Short Communication

Shrina Patel*, Elyzabeth Amador, Jonathan M. Fischell, Erin Bewley, Kaitlin Jeffries, Paula G. Newton and Stefanie Zaner Fischell

The impact of the COVID-19 pandemic on DKA severity in Black and White pediatric patients

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Abstract

Objectives: Diabetic ketoacidosis (DKA) is a complication of uncontrolled diabetes mellitus, with a known increase in severity and incidence during the COVID-19 pandemic. Our institution also observed a rise in pediatric DKA cases in our largely underserved patient population. We hypothesized that the impact would be more pronounced in Black patients due to prepandemic healthcare inequities.
Methods: To investigate this, we confirmed the increased number of severe DKA cases in our pediatric patients during the pandemic and then stratified data to compare laboratory values between Black and White patients. We analyzed patients with a DKA diagnosis admitted to our institution's pediatric intensive care unit (PICU) prior to the pandemic (March 2016 to December 2017) and during its peak (March 2020 to December 2021).
Results and Conclusions: Our data demonstrated more cases of severe DKA overall during 2020–2021 and when compared to prepandemic years, a statistically significant increase in severity for Black, but not White patients.

Keywords: COVID-19; diabetes; DKA; health disparity

Introduction

Diabetic ketoacidosis (DKA) is a severe complication of uncontrolled type 1 and type 2 diabetes mellitus, caused by either absolute or relative insulin deficiency [1]. It can be prompted by various events such as insufficient insulin due to improper insulin dosing/malfunctioning insulin pumps, illness, noncompliance, and limited access to medication, all of which may be exacerbated by health inequity [2]. While many patients recover from DKA with prompt treatment, typically intensive care unit (ICU) admission is required and occasionally patients suffer severe and potentially permanent morbidity such as neurological or respiratory compromise, and even death [2, 3].

It has been documented that in both adult and pediatric patients, the incidence of DKA increased during the COVID-19 pandemic and that children admitted with DKA during the pandemic were likely to have more severe DKA and higher hemoglobin (Hb) A_{1c} [4, 5]. Recent literature has also reported more cases of DKA in non-Hispanic Black vs. non-Hispanic White patients, but these focused on populations with concomitant COVID-19 infection or newly diagnosed type 1 diabetes mellitus [6, 7]. To our knowledge, no study to date has merged these topics in a population where the scope was not limited to COVID-19 infection or first presentation of DKA. We aim to review the pediatric DKA cases at our institution during the peak of the COVID-19 pandemic and identify the impact, if any, that race had on the severity of them.

Methods

A chart review was performed on patients admitted to the University of Maryland PICU for DKA during two different time periods: before the pandemic (March 2016–December 2017) and during the peak of the pandemic (March 2020–December 2021). The study population included all patients admitted and found to have DKA, including those for the first time and those who are not followed by the institution for their outpatient care. There were 214 cases total. These

Shrina Patel is first author. Elyzabeth Amador, Jonathan M. Fischell, Erin Bewley, Kaitlin Jeffries, and Paula G. Newton contributed equally to this work. Stefanie Zaner Fischell is senior author.

***Corresponding author: Shrina Patel**, MD, Department of Pediatrics, University of Maryland Medical Center, 22S. Greene Street, N5W70, Baltimore, MD 21201, USA, E-mail: shrina.patel@som.umaryland.edu
Elyzabeth Amador, Erin Bewley and Kaitlin Jeffries, Department of Pediatrics, University of Maryland Medical Center, Baltimore, USA
Jonathan M. Fischell, Department of Neurology, University of Maryland Medical Center, Baltimore, USA
Paula G. Newton and Stefanie Zaner Fischell, Department of Pediatrics, University of Maryland School of Medicine, Baltimore, USA

groups were subdivided by self-reported race; however, due to the smaller number of patients identifying as groups other than Black or White, only these two categories were included in further analysis. The final number of included cases was 199. Table 1 provides a detailed breakdown demographic data for patients included in this study. Serum pH on admission were each used independently to stratify DKA severity into "mild", "moderate", and "severe" groups. Mild DKA was defined as a pH of 7.25–7.30; moderate DKA was defined as a pH of 7.00–7.24; and severe DKA was defined as a pH<7.00. Frequencies in each group were compared using chi-squared analysis. The mean HbA_{1c} and blood glucose on admission were compared between groups using 2-tailed, unpaired t-tests. Statistical significance was assigned at $p<0.05$.

Results

For our analysis, we first investigated if patients were presenting with more severe DKA, based on blood pH on admission, before vs. after the onset of the COVID-19 pandemic, in Black compared to White patients (Figure 1A). We found a significant shift to more severe categories of DKA based on blood pH (i.e., mild to moderate or severe and moderate to severe) in Black patients, during COVID compared to White patients, during COVID (p=0.007**) and compared to Black patients before the onset of the pandemic (pre-COVID) (p=0.0014**). There was no difference in DKA severity in Black patients compared to White patients, pre-COVID (p=0.0723, NS); nor was there a significant change in White patients pre- vs. during COVID (p=0.8234, NS).

Table 1: Summary of data, demographics and variables of interest.

Demographics		**Variables of interest**				
Total, n	**214**	**Blood pH**	**Mild, n (%)**	**Moderate, n (%)**	**Severe, n (%)**	**Total, n (%)[c]**
Ethnicity	**n (%)**	Overall	43 (21.9)	76 (38.8)	77 (39.3)	196
White or black (included)	199 (93.0)	White	9 (13.4)	35 (52.2)	23 (34.3)	67
White	68 (31.8)	Black	34 (26.4)	41 (31.8)	54 (41.9)	129
Black	131 (61.2)	Pre-Covid	30 (27.0)	42 (37.8)	39 (35.1)	111
Other (excluded)	15 (7.0)	Post-Covid	13 (17.3)	24 (32)	38 (50.7)	75
Hispanic	7 (3.3)	White/pre-Covid	4 (11.1)	19 (52.8)	13 (36.1)	36
Multiracial/other	6 (2.8)	White/during Covid	5 (16.1)	16 (51.6)	10 (32.3)	31
Not reported	2 (0.9)	Black/pre-Covid	26 (30.6)	33 (38.8)	26 (30.6)	85
Asian/Pacific Islander	0 (0)	Black/during Covid	8 (18.2)	8 (18.2)	28 (63.6)	44
Native American	0 (0)					
COVID-19	**n (%)**	**Blood glucose**	**Mean, mg/dL**	**STD, mg/dL**	**Total, n[c]**	
Pre-Covid	123 (61.8)	Overall	566.6	248.7	199	
During Covid	76 (38.2)	White	511.0	206.2	68	
Age	**n (%)**	Black	597.6	265.3	131	
Age≤12	90 (45.2)	Pre-Covid	565.9	249.7	123	
Age>12	109 (54.8)	During Covid	567.5	248.9	76	
Gender	**n (%)**	White/pre-Covid	493.3	227.7	36	
Male	107 (53.8)	White/during Covid	530.4	181.6	32	
Female	92 (46.2)	Black/pre-Covid	599.3	253.7	87	
Diabetes type	**n (%)**	Black/during Covid	594.5	287.3	44	
Type 1	190 (95.5)					
Type 2	6 (3.0)	**HbA_{1c}**	**Mean, %**	**STD, %**	**Total, n[c]**	
Type 1.5, LADA	1 (0.5)	Overall	12.3	2.2	181	
Not reported	2 (1.0)	White	12.0	2.1	67	
New diagnosis	**n (%)**	Black	12.4	2.3	114	
No known hx of DM	60 (30.2)	Pre-Covid	12.0	2.0	110	
Known hx of DM	136 (68.3)	Post-Covid	12.6	2.5	73	
Not reported	3 (1.5)	White/pre-Covid	12.0	2.1	35	
	Mean (STD)	White/during Covid	12.0	2.1	32	
Age, years	12.7 (4.4)	Black/pre-Covid	12.1	2.0	75	
Years since DM dx (known hx only)	5.7 (3.8)	Black/during Covid	13.0	2.8	41	
Length of stay, days	3.3 (2.3)					

[a]For results of ">x", x was taken as the value. [b]Normal pH or bicarb included in mild category. [c]The number in some cases are lower than total number only if data not reported. dx, diagnosis; hx, history.

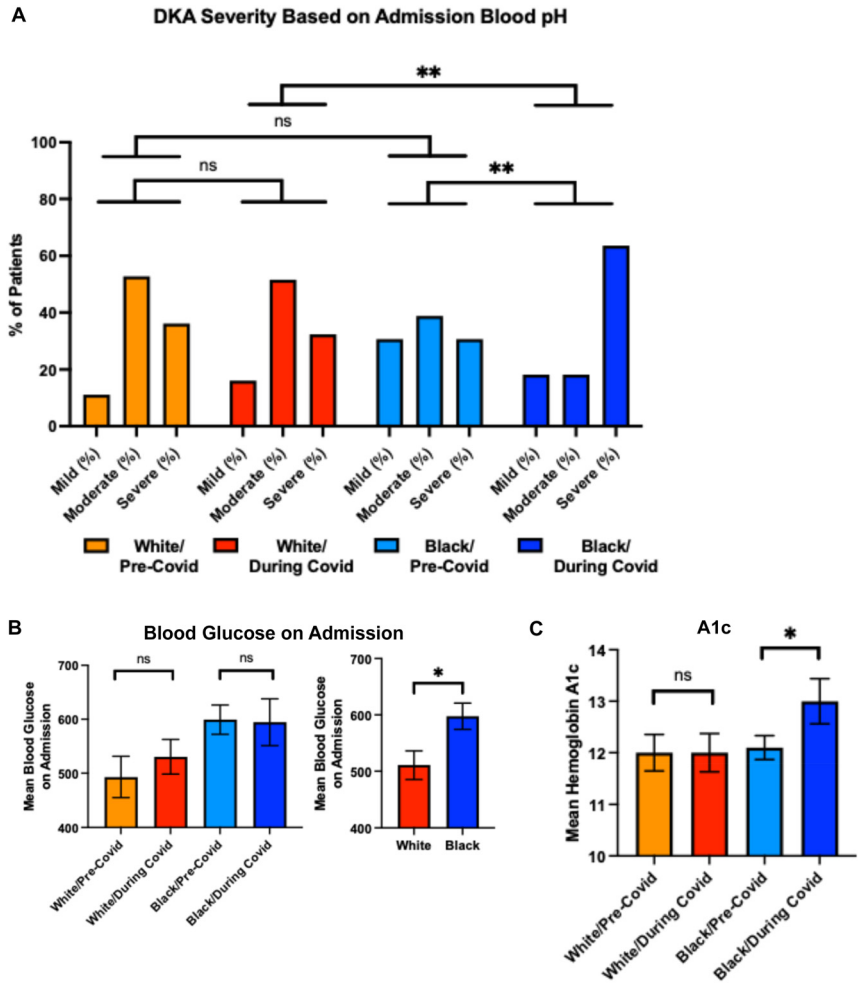

Figure 1: Differential impact of the COVID-19 pandemic on DKA severity and diabetes care in White vs. Black patients. (A) Impact on DKA severity based on blood pH. Significant rightward shift in DKA severity based on blood pH in Black patients compared to White patients during COVID ($N_{White/post}$ 31, $N_{Black/during}$ 44; chi-square 9.930; p=0.007) and in Black patients during COVID compared to pre-COVID ($N_{Black/pre}$ 85, $N_{Black/during}$ 44; chi-square 13.14; p=0.0014). (B) No effect of COVID on admission blood glucose in Black or White patients, although, overall Black patients had significantly greater mean blood glucose on admission (N_{White} 68, N_{Black} 131; t=2.348; p=0.0199). (C) No effect of COVID-19 on mean A_{1c} in White patients but statistically significant increase in mean A1c Black patients during COVID ($N_{Black/pre}$ 75, $N_{Black/post}$ 41; t=2.004; p=0.0475).

We next analyzed blood glucose on admission in Black compared to White patients pre and during COVID and found no difference in either group (Black: p=0.9223, NS; White: 0.464, NS) (Figure 1B). However, we did identify that admission blood glucose was higher in Black patients compared to White patients overall irrespective of COVID-19 (p=0.019*).

Finally, we evaluated HbA1c in our sample population, as a marker of chronic diabetes control (Figure 1C). We found a significant increase in HbA1c in Black patients during COVID compared to pre-COVID (p=0.0475*), but not in White patients (p>0.9999, NS). See Table 1 for all specific values related to our data analysis.

Conclusions

Prior literature has identified an increase in DKA incidence and severity during the COVID-19 pandemic [4–6, 8]. Our data revealed fewer cases of DKA during the pandemic period, but notably our institution had fewer inpatient admissions in general during this time. This could be due to patient hesitance in those with mild DKA coming to the emergency department or higher thresholds for admission to conserve beds during the pandemic. Using serum pH on admission to classify DKA severity in our pediatric population, we found increased DKA severity during the pandemic compared to prepandemic years in Black, but not White patients.

Separately, Black patients had a significantly higher HbA1c on presentation during the pandemic compared to prepandemic. It is important to note that at baseline, there may be racial differences in red blood cell glycation accounting for elevated HbA1c by approximately 0.4 % in Black vs. White people, even when blood glucose levels are comparable [9]. However, our data revealed that mean prepandemic HbA1c in both groups were quite similar but that the increase in Black patients' mean HbA1c was 0.9 %, whereas there was no change in that of White patients. The difference seen in these data goes beyond what racial differences can account for. While our analysis did not specifically address the reason behind this finding, one conjecture is that there may be pandemic-exacerbated health disparities that disproportionately affect the Black population [10].

The inconsistent utilization of COVID-19 testing early in the pandemic prevented us from being able to reliably report the number of DKA patients who were also COVID-19 positive, which is a limitation of the data. However, the conclusions drawn here will focus on environmental burdens amplified during the pandemic. There are many studies discussing the social determinants of health, which produce the health care disparities that negatively impact achieving optimal glycemic control in Black children [11, 12]. Transportation barriers to routine health visits, food deserts preventing proper nutrition, limited financial resources, microaggressions in physician–patient relationships, and inadequate health literacy all contribute to health inequities. During the pandemic, society as a whole suffered: diets worsened, mental health deteriorated, and healthcare access narrowed [13]. These changes were more prominent in minorities who often did not have the financial, educational, or social means to maintain optimal health during adverse situations. As diabetes is a complicated chronic medical condition, prepandemic challenges exacerbated during the pandemic likely played a multifactorial role in the increase in the frequency and severity of DKA admissions and increasing HbA1c measurements.

As previously mentioned, the greatest concern is that the pandemic exacerbated preexisting obstacles to care for the Black population. While ongoing research is conducted, this study should prompt healthcare providers to identify and address barriers to care. Actions could include dedicating more time to educate at-risk patients and their caregivers on the signs and symptoms of DKA and how to promptly implement sick day management; providing regular medication check-ins via virtual platforms or telephone; identifying transportation difficulties that impact access to care; addressing food insecurity; and continuing to scrutinize implicit biases when caring for underrepresented minorities.

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