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Care of Pediatric Patients with Diabetes During the Coronavirus Disease 2019 (COVID-19) Pandemic

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KEYWORDS

• Pediatric type 1 diabetes • COVID-19 pandemic • Diabetic ketoacidosis
• Telemedicine

KEY POINTS

- During the COVID-19 pandemic pediatric patients with new-onset diabetes often presented with more severe diabetic ketoacidosis (DKA).
- Most pediatric patients with type 1 diabetes (T1D) who developed COVID-19 had mild disease or were asymptomatic similar to children without diabetes.
- Stay-at-home initiatives and school closures often resulted in improved glycemic control for children with diabetes secondary to closer parental monitoring.
- Improved telemedicine adaptations for pediatric diabetic teams will likely continue to support care for these children after the pandemic.

CORONAVIRUS DISEASE 2019 AND DIABETES

The coronavirus disease 2019 (COVID-19), which is caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), created a pandemic in March 2020 with now more than 120 million cases and more than 2.5 million deaths worldwide. Early observations from studies in China, Italy, England, and the United States reported that adults with diabetes were more vulnerable to developing severe complications of COVID-19 including severe acute respiratory syndrome (SARS) with multiorgan failure and death.[1–3] As type 2 diabetes (T2D) is the more common form of diabetes in adults, it was unclear during the early phase of the pandemic if there was a similar increased risk of morbidity among individuals with type 1 diabetes (T1D) and COVID-19. One study of hospitalized adult patients with COVID-19 in the United Kingdom reported that of the 23,698 patients who died, one-third had diabetes with 31.4% T2D compared with 1.5% T1D.[4] Observations in adults with T2D and

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COVID-19 reported higher morbidity in individuals with a history of microvascular and macrovascular complications associated with diabetes.[5] Therefore, early during the COVID-19 pandemic diabetes was one of the major pre-existing conditions associated with increased morbidity and mortality.

It was important to further understand factors that contributed to lower rates of hospitalization among individuals with T1D during the COVID-19 pandemic. First, T1D is more common in younger individuals, whereas higher rates of hospitalization and mortality were seen in elderly patients with COVID-19. Second, individuals with T1D typically receive ongoing education about management of diabetes when ill to help avoid hospitalization. Third, the immune system in patients with T1D may provide an advantage to decrease disease severity from SARS-CoV-2. T1D and COVID-19 are both associated with inflammatory changes. The destruction of the pancreatic β-cells in T1D is mediated by Th1 immunity, which may protect against pathogens like SARS-CoV-2.[6,7] On the other hand, diabetic ketoacidosis (DKA), a well-known complication frequently seen in T1D that can result in significant morbidity and mortality, may be associated with Th1-type cytokines. DKA is characterized by hyperglycemia with metabolic acidosis and ketosis. DKA causes inflammatory changes that increase cytokines, including interleukin (IL)-6, tumor necrosis factor-α, and IL-β, that together exacerbate the cytokine storm associated with COVID-19 that is mediated by high levels of IL-6. IL-6 is one of the cytokines that is involved in Th1 autoimmunity of T1D.[8]

SARS infection is associated with glucose dysregulation. Review of historical data from individuals without diabetes who were infected with SARS showed a transient fasting hyperglycemia.[9] One proposed mechanism through which SARS coronavirus may impair insulin secretion is by damaging the pancreas by binding to angiotensin-converting enzyme-2 (ACE2) receptors in the pancreatic β-cells. However, this proposed mechanism is based on limited data showing detection of ACE2 protein in the pancreas from single donor and ACE2 mRNA expression in a pooled pancreas sample from 3 donors.[9,10]. An additional study showed that SARS-CoV-2 binds to ACE2 and infects pancreatic β-cells derived from human pluripotent stem cells.[11] Therefore, these observations together support a direct effect of SARS-CoV-2 in the pancreatic β-cell that may contribute to impairment of insulin secretion, which can lead to hyperglycemia and increase morbidity among patients with diabetes.

INITIAL CONCERNS ABOUT CORONAVIRUS DISEASE IN PEDIATRIC PATIENTS WITH TYPE 1 DIABETES

Owing to increased morbidity among adult patients with diabetes and COVID-19, concerns were raised about whether children with T1D could become very ill from COVID-19 as well. One study collected data on children living in 4 areas affected early by the COVID-19 pandemic: (1) Wuhan, China; (2) Catalonia, Spain; (3) Italy; and (4) San Francisco-Bay Area in the United States.[12] Although these 4 locations included large populations, there was only one patient who required hospitalization, a 20-year-old female from Spain with uncontrolled T1D (hemoglobin A_{1C} [HbA_{1C}] 11%) developed bilateral pneumonia and was intubated but was subsequently discharged from the hospital within 2 weeks. Wuhan reported no cases of children with T1D and COVID-19, whereas San Francisco reported 2 pediatric patients with T1D and COVID-19, but they did not require hospitalization. The Italian Society of Pediatric Endocrinology and Diabetes registry collected data on 15,500 pediatric patients with T1D from March 1, 2020, to August 31, 2020. Only 11 patients with T1D tested positive for COVID-19, and 5 of these patients had mild symptoms including fever, cough, conjunctivitis, anosmia, and transient hyperglycemia. Three patients with COVID-19 were admitted

to the hospital: 2 required extensive education for new-onset T1D and one of these patients also had DKA without any COVID-related complications. The third patient who was admitted to the hospital had moderate DKA but recent glycemic control as close to target goal (HbA_{1C} 7.8% with target less than 7.5%). Therefore, this early observation on the effects of COVID-19 in pediatric patients with T1D showed that most children have mild disease compared with adults with diabetes.

A survey conducted by the T1D Quality Improvement Collaborative (T1DX-QI) along with 49 other endocrinology clinics in the United States identified 33 patients with COVID-19 early in the pandemic.[13] In this group of patients, the mean age was 24.8 years with the youngest patient aged 7 years and most patients had hyperglycemia and mild symptoms including fever, cough, fatigue, and shortness of breath. The most common comorbidities among these patients were obesity and hypertension/cardiovascular, and one death was reported in a patient with DKA. Overall, the study concluded that children and adolescents with T1D and COVID-19 had a similar disease course as other children with COVID-19 who did not have diabetes. Taken together, these studies show that most pediatric patients with T1D do not become severely ill with COVID-19, unlike adults with diabetes and COVID-19.

THE IMPACT OF CORONAVIRUS DISEASE 2019 IN PEDIATRIC PATIENTS WITH NEWLY DIAGNOSED TYPE 1 DIABETES

Although the clinical course among pediatric patients already diagnosed with diabetes and COVID-19 was not as severe as expected, some reports examined whether COVID-19 had any impact on the initial diagnosis of T1 in pediatric patients. It is well known that there is a seasonal variation associated with new-onset T1D with increased cases during the fall and winter when exposure to viruses increase.[14–17] One study examined the effect of the COVID-19 pandemic on the new diagnosis of T1D in pediatric patients in Italy.[18] A cross-sectional analysis of pediatric diabetes centers in Italy examined data from children diagnosed with new-onset T1D or established patients with T1D presenting with DKA during 2 time periods: February 20, 2019, to April 14, 2019, and February 20, 2020, to April 14, 2020. In 2020 there were 160 newly diagnosed patients compared with 208 patients in 2019. The 23% decrease in new cases of T1D during the pandemic was attributed to effects of social distancing requirements and school closures, which together reduced exposure to seasonal viruses. The study also, however, reported a significantly higher proportion of patients presenting with severe DKA (pH < 7.1 and bicarbonate < 5 mmol/L) during the COVID-19 pandemic compared with the previous year (44.3% compared with 36%, *P* value < .03). Eight patients were diagnosed with COVID-19, 4 had mild symptoms, and the others were asymptomatic. The investigators concluded that several factors may have contributed to fewer cases of new-onset T1D but increased number of patients with severe DKA during the COVID-19 pandemic. First, lockdown restrictions implemented during the pandemic decreased exposure to seasonal viruses, which are associated with new-onset T1D. Second, families were more hesitant in seeking medical care early when children became ill due to fear of exposure to COVID-19. Finally, other reports highlighted the impact of unintended consequences of the pandemic on routine care at clinics and acute care in emergency room, which together contributed to a delay in diagnosis of diabetes causing more severe DKA in children in several countries.[19–21]

Two other studies also examined changes in pediatric T1D during the COVID-19 pandemic. First, a study that included 30 pediatric patients in the United Kingdom reported an increase in the number of new cases of T1D by 80% compared with

previous years.[22] This observation was limited to only patients admitted to 2 of 5 inpatient units included in the study. Furthermore, there was no evidence that the increase in new cases of T1D was statistically significant or directly linked to exposure to SARS-CoV-2. Similar to observations in Italy during the COVID-19 pandemic, most patients with new-onset T1D presented with DKA (70%), of which 52% had severe DKA. Only 21 patients were screened for SARS-CoV-2 and 3 of 5 patients who tested positive presented with severe DKA complicated by refractory hypokalemia. One of these patients with severe hypokalemia had a cardiac arrest but survived. Although hypokalemia is the common electrolyte abnormality seen during DKA, the investigators proposed that SARS-CoV-2 might exacerbate hypokalemia by modulating the renin-angiotensin system (RAS).[23] SARS-CoV-2 enters the cell by binding to ACE2, which also plays an important role in decreasing RAS activity to limit the effects of angiotensin II and aldosterone. In patients with COVID-19 decreased regulation of RAS activity by ACE2 contributes to prolonged effects of angiotensin II and aldosterone, which increases potassium excretion, which is the major cause of hypokalemia.[24] An increase in the prevalence of hypokalemia was also reported in adults who were critically ill with COVID-19.[24]

A study conducted in Germany also examined the impact of COVID-19 on the incidence of pediatric T1D. This study included patients from 216 centers diagnosed with T1D between March 13 and May 13 yearly from 2011 to 2020 and estimated the incidence per 100,000 patient-years.[25] Although the incidence of pediatric T1D increased significantly from 2011 to 2019 (16.4–22.2, respectively, P value = .04), there was no significant change in the incidence of T1D among 532 patients in 2020 compared with predicted incidence (23.4 vs 22.1). This study concludes that during the COVID-19 pandemic there was no significant increase in the incidence of pediatric T1D among children in Germany, which is similar to observations in Italy but not those in the United Kingdom.

CORONAVIRUS DISEASE 2019 IN PEDIATRIC PATIENTS WITH A HISTORY OF TYPE 1 DIABETES

Studies in Italy and the United Kingdom reported no significant increase in hospitalization among pediatric patients with a history of T1D, although there were some reported cases of DKA.[18,22] Others had also reported overall fewer cases of severe illness among pediatric patients with diabetes.[12] Patients with a history of T1D receive extensive education regarding management of diabetes during illnesses. These specific instructions called *sick day guidelines* provide important tools to help patients avoid hospitalization, which may have contributed to decreased disease severity among these patients during the pandemic. In addition, stay-at-home orders and school closures likely promoted more engagement among patients and their caregivers with diabetes management at home. Therefore, parents had more time to supervise their children with testing blood glucose, monitoring food intake, and administering insulin, which together may have helped to decrease emergency room visits and hospitalizations in patients with a history of T1D.

Although most pediatric patients with T1D and COVID-19 had mild disease, some patients required hospitalization and had significant morbidity. Two studies provided early characteristics of pediatric patients with COVID-19 admitted to pediatric intensive care units (PICUs). The first study reported 48 children admitted to 14 PICUs in the United States of which 83% had pre-existing health conditions and 8% had T1D with 75% of T1D patients presenting with DKA.[26] The second study reported that among pediatric patients admitted to PICU with COVID-19, those with T1D had

increased need for respiratory support including use of high-flow nasal cannula as well as mechanical and high-flow frequency ventilation.[27]

As COVID-19 hospitalizations increased in the United States, reports showed that socioeconomic factors contributed to worse health outcomes, and some ethnic minorities had more severe outcomes.[28,29] A cross-sectional multisite study of patients with T1D and COVID-19 in the United States examined differences in DKA presentation among different ethnic groups.[30] Of the 180 patients, 44% were non-Hispanic (NH) white, 31% were NH black, and 26% were Hispanic with 42% patients being in the pediatric group (age $\leq$ 19 years). NH blacks and Hispanics had significantly elevated HbA1c compared with NH whites (11.7% and 9.7%, compared with 8.3%, *P* value = .001 and .01, respectively) and were more likely to present with DKA compared with NH whites (55% and 33% compared with 13%, respectively). After adjusting for age, sex, glycemic control, and insurance status, NH blacks were 3.7 times more likely than NH whites to present with DKA during the COVID-19 pandemic, but there was no statistical difference between Hispanics and NH whites. The study suggests that multiple factors may contribute to ethnic disparities in DKA: social determinants of health, inadequate access to health care services, inability to self-manage diabetes especially when ill, and delay in seeking medical assistance if condition worsens. This study also highlights that health disparity that existed among patients with T1D and DKA before the COVID-19 pandemic persisted and became more evident among patients with COVID-19. Although the study highlights the need to provide more targeted approach to vulnerable patients with T1D, no new insights were identified that could be immediately implemented especially during the pandemic.

CHALLENGES WITH OUTPATIENT MANAGEMENT OF PEDIATRIC TYPE 1 DIABETES DURING THE CORONAVIRUS DISEASE 2019 PANDEMIC

During the COVID-19 pandemic, the implementation of social distancing and stay-at-home orders or lockdown in many countries directly impacted how health care providers interacted with their patients to provide routine care, which was particularly challenging for pediatric patients with T1D. Most clinics had to implement changes quickly to accommodate the needs of patients and their caregivers while simultaneously redefining roles and responsibilities of health care team members to navigate the complexity of shifting from in-person clinic visits to a telemedicine platform as the primary mode of care. Many pediatric patients with T1D use advanced diabetes devices including continuous subcutaneous insulin infusion (insulin pumps) and continuous glucose monitors (CGMs). Both insulin pumps and CGMs use Web-based management software to collect and store data that can be shared between patients and their health care team members. This remote monitoring aspect of diabetes is used routinely throughout pediatric clinics even before the COVID-19 pandemic allowing for frequent insulin dose adjustments in the growing child. In addition, remote access to data is particularly helpful to assist with management of emergencies including hypoglycemia and hyperglycemia. Although this remote technology was used in many pediatric diabetes clinics before COVID-19, several adaptations were needed to provide ongoing care for patients during the pandemic. Before the pandemic families were not always expected to upload data from diabetes devices before coming to clinic and therefore needed assistance from the health care team as well as technical support from the diabetes device company. Families also needed access to the Internet and a computer at home to upload data that could be reviewed by their health care team. Finally, owing to limitations with in-person clinic visits during the COVID-19 pandemic, many patients and their families had to participate in virtual visits

(telemedicine) to receive ongoing care for diabetes management. Several studies have examined the impact of telemedicine visits on glycemic control in pediatric patients with T1D, and the results are promising and indicate that telemedicine may become an important component of routine care for outpatient management of diabetes (see following paragraphs).

Some studies examined the use of telemedicine in pediatric diabetes clinics during the COVID-19 pandemic. One study conducted a survey analyzing the impact of changes in pediatric diabetes clinics on the patients and their providers from different countries.[31] There were several major concerns about telemedicine visits. Accessing patient data was challenging for providers who often had to help guide family with specific instructions to share data from insulin pumps and glucose monitoring devices. The ability to retrieve data often depended on good Internet connection as well as access to electronic devices. Providers were initially concerned about the increased risk of DKA in children with T1D during the COVID-19 pandemic, but many clinics did not report any significant morbidity among their patients. Providers observed more health care disparities among vulnerable patients who had limited access to the Internet to connect with the health care team virtually as well as lack of close follow-up by social worker and assistance with diabetes care by school nurses. This study also identified some benefits of telemedicine that included the following: educating families about data sharing, improving efficiency during patient interactions, and improving adherence to diabetes management plan. Overall, the COVID-19 pandemic forced health care team to quickly implement changes to use telemedicine as a tool to provide ongoing care for pediatric patient with diabetes.

Several other studies examined the impact of telemedicine on metrics used to assess improvement in glycemic control in pediatric patients during the COVID-19 pandemic. A study in Italy examined changes in glycemic control 3 weeks before and after the lockdown was implemented during the pandemic.[32] A total of 62 pediatric patients with T1D using the Dexcom G6 CGM device (Dexcom, Inc) were followed via telemedicine during 2 time periods: November 26, 2019 to February 23, 2020, and February 24, 2020, to May 18, 2020. Although patients were more sedentary, there was a significant increase in the median time that glucose levels were in the target range (60.5% to 63.5%) and a decrease in the time that glucose levels were above the target range (37.3% to 34.1%) and below the target range (1.85 to 1.45%). A multicenter study conducted in Israel among 195 children with T1D (mean age 14.6 ± 5.3 years) examined changes in time in range 2 weeks before and after telemedicine visits during the Israeli lockdown from March 15, 2020, to April 12, 2020.[33] Among the 121 patients who completed the telemedicine visit, time in range improved (62.9% compared with 59%) during the 2-week period after the telemedicine visit. Therefore, the use of telemedicine together with remote monitoring of diabetes during the COVID-19 pandemic showed positive changes in metrics that directly impact glycemic control.

Finally, pediatric endocrinologists at the University of Pittsburgh Medical Center in the United States provided some recommendations and insights for using telemedicine services to provide ongoing patient care during the COVID-19 pandemic.[34] First, a representative from each member of the health care team should always be part of the development and assessment of telemedicine services that will be offered to patients. Second, different telemedicine platforms may be required to communicate with patients/families effectively and when possible choose one that can integrate with the electronic medical record. Third, one should remember to address any concerns about billing requirements when conducting telemedicine visits. Fourth, administrative staff will need to provide clear instructions for patients to use during the telemedicine

visit. Fifth, it is important to continue to integrate different members of the health care team during the telemedicine visit including pediatric endocrinologist, trainees on team, diabetes nurse, certified diabetes educator, registered dietitian, and social worker. Sixth, problems encountered with telemedicine services related to institutional policies as well as limitations inherent to conducting virtual visits should be identified and steps should be taken to quickly resolve them (eg, inability to perform a comprehensive examination or laboratory testing). Finally, it is important that both health care team members and families attempt to maintain a positive attitude when implementing telemedicine to provide ongoing care for pediatric patients with diabetes especially during the COVID-19 pandemic.

In summary, during the COVID-19 pandemic pediatric patients with new-onset diabetes presented with more severe DKA. Most pediatric patients with a history of T1D who developed COVID-19 had mild disease or were asymptomatic similar to their peers without diabetes. Children with T1D and COVID-19 clearly had less severe disease than adults with diabetes and COVID-19. Telemedicine was successfully used to provide ongoing care for pediatric patients with T1D and provide some insights about positive changes in glycemic control during the pandemic. Lessons learned about management of diabetes during the COVID-19 pandemic should help to provide better care for pediatric patients with T1D and improve their health outcomes.

CLINICS CARE POINTS

- Most pediatric patients with T1D do not become severely ill with COVID-19, unlike adults with diabetes and COVID-19.
- Delay in access to medical care during the COVID-19 pandemic contributed to an increase in cases of severe DKA among pediatric patients with newly diagnosed T1D.
- The use of remote technology and telemedicine in pediatric diabetes clinics during the COVID-19 pandemic had a positive impact on glycemic control.

DISCLOSURE STATEMENT

Dr Buggs-Saxton has the following disclosures:

- Coinvestigator for NIH/NIDDK RO1 DK110075: Effectiveness of an E-Health Intervention to Support Diabetes in Minority Youth
- Data Safety Monitoring Board Member: Defining the role of management factors in outcome disparity in pediatric T1D

REFERENCES

1. Bode B, Garrett V, Messler J, et al. Glycemic Characteristics and Clinical Outcomes of COVID-19 Patients Hospitalized in the United States. J Diabetes Sci Technol 2020;14(4):813–21.
2. Huang I, Lim MA, Pranata R, et al. Diabetes mellitus is associated with increased mortality and severity of disease in COVID-19 pneumonia - A systematic review, meta-analysis, and meta-regression. Diabetes Metab Syndr 2020;14(4):395–403.
3. Williamson EJ, Walker AJ, Bhaskaran K, et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature 2020;584(7821):430–6.
4. Barron E, Bakhai C, Kar P, et al. Associations of type 1 and type 2 diabetes with COVID-19-related mortality in England: a whole-population study. Lancet Diabetes Endocrinol 2020;8(10):813–22.

5. Apicella M, Campopiano MC, Mantuano M, et al. COVID-19 in people with diabetes: understanding the reasons for worse outcomes. Lancet Diabetes Endocrinol 2020;8(9):782–92.
6. Iughetti L, Trevisani V, Cattini U, et al. COVID-19 and Type 1 Diabetes: Concerns and Challenges. Acta Biomed 2020;91(3):e2020033.
7. Tatti P, Tonolo G, Zanfardino A, et al. Is it fair to hope that patients with Type 1 Diabetes (autoimmune) may be spared by the infection of Covid-19? Med Hypotheses 2020;142:109795.
8. Hundhausen C, Roth A, Whalen E, et al. Enhanced T cell responses to IL-6 in type 1 diabetes are associated with early clinical disease and increased IL-6 receptor expression. Sci Transl Med 2016;8(356).
9. Yang JK, Lin SS, Ji XJ, et al. Binding of SARS coronavirus to its receptor damages islets and causes acute diabetes. Acta Diabetol 2010;47(3):193–9.
10. Harmer D, Gilbert M, Borman R, et al. Quantitative mRNA expression profiling of ACE 2, a novel homologue of angiotensin converting enzyme. FEBS Lett 2002; 532(1-2):107–10.
11. Yang L, Lin SS, Ji XJ, et al. A Human Pluripotent Stem Cell-based Platform to Study SARS-CoV-2 Tropism and Model Virus Infection in Human Cells and Organoids. Cell Stem Cell 2020;27(1):125–36.e127.
12. Cardona-Hernandez R, Cherubini V, Iafusco D, et al. Children and youth with diabetes are not at increased risk for hospitalization due to COVID-19. Pediatr Diabetes 2021;22(2):202–6.
13. Ebekozien OA, Noor N, Gallagher MP, et al. Type 1 Diabetes and COVID-19: Preliminary Findings From a Multicenter Surveillance Study in the U.S. Diabetes Care 2020;43(8):e83–5.
14. Knip M, Veijola R, Virtanen SM, et al. Environmental triggers and determinants of type 1 diabetes. Diabetes 2005;54(Suppl 2):S125–36.
15. Craig ME, Nair S, Stein H, et al. Viruses and type 1 diabetes: a new look at an old story. Pediatr Diabetes 2013;14(3):149–58.
16. Elding Larsson H, Vehik K, Gesualdo P, et al. Children followed in the TEDDY study are diagnosed with type 1 diabetes at an early stage of disease. Pediatr Diabetes 2014;15(2):118–26.
17. Laitinen OH, Honkanen H, Pakkanen O, et al. Coxsackievirus B1 is associated with induction of beta-cell autoimmunity that portends type 1 diabetes. Diabetes 2014;63(2):446–55.
18. Rabbone I, Schiaffini R, Cherubini V, et al. Has COVID-19 Delayed the Diagnosis and Worsened the Presentation of Type 1 Diabetes in Children? Diabetes Care 2020;43(11):2870–2.
19. Cella AM,F, Iughetti L, Di Biase AR, et al. Italian COVID-19 epidemic: effects on paediatric emergency attendance—a survey in the Emilia Romagna region. BMJ Paediatrics 2020;4(1).
20. Cherubini V, Gohil A, Addala A, et al. Unintended Consequences of Coronavirus Disease-2019: Remember General Pediatrics. J Pediatr 2020;223:197–8.
21. Scaramuzza A, Tagliaferri F, Bonetti L, et al. Changing admission patterns in paediatric emergency departments during the COVID-19 pandemic. Arch Dis Child 2020;105(7):704–6.
22. Unsworth R, Wallace S, Oliver NS, et al. New-Onset Type 1 Diabetes in Children During COVID-19: Multicenter Regional Findings in the U.K. Diabetes Care 2020; 43(11):e170–1.
23. Pal R, Bhansali A. COVID-19, diabetes mellitus and ACE2: The conundrum. Diabetes Res Clin Pract 2020;162:108132.

24. Chen D, Li X, Song Q, et al. Assessment of Hypokalemia and Clinical Characteristics in Patients With Coronavirus Disease 2019 in Wenzhou, China. JAMA Netw Open 2020;3(6):e2011122.
25. Tittel SR, Rosenbauer J, Kamrath C, et al. Did the COVID-19 Lockdown Affect the Incidence of Pediatric Type 1 Diabetes in Germany? Diabetes Care 2020;43(11): e172–3.
26. Shekerdemian LS, Mahmood NR, Wolfe KK, et al. Characteristics and Outcomes of Children With Coronavirus Disease 2019 (COVID-19) Infection Admitted to US and Canadian Pediatric Intensive Care Units. JAMA Pediatr 2020;174(9):868–73.
27. Loomba RS, Villarreal EG, Farias JS, et al. Pediatric Intensive Care Unit Admissions for COVID-19: Insights Using State-Level Data. Int J Pediatr 2020;2020: 9680905.
28. Laurencin CT, McClinton A. The COVID-19 Pandemic: a Call to Action to Identify and Address Racial and Ethnic Disparities. J Racial Ethn Health Disparities 2020; 7(3):398–402.
29. Wiemers EE, Abrahams S, AlFakhri M, et al. Disparities in Vulnerability to Severe Complications from COVID-19 in the United States. Res Soc Stratif Mobil 2020; 69:100553.
30. Ebekozien O, Agarwal S, Noor N, et al. Full Inequities in Diabetic Ketoacidosis among Patients with Type 1 diabetes and COVID-19: Data from 52 US Clinical Centers. J Clin Endocrinol Metab 2021;106(4).
31. Sarteau AC, Souris KJ, Wang J, et al. Changes to care delivery at nine international pediatric diabetes clinics in response to the COVID-19 global pandemic. Pediatr Diabetes 2021;2021:1–6.
32. Predieri B, Leo F, Candia F, et al. Glycemic Control Improvement in Italian Children and Adolescents With Type 1 Diabetes Followed Through Telemedicine During Lockdown Due to the COVID-19 Pandemic. Front Endocrinol (Lausanne) 2020;11:595735.
33. Rachmiel M, Lebenthal Y, Mazor-Aronovitch K, et al. Glycaemic control in the paediatric and young adult population with type 1 diabetes following a single telehealth visit - what have we learned from the COVID-19 lockdown? Acta Diabetol 2021;58(6):697–705.
34. March CA, Flint A, DeArment D, et al. Paediatric diabetes care during the COVID-19 pandemic: Lessons learned in scaling up telemedicine services. Endocrinol Diabetes Metab 2020;e00202.