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# Clinical characteristics and outcomes of COVID-19 hospitalized patients with diabetes in the United Kingdom: A retrospective single centre study

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## ARTICLE INFO

### Article history:

Received 21 May 2020

Accepted 4 June 2020

Available online 10 June 2020

### Keywords:

COVID-19

Diabetes

Diabetic ketoacidosis

Length of stay

## ABSTRACT

**Aim:** To describe the clinical characteristics and outcomes of hospitalized COVID-19 patients with diabetes.

**Methods:** A retrospective cross-sectional study was conducted among patients admitted to the William Harvey Hospital in England between March 10th and May 10th, 2020 with a laboratory-confirmed severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), known as COVID-19. Variation in characteristics, length of stay in hospital, diabetes status, duration of diabetes, control of diabetes, comorbidities and outcomes were examined.

**Results:** There were 232 COVID-19 presentations. Mean (standard deviation (SD), range) age was 70.5 ( $\pm 15.7$ , 30–101) years, 62.5% were male, and 37.5% were having diabetes. There were 43.4% males and 27.6 females,  $p = 0.016$ , with diabetes admitted to our hospital due to COVID-19. Patients with diabetes were more likely to have longer length of stay (LOS) in hospital, 14.4 (SD  $\pm 9.6$ ) days, compared to the patients without diabetes, 9.8 (SD  $\pm 17.1$ ) days,  $p < 0.0001$ . Patients with diabetic ketoacidosis (DKA) were more likely to survive (87.1%) compared to patients without DKA (50.6%),  $p = 0.046$ .

**Conclusion:** Males were more likely to be admitted to hospital with COVID-19 illness than females. Hospitalized COVID-19 patients with diabetes had a longer LOS in hospital than patients without diabetes. Older age COVID-19 patients with diabetes and patients without DKA were less likely to survive compared to younger patients and patients with DKA, respectively. Further studies with large sample size are needed.

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<https://doi.org/10.1016/j.diabres.2020.108263>

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## 1. Introduction

The burden of the Severe Acute Respiratory Syndrome-Coronavirus-2 (SARS-CoV-2), which is known as COVID-19 has been increasing worldwide. Since December 2019, more than 4 million people have been infected including over 300 thousand deaths [1].

The inflammatory process associated with diabetes and chronic high levels of glucose in the blood can lead to low immunity response which aggravate infections in patients with diabetes [2].

Historically, coronaviruses, middle east respiratory syndrome (MERS) and severe acute respiratory syndrome (SARS), epidemics associated with severe consequences including higher deaths among patients with diabetes [3,4]. Despite limited data about the impact of the current COVID-19 pandemic on patients with diabetes, some recent studies have suggested that patients with diabetes are at high risk of having severe form of COVID-19 illness and encounter higher mortality rates [5-7].

This study assessed the impact of the factors associated with glycaemic state on the outcomes of hospitalized patients in a general hospital in the United Kingdom.

## 2. Methods

### 2.1. Study design and setting

A retrospective cross-sectional study evaluated glycaemic status and clinical outcomes of hospitalized adult patients with laboratory-confirmed COVID-19 illness between March 10, and May 10, 2020 in the William Harvey Hospital (WHH), Ashford, United Kingdom. The WHH is an acute 476 bedded hospital providing a range of emergency and elective services [8].

### 2.2. Measurements and definition

A diagnosis of COVID-19 illness was defined as a confirmed positive SARS-CoV-2 laboratory result [9]. Hospital admission was defined as patient presence in the hospital for > 24 h [10]. Diabetes was defined as glycated haemoglobin (HbA1c)  $\geq$  6.5% [11] or any established diagnosis prior admission. Uncontrolled hyperglycaemia was defined as being present when two or more blood glucose level > 11.1 mmol/l and hypoglycaemia defined as blood glucose level < 4 mmol/l [12]. Diabetic ketoacidosis (DKA) defined as presences of acidosis, blood or urine ketones [13].

### 2.3. Data collection and variables

The data were sourced from the hospital information system. The data was extracted for all COVID-19 patients including patients with diabetes who were admitted to the WHH within the study period. The variables that were considered for the study included age, gender, type of diabetes, duration of diabetes, blood glucose level, HbA1c level, co-morbidities, duration of admission and the outcome of the patient (recovered or died). Admitted patients with an on-going COVID-19 were excluded from analysis.

Institutional Review Board approval was not required for this observational, retrospective study of routinely transmitted patient information.

### 2.4. Statistical analysis

Frequencies with proportions were reported for categorical variables and means with standard deviations (SDs) were reported for continuous variables. Bivariate analyses ( $\chi^2$ , t-test) were conducted to identify factors associated with COVID-19 patients based on their diabetes status. Furthermore, factors associated with the outcomes for patients with diabetes were assessed. A Kaplan-Meier survival curves was produced according to controlled diabetes, uncontrolled diabetes and no diabetes. Statistical significance was set at p value  $\leq$  0.05 (two-sided). The data analysis was performed

**Table 1 – Characteristics of study subjects for all patients and patients with diabetes.**

All patients, N = 232	
<b>Gender, n (%)</b>	
Male	145 (62.5)
Female	87 (37.5)
<b>Age, years</b>	
mean (SD)	70.5 (15.7)
<b>Duration of admission, days</b>	
Mean (SD)	11.5 (8.2)
<b>Number of comorbidities, n (%)</b>	
None	38 (16.4)
1-2	115 (49.6)
$\geq$ 3	79 (34)
<b>Types of comorbidities, n (%)</b>	
Asthma	6 (2.6)
Chronic obstructive pulmonary disease (COPD)	17 (7.3)
Heart disease	18 (7.8)
Hypertension	34 (14.7)
Cancer	7 (3)
Others	111 (47.8)
<b>Outcome, n (%)</b>	
Recovered	143 (61.6)
Died	89 (38.4)
<b>Patients with diabetes N = 87</b>	
<b>Gender, n (%)</b>	
Male	63 (72.4)
Female	24 (27.6)
<b>Age, years</b>	
Mean (SD)	71.4 (13.1)
<b>Diabetes type, n (%)</b>	
1	11 (12.6)
2	76 (87.4)
<b>DM duration, years</b>	
Mean (SD)	15.5 (14.1)
<b>HbA1c, mmol/dl</b>	
Mean (SD)	58.9 (16.9)
<b>Diabetes control, n (%)</b>	
Controlled	28 (32.2)
Uncontrolled	32 (67.8)
<b>Duration of admission, days</b>	
Mean (SD)	14.4 (9.6)
<b>Outcome, n (%)</b>	
Recovered	47 (55.4)
Died	40 (46)

with the Statistical Package for Social Sciences (SPSS) V.25 (IBM, New York, USA).

### 3. Results

Out of 232 laboratory-confirmed COVID-19 patients admitted to the WHH, 87 (37.5%) of them were having diabetes. The mean age of the entire COVID-19 patients was 70.5 years old (SD  $\pm$  15.7 years, range 30–101 years), with 145 (62.5%) of them were males (Table 1).

Table 2 showed the characteristics of COVID-19 patients based on their diabetes status. There were more males (43.4%) with diabetes admitted to our hospital due to COVID-19 than females (27.6%),  $p = 0.016$ . COVID-19 patients with diabetes were more likely to stay longer in hospital, 14.4 (SD  $\pm$  9.6) days, compared to the patients without diabetes, 9.8 (SD  $\pm$  17.1) days,  $p < 0.0001$ . Moreover, patients with diabetes admitted to the WHH had significantly high prevalence of heart diseases,  $p = 0.018$ .

Table 3 showed the outcomes of COVID-19 patients with diabetes based on their characteristics. There were high death rates among old patients with diabetes, mean age 75 years old (SD  $\pm$  13), compared to young patients with diabetes, mean age, 67.7 years old (SD  $\pm$  16.6),  $p = 0.003$ . Patients with DKA were less likely to die (13%) compared to patients without DKA (49.4%),  $p = 0.046$ . There were no statistically significant differences in the outcome COVID-19 patients with diabetes in terms of gender, age, type of diabetes, control of diabetes and comorbidities,  $p > 0.05$ .

Kaplan-Meier survival curves showed that patients with DKA were more likely to survive compared to the patients without DKA,  $p = 0.046$  (Fig. 1).

### 4. Discussion

In this retrospective observational study, we aimed to assess the outcomes of COVID-19 illness with diabetes among hospitalized patients. Most of the patients are type 2 with fewer ones has type1; therefore, this study can be more applied for type 2 rather than type 1 diabetes.

Majority of admitted patients to our hospital were men (61.2%), this agrees with emerging studies showing that men with COVID-19 are at higher risk for developing severe outcomes including death than women [14,15]. This difference in risk has been explained partially by patterns and prevalence of smoking among men [16,17] which has been identified as a significant contributor to disease severity [18]. However, our data did not show significant gender differences in mortality among hospitalized patients. As it is known that diabetes was found to be a strong predictor of a length of stay (LOS) in hospital [19], our study also, our data agreed with a recent study [20] from the United States showed that COVID-19 patients with diabetes had a longer LOS than patients without diabetes.

Furthermore, our data identified an association between older age of diabetic COVID-19 patients and lower probability of survival. In general, all age groups are susceptible to encounter COVID-19 infection, however, older patients and individuals with pre-existing medical conditions such as diabetes found to be more vulnerable to severe outcomes including death [7,20–22].

Our study found no difference in mortalities based on the diabetes status, control or complications. Bruce et al. [20] found that patients with diabetes and/or uncontrolled hyperglycaemia had significantly higher death than patients

**Table 2 – Characteristics of subjects with COVID-19 by their diabetes status, N = 232.**

	Diabetes Status		P value
	No	Yes	
<b>Gender, n (%)</b>			
Male	82 (56.6)	63 (43.4)	<b>0.016</b>
Female	63 (72.4)	24 (27.6)	
<b>Age, years</b>			
mean (SD)	69.9 (17.1)	71.4 (13.1)	0.498
<b>Duration of admission, days</b>			
Mean (SD)	9.8 (6.8)	14.4 (9.6)	<b>&lt; 0.0001</b>
<b>Number of comorbidities, n (%)</b>			
None	25 (65.8)	13 (34.2)	0.732
1–2	69 (60)	46 (40)	
$\geq 3$	51 (64.6)	28 (35.4)	
<b>Types of comorbidities, n (%)</b>			
Asthma	4 (66.7)	2 (33.3)	<b>0.018</b>
COPD	9 (52.9)	8 (47.1)	
Heart disease	4 (22.2)	14 (77.8)	
Hypertension	22 (64.7)	12 (35.3)	
Cancer	4 (57.1)	3 (42.9)	
Other	75 (67.6)	36 (34.4)	
<b>Outcome, n (%)</b>			
Recovered	96 (67.1)	47 (32.9)	0.065
Died	49 (55.1)	40 (44.9)	

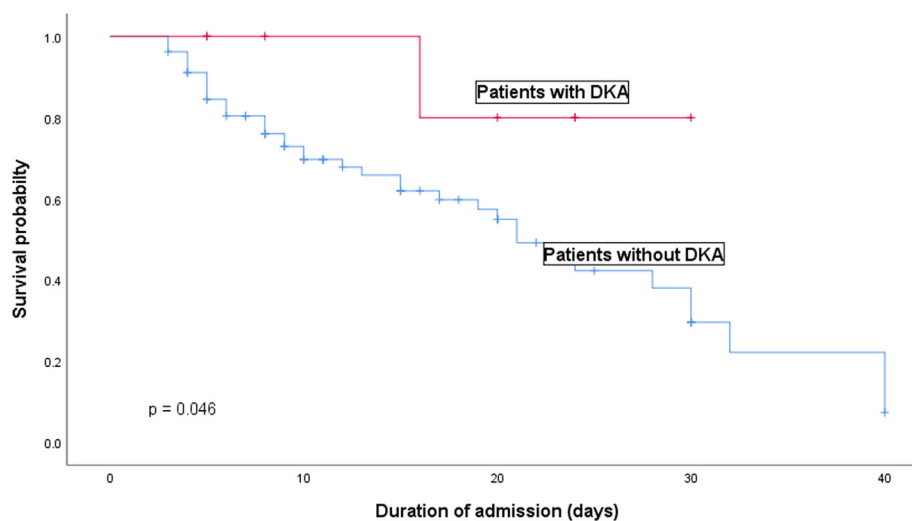
P values in bold are statistically significant.

SD = Standard deviation. COPD = Chronic obstructive pulmonary disease

**Table 3 – Characteristics of COVID-19 patients with diabetes by their outcome, N = 87.**

	Outcome		P value
	Recovered	Died	
<b>Gender, n (%)</b>			
Male	33 (70.2)	14 (29.8)	0.619
Female	30 (75)	10 (25)	
<b>Age, years</b>			
Mean (SD)	67.7 (16.6)	74.9 (13.1)	<b>0.003</b>
<b>Diabetes type, n (%)</b>			
1	5 (45.5)	6 (54.5)	0.542
2	42 (55.3)	34 (44.7)	
<b>DM duration, years</b>			
Mean (SD)	15.6 (15.1)	15.4 (12.9)	0.938
<b>HbA1c, mmol/dl</b>			
Mean (SD)	56.9 (15.7)	61.3 (18)	0.232
<b>Diabetes control, n (%)</b>			
Controlled	15 (53.6)	13 (46.4)	0.954
Uncontrolled	32 (54.2)	27 (45.8)	
<b>Duration of admission (days)</b>			
Mean (SD)	15 (8.9)	13.7 (10.5)	0.530
<b>Glycaemic complications, n (%)</b>			
Hyperglycaemia	2 (40)	3 (60)	0.246
Hypoglycaemia	4 (66.7)	2 (33.3)	
Both	0 (0)	2 (100)	
<b>DKA status, n (%)</b>			
No DKA	40 (50.6)	39 (49.4)	<b>0.046</b>
DKA	7 (87.1)	1 (12.9)	
<b>Number of comorbidities, n (%)</b>			
None	10 (76.9)	3 (23.1)	0.125
1–2	25 (54.3)	21 (45.7)	
≥ 3	12 (42.9)	16 (57.1)	
<b>Types of comorbidities, n (%)</b>			
Asthma	2 (100)	0 (0)	0.156
COPD	3 (37.5)	5 (62.5)	
Heart disease	7 (50)	7 (50)	
Hypertension	9 (75)	3 (25)	
Cancer	2 (66.7)	1 (33.3)	
Other	15 (41.7)	21 (58.3)	

P values in bold are statistically significant.  
SD = Standard deviation. COPD = Chronic obstructive pulmonary disease. DKA = Diabetic ketoacidosis.

**Fig. 1 – Kaplan-Meier estimates of survival for diabetic COVID-19 patients with DKA and without DKA.**

without diabetes or uncontrolled hyperglycaemia. These variations between our study and the other study may have been due to differences in research methods including sample size and population types.

Generally, diabetic ketoacidosis (DKA) result in high mortality among patients with diabetes. However, interestingly, our study showed that COVID-19 patients with diabetes who are suffering from DKA were more likely to survive compared to the ones without DKA. Recent literature found that children's COVID-19 patients were generally less likely to be symptomatic or develop severe symptoms than those of adult patients [23,24]. It is known that children have normal physiological metabolic acidosis compared to adult [25]. Which could raise a question "is patient's acidity play protective role against severe forms of the disease? Further studies with large sample size are required to assess our finding.

To the best of our knowledge, this is the first study in the United Kingdom to assess the outcomes of hospitalized COVID-19 patients with diabetes. However, our study encountered some limitations. The main limitation of this study was the small number of COVID-19 patients with diabetes in our sample. This limitation did not allow us to conduct further regression statistical analyses to adjust for confounders such as comorbidities, type of diabetes and medications. In addition, our analysis did not include patients who are still in admission without identified outcome.

## 5. Conclusions

Males were more likely to be admitted to hospital with COVID-19 illness than females. Hospitalized COVID-19 patients with diabetes had a longer LOS in hospital than patients without diabetes. Older age patients were less likely to survive compared to younger patients. Patients with DKA encountered lower mortality than patients without DKA. We recommend for further studies with large sample size.

## Funding source

None.

## Declaration of Competing Interest

None.

## Acknowledgments

None.

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