EDITORIAL

Being caught in the perfect storm of a diabetes epidemic and the COVID-19 pandemic: What should we do for our patients?

The pandemic of coronavirus disease 2019 (COVID-19) has overwhelmed the whole world since the first case was reported in Wuhan, China, in December 2019. The infection, called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), induces various symptoms, including fever and respiratory and enteric symptoms, but some people are asymptomatic[1,2]. Although the fatality rate of COVID-19 is lower than that of SARS-CoV-1 and Middle East respiratory syndrome coronavirus, the absolute number of fatalities as a result of COVID-19 is quite high because of the high prevalence of the viral infection. Deaths due to COVID-19 are caused by hyperinflammation as a result of cytokine storm syndrome, and to solve this problem, studies on the use of various therapeutic agents, such as steroids, intravenous immunoglobulin, selective cytokine blockade and JAK inhibition, are underway[3]. According to the World Health Organization, as of 14 September 2020, >30 million people have been confirmed to be infected with COVID-19, >900,000 of whom have died[4]. A major concern is that this trend is continuing around the world. Even today, 9 months after the first case was reported, COVID-19 is still affecting everyone's daily life, leading to not only medical problems, but also socioeconomic problems.

The prevention, early detection and appropriate treatment of the COVID-19 infection in diabetes patients are especially important. The reason these measures are important is because several studies have shown an association between COVID-19 infection severity and diabetes. First, statistically, the odds ratio of intensive care unit care and mechanical ventilation for COVID-19 infection has been shown to be significantly higher in diabetes patients[5]. In a study carried out in Italy on intensive care unit inpatients with COVID-19 infection, diabetes was the most common comorbidity, followed by hypertension, cardiovascular disorders and hypercholesterolemia[6]. In a retrospective study comparing patients without any comorbidities and patients with diabetes without other comorbidities, a significant decrease in red blood cells and lymphocytes, and a significant elevation in serum ferritin and alanine aminotransferase were observed in patients with diabetes[7]. These hematological markers are associated with secondary hemophagocytic lymphohistiocytosis, defined as hyperinflammatory syndrome[3]. The levels of various markers of inflammation and infection, such as α-hydroxybutyrate dehydrogenase, lactic dehydrogenase, neutrophils, interleukin-6, fibrinogen, D-dimer, and C-reactive protein, were also increased in patients with diabetes[7].

Furthermore, in that study, the severity of lung inflammation, as assessed by the chest computed tomography score, was significantly higher in patients with diabetes.

Many other reports from several countries have clearly shown a link between diabetes and mortality caused by COVID-19[8,9]. According to a report from the Korea Centers for Disease Control and Prevention released in July, a total of 299 people died from COVID-19 in Korea; 75.6% of the patients had cardiovascular diseases, including hypertension, myocardial infarction, heart failure and stroke, and 47.8% of the patients had endocrine and metabolic diseases, such as diabetes[10–12]. This comorbidity was higher than that of respiratory diseases, which was 26.4%, including asthma and chronic obstructive pulmonary disease. In addition, in a study of 9,148 people diagnosed with COVID-19 in Korea, the odds ratio of death among people with diabetes was 1.82 (95% confidence interval 1.25–2.67)[13]. In the largest case series published by the Center for Disease Control and Prevention in China, 2.3% of the 44,672 patients with positive viral nucleic acid test results died; the case fatality rate was 10.5% in patients with cardiovascular disease and 7.3% in patients with diabetes[1]. Additionally, the Kaplan–Meier survival curves of 51,633 patients confirmed to have COVID-19 infection in Mexico showed that the mortality rate was higher in patients with diabetes only than in those with other comorbidities without diabetes[5]. Although the odds ratio of the mortality rate showed that being aged <40 years was a protective factor (hazard ratio 0.26, 95% confidence interval 0.23–0.29), the mortality rate (11.3%) of patients with diabetes aged <40 years was higher than the overall mortality rate (10.33%). Therefore, the prevention of COVID-19 infection in patients with diabetes in particular is very important due to the increased severity of symptoms and mortality rate.

Furthermore, several studies have suggested that appropriate glycemic control is important in patients with diabetes and COVID-19 infection. In China, septic shock, acute respiratory distress syndrome, acute kidney injury and acute heart injury were significantly more common in diabetes patients with poor glycemic control than in those with good glycemic control[14]. Even in patients who had not previously been diagnosed with diabetes, defined as a glycated hemoglobin level of ≥6.5%, but had hyperglycemia, the mortality rate due to COVID-19 was significantly higher than in those without hyperglycemia or diabetes[15]. These studies showed that appropriate monitoring and

management of blood glucose levels are critical for not only patients diagnosed with diabetes, but also patients newly diagnosed with diabetes during the treatment of COVID-19 infection. Vaccines have not been developed yet, and the most important methods of preventing infection are social distancing, wearing a mask and performing proper hand hygiene.

However, maintaining an appropriate physical distance and self-isolation during the COVID-19 pandemic clearly hinders appropriate monitoring, evaluations and consultations with patients with diabetes due to limitations in accessing medical institutions caused by a fear of becoming infected with COVID-19. In addition, patients with mild symptoms of COVID-19 infection stay in a health treatment center in Korea, and require at least 3 weeks of quarantining until they test negative for the virus twice with a reverse transcription polymerase chain reaction kit. During the isolation period, it is difficult to maintain adequate lifestyle management, carry out self-blood glucose monitoring and adjust one's antidiabetic medications. To overcome the physical and psychological barriers to diabetes patients' access to medical institutions, remote monitoring and evaluations through various communication tools, including mobile phones, the internet and telephones, can be considered acceptable alternatives. In fact, many countries are already actively adopting mobile healthcare systems for managing diabetes patients. In Qatar, where the incidence of diabetes patients is high, clinicians directly message patients to ensure that individuals with diabetes are performing measures, such as preventive measures for COVID-19 infection, self-monitoring, drug and complications management, lifestyle modifications, and psychological health management[16]. In addition, based on their medical records, diabetes patients aged >50 years who receive insulin treatments and do not show glycemic control, with a glycated hemoglobin level >8%, undergo a teleconsultation with a doctor and a diabetes educator. In the UK, doctors are also trying to overcome the limitations of face-to-face care and education through the management of diabetes and continuous lifestyle correction education in various ways using technology[17]. Additionally, smartphones, text messages and the "Internet of things" are being used to promote continuous education and non-face-to-face treatment for proper glucose control in patients in China, France, Italy and the USA[18]. In Korea, temporary telemedicine is also provided for patients who have difficulty accessing medical institutions due to the need to self-isolate after testing positive for COVID-19 infection or being in close contact with an infected person. Additionally, the Korean Diabetes Association has provided basic guidelines for preventing COVID-19 infection in diabetes patients (Table 1)[18,19]. Accordingly, individuals with diabetes who require continuous management can self-monitor their blood glucose levels and the side-effects of medications at home through interviews with their doctor by telephone, and doctors can prescribe new drugs to prevent poor blood glucose control, if required. Self-management and education among patients have been carried out using the Internet of things in several

studies. In a systemic review of several meta-analyses, education and support for diabetes self-management provided using various technologies, such as the internet, text messaging and videos enabled on smartphones, have been shown to be effective in reducing the glycated hemoglobin level with a complete feedback loop[20]. Therefore, even without face-to-face treatment, effective glucose control can be achieved in patients diagnosed with diabetes through continuous patient–doctor communication using various remote technologies. However, we could not find a well-established mobile healthcare platform that is used in any country. We already have enough technology, including network systems; mobile devices for glucose, blood pressure and body temperature monitoring; and various mobile application programs for diabetes. However, authentic healthcare systems that require fees for service systems based on face-to-face contact clearly prevent the healthcare system from advancing. We urgently need to establish a new system that can be used globally; develop new payment options, such as performance payment systems; and finally, actively adopt new technologies to support patient care.

In the past, humanity has overcome medical crises successfully and made breakthroughs in medical care based on these experiences. Today, with advanced medicine, not only were we able to quickly identify SARS-CoV-2, the causative virus of COVID-19 infection, within 7 months after the first case was confirmed, but also, we implemented a reverse transcription polymerase chain reaction kit for the rapid screening of suspected patients, and efforts are being made to quickly discover and develop effective treatments and vaccines. In addition, with advanced citizenship, the primary and most important methods for the prevention of infection, including keeping a physical distance, wearing masks and hand sanitization, have been practiced not only in Korea, but also worldwide. Now, we must be careful and provide more care for individuals with diabetes who are vulnerable to severe infections. Relatedly, there are ongoing efforts to elucidate the association between COVID-19 and diabetes, and to make it possible to actively provide healthcare in difficult real-life situations. To achieve this, the CoviDiab registry has been established to identify cases of diabetes caused by COVID-19 infection and severe acute complications in diabetes patients during the management of COVID-19 worldwide[21]. More studies are required to investigate the epidemiological features and causes of COVID-19-related diabetes, and to guide treatment. Additionally, in the 21st century, we have developed several technologies that enable patient care, even in the midst of a pandemic, and many countries are working to use them appropriately to achieve strict glycemic control.

Even if the crisis is successfully overcome, pandemics caused by new infections continue to threaten humanity. During this disaster situation, it is necessary to ensure sophisticated patient care by continuing to pursue ways to enable two-way management with non-face-to-face methods, using advanced technologies that have already been proven to be beneficial, so that not

Table 1 | Prevention and management recommendations for patients with diabetes and their physicians during the COVID-19 pandemic[†]

General care	• Wash your hands often, and do not touch your eyes, nose or mouth with dirty hands • Make sure to wear a mask before going out • To keep a physical distance, leave your home as infrequently as possible and do not visit crowded places • Avoid contact with people with fever or respiratory symptoms • Drink enough water to prevent infection
Outpatient management	• Make sure to take the appropriate dosages of oral drugs and insulin to maintain adequate glycated hemoglobin levels, according to the guidelines • Self-monitoring of blood glucose levels should be performed more often than usual and at least twice a day • If your blood glucose level continues to be higher than usual during self-monitoring checks, consult your doctor • To maintain immunity, a certain amount of exercise should be performed regularly at home
Recommendations for virtual consultations	• Diabetes patients whose blood glucose control is usually good should be followed up regularly • Frequent and intensive follow ups are required for high-risk patients, such as those who have recently been hospitalized or have recurrent severe hypoglycemia • A diabetes patient in close contact with a COVID-19 patient should perform self-isolation • A person with diabetes, infected with COVID-19, with mild symptoms should be quarantined in self-isolation outside of a medical institution • The risk is greater than the benefits of face-to-face care in some individuals, such as those aged >70 years
Recommendations for urgent face-to-face consultations	• Diabetes patients who need a new diagnosis should visit a clinic • Patients with symptoms due to unregulated diabetes should visit a clinic • If your blood glucose suddenly rises during the self-monitoring checks, you blood glucose level should be checked by a physician • Patients needing insulin for the first time should visit a clinic • If physical examination is required among the symptoms caused by complications caused by diabetes; for example, retinopathy, foot ulcer or other infection etc.

[†]Recommendations that diabetes patients and their physicians must follow to prevent infection during the coronavirus disease 2019 (COVID-19) pandemic and to manage diabetes properly. As shown in the table above, the prevention of COVID-19 infection and thorough blood glucose control in individuals with diabetes are very important in relation to symptom severity and mortality, so more careful diabetes care is required through face-to-face and virtual methods.

only medical staff, but also government officials in every country can help patients through this disaster.

DISCLOSURE
The authors declare no conflict of interest.

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