had the lowest levels of education, income, and BMI; had higher Medicaid eligibility; and were least likely to report knowing how to use a computer. Charlson Comorbidity Index scores did not differ between the racial/ethnic groups, but there were significant differences in depression and general health.

A1C levels over time (adjusted means and SE) in each racial/ethnic group are shown in Table 2 (see also Supplementary Table 1, observed means [SD]). At baseline, whites had mean A1C levels of 6.97 and 7.10% in usual care and telemedicine groups, respectively, and A1C levels <7.0% over years 1–5 in both groups. Blacks had worse glycemic control (A1C >7%) in both the telemedicine and usual care groups at baseline, with the telemedicine group trending toward better control over time, achieving mean A1C <7.0% at 5 years. Hispanics had the highest A1C levels at baseline (7.94 and 7.69% in usual care and telemedicine groups, respectively). Whereas A1C levels remained >7.0%, the Hispanic telemedicine group compared with the usual care group had significantly lower A1C levels (7.32 vs. 7.82%) at the end of 5 years. The treatment effect was 0.50 (95% CI 0.22–0.78) for Hispanics compared with 0.29 (0.12–0.46) overall, as previously reported (6). A1C levels fell in all three ethnic/racial groups (Tables 2 and 3). IDEATel was powered to detect a change in the total sample (n = 1,665). As previously reported, there was a reduction in A1C in the treatment compared with the usual care group overall (7). Because of the relatively large reduction in the Hispanic subgroup (Fig. 1), the difference between treatment and usual care groups was statistically significant in this subgroup. There was a significant difference in the slopes between the treatment groups for blacks (group by time^2 P = 0.0264) and Hispanics (group by time^2 P = 0.0317; group by exponential time P = 0.0250), but not for whites (P = 0.9269).

Observed A1C levels [mean (SD)] by sex over 5 years are shown (Supplementary Table 2). For females, A1C was 7.40% and 7.35% at baseline, and 7.33% and 7.01% at 5 years in usual care and telemedicine groups. For males, A1C was 7.40% at baseline in both groups, and 7.31% and 7.15% at year 5 in usual care and telemedicine groups. Insulin use over the 5 years was also examined (Supplementary Table 3). For individuals with A1C ≥7.0%, the proportion who used insulin at baseline and year 5 was 34 and 48% in whites, 35 and 47% in blacks, and 33 and 43% in Hispanics. For individuals with A1C <7.0%, the proportion who used insulin at baseline and year 5 was 18 and 25% in whites, 25 and 30% in blacks, and 16 and 17% in Hispanics.

A1C levels were analyzed with racial/ethnic groups entered as covariates along with number of glucose uploads (Fig. 2), female sex, insulin use, OHA use and BMI; number of glucose uploads, insulin use, OHA use and BMI were treated as time-varying covariates. These analyses showed that being female (P = 0.003), having more glucose uploads (P = 0.016) and taking OHAs (P = 0.004) were associated with lower A1C levels; taking insulin was associated with higher A1C levels ($P < 0.0001$) Blacks and Hispanics had higher mean A1C levels ($P < 0.0001$) compared with whites (Table 3). BMI was not significantly associated with A1C levels. Blacks and Hispanics had significantly fewer glucose uploads than whites ($P < 0.0001$; Supplementary Table 4).

At baseline, approximately half of participants had diabetes for ≥10 years, with no significant differences between racial/ethnic groups (Table 1). Similar proportions of participants in each racial/ethic group at baseline were using

Table 1—*Baseline characteristics by racial/ethnic group (% unless otherwise indicated)*

		Race/ethnicity			
		White	Black	Hispanic	*P*
n		821	248	585	
Age (years)*		71.28 ± 6.95	70.73 ± 7.06	70.27 ± 5.88	<0.05
Female sex		55.54	74.60	68.38	<0.01
Education (years)*		11.99 ± 2.86	10.49 ± 2.93	6.33 ± 3.74	<0.01
Marital status	Married/living with significant other	56.39	16.13	30.26	<0.01
	Single, never married	4.26	23.39	16.41	
	Separated/divorced	10.48	18.95	26.15	
	Widowed	28.75	41.13	27.18	
	Data missing	0.12	0.40	0.00	
Lives alone	Yes	31.67	50.20	40.58	<0.01
Annual household income (dollars)	<5,000	2.92	3.23	5.30	<0.01
	5,001–10,000	14.01	56.85	85.47	
	10,001–20,000	33.25	25.40	6.67	
	20,001–30,000	21.92	3.23	0.17	
	30,001–40,000	8.16	0.00	0.00	
	>40,000	10.35	1.21	0.17	
	Data missing	9.38	10.08	2.22	
Participant dually eligible for Medicare and Medicaid (yes)		12.30	43.15	74.70	<0.01
Duration of diabetes (years)	<5	32.28	25.40	29.74	NS
	5–9	20.58	21.77	18.97	
	10–14	15.96	13.71	19.49	
	≥15	29.72	37.50	31.28	
	Data missing	1.46	1.61	0.51	
Diabetes treatment	Oral agents alone (monotherapy)	36.66	39.52	36.24	NS
	Oral combination therapy (2 or more classes)	30.69	24.60	30.77	
	Insulin alone	11.08	18.15	9.91	
	Insulin and pills	14.49	10.89	16.07	
	Diet alone	7.06	6.45	6.84	
	Data missing	0.00	0.40	0.17	
Participant knows how to use a computer	No	63.95	88.71	96.75	<0.01
	Yes	34.59	10.08	2.91	
	Data missing	1.46	1.21	0.34	
BMI (kg/m^2)*		33.11 ± 7.02	32.91 ± 7.38	29.77 ± 5.47	<0.01
A1C (%)*		7.02 ± 1.25	7.58 ± 1.78	7.79 ± 1.68	<0.01
Urine microalbumin-to-creatinine ratio (log transformed)*		1.56 ± 0.53	1.47 ± 0.58	1.54 ± 0.57	NS
Charlson Comorbidity Index*		2.89 ± 2.04	2.82 ± 1.79	2.91 ± 1.71	NS
CARE Depression*		4.47 ± 3.69	5.26 ± 4.14	7.54 ± 5.73	<0.01
Index of General Health*		3.44 ± 1.70	4.06 ± 1.88	4.85 ± 1.71	<0.01

*Data are means ± SD. Charlson, Depression, and General Health are all measured in the disordered impaired direction.

oral monotherapy, combination therapy, and insulin therapy. Over time, insulin use increased in all racial/ethnic groups for participants with A1C levels >7.0% (Supplementary Table 3); participants taking insulin had higher A1C levels over time ($P < 0.0001$).

CONCLUSIONS—These analyses demonstrated racial/ethnic disparities in glycemic control at baseline among IDEATel participants, who were older, ethnically diverse, and living in underserved areas. Duration of diabetes did not differ between racial/ethnic groups. There may have been earlier detection, more intensive care, or less advanced disease before the baseline visit in whites, but comorbidities were similar among the racial/ethnic groups. Disparities in glycemic control have been previously reported, with Hispanics having worse control despite quality improvement efforts (13,14).

We report a persistent benefit of telemedicine, particularly in Hispanics, the group with the worst glycemic control and the lowest income, educational attainment, and computer experience. There was high participant and PCP satisfaction (15,16). Although Hispanics had the greatest reduction in A1C in response to the intervention, their average

Table 2—*Adjusted mean and SE A1C levels (%) by racial/ethnic group*

	White				Black				Hispanic			
	Usual care		Telemedicine		Usual care		Telemedicine		Usual care		Telemedicine	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Baseline	6.97	0.06	7.10	0.06	7.56	0.14	7.61	0.12	7.94	0.09	7.69	0.08
Year 1	6.82	0.05	6.82	0.05	7.17	0.13	7.21	0.11	7.60	0.08	7.27	0.08
Year 2	6.81	0.05	6.76	0.06	7.08	0.13	7.23	0.12	7.54	0.08	7.27	0.08
Year 3	6.84	0.05	6.77	0.06	7.09	0.13	7.26	0.13	7.61	0.09	7.35	0.09
Year 4	6.88	0.06	6.82	0.06	7.14	0.14	7.19	0.12	7.71	0.08	7.37	0.08
Year 5	6.93	0.07	6.87	0.09	7.20	0.16	6.95	0.16	7.82	0.10	7.32	0.10

Nonlinear models with quadratic [group × (time)^2] (time-centered) and/or exponential ($e^{-\text{time}}$) terms to model nonlinearity with First Order Auto-Regressive covariance structure were used for this analysis (SAS Proc Mixed). Model was adjusted for clustering and heterogeneous variances. Up to six waves of data (baseline plus five follow-ups) were included in the analyses.

A1C was higher than in whites or blacks. It is possible that this group is more distrustful of taking medications, has difficulty with numeracy, and is less likely to follow PCP advice, or their PCPs were less aggressive in prescribing medications (17–19). The Hispanics had the greatest dual eligibility for Medicare and Medicaid, so cost of medications should have been less of a problem compared with the other groups. We previously reported that although IDEATel telemedicine participants used more statin therapy than usual care, Hispanics were less likely to take statins, suggesting a possible reluctance to take medications (20). Blacks were reported to have higher A1C levels at similar levels of glycemia (21). Given the small difference in A1C levels between whites and blacks at 5 years, it is possible that the intervention eliminated disparities in glycemia between these two groups.

In the intervention, educators used home televisits every 4–6 weeks with goal-setting to encourage lifestyle change. The most common goals were related to monitoring (8). Glucose uploads were reviewed at each televisit. More uploads were related to lower A1C values, perhaps reflecting improved adherence and success with goal-setting. Glucose upload levels were higher among whites, suggesting less self-monitoring among blacks and Hispanics.

The telemedicine intervention was shown to have been related to improved self-efficacy, which was directly and indirectly related to improved glycemic control (22). The intervention also improved self-reported diet and exercise knowledge, practices, and behaviors (23). Hispanics were less obese than blacks and whites, but BMI was not associated with lower A1C levels. The proportion of females in the Hispanic group was intermediate compared with blacks and whites. Female sex was also associated with lower A1C levels. The reason for this is unclear; we cannot determine from this study if females respond better to this intervention than males. There were differences in depression scores at baseline between the racial/ethnic groups. Because we have previously shown that baseline depression did not predict change in A1C for usual care or telemedicine intervention groups in any racial/ethnic group at 1 year (24), we think it is unlikely that depression played a major role in this difference. The number of glycemic control medications used did not significantly differ in usual care or telemedicine groups at baseline or over time. As expected, more insulin was used in participants with A1C levels >7.0%.

Home televisits to improve glycemic control were part of a larger telemedicine intervention that was designed to improve comprehensive diabetes management including blood pressure and lipid levels (5–7). Reduction in Medicare

Table 3—*Predictors of A1C levels*

	Estimate	SE	*P*
Intercept	6.8949	0.1631	<0.0001
Group	−0.0911	0.0630	0.1486
Time	0.0727	0.0187	0.0001
Group by time^2	−0.0380	0.0156	0.0148
Exponential time	0.5194	0.0784	<0.0001
Group by exponential time	0.4312	0.1449	0.0029
Number of glucose uploads	−0.0002	0.0001	0.0163
Black	0.4074	0.0815	<0.0001
Hispanic	0.7251	0.0845	<0.0001
Female	−0.1524	0.0509	0.0028
Takes insulin	0.3537	0.0432	<0.0001
BMI	−0.0029	0.0032	0.3706
Education (years)	0.0076	0.0074	0.3039
Dual eligibility	0.0296	0.0617	0.6309
Takes oral glycemic medications	−0.1232	0.0426	0.0038
Fit statistics			
−2 Residual log likelihood		20,926.5	
Akaike's information criterion (AIC)		20,936.5	
Corrected Akaike's information criterion (AICC)		20,936.6	
Bayesian information criterion corrected Akaike's information criterion (BIC)		20,957.7	

Nonlinear models with quadratic [group × (time)^2] (time-centered) and/or exponential ($e^{-\text{time}}$) terms to model nonlinearity with First Order Auto-Regressive covariance structure were used (SAS Proc Mixed). Model was adjusted for clustering and heterogeneous variances. Up to six waves of data (baseline plus five follow-ups) were included. Number of glucose uploads, diabetes medication status, and BMI were treated as time-varying covariates. For number of glucose uploads, usual care participants and telemedicine intervention participants with no uploads were assigned zero. Non-Hispanic white is the reference group for race/ethnicity.

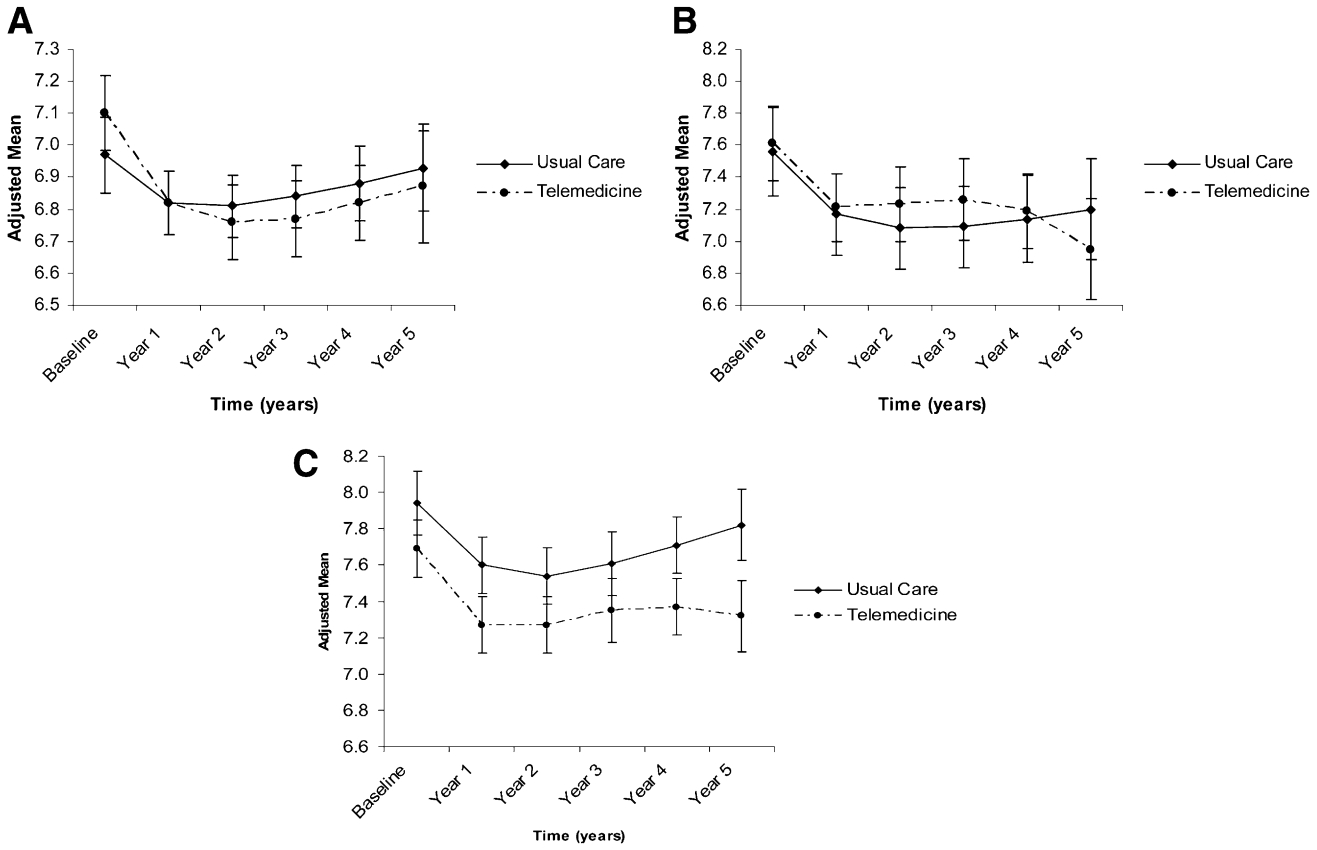

Figure 1—*A1C levels (adjusted means) by racial/ethnic group.* A*: White.* B*: Black. C: Hispanic. Error bars represent 95% CIs.*

claims in this medically underserved population was not observed (25). Implementation costs were high, representing the hardware and software available when IDEATel was initiated. Lower cost technology is needed.

Strengths of IDEATel include that it was a large 5-year randomized trial that successfully used home telemedicine in an underserved ethnically diverse older population with diabetes. Limitations are acknowledged. Because all racial/ethnic groups did not have similarly elevated A1C levels at baseline, we do not know if they all would have responded similarly to the telemedicine intervention, although blacks responded in a fashion more similar to white participants. There were relatively few participants with A1C levels (>9%), so there was insufficient power to examine the effectiveness of this intervention in individuals with the worst glycemic control. Because glucose levels were uploaded at each televisit, we could not distinguish between the effects of goal-setting, review of uploads, and other aspects of the intervention. Examination of the role of race/ethnicity was not the primary preplanned analysis, and the study was not originally powered to consider such subgroup analyses. Lastly, we were unable to assess intensification of dosing of medications, including insulin.

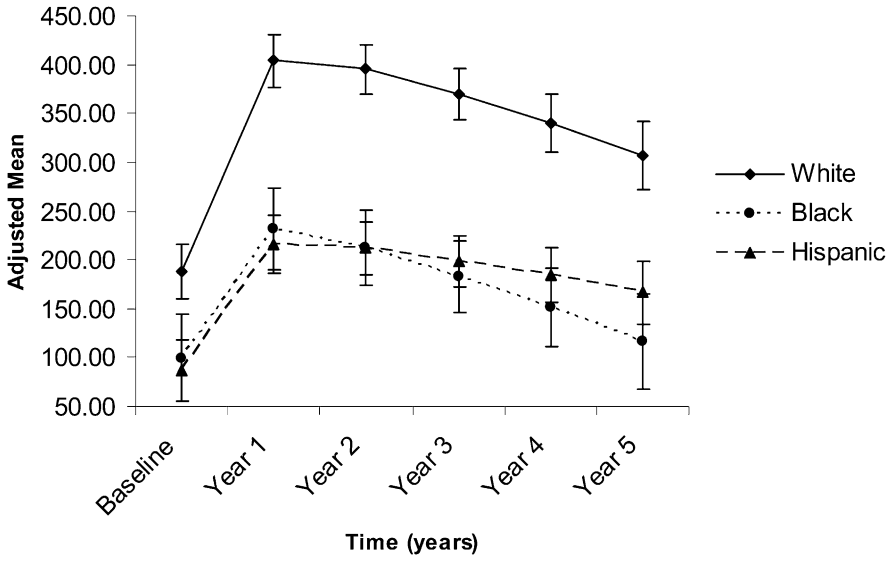

Figure 2—*Number of glucose uploads (adjusted means) by racial/ethnic group in telemedicine intervention participants* (n = *844). Error bars represent 95% CIs.*

In conclusion, we demonstrate, for the first time, that a telemedicine intervention that includes regularly scheduled home televisits with a diabetes educator, review of glucose uploads, individualized goal-setting, web access to educational materials, and recommendations for changes in therapy to PCPs can reduce

racial/ethnic disparities in glycemic control in older underserved adults. Hispanics had the highest A1C levels at baseline and demonstrated the greatest improvement. Whereas reduction in health disparities is difficult to achieve, these findings add to our knowledge about factors that may contribute to the inability to achieve glycemic goals. Blacks and Hispanics, the groups with lower education attainment, were less likely to monitor their blood glucose levels than whites, and such monitoring was related to better glucose control. Further studies including tailored education interventions for underserved diabetic populations are warranted.

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R.S.W. researched data, contributed to discussion, and wrote the manuscript. J.A.T. researched data, contributed to discussion, and reviewed and edited the manuscript. R.G., R.I., and W.P. researched data, contributed to discussion, and reviewed and edited the manuscript. J.P.E. researched data and reviewed and edited the manuscript. S.E. contributed to discussion and reviewed and edited the manuscript. S.S. reviewed and edited the manuscript.

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