Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Original Article

Correlation of Hemoglobin A1C and Outcomes in Patients Hospitalized With COVID-19

Amy J. Patel, MD [1], Stanislaw P. Klek, MD, CDCES [1], Virginia Peragallo-Dittko, RN, BC-ADM, CDCES [2], Michael Goldstein, MD [3], Eric Burdge, BS [3], Victoria Nadile, BA [3], Julia Ramadhar, BA [3], Shahidul Islam, DrPH [2], Gary D. Rothberger, MD, ECNU [1,*]

[1] Division of Endocrinology, Diabetes, and Metabolism, New York University Long Island School of Medicine, Mineola, New York
[2] Department of Foundations of Medicine, New York University Long Island School of Medicine, Mineola, New York
[3] Department of Medicine, New York University Long Island School of Medicine, Mineola, New York

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ABSTRACT

Objective: Diabetes is a known risk factor for severe coronavirus disease 2019 (COVID-19). We conducted this study to determine if there is a correlation between hemoglobin A1C (HbA1C) level and poor outcomes in hospitalized patients with diabetes and COVID-19.

Methods: This is a retrospective, single-center, observational study of patients with diabetes (defined by an HbA1C level of ≥6.5% or known medical history of diabetes) who had a confirmed case of COVID-19 and required hospitalization. All patients were admitted to our institution between March 3, 2020, and May 5, 2020. HbA1C results for each patient were divided into quartiles: 5.1% to 6.7% (32-50 mmol/mol), 6.8% to 7.5% (51-58 mmol/mol), 7.6% to 8.9% (60-74 mmol/mol), and >9% (>75 mmol/mol). The primary outcome was in-hospital mortality. Secondary outcomes included admission to an intensive care unit, invasive mechanical ventilation, acute kidney injury, acute thrombosis, and length of hospital stay.

Results: A total of 506 patients were included. The number of deaths within quartiles 1 through 4 were 30 (25%), 37 (27%), 34 (27%), and 24 (19%), respectively. There was no statistical difference in the primary or secondary outcomes among the quartiles, except that acute kidney injury was less frequent in quartile 4.

Conclusion: There was no significant association between HbA1C level and adverse clinical outcomes in patients with diabetes who are hospitalized with COVID-19. HbA1C levels should not be used for risk stratification in these patients.

Introduction

A novel coronavirus affecting humans was identified in 2019 and was later classified as SARS-CoV-2. Infection with this virus causes a respiratory disease known as COVID-19.[1] There is a spectrum of disease severity in patients with COVID-19, including asymptomatic carriers, mild upper-respiratory symptoms, and severe systemic symptoms including acute respiratory failure, thrombophilia, and death.[2] Several risk factors for severe disease have been determined, including increasing age, compromised immune function, and pre-existing conditions such as cardiovascular disease, obesity, and diabetes.[3–5]

Patients with diabetes comprise approximately one-third of confirmed cases of COVID-19.[4] Several studies have demonstrated that patients with diabetes are at increased risk of severe disease and poor outcomes.[6–8] In addition, elevated levels of glycemia during hospital admission has been demonstrated to correlate with poor outcomes.[9,10] The correlation between hemoglobin A1C (HbA1C) levels and outcomes are less clear.[11] Several studies have reported an association between higher HbA1C levels and worse outcomes in COVID-19, although all had small samples sizes, and 2

Abbreviations: AKI, acute kidney injury; CKD, chronic kidney disease; CVD, cardiovascular disease; HbA1C, hemoglobin A1C; ICU, intensive care unit.

* Address correspondence to Dr Gary D. Rothberger, Division of Endocrinology, Diabetes, and Metabolism, New York University Long Island School of Medicine, 101 Mineola Boulevard, Mineola, NY 11501.
E-mail address: Gary.rothberger@nyulangone.org (G.D. Rothberger).

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of these studies defined elevated HbA1C as >6.5% (>48 mmol/mol) without stratifying these patients further.[12–15] Other studies have found no association between HbA1C levels and outcomes in patients with COVID-19, although several are limited by incomplete data.[16–19] Our study was designed to specifically investigate the correlation between overall glycemia prior to hospitalization, based on HbA1C levels measured on admission, and outcomes in patients hospitalized with COVID-19.

Materials and Methods

This is a retrospective, single-center, observational study of patients with diabetes mellitus who had a confirmed case of SARS-CoV-2 infection on polymerase chain reaction testing of a nasopharyngeal sample and required hospital admission. Our institutional review board approved this study, and the requirement for informed consent was waived. All patients were admitted to the general medical floor or intensive care unit (ICU) at our institution between March 3, 2020, and May 5, 2020, inclusive of those dates. Patients were excluded if the hospital course was not completed prior to completion of data collection. Data were retrieved from EPIC electronic health record software and analyzed with Research Electronic Data Capture.

Patients included in the study were considered to have confirmed infection if their initial test result was positive on admission or if they had at least 1 positive test result during admission, if testing was repeated for high clinical suspicion despite an initial negative result. All patients with confirmed COVID-19 infection had HbA1C tested on admission as part of our institution's COVID-19 admission order set. The presence of diabetes was defined by a HbA1C level of ≥6.5% (48 mmol/mol) or a history of diabetes and current administration of at least 1 antihyperglycemic medication.

Variables

Collected variables included demographic information, comorbidities, laboratory data, and clinical data. Charts were reviewed to determine the diabetes subtype and the presence of medical comorbidities. Cardiovascular disease (CVD) was defined as the presence of coronary artery disease, congestive heart failure, or arrhythmia. Pulmonary disease included asthma and chronic obstructive pulmonary disease. Chronic kidney disease (CKD) was assessed based on a diagnosis of CKD from medical history. Patients were considered immunocompromised if they had a long-term glucocorticoid use, an active hematologic malignancy, a history of solid organ transplant, human immunodeficiency virus, or an acquired immunodeficiency syndrome. Medications utilized for the treatment of COVID-19 were recorded, including hydroxychloroquine, tocilizumab, remdesivir, and glucocorticoids.

Laboratory Values

Laboratory values include initial laboratory tests (HbA1C, serum creatinine, serum glucose, alanine transaminase, aspartate transaminase, β-hydroxybutyrate, white blood cell count, and absolute neutrophil count), all of which were collected within 24 hours of admission. Interleukin-6, D-dimer, procalcitonin, and inflammatory markers (C-reactive protein, erythrocyte sedimentation rate, ferritin, lactate dehydrogenase) were recorded, as available throughout hospitalization.

Primary and Secondary Outcomes

The primary outcome was in-hospital mortality. Secondary outcomes included admission to the ICU, invasive mechanical ventilation, acute kidney injury (AKI), acute thrombosis, and length of hospital stay. AKI was defined as per the Kidney Disease: Improving Global Outcomes guidelines as an increase in serum creatinine by 0.3 mg/dL within 48 hours, an increase in serum creatinine to ≥1.5 times baseline, or a urine volume <0.5 mL/kg/h for 6 hours.[20]

Data Analysis

HbA1C results for each patient were divided into quartiles: 5.1% to 6.7% (32-50 mmol/mol), 6.8% to 7.5% (51-58 mmol/mol), 7.6% to 8.9% (60-74 mmol/mol), and >9% (75 mmol/mol). Since quartile 4 encompassed a wide range of HbA1C values, HbA1C was also evaluated as a continuous variable. A subgroup analysis was performed in patients >65 years of age to assess the impact that age may have on primary and secondary outcomes.

Data were summarized by these subgroups and presented as median (25th percentile-75th percentile) and frequency (percentage), as appropriate. Continuous variables were assessed for normality using the Kolmogorov-Smirnov test and visual graphs, including histograms and Q-Q plots. Demographics and clinical characteristics were compared between groups via Kruskal-Wallis, χ^2, and Fisher exact tests based on the type and distribution of the data. Multiple logistic regression models were used to find factors associated with the outcomes. Akaike Information Criterion and Hosmer and Lemeshow goodness-of-fit tests were used to assess the model fit. SAS 9.4 software was utilized to perform all analyses and a $P < .05$ was considered to be statistically significant.

Results

In total, 506 patients met eligibility criteria and were included in this study. The mean age was 66 years, 58% were male, and 94% had type 2 diabetes. Demographics, comorbidities, treatment, and laboratory results are presented in Table 1. The most common comorbidity was hypertension, in 381 patients (75%), followed by CVD in 147 patients (29%).

Patients in quartile 4 (HbA1C levels >9% [75 mmol/mol]) were younger, less likely to have CVD or be immunocompromised, less likely to carry a new diagnosis of diabetes, and more likely to be treated with insulin and metformin prior to hospitalization, compared with those in other quartiles. As expected, serum glucose level on admission was highest in quartile 4. In addition, patients in quartile 4 were less likely to be treated with glucocorticoids. No other significant differences were present among the groups.

The overall mortality rate was 25% ($n = 125$). A total of 206 (41%) patients had AKI, 143 (28%) patients were admitted to the ICU, 124 (25%) patients required invasive mechanical ventilation, and 37 (7%) patients had acute thrombosis.

Table 2 illustrates primary and secondary outcomes within each quartile. The number of deaths within quartiles 1 through 4 were 30 (25%), 37 (27%), 34 (27%), and 24 (19%), respectively. No significant difference was seen among quartiles in the primary outcome or any of the secondary outcomes, with the exception of a lower frequency of AKI in quartile 4. In a multivariable model (Supplementary Table 1), adjusting for age, diabetes type, CVD, CKD, immunocompromised state or active malignancy, glucocorticoid use, and laboratory values (creatinine, aspartate transaminase, serum glucose, and D-dimer), AKI was less frequent in quartile 4 (adjusted odds ratio = 0.42, 95% confidence interval = 0.2-0.91, $P = .02$). For patients in quartile 4, only the presence of

Table 1
Characteristics of Hospitalized Patients With Diabetes and COVID-19

Demographics	Hemoglobin A1C quartiles					*P* value[a]
	5.1-6.7 ($n = 121$)	6.8-7.5 ($n = 135$)	7.6-8.9 ($n = 126$)	9.0-17.1 ($n = 124$)	Overall ($N = 506$)	
Age (y)	68 (58-79)	69 (60-80)	67 (57-75)	58 (50-67)	66 (56-76)	<.001
BMI (kg/m^2)	29 (26-33.1)	28.5 (25-33)	29 (26-35)	30 (26-35)	29.1 (25.7-34)	.37
Male	51 (42%)	62 (46%)	47 (37%)	52 (42%)	212 (42%)	.57
Comorbidities						
Diabetes type						.03
Type 2 diabetes	105 (88%)	130 (96%)	119 (95%)	118 (95%)	472 (94%)	
New diagnosis of diabetes	54 (45%)	46 (34%)	19 (15%)	12 (10%)	131 (26%)	<.001
CVD	41 (34.2%)	48 (35.6%)	30 (23.8%)	28 (22.6%)	147 (29.1%)	.037
CKD	39 (32.2%)	31 (23.0%)	24 (19.2%)	27 (21.8%)	121 (24.0%)	.09
Pulmonary disease	22 (18.2%)	27 (20.0%)	27 (21.4%)	21 (17.1%)	97 (19.2%)	.826
Hypertension	89 (73.6%)	106 (78.5%)	96 (76.2%)	90 (72.6%)	381 (75.3%)	.684
Immunocompromised	9 (7.4%)	16 (11.9%)	10 (7.9%)	3 (2.4%)	38 (7.5%)	.04
Active malignancy	9 (7.4%)	12 (9.0%)	7 (5.6%)	2 (1.6%)	30 (5.9%)	.051
Long-term insulin therapy	13 (10.7%)	21 (15.7%)	38 (30.4%)	48 (38.7%)	120 (23.8%)	<.001
Metformin use	23 (19%)	58 (43%)	72 (57%)	70 (56 %)	223 (44%)	<.001
Laboratory data						
Creatinine, mg/dL	1.1 (0.8-1.7)	1.1 (0.7-1.5)	1.0 (0.8-1.5)	1.0 (0.8-1.4)	1.0 (0.8-1.5)	.236
Potassium, mmol/L	4.3 (3.9-5.0)	4.3 (3.9-4.8)	4.4 (4.0-4.7)	4.4 (4.0-4.9)	4.3 (4.0-4.8)	.395
AST, U/L	47.0 (33.0-65.0)	46.5 (35.0-71.0)	43.0 (32.0-64.0)	42.0 (26.0-61.0)	44 (32-66.5)	.06
ALT, U/L	32.0 (22.0- 53.0)	36.0 (23.0-63.0)	29.0 (23.0 - 53.0)	32.0 (22.5-47.0)	32 (23-52.0)	.609
WBC, $\times 10^9$/L	7.6 (5.8-10.2)	7.0 (5.5-9.4)	7.4 (5.7-9.4)	7.6 (5.8-10.6)	7.4 (5.7-9.7)	.338
ANC, /mm^3	6.0 (4.4-8.5)	5.4 (3.6-7.9)	5.6 (4.3-7.5)	6.1 (4.2-8.5)	5.8 (4.2-8.1)	.371
Glucose, mg/dL	108.0 (95-130)	133 (109-171)	176 (126-221)	243 (179-322)	149 (111-220)	<.001
CRP, mg/L	125 (66-199)	122 (75-182)	120 (67-178)	122 (76-202)	122 (69-188)	.862
ESR, mm/h	73 (56-105)	73 (49-106)	69 (49-99)	73 (52-98)	72 (51-103)	.754
Procalcitonin, ng/mL	0.18 (0.07-0.7)	0.20 (0.05-0.6)	0.17 (0.08-0.5)	0.19 (0.07-0.5)	0.19 (0.07-0.5)	.958
Ferritin, ng/mL	768 (358-1602)	592 (329-1140)	632 (286-1335)	700 (414-1300)	698 (346-1335)	.278
LDH, U/L	410 (342-521)	380 (292-522)	396 (293-552)	402 (299-558)	396 (305-537)	.676
Interleukin-6, pg/mL	13 (6-31)	12 (7-32)	14 (5-30)	12 (5-40)	13 (6-32)	.847
D-dimer, ng/mL	585 (294-1110)	496(315-1055)	425 (287-818)	387 (243-962)	485 (274-962)	.102
COVID-19 therapy						
Hydroxychloroquine	104 (86%)	116 (86%)	108 (86%)	111 (90%)	439 (87%)	.779
Remdesevir	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	.239
Tocilizumab	37 (30.6%)	35 (25.9%)	35 (27.8%)	33 (26.6%)	140 (27.7%)	.853
Glucocorticoids	15 (12.4%)	21 (15.6%)	24 (19.0%)	9 (7.3%)	69 (13.6%)	.046

Abbreviations: ALT = alanine aminotransferase; ANC = absolute neutrophil count; AST = aspartate aminotransferase; BMI = body mass index; CKD = chronic kidney disease; CRP = C-reactive protein; CVD = cardiovascular disease; ESR = erythrocyte sedimentation rate; LDH = lactate dehydrogenase; WBC = white blood cell.
Data are presented as median (interquartile range) or frequency (%).
[a] *P* values are from Kruskal-Wallis test for continuous variables and from χ^2 test or Fisher exact test for categorical variables.

Table 2
Comparisons of Clinical Outcomes Between Hemoglobin A1C Groups

Outcomes	Hemoglobin A1C quartiles					*P* value[a]
	5.1-6.7 ($n = 121$)	6.8-7.5 ($n = 135$)	7.6-8.9 ($n = 126$)	9.0-17.1 ($n = 124$)	Overall ($N = 506$)	
Mortality	30 (25.2)	37 (27.4)	34 (27.2)	24 (19.4)	125 (25.0)	.41
Acute kidney injury	59 (50)	57 (42.2)	52 (41.3)	38 (30.7)	206 (41.0)	.02
Acute thrombosis	10 (8.5)	9 (6.7)	9 (7.1)	9 (7.3)	37 (7.4)	.95
Admission to the ICU	34 (28.6)	38 (28.2)	37 (29.4)	34 (27.4)	143 (28.4)	.99
Mechanical ventilation	31 (26.1)	30 (22.2)	34 (27)	29 (23.4)	124 (24.6)	.79
Length of stay, days, median (IQR)	7 (4-13)	9 (5-14)	8 (4-14)	7 (5-11)	8 (4-14)	.55

Abbreviations: ICU = intensive care unit; IQR = interquartile range.
Data are presented as frequency (%) unless otherwise stated.
[a] *P* values are from the χ^2 test.

CKD conferred risk of AKI; a higher HbA1C level was not associated with risk of AKI in these patients (Supplementary Table 2).

Since the mean age in quartile 4 was significantly lower than in other quartiles, we assessed outcomes of patients >65 years of age in each quartile to see if the HbA1C level, when adjusted for age, would affect outcomes. Results were similar to those from the entire cohort (Table 3).

In order to confirm that our observed outcomes were not a function of the quartile ranges that were used in this study, we analyzed HbA1C as a continuous variable and assessed its relationship to outcomes (Table 4). Results were unchanged, with a lower frequency of AKI as the HbA1C level increased. Other outcomes were not significantly associated with HbA1C.

Discussion

Diabetes has significant prognostic implications in patients with COVID-19. Patients with diabetes and COVID-19 are more likely to have severe disease, including hospitalization and death.[6–8] This may stem from the underlying immune dysregulation and microvascular and macrovascular complications associated with diabetes.[21] In addition, hyperglycemia has a direct impact on airway

Table 3
Demographics and Outcomes of Patients Over 65 Years of Age

Demographics	Hemoglobin A1C quartiles					*P* value[a]
	5.1-6.7 ($n = 68$)	6.8-7.5 ($n = 80$)	7.6-8.9 ($n = 68$)	9.0-17.1 ($n = 38$)	Overall ($n = 254$)	
Age (y)	78.5 (71.5-83.5)	77 (72-83.5)	74 (71-80.5)	72 (69-78)	76 (71-82)	.01
BMI (kg/m^2)	27.5 (25-31)	28.2 (24.2-30.8)	28.1 (24.4-33)	29 (24.3-32.7)	28 (24.4-32)	.92
Female	33 (48.5%)	39 (48.8%)	28 (41.2%)	18 (47.4%)	118 (46.5%)	.79
Comorbidities						
Type 2 diabetes	58 (86.6%)	76 (95.0%)	63 (94.0%)	37 (97.4%)	234 (92.9%)	.18
Newly diagnosed diabetes	25(37.3%)	25(31.3%)	8(11.8%)	3(7.9%)	61(24.1%)	<.001
CVD	36 (52.9%)	42 (52.5%)	26 (38.2%)	17 (44.7%)	121 (47.6%)	.26
CKD	30 (44.1%)	25 (31.3%)	14 (20.6%)	9 (23.7%)	78 (30.7%)	.02
Pulmonary disease	16 (23.5%)	21 (26.3%)	17 (25.0%)	11 (29.7%)	65 (25.7%)	.92
Hypertension	58 (85.3%)	71 (88.8%)	56 (82.4%)	31 (81.6%)	216 (85.0%)	.66
Immunocompromised	6 (8.8%)	10 (12.5%)	7 (10.3%)	1 (2.6%)	24 (9.4%)	.41
Active malignancy	6 (8.8%)	10 (12.7%)	6 (8.8%)	1 (2.6%)	23 (9.1%)	.40
Outcomes						
Mortality	21 (31.3)	31 (38.8)	22 (32.8)	13 (34.2)	87 (34.5)	.80
Acute kidney injury	42 (62.7)	44 (55.0)	30 (44.1)	12 (31.6)	128 (50.6)	.01
Acute thrombosis	5 (7.6)	5 (6.3)	6 (8.8)	4 (10.5)	20 (7.9)	.82
Admit to ICU	20 (29.9)	23 (28.8)	19 (27.9)	11 (29.0)	73 (28.9)	.99
Mechanical ventilation	18 (26.9)	17 (21.3)	17 (25.0)	9 (23.7)	61 (24.1)	.88

Abbreviations: BMI = body mass index; CKD = chronic kidney disease; CVD = cardiovascular disease; ICU = intensive care unit.
Data are median (interquartile range) or frequency (%).
[a] *P* values are from Kruskal-Wallis test for continuous variables and from χ^2 test or Fisher exact test for categorical variables.

Table 4
Univariate Logistic Regression Model Using Hemoglobin A1C Values as an Independent Variable

Outcome	Odds ratio (95% CI)	*P* value
Mortality	0.91 (0.82-1.01)	.08
Acute kidney injury	0.87 (0.79-0.96)	.004
Acute thrombosis	1.03 (0.88-1.20)	.74
Admit to ICU	1.00 (0.91-1.09)	.94
Mechanical ventilation	0.97 (0.88-1.08)	.58

Abbreviations: ICU = intensive care unit.
Odds ratios and *P* values were estimated via logistic regression models using hemoglobin A1C as the continuous independent variable.

epithelia and lung integrity, rendering quicker respiratory decline in this subpopulation.[22] Our study demonstrates that long-term glycemia, as measured by HbA1C, does not predict worse outcomes in patients hospitalized with COVID-19. Among the total cohort of 506 patients, with an overall mortality rate of 25%, there was no statistically significant increase in the frequency of primary or secondary outcomes in higher quartiles of HbA1C.

It is important to note that the mean age of patients in quartile 4 was significantly lower than that in quartiles 1, 2, and 3. It has been established that age is a key prognostic determinant of outcomes in COVID-19, owing to higher susceptibility to the virus and severity of complications in elderly populations.[23] One may attribute the lack of worse outcomes in patients with the highest HbA1C levels to younger age. However, analysis of patients >65 years of age failed to reveal any worse outcomes in patients with higher HbA1C levels.

Previously undiagnosed diabetes is common in hospitalized patients with COVID-19. A recent meta-analysis including more than 3700 patients showed that 14.4% of hospitalized patients had newly diagnosed diabetes.[24] In our cohort, nearly 26% of all patients had previously undiagnosed diabetes, similar to the results reported by Li et al.[25] We noted that patients in quartile 4 were less likely to have a new diagnosis of diabetes compared with patients in quartiles 1 and 2. This may have a protective impact on the outcomes of patients in quartile 4, as patients with newly diagnosed diabetes have worse COVID-19–related outcomes than those with pre-existing diabetes.[26,27] Patients in quartile 4 were more likely to be on long-term insulin therapy. This did not impact the outcomes, despite a prior study reporting that long-term insulin use is associated with worse outcomes in hospitalized patients with COVID-19.[17] Also, metformin use was more common in patients in quartile 4, and metformin has been associated with improved survival in patients with diabetes and COVID-19.[28]

We observed a lower frequency of AKI in quartile 4 compared with that in other quartiles, both in the entire cohort and in patients >65 years of age. Patients in quartile 4 were younger and had a lower incidence of CKD compared with patients in other quartiles, making them less prone to developing AKI. However, when adjusted for age and the presence of comorbidities, including CKD, HbA1C levels >9% (75 mmol/mol) were still associated with a lower risk of AKI (Supplementary Tables 1 and 2). These results are in contrast to the findings by Khalili et al,[29] who reported a higher HbA1C level as a risk factor for developing AKI in patients hospitalized with COVID-19. Furthermore, our data revealed that CKD was a much stronger risk factor for AKI than a high HbA1C level, and when analyzing patients in quartile 4, CKD was associated with AKI while a high HbA1C level was not (Supplementary Tables 1 and 2). While our data indicate that HbA1C is negatively associated with AKI, it is likely that our observed rates of AKI in quartile 4 were influenced more by the lower rate of CKD in this group.

The absence of worse outcomes in patients with higher levels of HbA1C is surprising. Diabetes is a known risk factor for worse outcomes in COVID-19, as well as previous infectious outbreaks, including H1NI influenza and Middle East respiratory syndrome.[30,31] Chronic hyperglycemia impairs immune function, and there is evidence that levels of angiotensin-converting enzyme-2, which serves as a port of entry for SARS-CoV-2, are increased in patients with diabetes.[32–34] One could therefore expect high levels of HbA1C to predict a more severe course in patients with COVID-19. Nonetheless, results from our study are consistent with the findings of several recent studies. The CORONADO study (a large multicentered study of 1317 patients with COVID-19 from France) reported that long-term glycemia as assessed by HbA1C level did not impact the severity of infection or mortality rates in hospitalized patients.[16] Results from the CORONADO study are limited by missing data, as HbA1C levels were not available for nearly 40% of patients. A study from New York City that included 1126 patients with diabetes who were hospitalized owing to COVID-19 reported

no association between HbA1C levels and mortality, including in patients with HbA1C levels >9% (75 mmol/mol).[17] This study was limited in that only 18% of patients had HbA1C measured within 1 week of hospitalization, although most patients (75%) had HbA1C measured within 1 year of admission. Finally, a smaller study of 166 hospitalized patients found no differences in mortality rates based on HbA1C levels.[35] Our study, with HbA1C measured in all cases on admission, confirms and supports the findings of these studies.

While long-term management of glycemia may not have a direct impact on mortality in COVID-19, optimal management of glycemia during hospitalization has been linked to a reduction in mortality.[9] Sardu et al[36] showed that a substantial reduction in blood glucose, with utilization of insulin infusion, improved outcomes and prognosis in patients with COVID-19. In addition, Zhu et al[37] found lower in-hospital death rates from COVID-19 (1.1% vs 11%) in patients with well-managed glycemia (defined as blood glucose between 70 and 180 mg/dL) compared with rates in patients with hyperglycemia (glucose level of >180 mg/dL) during hospitalization. Mazori et al[38] reported lower survival rates for patients without diabetes who had early hyperglycemia (glucose level of >180 mg/dL) in the first 2 days of ICU admission than for patients with or without diabetes who did not have hyperglycemia. Maintaining optimal glycemic targets has been associated with a reduction in inflammatory cytokines and coagulation factors, theorizing the mechanism behind improvement in outcomes.[39] Although admission glucose levels were recorded in our study, we did not evaluate overall inpatient glycemia and its effect on primary and secondary outcomes. This would be an important focus of future studies.

Our study holds clinical significance when determining treatment plans and assessing mortality risk in hospitalized patients. Our findings are indeed reassuring for patients with a history of diabetes, specifically those with suboptimal chronic glycemia. Nonetheless, optimal glycemic management during the course of illness remains an important aspect for the treatment of COVID-19 to limit the incidence of poor outcomes.

The main strengths of our study are a robust sample size and the availability of HbA1C levels for all subjects. The latter differentiates our study from the previous studies that found no correlation between HbA1C levels and outcomes in COVID-19. HbA1C levels were available for 846 of the 1317 patients (64%) in the CORONADO study,[16] whereas only 18% of patients in the study by Agarwal et al[17] had HbA1C levels measured within 1 week of hospitalization.

However, our study has several limitations. It is a single-center retrospective study, and our results would be strengthened by prospective multicenter studies. We did not compare outcomes with those of patients without diabetes, so we cannot draw conclusions regarding the impact of diabetes on outcomes. Lastly, HbA1C levels may be misleading or skewed in patients with chronic medical conditions, such as CKD or anemia, and may not be an accurate reflection of long-term glycemia in some patients.

Conclusion

This study analyzed the impact of HbA1C levels on admission and outcomes in 506 patients hospitalized with COVID-19. There was no increase in mortality, acute renal failure, acute thrombosis, admission to the ICU, need for invasive mechanical ventilation, or hospital length of stay in patients with higher HbA1C levels. HbA1C levels should not be used for risk stratification for patients with diabetes who are hospitalized with COVID-19.

Disclosure

The authors have no multiplicity of interest to disclose.

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