Characteristics and Diabetes Control in Adults With Type 1 Diabetes Admitted With COVID-19 Infection

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Diabetes has been identified as one of the major risk factors for developing severe forms of coronavirus disease 2019 (COVID-19), which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (1). While data show a higher incidence of severe acute respiratory distress syndrome and increased mortality in patients with diabetes, the majority of these patients have type 2 diabetes (2), and less is known about the implications of type 1 diabetes in COVID-19. A report from the U.K. describes the COVID-19 mortality rate as significantly higher in older patients with type 1 diabetes compared with those with type 2 diabetes (3). Among young adults with type 1 diabetes in the U.S., diabetic ketoacidosis (DKA) was commonly encountered in those diagnosed with COVID-19 (4). Little is known about adults with type 1 diabetes and COVID-19 who require hospitalization. The goal of this study was to define the clinical characteristics, outpatient diabetes management and control, and disease course of people with type 1 diabetes who were admitted to a tertiary care center for COVID-19.

We retrospectively reviewed the charts and collected data for all patients with an established diagnosis of type 1 diabetes who were admitted to Beth Israel Deaconess Medical Center in Boston, MA, between 1 March 2020 and 1 June 2020. After excluding patients admitted for obstetrical reasons, we identified 35 adults with confirmed type 1 diabetes. Preceding data up to 6 months on glycemic control, diabetes management, and complications as well as the in-hospital course were recorded. We calculated insulin dose per kilogram of body weight. We defined a composite primary outcome including intensive care unit (ICU) admission, intubation, or death. The study was approved as exempt by the local institutional review board. Statistical analyses were performed by using unpaired two-sided *t* test for normally distributed continuous variables, Wilcoxon rank-sum test for nonnormally distributed continuous variables, and χ^2 for categorical variables. We set the level of statistical significance at a *P* value <0.05.

We describe a series of hospitalized patients with type 1 diabetes and COVID-19 and compare this series with patients with type 1 diabetes who did not have COVID-19 and were simultaneously admitted to the hospital (Table 1). Seven patients were positive for COVID-19 by PCR test. The remainder were negative for COVID-19 ($n = 24$) or not tested ($n = 4$) and were used as the control group in this analysis. COVID-19+ patients were of similar age as COVID-19− adults with type 1 diabetes. There was a larger percentage of non-Hispanic Black Americans in the COVID+ group as compared with the COVID-19− group. We observed no significant differences in sex, body weight, glucose, or HbA_{1c} on admission between groups. The outpatient insulin regimen for all COVID-19+ adults with type 1 diabetes consisted of multiple daily injections. Outpatient insulin doses corrected for body weight and glycemic control in the months preceding admission were not different between groups. DKA occurred in one patient in the COVID+ group and two in the COVID-19− group. Both COVID-19+ and COVID-19− patients with type 1 diabetes had a significant number of preexisting, diabetes-related complications. More than 50% of patients in each group had been diagnosed with nephropathy, and 14% in each group were organ transplant recipients on immunosuppression therapy. The composite outcome occurred in two COVID-19+ patients (ICU admission without intubation, both recovered) and in four COVID-19− patients, including two deaths.

Our data show remarkable similarities in age, glycemic control, and diabetes management between COVID-19+ patients and patients admitted for other reasons. A larger percentage of COVID-19+ patients were non-Hispanic Black,

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Table 1—Characteristics of adults with type 1 diabetes with and without COVID-19 infection admitted to a tertiary center between 1 March 2020 and 1 June 2020

	COVID-19+	COVID-19−	*P* value
Number of patients	7	28	
Age (years)	51.8 (13.4)	52.3 (12.9)	0.93
Sex (*n* male/*n* female)	5/2	12/16	0.17
Race/ethnicity (*n* non-Hispanic White/*n* non-Hispanic Black)	3/4	26/2	0.01*
Weight (lb)	175.3 (45)	155.1 (30.3)	0.16
BMI (kg/m^2)	26.1 (5.8)	24.3 (4.1)	0.34
Glucose on admission (mg/dL)	263 (228)	269 (172)	0.93
HbA_{1c} on admission (%)	8.4 (1.2)	9.2 (2.7)	0.45
HbA_{1c} prior to admission (%)	9.4 (2.4)	8.7 (2.2)	0.46
Insulin treatment at home (MDI/CSII/pancreas transplant)	7/0/0	21/5/2	
Basal insulin (units)	23.5 (16.7)	23.7 (11.6)	0.97
Bolus insulin (units)	27.5 (24.3)	23.5 (10.9)	0.51
Total daily insulin dose (units)	47.5 (38.6)	43.9 (16.5)	0.7
Total daily insulin/kg (units/kg/day)	0.7 (0.6)	0.6 (0.3)	0.53
DKA (yes/no)	1/6	2/26	0.55
CAD/CVD, % (*n*)	28.5% (2)	28.5% (8)	0.95
Retinopathy, % (*n*)	42.8% (3)	42.8% (12)	1
Neuropathy, % (*n*)	28.5% (2)	42.8% (12)	0.47
Nephropathy, % (*n*)	57.1% (4)	82.1% (23)	0.16
Transplant status, % (*n*)	14.3% (1)	4.3% (4)	1
Gastroparesis, % (*n*)	14.35% (1)	17.9% (5)	0.82
Hypertension, % (*n*)	57.1% (4)	50% (14)	0.87
Length of hospital stay (no. days)	10.6 (8.2)	7.3 (6.6)	0.27
C-reactive protein (mg/dL)	60.5 (36.3)	101.7 (94.6)	0.35
D-dimer (ng/mL)	1,525.5 (1,144.8)	1,670.8 (2,330.7)	0.86
Ferritin (ng/mL)	1,145.9 (1,377.4)	705.4 (833.7)	0.36
Fibrinogen (mg/dL)	451.2 (211.9)	482.8 (241.3)	0.95
Troponin T (ng/mL)	0.04 (0.07)	0.09 (0.14)	0.43
APTT (s)	32.7 (3.3)	32.0 (7.0)	0.88
PT (s)	14.3 (3.4)	15.7 (10.4)	0.58
Hemoglobin (g/dL)	10.6 (2.3)	10.9 (2.0)	0.78
Hematocrit (%)	33.0 (8.2)	33.7 (5.7)	0.69
White blood cell count (K/μL)	7.2 (4.1)	14.8 (32.7)	0.08
Lymphocytes (%)	18.1 (11.8)	13.5 (7.7)	0.19
Neutrophils (%)	71.0 (12.2)	77.0 (9.0)	0.24
Platelets (K/μL)	227.4 (112.1)	287.8 (145.1)	0.27
Creatinine (mg/dL)	2.2 (1.3)	2.1 (2.8)	0.96
Bicarbonate (mEq/L)	21.5 (7.0)	21.8 (4.3)	0.89
Aspartate aminotransferase (IU/L)	47.3 (50)	41.8 (51.3)	0.8
Alanine aminotransferase (IU/L)	35.9 (29.9)	27.9 (28.4)	0.51
Composite outcome (ICU, intubation, or death), *n* (%)	2 (28.5%)	4 (14.3%)	0.37

Data are in units (SD) unless otherwise indicated. CAD, coronary artery disease; CSII, continuous subcutaneous insulin infusion; CVD, cerebrovascular disease; MDI, multiple daily injections; PT, prothrombin time; APTT, activated partial thromboplastin time. *Statisically significant.

which is in line with prior data from larger retrospective studies that have shown that COVID-19 has disproportionately affected this population (5). Our data show a lower incidence of DKA compared with that reported by Ebekozian et al. (4). In the latter study, conducted by questionnaire, only 57% of the COVID-19–confirmed patients required hospital admission, and this group included five cases (15%) of new-onset type 1 diabetes. The difference in DKA incidence could be related to differences in age, as patients in our study were significantly older. New-onset type 1 diabetes, which carries a high risk of DKA, was not seen in our cohort.

Taken together, these data demonstrate that adult patients with type 1 diabetes who were admitted as COVID-19+ show similar outpatient glycemic control prior to admission and similar clinical characteristics upon admission as COVID-19− patients with type 1 diabetes. Larger studies are needed to confirm

these findings in younger adults and children and to better characterize risk factors for hospital admission in people with type 1 diabetes and COVID-19.

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