Racial Differences in Glycemic Control in a Well-Functioning Older Diabetic Population

Findings from the Health, Aging and Body Composition study

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OBJECTIVE — To evaluate racial differences and factors associated with worse glycemic control in well-functioning older individuals with type 2 diabetes. Our hypothesis was that glycemic control would be worse among black than white diabetic individuals but that this association would be explained by differences in severity of diabetes, health status, health care indicators, and social, psychological, or behavorial factors. We further hypothesized that the association of race with poorer glycemic control would be limited to those with lower education or lower income.

RESEARCH DESIGN AND METHODS — Cross-sectional analysis of 468 diabetic participants among a cohort of 3,075 nondisabled blacks and whites aged 70–79 years living in the community enrolled in the Health, Aging and Body Composition Study. Glycemic control was measured by the level of HbA_{1c}.

RESULTS — A total of 58.5% of the diabetic individuals were black. Although control was poor in all diabetic participants ($HbA_{1c} \geq 7\%$ in 73.7%), blacks had worse glycemic control than whites (age- and sex-adjusted mean HbA_{1c}, 8.4% in blacks and 7.4% in whites; $P < 0.01$). Race differences in glycemic control remained significant, even after adjusting for current insulin therapy, cardiovascular disease, higher total cholesterol, and not receiving a flu shot in the previous year, all of which were associated with higher HbA_{1c} concentrations. Controlling for these factors reduced the association by 27%. Race remained an important factor in glycemic control, even when results were stratified by education or income.

CONCLUSIONS — HbA_{1c} concentrations were higher in older black diabetic individuals. Differences in glycemic control by race were associated with disease severity, health status, and poorer quality of care, but these factors did not fully explain the higher HbA_{1c} levels in older black diabetic individuals.

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Type 2 diabetes is one of the most common chronic diseases of old age in the U.S. (1), affecting nearly 20% of the U.S. population aged ≥75 years (2). The prevalence of type 2 diabetes varies considerably by ethnic group and is higher among African Americans and Hispanics compared with Caucasians (2,3). Poor glycemic control frequently occurs in U.S. patients with type 2 diabetes, particularly in African Americans and Hispanics (4), and poor glycemic control contributes to increased mortality and complications in these minority groups (5–7). Few factors seem to explain racial differences in glycemic control (4,8). To date, few studies have focused on glycemic control in older individuals with type 2 diabetes (9,10), particularly on racial differences in glycemic control in old age.

We used baseline data from the Health, Aging and Body Composition (Health ABC) study focusing on the 468 known diabetic individuals in a population of 3,075 black and white men and women aged 70–79 years who were drawn from a sample of Medicare recipients. We hypothesized that poor glycemic control would be associated with black race but that the poor glycemic control disparity between blacks and whites would be explained by differences in severity of diabetes (age at diagnosis and type of treatment), health status (weight, prevalent diseases, lipid levels, and functional status), socioeconomic factors (level of education, family income, access to care, and indicators of quality of care), and social, psychological, or behavorial factors (social support and physical activity). We further hypothesized that the association of race with poorer glycemic control would be limited to those of lower socioeconomic status (SES), whereas blacks with less than a high school education or lower income would have as good control as whites. Glycemic control was assessed by level of HbA_{1c}.

RESEARCH DESIGN AND METHODS

— The Health ABC study is a population-based clinical research study of the relationship of body composition, weight-related health conditions, and physical function in a cohort of blacks and whites, aged 70–79 years, who at baseline reported no difficulty

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Abbreviations: Health ABC, Health, Aging and Body Composition; SES, socioeconomic status.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

walking one-quarter mile or up one flight of stairs without resting. Participants were identified from a random sample of white Medicare beneficiaries and all age-eligible black community residents in designated zip code areas surrounding the Pittsburgh, Pennsylvania, and Memphis, Tennessee, field centers. Excluded from the Health ABC study cohort were *1*) individuals who reported difficulty walking one-quarter mile, walking up 10 stairs without resting, or performing basic activities of daily living and those who reported using a cane or other equipment to get around; *2*) individuals with known life-threatening cancers; and *3*) individuals who planned to leave the area within 3 years. All participants gave written informed consent, and all protocols were approved by the Institutional Review Boards at both study sites. The participants included 1,491 men and 1,584 women, 468 (15.2%) of whom identified themselves as having diabetes and/or using any hypoglycemic medication at the time of their recruitment into the study. A detailed interview regarding social demographics, health behaviors, indicators of SES, and health service utilization was administered in the home. Participants also underwent a clinical examination that included measurement of HbA_{1c}, fasting glucose, body composition, indicators of weight-related health conditions, and total, LDL, and HDL cholesterol.

The baseline home interview and clinic-based examination were performed between April 1997 and June 1998.

Assessment of diabetes

We used a combination of self-reported diagnosis and/or medications to identify individuals with diabetes.

Measure of glycemic control

The primary indicator of glycemic control was level of HbA_{1c} (Biorad Variant high-performance liquid chromatography [HPLC] assay.). This measure integrates control over the prior 6–8 weeks. In clinical practice, the goal for good control is HbA_{1c} <7% (11). Fasting glucose level was also measured.

Severity of diabetes

Severity of diabetes was examined in two ways. First, duration of diabetes was defined as either ≤5 years, 6–15 years, or >15 years; patients with duration of diabetes >15 years were defined as the reference group. Also, we characterized current treatment as insulin, oral hypoglycemics, or no medication, with insulin treatment indicating more severe disease.

Health status

Lack of glycemic control might relate to poorer health status; therefore, we assessed diabetes-related illnesses, weight, lipid levels, and functional status. We used a combination of self-reported diagnoses and/or medications to establish the prevalence of cardiovascular disease (heart disease or stroke).

For hypertension, we used self-report, medications, and measured blood pressure. Peripheral arterial disease was identified by an ankle-arm blood pressure ratio. Cognitive function was assessed by the Teng Modified Mini-Mental State Exam, and eyesight and urinary incontinence symptoms were assessed by questionnaire. We examined weight and standing height expressed as BMI (weight in kilograms divided by height in meters squared).

Total cholesterol, HDL cholesterol, and triglyceride levels were measured on a Vitros 950 analyzer (Johnson & Johnson), and LDL cholesterol level was calculated using the Friedewald equation.

To assess whether differences in functional status would affect level of glycemic control, we used a summary measure that combines usual gait speed, gait speed over a narrow walk course (20 cm), time to complete five chair stands, and standing balance. The development and validation of this summary measure have been described in detail elsewhere (12). The measure ranges from 0 to 4; a higher score indicates better function.

SES

The SES variables included education, income, access to care, and indicators of quality of health care. Education was considered in two groups: <12 years of school and ≥12 years of school. We also considered other SES indicators, including family income of ≤$25,000 or >$25,000. Income included wages, salaries or retirement benefits, help from relatives, rent from property, and any other source of income in the year before the interview.

Access and quality of care

Access to care and quality of care were important to explore as potential explanatory variables. In cardiovascular care, in particular, individuals of black race have been associated with worse quality of care (13). All participants were assumed to be enrolled in Medicare, because this was the sampling frame. Additional health insurance status was defined in three levels: no prescription coverage, no prescription coverage but supplemental health insurance through the federal government or a private agency, or prescription coverage with either Medicaid or supplemental health insurance. Access to care was defined as report of having a place to visit for usual health care or health care advice, including health maintenance organizations (HMOs) or private doctor's offices. Indicators of quality of care included report of receiving a flu shot in the past 12 months and whether two of the following cardiovascular risk factors were below recommended levels: systolic blood pressure (<140 mmHg), diastolic (<90 mmHg), or LDL cholesterol level <130 mg/dl.

Social, psychological, and behavioral indicators

Social health was assessed by social support (i.e., the number of relatives or friends who participants felt close to or could call on for help). Psychological health was assessed by a 20-item CES-D scale (14), which is used to assess depressive symptoms by self-rated health status. We did not have direct indicators of self-care related to diabetes; therefore, we used other health practice indicators. These included participation in regular walking for exercise during the last 12 months as a positive indicator of self-care and current smoking as a negative indicator.

Statistical methods

Baseline descriptive characteristics of the diabetic study population were compared by sex and race using the χ^2 test for dichotomous variables and generalized linear models for continuous variables. We then assessed each of these characteristics in relation to glycemic control using HbA_{1c} as a continuous variable in a linear regression model and retained those variables related to both race and glycemic control ($P \leq 0.10$) after controlling for age, sex, BMI, duration of diabetes, and study site. We then created a multivariate analysis to test whether the effect of race on glycemic control could be explained

Table 1—*Characteristics of the diabetic population in the Health ABC study*

	Women (n = 218)		Men (n = 250)		
	Black	White	Black	White	
n	154 (21.1%)	64 (7.5%)	120 (21.7%)	130 (13.8%)	
Demographics					
Age (years)	73.4 ± 2.9	73.3 ± 3	73.7 ± 2.7	73.9 ± 2.8	NS
Disease severity					
Age at diagnosis (years)	60.2 ± 11.6	58.9 ± 13.6	59.6 ± 10.5	60.4 ± 13	NS
Treatment					
No medication	10.4%	31.3%	14.2%	23.1%†	
On insulin	31.8%	18.8%	29.2%	16.2%*†	
On oral hypoglycemics	59.7%	53.1%	60%	62.3%	NS
Fasting glucose (mg/dl)	157.3 ± 65.8	140.7 ± 43	156 ± 63.9	155.5 ± 51.7	NS
HbA_{1c} (%)	8.3 ± 1.8	7.3 ± 1.2	8.5 ± 1.6	7.5 ± 1.2*†	
HbA_{1c} ≥7%	77.9%	65.6%	80.8%	66.2%*	
Health status					
Cardiovascular disease	32.5%	35.9%	33.3%	40%	NS
Systolic BP (mmHg)	139.2 ± 22.2	135.1 ± 15.1	140.4 ± 22.7	135.8 ± 19.8	NS
Diastolic BP (mmHg)	68.5 ± 11.5	66.4 ± 10.2	73.4 ± 12.1	68.6 ± 11.3*§	
Ankle arm index	0.97 ± 0.2	1.06 ± 0.2	0.98 ± 0.2	1.08 ± 0.2*†	
Urinary incontinence symptoms	40.5%	65%	25.8%	37.2%†‡§	
Mini-mental score (Teng)	84.7 ± 10	93 ± 5.9	84.7 ± 9.6	91.2 ± 6.9*†	
BMI (kg/m^2)	31.1 ± 5.4	28.6 ± 5.7	28.6 ± 4.2	27.9 ± 3.8†§	
Cholesterol (mg/dl)	210.9 ± 41.1	211 ± 43.5	185.1 ± 35.4	183.7 ± 36.1‡§	
HDL cholesterol (mg/dl)	57.7 ± 18.4	50.16 ± 12.5	47.9 ± 13.6	41.15 ± 12.5*†‡§	
Triglycerides (mg/dl)	132.7 ± 59.6	205.2 ± 120.5	121.4 ± 66.3	181.8 ± 121.6*†	
Physical performance score	1.71 ± 0.6	2.0 ± 0.5	1.99 ± 0.6	2.27 ± 0.5*†‡§	

Data are means ± SD unless otherwise indicated. *$P < 0.05$, comparison between race in men; †$P < 0.05$, comparison between race in women; ‡$P < 0.05$, comparison between sex in whites; §$P < 0.05$, comparison between sex in blacks. NS, not significant at $P < 0.05$. BP, blood pressure.

by these variables. To check whether the results were sensitive to nonlinear effects, we also performed the analysis using selected HbA_{1c} cut points as previously published. We also performed a stratified analysis by treatment (insulin, oral hypoglycemics, and no medication). To further test our hypothesis that race would influence glycemic control more in those with lower SES, we tested for an interaction of education with race and income with race and also performed stratified analyses by the level of education (<12 years and ≥12 years) and by the level of income (≤$25,000 and >$25,000). All analyses were performed using SAS software (SAS Institute, Cary, NC).

RESULTS — Baseline characteristics of the diabetic population are shown in Table 1. Of the 468 diabetic participants in the Health ABC study cohort (15.2% of our cohort), 274 (58.5%) were black. From the whole cohort, blacks had a higher proportion of diabetic individuals than whites (21.4 vs. 10.8%, respectively). More men (35.5%) than women (28.6%) had diabetes, and the level of control among all diabetic individuals in the study was poor (73.7% with HbA_{1c} ≥7%, regardless of race).

Among diabetic participants, 82.3% took either insulin or hypoglycemic agents; 25% of these individuals were on insulin. A total of 30% of the blacks were on insulin versus 17% of the whites. Duration of diabetes did not vary by race or sex. Although fasting glucose did not vary by race, HbA_{1c} levels were higher in blacks (age- and sex-adjusted HbA_{1c} 8.4% in blacks vs. 7.4% in whites). Ankle-arm index levels were consistent; more peripheral artery disease was noted in both black men and women, although prevalence of cardiovascular disease was similar by race. HDL cholesterol levels were higher and triglyceride level were lower in diabetic blacks, whereas diastolic blood pressure was higher in black men. BMI was higher in blacks, particularly women. Blacks with diabetes scored more poorly on tests of cognitive function and physical function and reported worse health status.

For SES indicators (Table 2), blacks had lower education, lower family income, less additional health insurance, less access to care, and worse indicators of quality of care (having had a flu shot in women, and poorer diastolic blood pressure in men) than whites. The only differences by race for social, psychological, and behavioral indicators were that more black diabetic men walked for exercise and were more likely to be current smokers.

Correlates of glycemic control

Black race was consistently associated with worse glycemic control, regardless of type of treatment. Among people using insulin therapy, blacks had worse control than whites (mean HbA_{1c} 8.6 and 7.8%, respectively, in models adjusted for age, sex, BMI, duration of diabetes, and study site; $P < 0.05$). Findings were similar among participants using oral hypoglycemic agents (adjusted mean HbA_{1c} level 8.4% for blacks and 7.7% for whites; $P < 0.01$). Even among participants using no drug therapy, there was still a significant

Table 2—*SES, access, and quality of care indicators and other health status variables among the diabetic population*

	Women (N = 218)		Men (N = 250)		
	Black	White	Black	White	
n	154 (21.1%)	64 (7.5%)	120 (21.7%)	130 (13.8%)	
SES					
Education					
<12 years	50.3%	7.8%	49.6%	17.7%	
≥12 years	49.7%	92.2%	50.4%	82.3%*†	
Family income					
≤$25,000	86.2%	45.0%	69.3%	37.1%	
>$25,000	13.9%	55.0%	30.7%	62.9%*†§	
Access and quality of care					
No prescription coverage	20.7%	0.0%	19.8%	6.3%	
No prescription coverage but supplemental health insurance	14.7%	23.4%	16.4%	28.1%	
Prescription coverage with either medicaid or supplemental health insurance	64.7%	76.6%	63.8%	65.6%*†	
Usual place of care is private doctor's office or HMO	77.3%	96.8%	65.8%	93.9%*†§	
Had flu shot in the past 12 months	62.1%	84.1%	73.3%	81.4%†§	
Systolic BP <140 (mmHg)	55.8%	64.1%	51.7%	63.1%	NS
Diastolic BP <90 (mmHg)	96.8%	100%	88.3%	96.9%*§	
LDL cholesterol <130 (mg/dl)	57.8%	57.8%	68.3%	79.2%‡	
Social, psychological, and behavioral					
Social support from relatives	4.1 ± 3.3	5.1 ± 5.1	4.1 ± 4.6	4.2 ± 4.9	NS
Social support from friends	2.6 ± 2.6	5.1 ± 6.1	3.3 ± 9.5	4.6 ± 6.1†	
Fair or poor self-rated health	37.3%	15.6%	36.7%	10.9%*†	
Walking for exercise in previous 12 months	47.4%	56.3%	46.7%	68.5%*	
Current smokers	11.0	6.3	21.7	6.9*§	

Data are *n* (%), means ± SD, and %. *$P < 0.05$, comparison between race in men; †$P < 0.05$, comparison between race in women; ‡$P < 0.05$, comparison between sex in whites; §$P < 0.05$, comparison between sex in blacks. NS, nonsignificant. BP, blood pressure.

difference in levels of HbA_{1c} between race (adjusted mean HbA_{1c} level 8.1% for blacks and 6.6% for whites; $P < 0.01$). In the multivariate models, race was no more associated with poorer control when only those on insulin therapy were examined.

Black race was associated with worse glycemic control than white race (Table 3), and adjustment for factors associated with poor control, including prevalent cardiovascular disease, higher total cholesterol level, greater BMI, poorer summary performance measure, and use of insulin therapy, did not change this. The results were not affected by addition of indicators of quality of care, level of education, or social support. In multivariate models, in addition to race ($P < 0.001$), male sex ($P < 0.01$), prevalent cardiovascular disease ($P < 0.001$), higher total cholesterol ($P < 0.01$), use of insulin therapy ($P < 0.05$), and study site ($P < 0.05$) still were associated with poorer control. One measure of quality of care, not receiving a flu shot, also was associated with higher HbA_{1c} levels ($P < 0.05$). Controlling for all these factors decreased the association between glycemic control and race by 27% (β-parameter 0.66, $P < 0.0001$). Results were similar when using selected HbA_{1c} cutpoints (data not shown).

SES, race, and glycemic control

To examine whether differences by race existed across the range of SES levels, we first examined the association of confounding variables with education level and with income level. Participants with <12 years of education were more frequently using insulin therapy and had poorer self-perceived health status. They also had a lower income, poorer quality of care (as indicated by not having a flu shot; $P < 0.01$), and were less likely to have supplemental insurance or a usual place of care. However, there was no significant interaction found between race and education level or between race and income level, and race was associated with poorer glycemic control in both higher and lower education groups and in both higher and lower income groups. Among those with <12 years of education, black race was a significant correlate of glycemic control. Multivariate adjustment, including factors more likely to be associated with lower education, reduced differences in HbA_{1c} by race. Although blacks continued to have higher HbA_{1c} levels, this difference was no longer significant (Table 3). Among those with ≥12 years of education, blacks had worse control than whites ($P < 0.01$) and adjustment for multiple risk factors did not affect the results. Similar results were found when level of family income was used to stratify the population. Black race continued to be associated with poorer glycemic control, whatever the income level.

CONCLUSIONS — In our study population, black race was associated with poorer glycemic control, even when we restricted the study population to those with a high school education or more or greater family income. Previous studies have shown that blacks had worse control, but the study populations were younger (4,15) and access to medical care

Table 3—*Multivariate and stratified analyses for glycemic control by race*

	β-Coefficient for race*	HbA_{1c}		
		White	Black	
All diabetic participants (*n*)		194	274	
1: Race	0.91	7.47	8.38‡	
2: + Age, sex, insulin therapy, duration of diabetes, and site	0.88	7.49	8.37‡	
3: + BMI, cardiovascular disease, total cholesterol	0.87	7.49	8.37‡	
4: + Education, social support	0.72	7.59	8.30‡	
5: + Having a flu shot, physical performance score	0.66	7.61	8.27‡	
SES stratified analysis				
Education-stratified				
Education ≥12 years (*n*)		166	136	
1: Race	0.75	7.45	8.21‡	
2: + Age, sex, insulin therapy, duration of diabetes, and site	0.68	7.49	8.16‡	
3: + BMI, cardiovascular disease, total cholesterol	0.69	7.48	8.17‡	
4: + Social support	0.68	7.49	8.17‡	
5: + Having a flu shot, physical performance score	0.66	7.52	8.18‡	
Education <12 years (*n*)		28	136	
1: Race	0.95	7.59	8.54†	
2: + Age, sex, insulin therapy, duration of diabetes, and site	0.87	7.66	8.52†	
3: + BMI, cardiovascular disease, total cholesterol	0.83	7.69	8.52	0.06
4: + Social support	0.80	7.71	8.51	0.07
5: + Having a flu shot, physical performance score	0.69	7.75	8.44	0.11
Income stratified				
Income >25,000 (*n*)		106	53	
1: Race	1.05	7.43	8.49‡	
2: + Age, sex, insulin therapy, duration of diabetes, and site	0.94	7.47	8.41‡	
3: + BMI, cardiovascular disease, total cholesterol	0.97	7.46	8.43‡	
4: + Education, social support	0.93	7.47	8.40‡	
5: + Having a flu shot, physical performance score	0.87	7.50	8.37‡	
Income ≤$25,000 (*n*)		70	191	
1: Race	0.82	7.52	8.34‡	
2: + Age, sex, insulin therapy, duration of diabetes, and site	0.81	7.52	8.34‡	
3: + BMI, cardiovascular disease, total cholesterol	0.85	7.50	8.35‡	
4: + Education, social support	0.68	7.62	8.30‡	
5: + Having a flu shot, physical performance score	0.62	7.65	8.27†	

*β-Coefficient for race in the association with HbA_{1c} level; †$P < 0.05$; ‡$P < 0.01$; §for income variable, 48 values were missing.

could not be adequately controlled for. In an older population, all Medicare-eligible individuals, the issue of access to care should be minimized as a factor contributing to potential differences in glycemic control by race. Shorr et al. (9) examined data from the National Health and Nutrition Examination Study III and found that many older adults with type 2 diabetes did not achieve targets for glycemic control, but there was no evidence that these community-dwelling diabetic elderly individuals were less well controlled and treated less vigorously than younger diabetic individuals. However, blacks of all ages were approximately twofold more likely to have poorer glycemic control than whites with few differences (4,9). There were relatively few blacks >70 years of age in that study, which limited the possibility of exploring explanatory relationships in old age specifically.

We examined several factors that might explain the relationship observed between race and glycemic control. One such factor is the severity of diabetes. Duration of diabetes was similar in whites and blacks and was not associated with poorer control, as found in other studies (8,15). Blacks could have been diagnosed later than they reported, but a recent analysis on undiagnosed diabetes in the Health ABC study showed that race was not significantly associated with undiagnosed diabetes (16). Blacks were more likely to be taking insulin, as has been found in other studies (4,15,17). Whether this difference in therapy reflects poorer disease course or an earlier failure rate on other medications is unclear. Insulin therapy was still associated with poorer control in multivariate models, but controlling for current medication type did not explain the racial difference. In other studies, insulin treatment in general is associated with poorer control (15,17), but physician reasons for switching patients to insulin therapy have not been systematically assessed.

A second factor was quality of care received by the diabetic population. We included three direct and indirect indicators of adequate medical care: control of cholesterol, control of blood pressure, and reporting of a flu shot in the past year. Of these, flu shot administration is best established as an indicator of care. Sub-

stantial disparities have been reported in studies of black and white patients (18) for a variety of medical treatments, including vaccination for flu in managed care. In a diabetic Medicare population aged 65 years and older, Chin et al. (19) found that black patients who had <12 years of education had fewer measurements of HbA_{1c} and fewer influenza vaccinations. In our study, receiving a flu shot was independently associated with better glycemic control, independent of race.

A third factor may be level of self-care. We did not have direct measures of self-care for diabetes, but we used two surrogate measures of self-care: participation in a physical activity or current smoking. These indirect measures of self-care also did not influence glycemic control. We had no data on patient education or self-monitoring of blood glucose on glycemic control; there is evidence that this may influence the level of glycemic control. Several studies have shown that an education program can lead to improvement of glycemic control, even in older people (20–23). Cowie et al. (24) found that the median number of hours of instruction was lower for blacks, and this may provide some insight into worse glycemic control in that population. Self-monitoring of blood glucose among insulin-treated patients is lower in blacks in the National Health and Nutrition Examination Study III (17). Clinical research (25) also suggests that nurse care managers may be an important factor in differences in level of control because they contribute to adherence to diet, weight loss, prescribed medication intake, and self-monitoring of blood glucose. Another aspect of self-care that might have influenced glycemic control is drug adherence; one study (26) demonstrated a strong association between poorer adherence to diabetes drug therapy and worse metabolic control in blacks compared with whites. We did not have data on adherence but coverage for drug benefits and family income did not predict control.

Few studies have had adequate power to address effects of SES on control of diabetes in older people. It was surprising that the association of race with glycemic control was present, even among those with higher educational levels or higher income, despite controlling for factors hypothesized to explain the association. The association among the lower education group was of borderline significance after adjustment, probably reflecting the small number of whites in the lower education diabetic group. That SES stratification did not resolve the association of race, and higher HbA_{1c} levels may suggest a stronger role for adequacy of care, consistent with data on other health conditions and race.

Given priorities to study health disparities, racial differences in glycemic control should be further studied to identify factors amenable to intervention. Efforts in this direction are likely to benefit all older individuals with diabetes.

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