American Diabetes Association Framework for Glycemic Control in Older Adults: Implications for Risk of Hospitalization and Mortality

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OBJECTIVE

The 2021 American Diabetes Association (ADA) guidelines recommend different A1C targets in older adults that are based on comorbid health status. We assessed risk of mortality and hospitalizations in older adults with diabetes across glycemic control (A1C <7%, 7 to <8%, ≥8%) and ADA-defined health status (healthy, complex/intermediate, very complex/poor) categories.

RESEARCH DESIGN AND METHODS

Prospective cohort analysis of older adults aged 66–90 years with diagnosed diabetes in the Atherosclerosis Risk in Communities (ARIC) study.

RESULTS

Of the 1,841 participants (56% women, 29% Black), 32% were classified as healthy, 42% as complex/intermediate, and 27% as very complex/poor health. Over a median 6-year follow-up, there were 409 (22%) deaths and 4,130 hospitalizations (median [25th–75th percentile] 1 per person [0–3]). In the very complex/poor category, individuals with A1C ≥8% (vs. <7%) had higher mortality risk (hazard ratio 1.76 [95% CI 1.15–2.71]), even after adjustment for glucose-lowering medication use. Within the very complex/poor health category, individuals with A1C ≥8% (vs. <7%) had more hospitalizations (incidence rate ratio [IRR] 1.41 [95% CI 1.03–1.94]). In the complex/intermediate group, individuals with A1C ≥8% (vs. <7%) had more hospitalizations, even with adjustment for glucose-lowering medication use (IRR 1.64 [1.21–2.24]). Results were similar, but imprecise, when the analysis was restricted to insulin or sulfonylurea users ($n = 663$).

CONCLUSIONS

There were substantial differences in mortality and hospitalizations across ADA health status categories, but older adults with A1C <7% were not at elevated risk, regardless of health status. Our results support the 2021 ADA guidelines and indicate that <7% is a reasonable treatment goal in some older adults with diabetes.

The 2021 American Diabetes Association (ADA) guidelines provide a framework for treating older adults with diabetes (1). This framework recommends treatment

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goals for glycemic control that are based on older patients' comorbid health and functional status. The comorbidities are listed as arthritis, cancer, congestive heart failure, depression, emphysema, falls, hypertension, incontinence, stage 3 or worse chronic kidney disease (CKD), myocardial infarction, stroke, cognitive function, and activities of daily living dependencies, with three or more comorbidities reflecting a "high burden" (2).

The rationale for targeting differing A1C goals according to health status is driven by life expectancy and time-to-benefit principles, under the assumption that older adults with diabetes who have very complex or poor health status may be at highest risk for adverse effects of treatment and less likely to benefit from intensive glucose control. Yet, the prognosis of diabetes in older adults is poorly characterized (2,3). It is also unclear whether the health status categories set forth in the ADA guidelines provide discrimination for mortality risk (4).

We used data from the Atherosclerosis Risk in Communities (ARIC) study to assess the current ADA framework and treatment goals among older adults with diabetes. Specifically, we sought to *1*) describe the characteristics of participants according to ADA comorbid health status categories and A1C treatment goals and *2*) examine prospective associations of health status categories with mortality and total hospitalizations during 6 years of follow-up, overall, and according to A1C categories.

RESEARCH DESIGN AND METHODS

The ARIC study is a community-based cohort that began in 1987–1989 when participants were middle aged (5). Participants were recruited from four centers: Forsyth County, North Carolina; Jackson, Mississippi; Minneapolis, Minnesota; and Washington County, Maryland. Visit 5 occurred in 2011–2013 when all 6,538 participants were >65 years of age.

Approximately one in three ARIC participants had diagnosed diabetes at visit 5 (self-report physician diagnosis or use of glucose-lowering medication, $n = 2{,}147$). For our analysis, we excluded visit 5 participants who were missing A1C measurement ($n = 60$), were missing comorbidity status ($n = 225$), or did not contribute follow-up data after visit 5 ($n = 2$) (Supplementary Fig. 1). We also excluded participants who self-reported their race as neither Black nor White, and Black participants at the Maryland and Minnesota centers because of small numbers ($n = 19$). Our final analytic sample was 1,841 older adults with diagnosed diabetes.

Measurement of A1C and Ascertainment of Glucose-Lowering Medication Use

A1C was measured in whole blood using a Tosoh G7 automated high-performance liquid chromatography analyzer (Tosoh Bioscience), which was standardized to the Diabetes Control and Complications Trial (DCCT) assay. Participants were asked to bring medication bottles used in the prior 2 weeks. Medications were transcribed and coded. We categorized participants as using insulin or sulfonylurea (with or without other glucose-lowering medications), other glucose-lowering medications (noninsulin/sulfonylurea), or no glucose-lowering medication.

Measurement of Comorbidities

Prevalent comorbidities were assessed at visit 5 (2011–2013 unless specified otherwise), on the basis of a history of one or more ICD-9 codes identified through hospital surveillance between 1987 and 2011, or on the basis of claims identified through the Centers for Medicare & Medicaid Services (CMS) linkage between 1987 and 2011. Arthritis was based on CMS inpatient and outpatient claims, any hospitalization identified through ARIC standard surveillance procedures where arthritis was recorded (see Supplementary Table 1 for ICD-9 codes used) before visit 5 (2011–2013), or self-report of arthritis at visit 4 (1996–1998). Cancer was ascertained through linkage to cancer registries. Congestive heart failure (reduced or preserved ejection fraction), myocardial infarction, and stroke (ischemic or hemorrhagic) were based on self-report at ARIC visit 1 (1987–1989) or any adjudicated event before visit 5 (2011–2013) on the basis of previously published approaches (6–8). Depression was defined using a score of ≥9 on the validated Center for Epidemiological Studies Depression 11-item questionnaire (9). Emphysema and chronic obstructive pulmonary disease (COPD) were self-reported at visit 5 and based on hospitalizations. History of falls was based on any prior fall-related hospitalization. Hypertension was defined as measured blood pressure ≥140/90 mmHg (mean of second and third measurement) or current hypertension medication use. Hypoglycemia was ascertained from hospitalizations and linkage to CMS claims (10,11). Incontinence was based on CMS claims and any hospitalization with incontinence recorded before visit 5. CKD was defined as an estimated glomerular filtration rate <60 mL/min/1.73 m^2 at visit 5 (stage 3+) on the basis of the Chronic Kidney Disease Epidemiology Collaboration equation using cystatin C and creatinine (12), an albumin-to-creatinine ratio of ≥30 mg/g at visit 5, prior CKD-related hospital admission by continuous active surveillance, or end-stage kidney disease event in the U.S. Renal Data System registry. Dementia was based on detailed neurocognitive testing and adjudication (13). Frailty was based on criteria previously described in ARIC on the basis of the presence of three or more of the following: low energy, low physical activity, low strength, slowed motor performance, and unintentional weight loss (14,15). Functional status was based on the Short Physical Performance Battery, with a score <7 indicating poor functional status and ≥7 indicating adequate functional status (16).

Outcomes

All-cause mortality was identified through semiannual follow-up telephone calls to participants or their proxies, state records, and linkage to the National Death Index. We also examined associations with number of hospitalizations. Hospitalization reports were identified from semiannual telephone contact with study participants or their proxies and from active surveillance of hospitalizations in community hospitals (17).

Statistical Analysis

Using the ADA framework, we categorized individuals with zero to two ADA comorbidities, no dementia, no frailty,

and adequate functional status as healthy. We classified individuals with three or more comorbidities, no dementia or frailty, and adequate functional status as having complex or intermediate health status. Finally, we classified individuals with dementia, frailty, or poor functional status, irrespective of the number of ADA comorbidities, as having very complex or poor health status.

We described the proportion of individuals with each individual comorbidity and the proportion within each comorbid health status category (healthy, complex/intermediate, very complex/poor) overall and by A1C category (<7%, 7 to <8%, ≥8% [<53, 53 to <64, ≥64 mmol/mol]). We used Kaplan-Meier survival methods and multivariable Cox proportional hazards regression to examine associations of health status categories overall and according to A1C category with all-cause mortality. We estimated incidence rates for mortality and total hospitalizations by health status and A1C categories. We used negative binomial regression to quantify associations with number of hospitalizations with an offset for ln(person-time). We also examined the associations of individual comorbidities with mortality and hospitalizations. Follow-up for both outcomes was available through 31 December 2018. In model 1, we adjusted for age, sex, and race-center (Minnesota Whites, Maryland Whites, North Carolina Whites, North Carolina Blacks, Mississippi Blacks). In model 2, we adjusted for model 1 covariates plus glucose-lowering medication categories (insulin/sulfonylurea, noninsulin/sulfonylurea only, none). We tested whether the associations of A1C categories with mortality and hospitalizations differed according to health status by including a cross-product term in model 2. We conducted a sensitivity analysis where we restricted our analysis to insulin or sulfonylurea users. Additionally, we examined associations of comorbid health status within the A1C categories <6% (<42 mmol/mol) and ≥9% (≥75 mmol/mol) for mortality and total hospitalizations.

RESULTS

The 1,841 older participants with diabetes were, on average, 75.4 years (SD 5.1) old; 56% were women, and 29% self-reported Black race/ethnicity. In the study population, 36% were insulin or sulfonylurea users (with or without other glucose-lowering medications); 25% used only other glucose-lowering medications, while 39% used no glucose-lowering medication.

Overall, 32% were classified as healthy, 42% had complex/intermediate health status, and 27% had very complex/poor health (Table 1). The mean A1C was 6.6% (SD 1.1%) (49 mmol/mol [12 mmol/mol]). Across all health status categories, most individuals (~70%) had an A1C <7% (<53 mmol/mol). Compared with individuals categorized as healthy, those with very complex/poor health status were older, more likely to be using glucose-lowering medications, and had longer duration of diabetes. Overall, hypertension, arthritis, and CKD were the three most common comorbidities (Table 1). Only 3.1% of participants overall had a history of severe hypoglycemia. In the very complex/poor category, 7% had a history of severe hypoglycemia (5.9% in A1C <7% [<53 mmol/mol], 5.6% in A1C 7 to <8% [53 to <64 mmol/mol], and 10.6% in A1C ≥8% [≥64 mmol/mol]).

Over a median of 6 years follow-up, 409 (22%) deaths occurred. Regardless of health status, older adults with A1C <7% were not at significantly higher risk of mortality than those with A1C ≥7% (≥53 mmol/mol) (Fig. 1). Within the very complex/poor category, individuals with high A1C (≥8% [≥64 mmol/mol]) had higher mortality risk (hazard ratio [HR] 1.76 [95% CI 1.15–2.71]) than those with A1C <7% (<53 mmol/mol) (model 1, Table 2). This pattern remained even after adjusting for glucose-lowering medication use (model 2, Table 2). Within all health status categories, there were no statistically significant differences in mortality between individuals with A1C 7 to <8% (53 to <64 mmol/mol) compared with those with A1C <7% (<53 mmol/mol) (Table 2). The association between health status and mortality did not differ by A1C category (model 2 *P* for interaction = 0.74). Within all A1C categories, very complex/poor health was associated with greater mortality risk compared with individuals classified as healthy (Supplementary Table 2). When we examined mortality risk for individuals with A1C <6% (<42 mmol/mol) and those with A1C ≥9% (≥75 mmol/mol), our results were similar, but CIs were wider (Supplementary Table 2).

The majority (70%) of participants were hospitalized at least once over the study period, and the median number of hospitalizations per individual was one per person (25th–75th percentile 0–3). Within the very complex/poor category, individuals with high A1C (≥8% [≥64 mmol/mol]) had more hospitalizations (incidence rate ratio [IRR] 1.41 [95% CI 1.03–1.94]) than those with A1C <7% (model 1, Table 3). After further adjustment for glucose-lowering medication use, results were attenuated for the very complex/poor category (IRR 1.38 [0.99–1.91]) (Table 3). In the complex/intermediate category, individuals with an A1C 7 to <8% (53 to <64 mmol/mol) and ≥8% (≥64 mmol/mol) had more hospitalizations compared with those with an A1C <7% (<53 mmol/mol); the association for A1C 7 to <8% (53 to <64 mmol/mol) was attenuated with further adjustment for glucose-lowering medication use (Table 3). There were no statistically significant differences in total number of hospitalizations by A1C categories among those classified as healthy (Table 3). Total number of hospitalizations did not differ according to health status and A1C categories (model 2 *P* for interaction = 0.21). Regardless of A1C, very complex/poor health was associated with a higher incidence rate of total hospitalizations (Supplementary Table 2). This pattern was similar when we stratified A1C categories further to examine incidence of total hospitalizations for individuals with A1C <6% (<42 mmol/mol) and for individuals with A1C ≥9% (≥75 mmol/mol) (Supplementary Table 2).

Insulin or sulfonylurea use was more common among individuals with greater health status complexity (Supplementary Table 3). Insulin or sulfonylurea use was lower in the subset with an A1C <7% (<53 mmol/mol) than the overall population (insulin or sulfonylurea use in the very complex/poor category: 43% overall vs. 29% subset with A1C <7% [<53 mmol/mol]). Severe hypoglycemia was more common among insulin or sulfonylurea users at 6.6% (95% CI 4.9–8.8) compared with 1.1% (0.6–1.9) among individuals not taking insulin or sulfonylurea. Patterns of other glucose-lowering

Table 1—Baseline characteristics of older adults with diabetes according to health status: the ARIC study, 2011–2013

	Health status		
	Healthy	Complex/ intermediate	Very complex/ poor
n	582	766	493
Visit 5 age (years), mean (SD)	73.5 (4.2)	75.5 (4.9)	77.5 (5.5)
Women	305 (52.4)	411 (53.7)	312 (63.3)
Black	159 (27.3)	178 (23.2)	188 (38.1)
Number of medications,* mean (SD)	9.3 (4.7)	10.9 (4.9)	11.4 (5.0)
A1C			
<7%	433 (74.4)	547 (71.4)	337 (68.4)
7 to <8%	101 (17.4)	143 (18.7)	90 (18.3)
≥8%	48 (8.2)	76 (9.9)	66 (13.4)
Diabetes medication			
None	257 (44.2)	289 (37.7)	166 (33.7)
Noninsulin/sulfonylurea only	159 (27.3)	192 (25.1)	115 (23.3)
Insulin or sulfonylurea	166 (28.5)	285 (37.2)	212 (43.0)
Diabetes duration ≥10 years	196 (33.7)	341 (44.5)	284 (57.6)
Comorbidities			
Arthritis	238 (40.9)	618 (80.7)	414 (84.0)
Cancer	54 (9.3)	258 (33.7)	122 (24.7)
CKD†	124 (21.3)	534 (69.7)	354 (71.8)
Coronary heart disease	25 (4.3)	219 (28.6)	105 (21.3)
Depression	14 (2.4)	94 (12.3)	68 (13.8)
Emphysema or COPD	8 (1.4)	91 (11.9)	48 (9.7)
Heart failure	9 (1.5)	192 (25.1)	151 (30.6)
History of hospitalized fall	5 (0.9)	34 (4.4)	34 (6.9)
History of severe hypoglycemia	3 (0.5)	22 (2.9)	32 (6.5)
Hypertension	418 (71.8)	707 (92.3)	426 (86.4)
Incontinence	14 (2.4)	133 (17.4)	104 (21.1)
Stroke	9 (1.5)	40 (5.2)	49 (9.9)
Dementia‡	—	—	86 (17.4)
Frailty	—	—	191 (38.7)
Poor physical function	—	—	382 (77.5)

Data are *n* (%) unless otherwise indicated. *Inclusive of prescription and over-the-counter medications and dietary supplements. †CKD refers to stage 3+ (estimated glomerular filtration rate <60 mL/min/1.73 m^2) or albuminuria (albumin-to-creatinine ratio ≥30 mg/g). ‡By definition, "—" means that there are no participants in this category (i.e., dementia, frailty, or poor physical function were used to define the very complex/poor heath category).

medications (noninsulin/sulfonylureas) were similar across health categories overall and within the A1C <7% (<53 mmol/mol) subset (Supplementary Table 3). The associations across A1C and comorbid health status categories with mortality were similar (but less precise) when restricted to individuals treated with insulin/sulfonylurea (Supplementary Table 4).

Individuals with complex/intermediate (HR 2.00 [95% CI 1.48–2.70]) or very complex/poor health (4.30 [3.16–5.86]) had higher mortality risk than those classified as healthy after adjustment for age, sex, and race-center (Table 2 and Supplementary Fig. 2). Results were slightly attenuated with adjustment for glucose-lowering medication use but remained statistically significant. The individual comorbidities were generally associated with higher risk of mortality. Cancer, CKD, coronary heart disease, emphysema or COPD, heart failure, history of falls, history of hypoglycemia, dementia, frailty, and poor functional status were associated with elevated mortality risk. Arthritis, depression, hypertension, incontinence, and stroke were not significantly associated with mortality but had effect estimates consistent with the hypothesized direction of elevated mortality (Supplementary Fig. 3).

Those with complex/intermediate health (IRR 2.20 [95% CI 1.90–2.55]) or very complex/poor health (3.56 [3.01–4.21]) had higher total hospitalization rates than those classified as healthy with adjustment for age, sex, and race-center (Table 3). All the individual comorbidities were associated with a greater number of hospitalizations (Supplementary Fig. 4).

CONCLUSIONS

In this community-based population of adults aged 66–90 years with diabetes, individuals meeting more stringent A1C goals (<7% [<53 mmol/mol]) did not have higher 6-year risk of mortality or hospitalizations compared with individuals with elevated A1C in any of the health status categories. This pattern was consistent after adjustment for glucose-lowering medication use. There were substantial differences in mortality on the basis of the ADA health status categories; however, some of the individual components, such as arthritis, depression, hypertension, and incontinence, were not associated with mortality. All the individual comorbidities were associated with a greater number of hospitalizations. Our results suggest that certain patients may safely achieve lower A1C goals in older age, even in the presence of comorbidities, and suggest opportunities to improve ADA health status categorization.

There is controversy regarding the potential for "overtreatment" of older adults with diabetes; prior studies have raised concerns that overtreatment is common and may be doing harm (18–25). The term overtreatment implies that *1*) the anticipated harms of glycemic control—typically hypoglycemia—exceed the benefits of glucose-lowering therapy (3) and *2*) individuals with presumed limited life expectancy may not live to experience benefits of tighter glycemic management (26,27). Yet, a clear definition of what actually constitutes overtreatment is lacking. Objective measures for clinicians to operationalize the proposed ADA health status framework are also needed; it is unclear which comorbid conditions to consider in this approach (28). Confusion also arises from lack of adequate representation of older adults in clinical trials to inform guidelines on diabetes management (29). Our findings help to inform guidelines and suggest that certain components of the health status framework (e.g., dementia, functional status, frailty) may be of greater

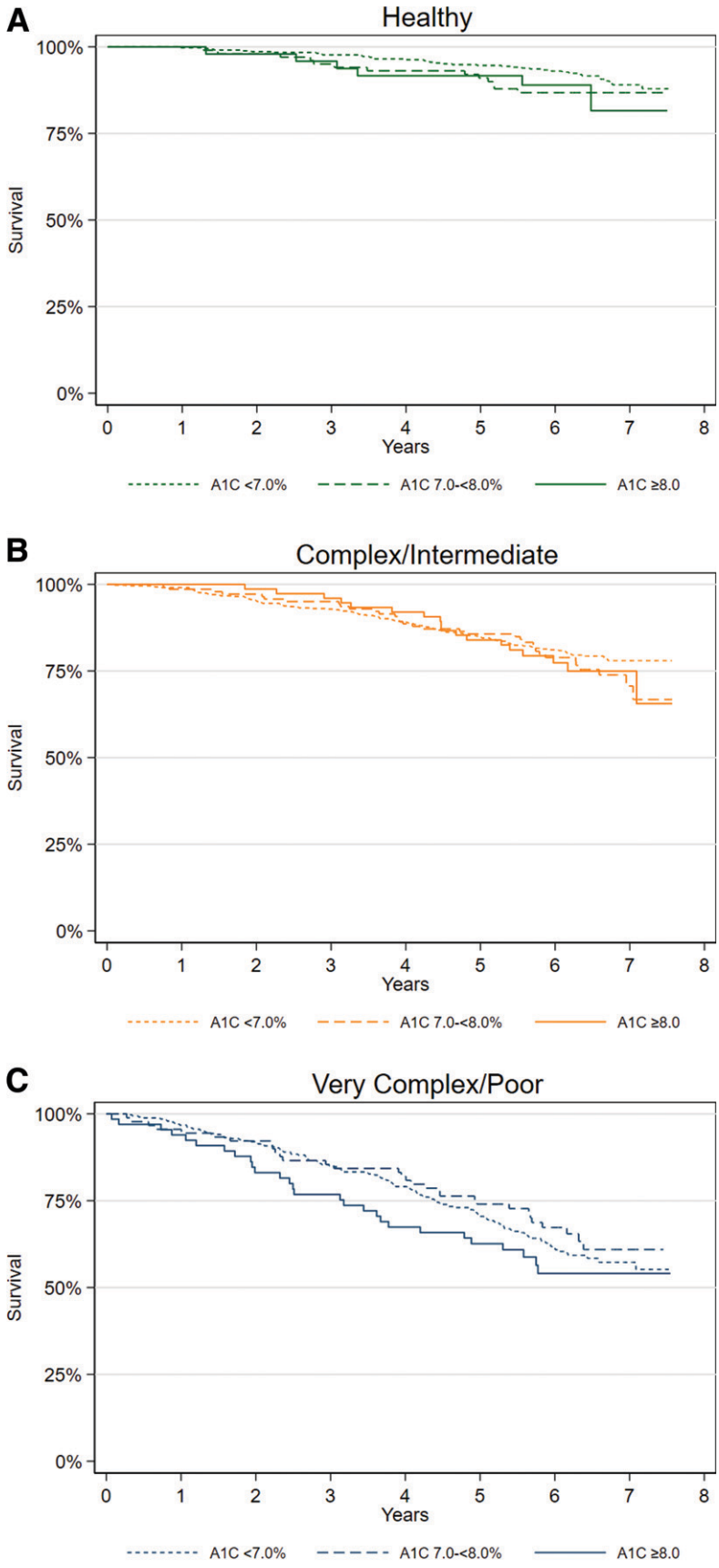

Figure 1—Kaplan-Meier curves of mortality in older adults with diabetes according to health status and A1C categories: the ARIC study, 2011–2018. *A*: Healthy. *B*: Complex/intermediate. *C*: Very complex/poor.

importance for the individualization of A1C goals. The presence of other comorbidities, such as arthritis or hypertension, should not carry as much influence for treatment decisions to relax A1C goals. Our findings highlight the need for research to inform evidence-based medicine for the management of diabetes in older adults.

Spotlighting the controversy regarding the benefits and risks of treatment intensification in older adults, the data safety and monitoring board for the Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial recommended in 2003 (the trial was published in 2008 [30]) that recruitment of adults aged ≥80 years be stopped because of the greater number of participants experiencing severe hypoglycemia within the intensive control arm (31). However, in post hoc analyses, the risk of hypoglycemia in the intensive treatment arm was concentrated among participants who had high A1C but were not achieving the A1C goals (32–34). This finding is further supported by studies that have demonstrated that the highest rates of hypoglycemia are among those with poorly controlled diabetes (10,35). Longer diabetes duration in older age, which is correlated with poorer glycemic control, is also associated with greater risk for hypoglycemia (10,36) and mortality (37–39).

Older adults are particularly susceptible to hypoglycemia partly because of the higher prevalence of CKD (reducing clearance of glucose-lowering medications), cognitive impairment, depression (which can adversely affect diabetes self-care habits), and polypharmacy (40). Polypharmacy has a potential to increase risk of hypoglycemia and other adverse outcomes as a result of drug-drug interactions (3,41). Insulin and sulfonylureas are among the leading medications associated with hospitalizations in those aged >65 years (42). Therapy simplification may be appropriate if the insulin regimen is complex and hypoglycemia occurs (or recurs) (1). Shared decision making is an important tool for clinicians to decide with the patient whether to maintain, deintensify, or intensify glycemic goals (43).

Several observational studies have reported a high prevalence of potential overtreatment of older adults with diabetes (18–25). In a cross-sectional

Table 2—Mortality in older adults with diabetes according to comorbid health status overall and by A1C categories: the ARIC study, 2011–2018

	n	5-year cumulative mortality, % (95% CI)	Mortality rate per 1,000 person-years (95% CI)	HR (95% CI)†	
				Model 1	Model 2
Health status category*					
Healthy	582	6.3 (4.6–8.6)	16.2 (12.0–20.3)	1 (Ref)	1 (Ref)
Complex/intermediate	766	15.1 (12.8–17.9)	36.4 (30.8–42.0)	2.00 (1.48–2.70)	1.96 (1.45–2.66)
Very complex/poor	493	30.0 (26.1–34.3)	75.5 (64.7–86.2)	4.30 (3.16–5.86)	4.22 (3.10–5.76)
Health status and A1C categories					
Healthy					
A1C <7%	433	5.4 (3.6–8.0)	14.4 (9.9–18.9)	1 (Ref)	1 (Ref)
A1C 7 to <8%	101	9.1 (4.9–16.8)	21.5 (9.8–33.2)	1.32 (0.70–2.48)	1.24 (0.62–2.44)
A1C ≥8%	48	8.5 (3.3–21.1)	21.5 (4.3–38.7)	1.80 (0.74–4.39)	1.65 (0.64–4.26)
Complex/intermediate					
A1C <7%	547	15.2 (12.4–18.5)	34.5 (28.1–41.0)	1 (Ref)	1 (Ref)
A1C 7 to <8%	143	14.4 (9.5–21.4)	41.1 (27.3–55.0)	1.24 (0.84–1.82)	1.11 (0.73–1.71)
A1C ≥8%	76	16.2 (9.6–26.8)	41.3 (22.2–60.4)	1.35 (0.81–2.23)	1.18 (0.69–2.02)
Very complex/poor					
A1C <7%	337	29.5 (24.9–34.7)	75.1 (62.2–88.1)	1 (Ref)	1 (Ref)
A1C 7 to <8%	90	26.1 (18.2–36.7)	65.7 (42.6–88.9)	1.00 (0.67–1.48)	1.00 (0.66–1.52)
A1C ≥8%	66	37.8 (27.2–50.9)	92.4 (58.2–126.7)	1.76 (1.15–2.71)	1.73 (1.10–2.73)

Ref, reference. *Healthy: fewer than three ADA comorbidities, no dementia, no frailty, adequate physical function; complex/intermediate: three or more ADA comorbidities, no dementia, no frailty, adequate physical function; and very complex/poor: dementia or frailty or poor physical function. ADA comorbidities are arthritis, cancer, congestive heart failure, depression, emphysema, falls, hypertension, incontinence, CKD, myocardial infarction, and stroke. †Model 1: age, sex, race-center. Model 2: model 1 + glucose-lowering medication use (insulin/sulfonylurea, noninsulin/sulfonylurea only, none).

analysis of data from the 2001–2010 National Health and Nutrition Examination Survey (NHANES) cycles, 62% of older adults with diabetes had an A1C <7% (<53 mmol/mol) (18). Of the individuals with A1C <7% (<53 mmol/mol), 60% of those with poor/very complex health were being treated with insulin or sulfonylureas. This and several other observational studies have postulated that many older adults may be experiencing more harm (i.e., hypoglycemia) than benefit from intensive glycemic control (18–25). Unlike for randomized clinical trials, participants with diabetes in observational studies with well-controlled A1C (i.e., <7% [<53 mmol/mol]) will reflect a mix of intensively treated individuals on multiple medications and those who have "mild"

Table 3—Comorbidity categories with total count of hospitalizations overall and by A1C categories: the ARIC study, 2011–2018

	n	Total hospitalizations	Person-years	Incidence rate per 1,000 person-years	IRR (95% CI)†	
					Model 1	Model 2
Health status category*						
Healthy	582	732	3,587	204.1	1 (Ref)	1 (Ref)
Complex/intermediate	766	1,859	4,473	415.6	2.20 (1.90–2.55)	2.12 (1.83–2.46)
Very complex/poor	493	1,539	2,477	621.3	3.56 (3.01–4.21)	3.41 (2.88–4.03)
Health status and A1C categories						
Healthy						
A1C <7%	433	546	2,704	201.9	1 (Ref)	1 (Ref)
A1C 7 to <8%	101	121	604	200.3	0.99 (0.71–1.39)	1.01 (0.71–1.44)
A1C ≥8%	48	65	279	233.0	1.16 (0.74–1.83)	1.17 (0.72–1.91)
Complex/intermediate						
A1C <7%	547	1,177	3,212	366.4	1 (Ref)	1 (Ref)
A1C 7 to <8%	143	393	826	475.8	1.32 (1.05–1.66)	1.24 (0.97–1.59)
A1C ≥8%	76	289	435	664.4	1.82 (1.36–2.44)	1.64 (1.21–2.24)
Very complex/poor						
A1C <7%	337	1,019	1,708	596.6	1 (Ref)	1 (Ref)
A1C 7 to <8%	90	276	469	588.5	0.98 (0.74–1.30)	0.94 (0.71–1.26)
A1C ≥8%	66	244	301	810.6	1.41 (1.03–1.94)	1.38 (0.99–1.91)

Ref, reference. *Healthy: fewer than three ADA comorbidities, no dementia, no frailty, adequate physical function; complex/intermediate: three or more ADA comorbidities, no dementia, no frailty, adequate physical function; very complex/poor: dementia or frailty or poor physical function. ADA comorbidities are arthritis, cancer, congestive heart failure, depression, emphysema, falls, hypertension, incontinence, CKD, myocardial infarction, stroke. †Model 1: age, sex, race-center. Model 2: model 1 + glucose-lowering medication use (insulin/sulfonylurea, noninsulin/sulfonylurea only, none).

disease and are on few medications. In an observational setting, the pathways by which patients achieve a well-controlled A1C will be diverse and typically unknown but would reflect real-world diabetes management practices. Indeed, older participants in our study with A1C <7% (<53 mmol/mol) were more likely to have a shorter duration of diabetes and to be taking fewer medications (any medications or for diabetes). It is not possible to know whether an older patient with diabetes with an achieved A1C <7% (<53 mmol/mol) is being overtreated per se.

Our study is not without limitations. First, the sample sizes were small in some subgroups, including in the A1C ≥8% (≥64 mmol/mol) group. However, we observed statistically significant higher risks of mortality and hospitalizations at higher A1C levels across all health status categories. Second, our analyses of combined comorbidities assume that each comorbidity had equal importance; this is unlikely to be the case. Nonetheless, our approach is consistent with how comorbidities are considered in the ADA guidelines. Third, we relied on hospital discharge codes and claims data to classify some comorbidities, which may have resulted in misclassification. For example, our definition of severe hypoglycemia (on the basis of hospitalization codes or claims) is a highly specific end point but likely underascertained (10,11). Finally, diabetes was defined on the basis of self-reported physician diagnosis or glucose-lowering medication use. This definition has been shown to be highly specific (44). Strengths of this analysis include the rigorous ascertainment of a wide array of comorbidities, information on diabetes duration, and standardized measurements conducted by trained personnel.

In summary, we found that among older adults with diabetes, there were substantial differences in mortality and hospitalizations on the basis of the ADA health status categories, but individuals meeting more stringent A1C goals (<7% [<53 mmol/mol]) were not at elevated risk, regardless of health status. Hospitalization and mortality risk were highest among individuals with high A1C (≥8% [≥64 mmol/mol]) across all health status categories. Our results support the 2021 ADA Standards of Care and suggest that A1C <7% (<53 mmol/mol) is a reasonable treatment goal in some older adults with diabetes.

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