Guidelines of the Diabetes Poland on the therapeutic management and glycemic monitoring in diabetic patients in the COVID-19 pandemic and other viral pandemics

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1. COVID-19 and clinically related viral outbreaks – general guidelines

Key recommendations
1. The health care system should be prepared for the constant threat to public health resulting from infectious diseases, with particular emphasis on viral infections. The most important factors that favor the occurrence of new pandemics caused by known and new pathogens are globalization, urbanization, climate warming, warfare and humanitarian crises.
2. During the COVID-19 pandemic, in addition to vaccinations, non-pharmaceutical intervention (NPI) such as face masks, disinfection, isolation of infected people, and use of appropriate personal protective equipment (PPE) by medical staff are important public health measures that aim to prevent and/or control SARS-CoV-2 transmission. These methods should be recommended in the future in order to reduce the number of cases of other viral respiratory track infections, especially in the group of patients over 60 years of age with comorbidities, including diabetes.
3. Viral infections should be considered in the differential diagnosis of patients with community-acquired pneumonia. In adults, especially those with comorbidities, including diabetes, multiplex polymerase chain reaction (PCR) respiratory panel should be done to diagnose viral infections other than SARS-CoV-2 [including influenza A and B, parainfluenza, respiratory syncytial virus (RSV), adenovirus, rhinovirus, human metapneumovirus] as a possible etiology of pneumonia. Patients over 60 years of age with comorbidities, including diabetes, are at particular risk of severe viral pneumonia, for example caused by RSV.
4. Due to the possible rapid increase in influenza cases in subsequent seasons, it is necessary to properly implement the vaccination program, with particular emphasis on patients with comorbidities, including diabetes, as well as early diagnosis and treatment of infected patients.

I. General remarks

The appearance in December 2019 of the new SARS-CoV-2 coronavirus responsible for the outbreak of a global pandemic, which is one of the greatest public health challenges in recent decades, indicates the importance of the threats associated with infectious diseases. Changes taking place in the modern world, such as globalization, urbanization, climate change, as well as warfare and humanitarian crises, significantly increase the risk of the emergence of known and new infectious diseases, including those causing severe viral infections with predominant clinical symptoms involving the respiratory tract. From the outbreak of the Spanish flu (AH1N1 influenza virus) in 1918 to 2019, numerous epidemics caused by influenza viruses and coronaviruses broke out around the world, which, despite differences in pathogenesis, were characterized by a similar spectrum of clinical symptoms (Table 1). Drawing conclusions from the most important past epidemics and pandemics caused by influenza viruses and coronaviruses, leading primarily to respiratory tract infections, including the development of interstitial pneumonia, should be the basis for creating clinical recommendations for similar future challenges. Using the experience gained during the last pandemic, it is necessary to prepare a strategy for dealing with new viral epidemics with a clinical picture similar to COVID-19, with particular emphasis on patients with chronic diseases, including diabetes, at risk of severe course of this type infections.

II. Methods of preventing the spread of viral infections in a group of patients with comorbidities

Vaccinations play a fundamental role in the prevention of infectious diseases. However, in the absence of their availability or insufficient vaccination of the population, the use of non-pharmaceutical interventions (NPI), such as protective face masks, disinfection, isolation of infected people, can significantly contribute to limiting the spread of viral infections. This is of particular importance in vulnerable populations, including diabetic patients, and can prevent serious complications and deaths. One of the meta-analyses showed that the use of protective face masks reduced the risk of infection with influenza virus, RSV, SARS and SARS-CoV-2. Indirect evidence of the effectiveness of the methods used to limit the transmission of the SARS-CoV-2 virus was the decrease in the incidence of other dangerous viral infections, including influenza, observed during the pandemic. Available data confirm that in the case of elderly people with comorbidities and immunosuppression, the use of face masks by both them and their contacts significantly reduced the risk of contracting

Table 1. The epidemics caused by influenza viruses and coronaviruses from 1918 to 2019

	Influenza virus A/H1N1 (Spanish flu)	Influenza virus A/H2N2 (Asian flu)	Influenza virus A/H3N2 (Hong-Kong flu)	SARS-CoV	Influenza flu A/H1N1v	MERS-CoV	SARS-CoV-2
Duration	1918–1921	1957–1958	1968–1969	2002–2004	2009–2010	2012–2015 currently only sporadic cases	2019–present
First cases	Fort Riley USA	China	Hongkong	China (Guang Dong province)	Mexico, USA	Middle East	China Wuhan
Virus' natural reservoir	Birds	Birds	Birds	Bats	Birds	Bats, dromedary camel	Bats (?)
mortality rate (%)	2	1.2–2.6	0.5	10	0.02–0.4	37	2–3
Total number of death per epidemic/ pandemic	50 million	1.1 million	1 million	774	151 700–575 400	866	6.76 million
Virus reproduction index (R number)	1.80	1.65	1.80	2–5	1.46	< 1	1.4–6.4
Hospitalization index (%)	29.7	28	25	~100	16–59	~100	~19

COVID-19. Isolation of infected persons is also an important strategy to limit the transmission of viral infections, including the ones occurring during hospitalization. These observations should be used to limit the spread of dangerous viral infections in the group of patients with comorbidities, including diabetes, in the future. Barrier methods provide protection not only for patients, but also for medical workers. In the case of COVID-19, the use of FFP2 masks reduced the risk of medical staff infection by 80%. Personal protective equipment (PPE) should be considered in the future, including when working with a patient with a droplet viral infection, especially when there is no active prophylaxis.

III. Severe viral respiratory infections in adults with comorbidities

Pneumonia is a serious infectious disease and one of the leading causes of hospitalization among adults. It is also one of the most common causes of death and one of the most common infections diagnosed in Intensive Care Units (ICU). In the case of community-acquired pneumonia (CAP), bacterial etiology is most often considered, and due to the limited diagnostic and therapeutic possibilities, viral etiology is most often overlooked during differential diagnosis. However, vaccination programs, the use of antibiotic therapy, aging of the population and the occurrence of comorbidities have significantly changed the etiology of CAP. Viral infections are increasingly becoming the cause of severe pneumonia in adults, while incidence of pneumococcal CAP is declining.

The most important viruses to consider in the diagnosis of pneumonia in adults include rhinoviruses (HRV), human adenovirus (HAdVs), human respiratory syncytial virus (RSV) and human metapneumovirus (hMPV). Information on the most important viruses causing pneumonia in adults is presented in Table 2. Of particular note is the increasing incidence of severe pneumonia caused by RSV infections in the group of elderly patients, especially those with comorbidities, including diabetes. Studies have shown that in this group RSV infection may be a more frequent cause of hospitalization due to pneumonia compared to the influenza virus. RSV pneumonia in adults carries a serious prognosis. Of the hospitalized patients, 10–30% require admission to the ICU, and 3–17% require mechanical ventilation. The mortality rate of pneumonia caused by RSV is comparable to that of influenza and ranges from 6–8%.

It is also noted that in the absence of a correct diagnosis of the cause of pneumonia and failure to take appropriate measures, including the isolation of the patient, there is a possibility of nosocomial infections. In the near future, we can expect an increase in the incidence of pneumonia caused by viruses other than SARS-CoV-2. In 2020, vir-

Table 2. Viruses most commonly responsible for pneumonia in adult patients

Virus	Basic information
Rhinoviruses (HRV) *Picornaviridae* family	RNA, 3 species (rhinovirus A, B, C), 160 serotypes Infections occur throughout the year, with particular intensity in late summer and early autumn Risk groups: • immunosuppressed patients • adults with comorbidities • CDC EPIC Study – 9% of CAP patients
Human adenovirus (HAdVs) *Adenoviridae* family	DNA, several species (HAdV-A to HAdV-G), species B, C, E most often responsible for infection of the respiratory No seasonality Risk groups: • immunosuppressed patients • immunocompetent patients
Respiratory syncytial virus (RSV) *Pneumoviridae* family	RNA, 2 serotypes, RSV-A, RSV-B Peak incidence from December to February Risk groups: • immunosuppressed adult patients • patients with comorbidities over 65 years of age (4–10%)
Human metapneumovirus (hMPV)	RNA, peak incidence in winter and spring Common cause of pneumonia in immunosuppressed adult patients (mortality 26%) Immunocompetent adults with CAP – 2–9% hMPV infection

tually no infections caused by RSV, parainfluenza or HMPV were observed. After this period, many countries recorded an increase in cases outside the normal season of their occurrence. It is not known how long it will take for the natural seasonality of these viral infections to reappear and what impact COVID-19 will have on their global prevalence.

Therefore, viral infections should be considered in the diagnosis of patients with community-acquired pneumonia. In adults, especially those with comorbidities, including diabetes, multiplex polymerase chain reaction (PCR) respiratory panel should be done in the event of a serious respiratory infection in order to diagnose viral infections other than SARS-CoV-2 (including influenza A and B, parainfluenza, syncytial respiratory virus (RSV), adenovirus, rhinovirus, human metapneumovirus) as a possible etiology of pneumonia.

IV. Influenza in a group of adult patients with comorbidities

As in the case of other viruses responsible for respiratory tract infection, low transmission of influenza virus was observed in most developed countries during the COVID-19 pandemic (Stephens *et al.* 2021).

Due to the lifting of restrictions and the humanitarian crisis, we must be prepared for an increase in the number of cases caused by the influenza virus. Transmission of influenza virus is currently observed in tropical countries (influenza A/H3N2, A/H1N1pdm09 and B/Victoria viruses). Low transmission of the influenza virus in 2020/2021 and lower vaccination coverage of the population may cause a sharp increase in the incidence in the 2022/2023 season. Due to the possible rapid increase in influenza cases in subsequent seasons, it is necessary to properly implement the vaccination program, with particular emphasis on patients with comorbidities, such as diabetes, as well as early diagnosis and treatment of infected patients. Detailed information on influenza vaccination in the group of patients with diabetes is presented in Chapter 2.

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2. Vaccinations

Key recommendations
1. Patients suffering from chronic diseases, including diabetes, are characterized by an increased risk of severe course of viral infections with dominant clinical symptoms in the respiratory tract. It should be assumed that these patients will have an increased risk of an unfavorable clinical course also in the case of subsequent similar epidemics/pandemics. Health care systems should be prepared to provide these groups of patients with targeted care, including preventive vaccinations as a priority.
2. Flu and COVID-19 vaccines are effective in preventing infection in people with diabetes. The benefits of their use outweigh the risks many times over. Vaccination against these diseases should be recommended for all people with diabetes.
3. Educating the general public, in particular risk groups such as patients with diabetes, about the benefits of vaccines should be part of preparing for future pandemics. Multi-specialty hospitals, where patients with chronic diseases are hospitalized, have an important role to play here.
4. Research on technologies enabling the rapid production of new antiviral drugs and large quantities of vaccines against new viruses and their variants should be treated as a priority by scientific and medical institutions.

I. Diabetes as a risk factor for adverse course of respiratory viral infection

Next to hypertension, cardiovascular and respiratory diseases, diabetes is one of the most common diseases coexisting with COVID-19. There was no higher incidence of COVID-19 among patients with diabetes, but people affected by it accounted for up to 25% of all hospitalized patients in Poland, almost three times more than the percentage of patients with diabetes in the general population. Diabetic patients are at higher risk of a worse clinical course, including severe complications of the disease, compared to non-diabetic patients. Diabetes is a strong independent risk factor for increased mortality from COVID-19. Patients hospitalized for COVID-19 who had previously been diagnosed with diabetes were two to three times more likely to die than those without diabetes. The relative risk of a severe course, including the need for ICU treatment, was several times higher in diabetes. Other top risk factors for hospital death from COVID-19 include older age, male gender, heart failure and chronic kidney disease.

Similarly to SARS-CoV-2, influenza is a viral infection with predominant respiratory symptoms, which, although less frequently, may be associated with severe course and death, especially if it

affects vulnerable populations. This number includes the elderly, pregnant women, very young children, as well as people suffering from chronic diseases, including diabetes.

The COVID-19 pandemic has clearly shown that in our societies there are groups of particular risk, which, in the event of an additional burden on the body with a severe infectious disease of the respiratory system, are characterized by a worse course than the rest of the population and a higher mortality rate. Therefore, it is these groups that should be covered by prophylaxis against such viral diseases with predominant pulmonary symptoms. It should be expected that the same groups will have an increased risk of an adverse clinical course during subsequent COVID-19-like epidemics/pandemics. Health systems should be prepared to provide these groups of patients with special care, including vaccination, as a priority.

II. Vaccination against viral infections in patients with diabetes

The importance of vaccination against viral diseases in people with diabetes has been strongly highlighted by the COVID-19 pandemic. Preventing vaccine-preventable infections not only directly prevents the incidence of these infections, but also reduces the number of hospitalizations, which may further reduce the risk of acquiring infections such as COVID-19. Children and adults with diabetes should receive vaccinations according to age-specific recommendations. It is worth noting that in Poland there are no mandatory vaccinations for adults over 19 years of age. There is only a list of vaccines that are recommended by the Ministry of Health. It includes vaccination against influenza, hepatitis B, diphtheria, tetanus and pertussis, vaccination against measles, as well as against mumps and rubella, chickenpox, tick-borne encephalitis, meningococcal and pneumococcal. The ministerial documents contain detailed groups of people and situations when vaccination is recommended.

Influenza is a common, preventable infectious disease with high mortality and morbidity in vulnerable populations such as adolescents, elderly, pregnant women, patients with chronic diseases, including diabetes. Influenza vaccination in people with diabetes has been shown to significantly reduce the number of hospital admissions associated with infection with influenza A and B viruses in this group of patients. In patients with diabetes and cardiovascular disease, the influenza vaccine is associated with a lower risk of all-cause mortality, cardiovascular mortality, and cardiovascular events. Given the benefits of annual influenza vaccination, it is recommended for all persons over 6 months of age who have no contraindications. Due to the high variability of the influenza virus and the need to modify the composition of vaccines, influenza vaccination is seasonal and should be repeated annually at the beginning of the influenza season. Inactivated influenza vaccines available in Poland contain two strains of influenza type A and one or two type B viruses recommended for a given season. Experts of the National Influenza Control Program recommend that, due to wider protection and comparable safety, a quadrivalent influenza vaccine should be used instead of the trivalent one. The effectiveness of influenza vaccination is highly variable and depends, among other things, on the match of the vaccine to the viruses circulating in a given season and the category of people vaccinated. The viral nature of influenza, the way the infection spreads, its clinical symptoms and the mass incidence are a set of features that resemble the current COVID-19 pandemic. There are diagnostic tests available on the market that, using the RT-PCR method, include both influenza A and B viruses as well as SARS-CoV-2 in a common respiratory panel. Unfortunately, the percentage of people vaccinated in Poland is still very low and amounts to just over 4%. There is no data on this percentage in patients with diabetes in our country, but it should not be expected to be significantly different from the general population. It is necessary to strive for the experiences resulting from the COVID-19 pandemic to change the behavior regarding this vaccine in the Polish population and improve this statistics.

Since 2021, vaccines against COVID-19 have been recommended for all adults and certain age groups in children, including – according to the position of the Polish Diabetes Association (PTD) – in people with diabetes. This is justified by the results of phase 3 clinical trials of COVID-19 vaccines and retrospective analyzes that have shown that they were equally effective and safe in people with and without diabetes. The preparations available in Poland are mRNA vaccines from Pfizer-BioNTech and Moderna, vector vaccines from AstraZeneca and Janssen, and a protein vaccine from NovaVax. Registrations regarding the use of individual COVID-19 vaccines in individual age groups are constantly expanding. Recommendations regarding the administration of booster doses are also constantly updated, including in risk

groups such as people with chronic diseases and immunocompromised. It is not clear whether the immunity from the vaccines will become permanent. Previous immunological studies on infection with other coronaviruses have suggested a persistent, or at least long-term, nature of immunity. The decrease in antibody levels observed in COVID-19 convalescents and vaccinated people and the emergence of new SARS-CoV-variants may suggest a limited period of immunity. However, it should be emphasized that people vaccinated in the case of SARS-CoV-2 infection have a significantly lower risk of severe illness, hospitalization and death. The COVID-19 vaccine is likely to become a routine part of the annual prevention schedule for people with diabetes.

Currently, the availability of the discussed vaccines against COVID-19 in Poland is sufficient. At the beginning of 2021, PTD and a national consultant in the field of diabetology appealed to the government that in the event of a shortage of vaccines patients with diabetes should be a prioritized group of recipients, over people who are not burdened with this disease. As part of the preparations for future pandemics, healthcare systems and health care decision-makers should provide these groups of patients with targeted care, including prioritized preventive vaccinations. Epidemiological data from the COVID-19 pandemic indicate that this postulate should apply to type 1 diabetes as much as type 2 diabetes.

III. Social education in the field of preventive vaccinations

The COVID-19 pandemic has changed a number of aspects of the functioning of not only health care, but also entire societies. This applies, for example, to the perception of the problem of vaccination, in particular in adults, including those affected by diabetes. The global COVID-19 pandemic has shown how important social awareness of the importance of preventive vaccinations is. The reluctance to vaccinate visible in large groups of the Polish population has been a major obstacle to achieving COVID-19 vaccination targets in a timely manner. This was probably due to a number of complex reasons, including socioeconomic status, cultural factors, health factors and sources of health information. Currently, these vaccinations are available in many places in Poland – vaccination points, GP clinics, pharmacies and others. However, the system should take care of those for whom there are still logistic and organizational problems preventing them from being vaccinated. Understanding the key interplay between all these barriers, experiences, and beliefs in our community is critical to addressing the underlying challenges of meeting population goals for COVID-19 vaccination and subsequent boosters. Populations excluded for various reasons – economic, cultural, linguistic – face greater barriers to accessing vaccinations and may have limited access to adequate information about vaccinations. These include the homeless, the unemployed, immigrants and refugees. In these lower healthcare contact groups, hospital stay for a variety of reasons provides an opportunity to provide preventive health messages about vaccinations. Hospitalizations may be a prerequisite to remove barriers to vaccination for some patients. Public hospitals provide care to those most at risk from COVID-19, including patients with multiple comorbidities, the elderly, and those from lower socioeconomic backgrounds who are more likely to be in households where people are at higher risk of infection or are at higher risk of developing severe complications from COVID-19. Such under-vaccinated social groups can exacerbate repeated outbreaks and ongoing social transmission, as seen in previous pandemics. Hospitals appear to be a potential gateway to under-vaccinated social groups at higher risk of outbreaks. During hospitalization, patients often come into contact with medical staff well prepared to provide education about vaccinations, and these facilities should also offer vaccinations during the hospital stay.

Educating the general public, especially at-risk groups such as patients with diabetes, about the benefits of vaccines should a be part of preparing for future pandemics.

IV. Future research into the development of vaccines and new antiviral drugs

The COVID-19 pandemic has shown the importance of developing international cooperation in the field of joint actions, including coordinated research, to create vaccines that would be quickly and widely available in the event of a viral pandemic. The priority should now be to identify common key research areas and provide financial support to public and private institutions involved in research aiming the development of vaccines and innovative antiviral drugs. It is also important to collect and analyze complete data on the use of already registered and new antiviral drugs and

vaccines. Particular support should be given to partnerships between governments, regulatory agencies, universities and other research institutions to support research into the development of new drugs, including in particular rapid production capacity of vaccines. In addition, investment in research and development must be targeted at vaccines that provide long-term protection against new viruses and their mutations. Finally, scientific and therapeutic networks should be supported to ensure that new scientific knowledge on future pandemics, in particular the treatment of affected patients, is disseminated rapidly and widely.

The experience of the COVID-19 pandemic is a strong argument for investing in the development of new technologies and innovative drugs. Investments made in this area before the outbreak of the COVID-19 pandemic led to the development of mRNA vaccines produced by chemical synthesis. These vaccines eliminate many phases in the production process because, instead of injecting viral proteins, the human body uses genetic information to produce them. This technology has shortened vaccine production time and saved millions of lives. The experience of the COVID-19 pandemic should also be used to develop appropriate vaccination strategies, in particular with new mRNA vaccines, in order to quickly achieve herd immunity and, consequently, reduce the number of infected and dead.

In conclusion, research into technologies enabling the rapid production of new antiviral drugs and large quantities of vaccines against new viruses and their variants should be treated as a priority by scientific and medical institutions.

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3. Outpatient and hospital care for patients with type 1 diabetes

Key recommendations
1. Similarly to patients with type 2 diabetes, people with type 1 diabetes are characterized by a higher risk of death and severe course of COVID-19 than their peers without diabetes. This applies in particular to the elderly patients and those with vascular complications. Health systems should be prepared to provide these groups of patients with appropriate care in the event of future similar epidemics/pandemics.
2. Telemedicine tools have been a key element of diabetes care for type 1 diabetes during the COVID-19 pandemic. Proper preparation of the health care system for future pandemics requires further improvement and preparation for use by both the medical community and patients.
3. The ability to modify insulin doses on an ongoing basis and to conduct self-monitoring, in particular the use of continuous glucose monitoring systems (CGMS), are necessary during the social lockdown caused by the viral pandemic to achieve and maintain proper glycemic control by patients with type 1 diabetes in outpatient care conditions.
4. Through periods of social lockdown during the COVID-19 pandemic, weight gain has been documented in patients with type 1 diabetes. Particular attention should be paid to proper eating habits and maintaining adequate physical activity during lockdown periods.
5. Diabetic indications for hospitalization of a patient with type 1 diabetes and SARS-CoV-2 infection are acute hyperglycemic complications, i.e., diabetic ketoacidosis or hyperglycemic-hypermolar state, and persistent hyperglycemia with ketonemia and/or glucosuria and acetonuria, despite intensification of insulin therapy and increasing insulin doses. Indications for hospitalization due to the severity of the infectious disease are pneumonia with reduced blood saturation, persistent fever above 39°C despite the use of antipyretics, impaired consciousness, chest pain, and multiple organ failure.
6. There is currently no convincing evidence that the SARS-CoV-2 virus initiates autoimmune processes leading to the permanent destruction of beta cells and causing type 1 diabetes. Patients with newly diagnosed type 1 diabetes and COVID-19 may have an absolute indication for hospitalization due to diabetic ketoacidosis or viral infection.
7. Diabetic treatment of hospitalized patients with type 1 diabetes and COVID-19 infection or other similar viral infection should be conducted in accordance with the Diabetes Poland recommendations. The use of CGMS during hospitalization of a patient with type 1 diabetes reduces the contact of medical staff with the infected patient.

I. A patient with type 1 diabetes during the COVID-19 pandemic – general remarks

Since the beginning of the COVID-19 pandemic, there have been concerns in the medical community about its potential impact on people with chronic diseases, including type 1 diabetes. Many early reports on COVID-19 and diabetes considered type 1 and type 2 diseases together. Later data showed that people with type 1 diabetes were, similarly to those with type 2 diabetes, severely affected by COVID-19. This included the effects of limited access to health care, especially during times of social lockdown, and the increased incidence of infectious complications and mortality in infected adults with type 1 diabetes compared to non-diabetic peers.

Type 1 diabetes is not associated with increased susceptibility to SARS-CoV-2 infection. People with type 1 diabetes have similar symptoms of COVID-19 as the general population. However, when an adult with type 1 diabetes becomes infected with SARS-CoV-2, they have a higher risk of the severe course of disease. Adults with type 1 diabetes have similar risks to those with type 2 diabetes in terms of disease severity, hospitalization, and in-hospital mortality. COVID-19 can be associated with hyperglycemia and even diabetic ketoacidosis (DKA) from the outset. Certain clinical features translate into an increased risk for infected patients with type 1 diabetes. These include advanced age, which, as in the general population, affects the likelihood of serious complications or death from COVID-19 in adults with type 1 diabetes being the most important risk factor for hospitalization and disease severity. There is no data indicating a higher mortality or incidence of serious complications of COVID-19 in adolescents with type 1 diabetes compared to healthy peers. In addition, poorer glycemic control at the time of infection may also play a role in the course of COVID-19 in patients with type 1 diabetes and increase the risk in patients with poorer metabolic control. COVID-19 may worsen glycemic control through

various mechanisms, such as impairment of residual endogenous insulin secretion, immobilization, and the hyperglycemic effect of the steroids used. The risk of death remains higher in patients with type 1 diabetes and vascular complications. The facts listed above resulted in modifying the initial government and expert recommendations in a number of countries and placing adult patients with type 1 diabetes among the high-risk groups for the course of COVID-19. Health systems should be prepared to provide these patients with appropriate care in the event of further similar viral epidemics/pandemics.

II. Telemedicine tools in outpatient care

A key element of outpatient care for patients with type 1 diabetes during a pandemic should be the possibility of conducting a teleconsultation visit if necessary. Properly conducted teleconsultation can be an effective diagnostic and therapeutic tool, especially during the lockdown. Telemedicine services are a legitimate part of medical operations. Therefore, they are subject to legal regulations on the provision of health services in Poland. The key elements of properly conducted televising, both during the pandemic and beyond, are:

1. Using technological solutions that guarantee the confidentiality of the telemedicine service.
2. Telemedicine services may be provided using regular telephones, however, teleservices with the use of secure internet connections within secured telemedicine platforms, applications or communication systems are preferred.
3. The use of specialized medical devices enabling remote diagnostics and monitoring is particularly recommended in the case of teleconsultations. These include glucose monitoring devices [continuous glucose monitoring systems (CGMS) and traditional glucometers] and personal insulin pumps. Solutions that enable efficient and secure transfer of data to the doctor, e.g., *via* the cloud, should be preferred.
4. The use of CGMS by the patient gives a much better insight into glycemic control in teleconsultation conditions compared to glucometer measurements. The assessment of compensation should be based primarily on the analysis of the percentage of time spent by the patient in the target glycaemia (TIR – time in range). In conditions of limited access to the HbA_{1c} measurements in the laboratory, a valuable alternative may be the GMI parameter (glucose management indicator) determined based on the CGMS records.
5. A patient using teleconsultation should, if possible, use solutions in the field of e-health, including medical documents issued in electronic form and the Patient's Internet Account (IKP).
6. Recommendations regarding the use of telemedicine tools are also included in the section on outpatient care for a patient with type 2 diabetes.

III. Self-management of type 1 diabetes during a pandemic at home

In the era of a pandemic, it is crucial to be able to self-modify the dose of insulin or after consulting a doctor, if necessary. This becomes particularly important in case of an infectious disease treated on an outpatient basis. A patient with type 1 diabetes should be encouraged in such situations to intensify self-monitoring, optimally using CGM, and respond to the increase in insulin demand on an ongoing basis. The patient should be warned that even a mild COVID-19 or other similar infection may increase the need for insulin by several dozen percent, with the need for increased dosage of both mealtime and basal insulin. Infection accompanied by high fever and/or muscle pain may cause a 2–3 fold increase in insulin requirements. In the event of a rapid increase in insulin requirements, patients treated with closed-loop hybrid systems should switch from automatic mode to manual mode, as the automatic mode algorithms are not prepared for a rapid increase in insulin demand over a short period of time.

Maintaining a proper diet and physical activity by a patient with type 1 diabetes during the pandemic may be the key to optimizing metabolic compensation and preventing excessive weight gain, to which the lockdown period predisposes. Weight gain may be additionally facilitated by the change in the nature of the patient's work during the pandemic. Factors conducive to reducing physical activity are restrictions on movement, and access to sports fields and gyms. In such situations, the patient is forced to undertake physical activity in a small space and to shift the emphasis towards resistance, anaerobic, interval effort. Education is recommended in the field of the impact of various forms of physical activity on glycaemia, and how to modify insulin therapy and carbohydrate intake.

Telemedicine tools have been a key element of diabetes care for type 1 diabetes during the

COVID-19 pandemic. Proper preparation of the health care system for future pandemics requires further improvement and preparation for use by both the medical community and patients.

IV. Hospital care for a patient with type 1 diabetes and COVID-19

A person with type 1 diabetes hospitalized due to COVID-19 infection is a patient with an increased risk of an adverse course of the disease. People with type 1 diabetes admitted to the hospital due to COVID-19 are at a higher risk of severe infectious disease and death, especially in the case of advanced age, obesity, presence of chronic microvascular complications, and renal failure.

Diabetic indications for hospitalization of a patient with type 1 diabetes and SARS-CoV-2 infection are:

- acute hyperglycemic complication (DKA and hyperglycemic-hypermolar state),
- persistent hyperglycemia with ketonemia and/or glucosuria and acetonuria, despite intensification of insulin therapy, increase of insulin doses.

Indications for hospitalization due to the severity of an infectious disease are:

- pneumonia with reduced saturation (SpO_2),
- persistent fever above 39°C despite the use of antipyretics,
- disturbances of consciousness,
- pain in the chest,
- multiple organ failure.

The key elements of metabolic management in a hospitalized patient with type 1 diabetes with COVID-19 are:

1. Reaching the glycemic goal of 100–180 mg/dl (5.6–10 mmol/l); the acceptable target is the range of 70–180 mg/dl, especially for patients treated with a personal insulin pump with automatic hypoglycemic infusion suspension and/or using continuous glucose monitoring systems.
2. If the patient's condition allows continuation of intensive insulin therapy and blood sugar monitoring on their own, the insulin therapy should be left in their hands, recommending modifications of insulin dosage depending on blood glucose concentration. Due to increased insulin requirements associated with inflammation, the dose of both basal insulin or basal infusion and mealtime insulin doses should be increased.
3. COVID-19 in patients with type 1 diabetes and good glycemic control did not increase the risk of hospitalization due to DKA. A severe course of COVID-19 increases the risk of DKA in the absence of response to high glycemic levels by modifying insulin doses and the occurrence of gastrointestinal symptoms (vomiting, diarrhea) that limit fluid and meal intake.
4. The most important recommendations for preventing the development of DKA in a type 1 diabetic patient with acute infection are:

- an absolute rule of not stopping insulin,
- increasing basal and mealtime insulin doses, initially by 10–20%,
- with blood glucose concentration > 250 mg/dl, control of ketonemia or acetonuria,
- staying hydrated by drinking the recommended amount of fluids,
- avoiding starvation by eating at least three light meals that contain carbohydrates that require a bolus of insulin,
- in the case of nausea or vomiting, it is recommended to administer an intravenous solution of 10% glucose with short-acting insulin (10–14 U) and potassium (5–15 mmol KCl, depending on the potassium level), in a slow infusion of 100–150 ml/hour, instead of a meal, basal insulin administered subcutaneously,
- glycemic monitoring using, if possible CGMS, with an application that allows medical staff to view glycemic data from a distance.

5. In the case of a severe condition with impaired consciousness and inability to feed orally, a continuous infusion of glucose with potassium is recommended with a parallel intravenous infusion of short-acting insulin at a rate ensuring the target glycaemia of 100–180 mg/dl.
6. In the case of development of DKA, treatment should be applied in accordance with the Diabetes Poland recommendations. In particular, this applies to hydration, intravenous insulin infusion and potassium supplementation. The possibility of using CGMS during hospitalization of a patient with type 1 diabetes allows to reduce the contact of medical personnel with the infected patient.

V. Management of a COVID-19 patient with a newly diagnosed type 1 diabetes

There is currently no convincing evidence that the SARS-CoV-2 virus initiates autoimmune processes leading to the permanent destruction of beta cells and causing type 1 diabetes. A report

based on a small number of cases suggested an increase in type 1 diabetes incidence in parallel with the COVID-19 pandemic. Later data from large populations did not confirm this observation, rather suggesting that those affected by type 1 diabetes and their caregivers sought medical attention at a late stage of the disease. As a result of this fact and due to the specificity of the organization of health care during the pandemic, this assistance was often provided in hospital wards, and not in outpatient settings. Nevertheless, further observations are needed to determine whether a subgroup of people with type 1 diabetes develop the disease after being infected with SARS-CoV-2.

Patients with newly diagnosed type 1 diabetes and COVID-19 may have absolute indications for hospitalization due to DKA or viral infection.

DKA in a patient with type 1 diabetes is an absolute indication for hospitalization, regardless of the severity of COVID-19. DKA therapy should follow the Diabetes Poland recommendations.

After elimination of DKA, it is recommended that patients in good clinical condition be issued with pen-type injectors, a glucometer and, if possible, the use of a CGMS; basic education in the field of intensive insulin therapy should also be carried out with the provision of educational materials and the recommendation to supplement the knowledge in outpatient settings. In patient education, remote techniques can be used and distance learning can be conducted.

In a patient requiring hospitalization due to COVID-19 and other severe infections with a recent clinical diagnosis of type 1 diabetes, i.e., in the absence of obesity, with symptoms of hyperglycemia and signs of absolute insulin deficiency and without DKA, treatment should be conducted in accordance with common diabetes standards. It is necessary to monitor blood sugar and treat hyperglycemia with insulin administered subcutaneously in the model of multiple injections (basal-bolus) or by continuous intravenous infusion. The decision on the route of insulin administration depends on the severity of the patient's clinical condition and blood glucose values. Target blood glucose values during hospitalization due to severe infection should be in the range of 100–180 mg/dl. Optimizing glycemic control in a patient with newly diagnosed diabetes in the course of COVID-19 reduces the risk of patient deterioration and death due to infectious disease.

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4. Outpatient care for patients with type 2 diabetes

Key recommendations
1. Next to advanced age, male gender, obesity, cardiovascular diseases and chronic kidney disease, type 2 diabetes is one of the most important risk factors for death and severe course of COVID-19. Affected patients should be subject to special outpatient medical supervision in the event of future similar epidemics/pandemics.
2. In the outpatient care of patients with type 2 diabetes during a pandemic, all basic therapeutic goals should be achieved and maintained – normalization of glycaemia and body weight as well as control of blood pressure and lipid profile. Such procedure should be treated as primary prevention of a severe course of SARS-CoV-2 infection or another viral pathogen of similar nature.
3. Telemedicine tools were effectively used during the COVID-19 pandemic in patients with diabetes, including those with type 2 disease. Among many patients from this group, however, there are barriers to their use. They are related to age, cognitive disorders, limitations in access to IT tools and lack of skills in their use. Eliminating these barriers should be an element of preparation for the next viral pandemics.
4. During periods of social isolation and remote work as a consequence of the COVID-19 pandemic, special attention should be paid to continuing education in the field of proper eating habits and maintaining adequate physical activity in order to avoid weight gain.
5. Recommendations regarding pharmacotherapy and therapeutic goals during the pandemic and the related social closure for non-infected patients should not differ from general diabetes recommendations. The issue of benefits and risks associated with the use of individual hypoglycemic drugs in a patient infected with SARS-CoV-2 or another viral pathogen requires further observation and evidence gathering.
6. In patients with type 2 diabetes who use insulin in a multiple-injection regimen, especially in those at high risk of hypoglycemia, CGMS are the optimal method of blood glucose monitoring.

I. A patient with type 2 diabetes in outpatient care during a viral pandemic – general remarks

The primary goal of diabetes care in patients with type 2 diabetes is to reduce the risk of chronic complications of the disease, in particular cardiovascular events, and to prolong the patient's life. Achieving these goals is possible through effective multifactor therapy aimed at controlling risk factors, including normalization of glycemia, optimally with the use of hypoglycemic drugs reducing cardiovascular risk. Next to advanced age, male gender, obesity, cardiovascular diseases and chronic kidney disease, type 2 diabetes is one of the most important risk factors for death and severe course of COVID-19. Therefore, during a pandemic, patients with type 2 diabetes who are not infected with the SARS-CoV-2 virus or another viral pathogen and remain in outpatient care should strive to achieve and maintain all multidirectional therapeutic goals in terms of glycaemia, blood pressure and lipid profile and body weight. The results of observational studies from the period of the last pandemic showed an association between the level of glycemia on admission to the hospital and the prognosis, including the risk of death, in a hospitalized patient with type 2 diabetes and COVID-19. Achieving a therapeutic goal in terms of glycaemia in a patient with type 2 diabetes should therefore be treated as primary prevention of a severe course of SARS-CoV-2 infection or another pathogen of similar nature. Patients with type 2 diabetes should be under special outpatient medical supervision in the event of future similar epidemics/pandemics.

II. Telemedicine tools in outpatient care for patients with type 2 diabetes

The COVID-19 pandemic has changed the functioning of the outpatient health care system for patients with all forms of diabetes, including the most common type – type 2 diabetes. During

the COVID-19 pandemic, regular contact with the patient and optimal supervision of their treatment are of great importance in the outpatient care of diabetic patients. It remains a particular challenge, especially in cases of limited access to stationary medical care, which took place during the COVID-19 pandemic. The use of remote tools in outpatient diabetes care brings a number of potential benefits – increasing the availability of health services, especially during the lockdown period, savings for the service provider and the recipient, potentially increasing patient involvement, optimizing the treatment process, overcoming geographical barriers and the possibility of individual and group education patients. Even before the pandemic, it was shown that the implementation of telemedicine tools in patients with type 2 diabetes results in improved glycemic control. During the COVID-19 pandemic, in countries where telemedicine tools were widely and effectively used, it was possible to avoid the deterioration of metabolic control and weight gain in patients with type 2 diabetes.

Among the limitations of telemedicine in the care of patients with type 2 diabetes, there are potential problems related to age and comorbidities, cognitive disorders, hearing or vision impairment, lack of access to IT tools for some people and skills in their use. Eliminating these barriers should be an element of preparation for the next viral pandemics.

A significant part of the visits was carried out using remote tools during the last pandemic. These tools create a wide range of communication options with the patient, for example, telephone, e-mail, short forms of communication (SMS, WhatsApp), instant messengers. In outpatient practice, Internet communicators should be preferred, giving the possibility of voice and video communication. A remote visit conducted with the use of such a tool enables the implementation of most elements of a traditional stationary visit – assessment of well-being and taking an anamnesis, conducting some components of a physical examination (e.g. elements of foot assessment in a diabetic patient), reading the results and analyzing them from various devices (e.g. glucometers systems, CGMS, insulin pumps, scales, blood pressure measuring devices and others), providing treatment recommendations, issuing e-prescriptions, e-orders or e-referrals. It is also possible to conduct education, including in the field of diet and physical activity, which is especially important during periods of social closure and remote work. In the process of expanding the use of telemedicine in outpatient diabetes care, the growing role of the nurse should be taken into account. This is especially true for online education. It is mainly the nursing staff who provide patients with information on how to use the glucometer, how to measure blood glucose and administer insulin. Therefore, the patient should be able to attend not only a medical teleconsultation, but also a nursing one.

It is the duty of the diabetes clinic to help the patient prepare for the remote visit. The contact person should inform the patient about the date and time of the remote visit and agree on the technological requirements needed for the connection. This will allow the patient, their family or caregivers to update necessary computer programs or download applications. As part of preparation for a remote visit, the patient should prepare:

- the right place to ensure peace and good lighting during the call,
- clothing that allows possible visual assessment of body parts, for example feet,
- record of blood glucose measurements, optimally generated from an application dedicated to a glucometer or CGMS,
- the results of other measurements – blood pressure, pulse, body weight,
- a list of questions for a doctor, nurse, dietitian, psychologist or other specialist,
- a list of medicines for which prescriptions should be renewed during the visit.

The role of reports generated not only by applications related to CGMS or glucometers, but also by tools for administering insulin (pumps, pens) is worth emphasizing.

In conclusion, during the period of limited access to stationary health care, especially in times of forced social isolation (lockdown) related to the COVID-19 pandemic or other infectious diseases, in order to reduce the transmission of the pathogen and the risk of infection, remote advice and telemedicine tools should be used wherever possible.

Telemedicine should be widely used in diabetology also after the end of the SARS-CoV-2 pandemic. Both doctors and nurses and other staff should learn to use it properly. In the future, it is also important to optimally refine organizational and procedural issues to make the teleconsultation as effective as possible. It should also become a necessary requirement to use technological

solutions that guarantee the confidentiality of telemedicine services on a par with standard services during a face-to-face visit. Telemedicine services may be provided using landline or mobile telephony, however, telemedicine services using secure internet connections as part of secured telemedicine platforms, applications or systems dedicated to this form of communication are preferred.

III. Antihyperglycemic therapy in the outpatient care of a patient with type 2 diabetes during the COVID-19 pandemic

Patients with type 2 diabetes who are at high risk of severe SARS-CoV-2 infection, but without clinical signs of infection, should continue their current antihyperglycemic therapy, as long as they remain within the individually defined therapeutic target of blood sugar level. Patients who do not have adequate glycemic control should intensify their activities, with the support of the health care system, to achieve the therapeutic goal in this regard. At the current stage of knowledge, there is no clear EBM (evidence-based medicine) data, which would indicate the need to apply additional restrictions in the scope of applied therapies during the pandemic, apart from those resulting from the characteristics of the medicinal product of individual classes of antihyperglycemic drugs.

Initial reports from the pandemic period suggested that sodium-glucose co-transporter type 2 (SGLT2) inhibitors, glucagon-like peptide-1 receptor agonists (GLP-1RA) and/or exogenous insulin (regardless of the regimen used) may induce increased expression of the ACE2 receptor, which could lead to significant health consequences for patients with type 2 diabetes in case of potential infection. Subsequent observations did not confirm the above hypotheses, indicating the potential clinical significance during the pandemic, in addition to the well-documented cardio- and nephroprotective role, of the anti-inflammatory effect of flozins and GLP-1RA. These data come from observational studies, they require confirmation, optimally in randomized studies.

Therapeutic goals in terms of glycemia, both for patients using glucometers and CGMS, blood pressure, lipid disorders and body weight remain unchanged during the pandemic compared to general diabetes recommendations.

During the pandemic, it is recommended that a person with type 2 diabetes has the following at home:

- a month's supply of all medicines,
- a glucometer with a supply of test strips and lancets for 1 month, if CGMS are used, this recommendation also applies to these products,
- if required by the clinical characteristics and treatment regimen, access to blood or urine ketone assessment.

During the COVID-19 pandemic, the number of new type 2 diabetes diagnoses and first-time diabetes visits decreased significantly, which was the result of a reduction in the number of referrals for laboratory screening tests. In order to reduce the time a patient stays in a health care facility, OGTT testing for fasting blood glucose or HbA_{1c} should be avoided during future pandemics. Expert groups and diabetes societies should consider recommending the diagnosis of diabetes based on glucometric determinations in future epidemiological crises.

At the current stage of knowledge and based on available data, in the case of patients with type 2 diabetes during SARS-CoV-2 infection with a mild clinical course, not requiring hospitalization, it is recommended to use metformin and/or SGLT2 inhibitors and/or GLP1-RA as the first-line therapy. In second-line therapy, depending on the clinical situation, comorbidities, previously used therapeutic regimen and patient preferences, a dipeptidyl peptidase 4 (DPP-4) inhibitor and/or a sulfonylurea derivative and/or insulin therapy should be considered. In each case, one should strive to achieve and then maintain an optimal, individually defined, metabolic balance. In patients with type 2 diabetes who use insulin in a multiple-injection regimen, especially those at high risk of hypoglycemia, CGMS are the optimal method of blood glucose monitoring. Febrile patients are predisposed to dehydration and deterioration of renal function. This, in turn, may cause the appearance of side effects of the hypoglycemic drugs used. In the case of using flozins, the risk of euglycemic ketoacidosis increases, and in the case of metformin, the increase in lactate levels, which in extreme cases may cause lactic acidosis. This requires monitoring the patient's condition and making appropriate therapeutic decisions, for example, discontinuing the drug, initiating or increasing the dose of insulin, or referring the patient to a hospital ward.

The issue of benefits and risks associated with the use of individual hypoglycemic drugs in a patient infected with SARS-CoV-2 or another viral pathogen requires further observation and gathering evidence.

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5. Hospital care for patients with type 2 diabetes

Key recommendations
1. Patients with type 2 diabetes, similarly like patients with type 1 diabetes, are at a higher risk of death and severe course of COVID-19 than people without diabetes. This applies in particular to elderly patients and those with vascular complications. Healthcare systems should be prepared to ensure that these groups of patients are properly cared for future similar pandemics.
2. In patients with type 2 diabetes, an additional factor that increases the frequency of hospitalization and mortality risk due to SARS-CoV-2 virus infection, is the coexistence of obesity and chronic diseases – hypertension, chronic coronary syndrome, heart failure, renal complications and increased prothrombotic proneness.
3. The indications for hospitalization of a patient with type 2 diabetes and SARS-CoV-2 infection due to diabetes are acute hyperglycemic complications, i.e., hyperosmotic-hyperglycemic state, diabetic ketoacidosis and persistent hyperglycemia with ketonemia and/or glucosuria and acetonuria, despite the intensification of diabetes treatment. Indications for hospitalization due to the severity of the infection are pneumonia with reduced blood oxygen saturation, persistent fever above 39°C despite the use of antipyretics, impaired consciousness, chest pain, and multiple organ dysfunction syndrome.
4. The treatment of hospitalized patients with type 2 diabetes and COVID-19 or other similar viral infection should be conducted in accordance with the Diabetes Poland recommendations. The use of CGMS during hospitalization of a patient with type 2 diabetes during COVID-19 infection allows to reduce the contact of medical personnel with the infected patient.
5. Proper metabolic control of type 2 diabetes, behavioral management and the use of medications aimed at reducing hyperglycemia and endogenous hyperinsulinemia are recommended to prevent the severe course of COVID-19 in patients with type 2 diabetes.

I. A patient with type 2 diabetes during the COVID-19 pandemic – general remarks

Epidemiological data indicate that SARS-CoV-2 infection increases the risk of hospitalization mainly in patients with obesity and type 2 diabetes. Data from the USA show that up to 40% of patients hospitalized because of SARS-CoV-2 infection are diabetic patients. European data, including Polish ones, indicate a percentage of over 25%. It should be pointed out that patients with type 2 diabetes have a more severe course of the infection and more often require ICU treatment. This can be partly explained by the frequent coexistence of other chronic diseases in patients with type 2 diabetes – primarily obesity and hypertension, chronic coronary syndrome, heart failure, and chronic kidney disease. An additional confirmation of the adverse impact of diabetes on the course of COVID-19 are the results of a large analysis of the mortality risk during hospitalization due to COVID-19 – over 30% of in-hospital deaths concerned people with type 2 diabetes. Factors associated with more severe course of COVID-19 in type 2 diabetes are not fully elucidated. One hypothesis is that insulin resistance and low-grade chronic inflammation associated with excess adipose tissue, which play an important role in the pathogenesis of type 2 diabetes, are also involved in the excess inflammatory response to SARS-CoV-2 infection. In addition to the general symptoms associated with the infection, this causes further increase in glycemia, which in turn impairs the proper immune response to the infection. This hypothesis is confirmed by data from experimental studies, which have shown that in conditions of hyperglycemia the replication of the virus and increased production of pro-inflammatory cytokines in monocytes are increased. In addition, not only hyperglycemia, but also hyperinsulinemia secondary to insulin resistance may affect the severe course of COVID-19. It has been shown that hyperinsulinemia increases the expression of the GRP78 (glucose-regulated protein 78) in adipocytes, which facilitates/exacerbates SARS-CoV-2 infection and thus affects the more severe course of SARS-CoV-2 infection. Actions aimed at reducing hyperinsulinemia – limiting food consumption, the use of antihyperglycemic medications (metformin, thiazolidinediones, SGLT2 inhibitors) in experimental studies resulted in a decrease in GRP78 expression. This argues for the need to reduce not only hyperglycemia, but also endogenous hyperinsulinemia in patients with type 2 diabetes in order to prevent the severe course of COVID-19. In addition, the expression of the angiotensin-converting enzyme 2 – ACE2 (a protein that is believed to be a receptor for the SARS-CoV-2 virus) has been shown to be increased in the lung tissue of diabetic patients compared to non-diabetic patients. This seems to facilitate the penetration of the virus into the lungs and occurrence of severe respiratory complications. The SARS-CoV-2 virus also penetrates the pancreatic beta cells, causing acute impairment of insulin secretion, which exacerbates metabolic decompensation in the course of diabetes.

In the time of the COVID-19 pandemic, important factors affecting the frequency of hospitalizations and the risk of more severe course of the infection were also the limited availability of healthcare services and regular visits to diabetes outpatient clinics, which resulted in poorer metabolic control of diabetes. In addition, people with type 2 diabetes, especially the elderly, were less likely to use teleconsultations effectively.

II. The use of antihyperglycemic medications in patients with type 2 diabetes during hospitalization

The use of antihyperglycemic medications in patients with type 2 diabetes during the COVID-19 pandemic has been the subject of numerous studies and discussions. The presented recommendations and opinions of experts are mostly based on data from observational studies, retrospective analyses, single randomized studies and recommendations of diabetes associations. Regarding the use of antihyperglycemic drugs during the hospitalization of a patient with type 2 diabetes and COVID-19 infection, the dominant view is that the choice of medication should depend on the severity of the infection. It should be noted that the available studies provide conflicting data on the effect of therapy of a given group of medications on the course of COVID-19 in patients with type 2 diabetes. There are reports indicating a positive, negative or neutral effect for a given group of drugs, which requires careful interpretation of the available results. In the case of severe course of COVID-19 in a patient with type 2 diabetes requiring hospitalization in an ICU, the only accepted method of diabetes treatment is continuous intravenous insulin infusion in appropriately adjusted doses. In the case of moderate severity of COVID-19 infection in a patient hospitalized with type 2 diabetes, treatment with multiple daily insulin injections can be

continued, or insulin therapy can be simplified by adding antihyperglycemic drugs. Some data on the use of insulin in patients with type 2 diabetes in the course of COVID-19 infection indicate a worse prognosis in patients treated with insulin. However, these results should be interpreted with caution, as patients with type 2 diabetes treated with multiple daily injections usually have longer history of diabetes, more advanced complications, and comorbidities, which may affect the obtained results.

In the light of the available data, metformin may be used in antihyperglycemic therapy in patients with type 2 diabetes and moderate severity of COVID-19 infection requiring hospitalization. Observational studies have shown that patients using metformin had lower mortality risk compared to patients not using metformin, but a recently published randomized trial suggests that it does not improve the prognosis of people with COVID-19. The limitations of metformin use in hypoxia, progressive renal failure and multiple organ failure due to the risk of lactic acidosis should also be borne in mind.

SGLT2 inhibitors can be used in patients with type 2 diabetes and moderate severity of COVID-19 infection requiring hospitalization. Although the results of the DARE-19 randomized trial did not show an advantage of using SGLT2 inhibitors in patients hospitalized with COVID-19, these medications were well tolerated. When using SGLT2 inhibitors in hospitalized patients with type 2 diabetes, attention must be paid to adequate hydration of the patient and the risk of euglycemic ketoacidosis.

GLP-1RA, in the light of published expert opinions, can be used in the treatment of patients with type 2 diabetes and moderate severity of COVID-19 infection requiring hospitalization. Antihyperglycemic and anti-inflammatory effects, beneficial effects on the cardiovascular system and protective effects on the lung tissue demonstrated in experimental studies are taken into account.

Data on DPP-4 inhibitors indicate that they can be used in the treatment of patients with type 2 diabetes and moderate severity of COVID-19 infection requiring hospitalization, especially in the case of elderly patients with impaired renal function and in combination with insulin.

III. Hospital care for patients with type 2 diabetes and COVID-19

A patient with type 2 diabetes hospitalized due to COVID-19 infection is a patient with a very high risk of an unfavorable course of the disease, mainly in the case of advanced age, concomitant obesity, micro- and macrovascular complications of diabetes and renal failure.

Diabetes-associated indications for hospitalization of a patient with type 2 diabetes and SARS-CoV-2 infection are:

- acute hyperglycemic complication (DKA and hyperosmolar-hyperglycemic state),
- persistent hyperglycemia with ketonemia and/or glucosuria and acetonuria, despite the intensification of insulin therapy with gradually increased insulin doses.

Indications for hospitalization due to the severity of infection disease are:

- pneumonia with reduced blood oxygen saturation (SpO_2),
- persistent fever above 39°C despite the use of antipyretics,
- impaired consciousness,
- chest pain,
- multiple organ dysfunction syndrome.

Key elements of metabolic management in a hospitalized patient with type 2 diabetes with COVID-19 are:

1. Achieving a glycemic glycemic target of 100–180 mg/dl (5.6–10 mmol/l).
2. In the case of moderately severe COVID-19 infection, type 2 diabetes can be treated with antihyperglycemic drugs, provided that the glycemic target is achieved:
   - when using metformin, limitations of its use in the case of hypoxia, progressive renal failure and multiple organ failure due to the risk of lactic acidosis should be remembered,
   - when using SGLT2 inhibitors, care should be taken to ensure proper hydration of the patient and the risk of euglycemic ketoacidosis should be considered.
3. Due to acute inflammation, patients with type 2 diabetes treated with multiple daily insulin injections prior to hospitalization will usually require increased insulin doses, which should be adjusted according to blood glucose levels.
4. In patients with severe COVID-19 requiring hospitalization in the ICU, continuous intravenous insulin infusion in appropriately adjusted doses depending on the parenteral/enteral nutrition used is recommended in the treatment of diabetes. The glycemic target for a patient hospitalized in the ICU should be 140–180 mg/dl.
5. Treatment of type 2 diabetes in a patient hospitalized because of COVID-19 requires

constant monitoring of blood glucose levels. It is recommended to monitor glycemia using CGMS, if possible, with an application that allows medical staff to view glycemic data remotely. This allows to reduce the contact of medical personnel with the infected patient.

6. In the case of development of DKA or hyperosmolar-hyperglycemic state, treatment should be applied in accordance with the Diabetes Poland recommendations in this regard. Particular attention should be paid to hydration, intravenous insulin infusion, potassium supplementation and antithrombotic treatment.

IV. De-intensification of treatment after hospitalization because of COVID-19

De-intensification of insulin treatment after SARS-CoV-2 infection in patients with type 2 diabetes is also an important issue. A patient after a severe infection is usually discharged from the hospital with multiple subcutaneous insulin injections. Due to the fact that after COVID-19 infection, it often required to continue the treatment with glucocorticoids, maintaining insulin therapy seems justified. However, as the dose of steroids is reduced during the recovery period, it is recommended that insulin doses be gradually reduced and other antihyperglycemic treatment should be considered.

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6. Care for pregnant women with diabetes

Key recommendations
1. Glycemic therapeutic goals in pregnant women with diabetes during the COVID-19 pandemic and others similar in nature are identical to the generally accepted diabetes recommendations. Their achievement is necessary to reduce the risk of adverse obstetric and neonatal events.
2. Telemedicine tools were a key element of diabetes care for pregnant women complicated by diabetes, regardless of the type of diabetes, during the COVID-19 pandemic. Proper preparation of the health care system for future similar viral pandemics requires further improvement and preparation for use by both the medical community and pregnant women. The transition to remote visits should not result in a decrease in the overall frequency of consultations.
3. Healthcare facilities, scientific associations and patient organizations should prepare training materials available on websites on all aspects of care for pregnant women with diabetes, both pregestational and gestational diabetes (GDM), or planning pregnancy.
4. In order to implement social distancing and limit contacts of pregnant women with diabetes in healthcare facilities, it is also necessary to simplify GDM screening tests and reduce the number of stationary specialist consultations. The tests proposed during the COVID-19 pandemic based on the assessment of fasting blood glucose, random blood glucose and HbA_{1c} level require validation and should not be recommended at present. The number of ophthalmologic consultations in patients with pregestational diabetes should be determined individually depending on pre-existing diabetic retinopathy, glycemic control and duration of diabetes.

I. A female patient with diabetes complicating pregnancy during a pandemic – general remarks

The COVID-19 pandemic has required a rapid transformation and adaptation of healthcare systems around the world to provide adequate and uninterrupted medical care for many groups of patients. This also applied to pregnant women with gestational diabetes (GDM) and pregestational diabetes. Diabetes is the most common comorbidity that complicates pregnancy and affects more than 10% of pregnant women worldwide and increases the risk of its unfavorable course. The incidence of pregestational and gestational diabetes is steadily increasing, especially in developed countries. Adequate glycemic control during any pregnancy complicated by diabetes is essential to minimize the risk of adverse outcomes for mother and newborn. The key element of diabetes care during the pandemic and the accompanying social isolation is proper education of pregnant women about diabetes. The period of pregnancy is characterized by the need to immediately introduce appropriate modifications of treatment based on blood glucose measurements. This requires frequent consultations with a diabetologist. However, during the COVID-19 pandemic and other similar viral pandemics, it is crucial to limit transmission of the virus through physical distancing and minimizing person-to-person contact. Pregnant women do not appear to be at higher risk of infection compared to the general population. However, patients with diabetes complicating pregnancy are potentially at higher risk of severe viral infection, such as COVID-19, due to additional predisposing factors such as hyperglycemia and, in the case of GDM, often accompanying obesity and hypertension. There is therefore a need to define a model of care that balances the need to prevent pregnancy complications associated with diabetes and reduce the risk of transmission of the virus to future mothers. At the beginning of 2020, diabetic prenatal care in Poland, as in the rest of the world, was quickly modified, in particular through the implementa-

tion of virtual tools, so as to adapt it to the new epidemiological conditions.

II. Telemedicine in outpatient care of patients with diabetes complicating pregnancy during a pandemic

Glycemic therapeutic goals in pregnant women with diabetes during the pandemic are identical to generally accepted diabetes recommendations. Their achievement is a prerequisite for reducing the risk of adverse obstetric and neonatal events. Data collected before and after the COVID-19 pandemic showed that the use of telemedicine tools in the care of pregnant women with diabetes is as effective as traditional visits to diabetes clinics. No published analyses, including those from Poland, reported a deterioration in diabetes and obstetric outcomes as a result of replacing some in-patient visits with remote visits. Therefore, in a pandemic crisis, it is necessary to be able to quickly implement remote access to diabetic prenatal care in order to enable direct contact with medical staff and achieve optimal glycemic control and minimize the need to move pregnant women to specialist centers. This will allow to reduce the number of stationary outpatient visits to pregnant women with diabetes and to carry them out effectively using telemedicine tools. A prerequisite is the ability of the patient to provide clinical observations, laboratory results and records of home glycemic monitoring during televisits. Telemedicine tools for assessing CGM results are particularly important for the care of patients on intensive insulin therapy planning pregnancy and pregnant women.

The total number of stationary and remote visits during pregnancy should be consistent with general diabetes recommendations, in particular those published by Diabetes Poland. Additional remote visits should be scheduled for patients who have failed to achieve their treatment goals. When planning stationary visits for pregnant women with diabetes, it should be considered to coordinate them with obstetric visits.

III. Education of pregnant women with diabetes in the conditions of a pandemic

The COVID-19 pandemic has resulted in the need to replace, at least partially, traditional education in diabetes clinics with remote teaching of patients conducted using mobile devices, interactive webinars and other tools available on the Internet. This type of management allows to reduce the exposure of women with pregestational diabetes and GDM to SARS-CoV-2 and other pathogens. The degree of use of these tools should be adapted to the individual situation of the patient.

The first visit of a GDM patient during a pandemic should be conducted in-patient and include key elements of education – self-monitoring, ketonuria monitoring, dietary advice, insulin therapy (if implemented), prevention and treatment of hypoglycemic episodes. Materials available on websites or online platforms are an important form of supplementing the initial education conducted in an outpatient setting. They should include the following topics:

- general information about gestational diabetes,
- the risk of GDM during and after pregnancy,
- ways to reduce the risk of GDM,
- diagnosing GDM,
- diet in GDM,
- physical exercise,
- glucose monitoring,
- insulin therapy,
- hypoglycemia and ketonuria,
- childbirth in a patient with GDM,
- the period immediately after childbirth and long-term care.

Education carried out by the therapeutic team in a pregnant patient with pre-gestational diabetes, mainly type 1 or other forms of the disease, should include the following elements:

- blood glucose monitoring with glucometers or CGMS,
- prevention and treatment of episodes of hypoglycemia and ketonuria,
- instructions on telemedicine contacts and useful applications,
- a diet plan for the next trimesters,
- current insulin/carbohydrate exchange ratio,
- patients with pre-gestational type 2 diabetes or other forms of the disease who have not been treated with intensive insulin therapy prior to pregnancy should be fully educated about this treatment,
- physical activity.

If a pregnant woman with pre-gestational diabetes is being introduced to insulin pump therapy and/or CGMS for the first time, training in the use of this equipment, in particular data transfer *via* remote tools, should be provided.

All necessary information that was not provided to the woman at the stage of pregnancy planning should be completed.

IV. Screening for GDM and specialist consultations in pregnant women with diabetes in condition of a pandemic

Implementing social distancing and reducing the number of contacts, including in healthcare facilities, is key to slow the spread of COVID-19 and other viral infections. Considering the above facts, during the viral pandemic, in the care of pregnant women with diabetes, it is necessary, among other measures, to simplify screening tests for GDM and reduce the number of stationary specialist consultations.

According to the current diabetes recommendations in Poland, all pregnant women in the third trimester of pregnancy and those from risk groups and with elevated fasting glucose in the first trimester are subject to a three-point standard oral glucose tolerance test (OGTT). This results in the need to stay in a medical facility for several hours. During the COVID-19 pandemic, several countries have proposed modified GDM screening algorithms and criteria to reduce the length of time women stay in outpatient clinics. These criteria were based on the determination and use of fasting or random glucose and HbA_{1c} levels. The proposed exemplary cut-off points were: HbA_{1c} > 5.7%, fasting glucose > 5.1 mmol/l, random glucose > 9.0 mmol. It was postulated to combine these measurements – in various combinations – into one diagnostic test. Retrospective analyses, however, have not shown that they are both sufficiently sensitive and specific to standard procedures, and therefore cannot be recommended for use in future pandemics. Thus, there is an urgent need to validate new methods for diagnosing GDM to prepare the healthcare system for future pandemics.

The most common routine specialist consultation in women with pregestational diabetes is an ophthalmological examination. Despite the progress and the use of new technologies in ophthalmology, it is associated with the risk of viral infection. It is therefore recommended that the number of ophthalmological consultations in patients with pregestational diabetes should be determined individually depending on the pre-existing diabetic retinopathy, glycemic control and duration of diabetes. In women with good glycemic control who were free of retinopathy in the year before pregnancy, eye examination may not be recommended until before delivery. On the other hand, in pregnant women with diabetes, in whom diabetic retinopathy was present before conception, especially when there was a significant reduction in glycaemia after conception, an ophthalmologist consultation should be recommended at the beginning of pregnancy, and subsequent consultations depending on the recommendations of an ophthalmologist.

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7. Blood glucose monitoring in ambulatory and hospital settings

Key recommendations
1. Individually selected glycemic monitoring is crucial for achieving metabolic control in patients with diabetes in outpatient care during a pandemic and social isolation.
2. The use of CGMS and telemedicine tools for transferring the obtained results allows for obtaining optimal glucose levels in many groups of patients, for example people with type 1 diabetes and pregnant women with diabetes complicating pregnancy.
3. Real world data (RWD) indicate that after the lockdown period and the end of social isolation, the glycemic control deteriorates. Emphasis should be placed on avoiding this phenomenon through proper education and continued appropriate treatment and glycemic monitoring.
4. The aim of monitoring glycemia in diabetic patients hospitalized during the COVID-19 pandemic and other similar ones should be to achieve optimal glycemic control while minimizing the exposure of medical personnel and the use of protective materials.
5. In the period before and during the COVID-19 pandemic, inpatient CGMS have been shown to reduce the risk of hypoglycemia and increase TIR. It is recommended to continue using the CGMS in the hospital for patients previously using this tool. Efforts should be made to implement CGMS as widely as possible in patients requiring intensive insulin therapy or remaining on intravenous insulin infusions.
6. Patients not using CGMS in the hospital ward should have an individually selected number of glucose measurements. To reduce healthcare staff exposure, patients should be allowed to use their own blood glucose meters and self-measure, and avoid intravenous insulin infusions in the presence of moderate hyperglycemia.
7. The balance of benefits and risks of using CGMS in critically ill patients, particularly in intensive care units (ICU), is not sufficiently documented. Due to the clinical characteristics of these patients and the use of some medications, CGMS may be potentially less accurate in the ICU setting. This requires extra care, such as periodic verification of measurements with glucose meters and regular calibration of the equipment, if the system allows it.
8. In order to prepare for the wide use of CGMS in hospitals in the event of a pandemic, it is necessary to train the medical staff, in particular nurses from various specialist departments in the field of putting on and using these tools.
9. The medical community, manufacturers of CGMS as well as regulatory institutions and decision-makers in health care should take action to obtain new medical data, extend registration records and modify clinical recommendations in order to safely expand the use of CGMS in hospital wards. Such action is one of the elements of preparing health systems for new viral pandemics.

I. Outpatient glucose monitoring during a pandemic and social lockdown

Glucose monitoring is one of the key tools to achieve optimal metabolic control in diabetic patients, and thus to reduce the risk of chronic micro- and macrovascular complications and to prevent acute complications, such as ketoacidosis. The goal of proper diabetes care during viral pandemics, for example COVID-19 or other of a similar nature, should be to prevent the deterioration of metabolic control due to social confinement. Such deterioration may be related to, among the other causes, the interruption of access to inpatient medical care and reduced access to education on glucose monitoring. Lockdowns can also cause supply chain deterioration and interruptions in the availability of glycemic monitoring tools, such as CGMS. This has been the case periodically during the COVID-19 pandemic. An element of preparing the diabetes care system for the next pandemics in the field of glycemic monitoring should be the creation of widely available remote educational tools in this area, providing all patients with diabetes and health care facilities with telemedicine tools for sending and receiving monitoring results, and maintaining local stocks tools for monitoring glycemia at a level that secures the continuity of supply in a pandemic situation.

Despite the progress in dissemination of CGMS, it should be expected that in the coming years glucometers will continue to be an important tool for glycemic monitoring. During the pandemic, recommendations regarding the frequency of glucometric measurements performed by patients, taking into account the therapeutic models used by them, should be identical to the general recommendations of Diabetes Poland. During the pandemic,

therapeutic goals for patients using glucometers and CGMS should also remain unchanged.

Observational data from the period of the COVID-19 pandemic from a number of countries, including Poland, have shown that the use of CGMS and telemedicine tools to transfer the obtained results allows for optimal glucose levels in many groups of patients, for example people with type 1 diabetes and pregnant women with diabetes complicating pregnancy. In cohorts of patients with type 1 diabetes who were metabolically well-balanced before pandemic and used CGMS during lockdown, glycemic control was similar to, or even slightly better, than pre-pandemic. The RWD data also indicate that after the lockdown period and the end of social isolation, there may be a significant deterioration in metabolic balance. Emphasis should be placed on avoiding this phenomenon through proper education and continued optimal treatment and glycemic monitoring.

In summary, individually tailored glycemic monitoring is the basis for achieving metabolic control in diabetic patients in outpatient care during the pandemic and social isolation.

II. Blood glucose monitoring in diabetic patients hospitalized during the COVID-19 pandemic

Approximately 25–30% of hospitalized COVID-19 patients had diabetes, and this group had a higher mortality rate than non-diabetics, especially when they had hyperglycemia and coexisting diabetes complications and comorbidities, such as heart failure or chronic kidney disease. A number of clinical observations made during the COVID-19 pandemic showed a relationship between glycemic control and the clinical course of the disease during hospitalization, including patient survival. Blood glucose monitoring with glucometers and CGMS has been a major challenge for hospitals caring for COVID-19 patients. Patients monitored in a hospital ward using traditional glucometric tests should have an individually tailored daily number of measurements. In order to reduce the exposure of medical staff, infected patients should be allowed to use their own glucometers and perform self-measurements, and coordinate the hours of glucometric measurements with the administration of subcutaneous insulin and other drugs as well as with medical procedures in the patient's room. It should also be recommended to avoid intravenous insulin infusions in patients with moderate hyperglycemia. The use of intravenous insulin necessitates hourly glucose monitoring and adjustment of the insulin infusion rate. Glucose profiles based on traditional glucose measurements provide only point-by-point views of 24-hour glucose changes and therefore do not fully reflect hyper- and hypoglycemic episodes that occur. This hinders the optimal metabolic control of diabetic patients with severe infections in hospital wards.

CGMS is an alternative to glucometers, not only in outpatient care but also in hospital care. Their use in hospital wards gained particular momentum during the COVID-19 pandemic. This was related to the efforts to reduce the exposure of medical staff to direct contact with infected people, reduce the workload of the nursing team and the need for personal protective equipment, and thus also reduce the cost of hospital stay. The use of CGMS in the hospital setting was already growing before the COVID-19 pandemic, which was the result of the increase in the number of diabetic patients using these devices in home conditions and the fact that these systems were connected more often to patients for the first time in the hospital. It has been documented that the use of CGMS during hospitalization of diabetic patients is associated primarily with the reduction of hypoglycemic incidents and the increase in TIR. The precision and accuracy of in-hospital CGMS relative to the reference glucose measurement method are constantly improving with each generation of these systems. In-hospital use of CGMS is potentially associated with common problems associated with other subcutaneous procedures, including infection, local bleeding, hematoma, pain or discomfort at the sensor site. In addition, an allergic reaction to the adhesive or irritation due to contact with it is possible. The use of these systems is characterized by a delay in the change of glucose level resulting from the measurement in interstitial fluid in relation to capillary blood.

Moreover, the accuracy of the CGMS decreases in certain clinical situations, such as in very critically ill patients, particularly those in intensive care units (ICU), with the use of certain medications and with extreme – very low or very high – glucose levels, and high dynamics of changes of these levels.

Hyperglycemia is a phenomenon that is common in critically ill patients. This is due to the reaction to the underlying disease, for example a severe infection, the supply of intravenous glucose as well as drugs that increase its level (e.g., steroids) or parenteral nutrition, lack of patient cooperation

and a number of others. Severely ill diabetic patients are often treated with intravenous insulin, which necessitates intensive glycemic monitoring, for example by hourly glucometric measurements. This causes problems related to the increased workload of the nursing team and their additional epidemiological exposure. ICU patients are at high risk of hypoglycemia for a number of reasons. They include the inability to communicate symptoms to healthcare professionals, rapid glycemic fluctuations due to changes in disease severity, nutrition and treatments that can affect glucose levels. The use of CGMS in critically ill patients has the potential to alleviate these problems by reducing staff workload, their exposure to an infected patient, which is especially important in a highly infectious disease. These systems should also reduce the number and severity of hypoglycemia. The problem remains that the accuracy of the sensors of CGMS in ICU patients is lower than in non-ICU patients. It is important to understand the mechanisms leading to reduced accuracy and thus reduced effectiveness of these systems and patient safety. In critically ill patients, these include impaired tissue perfusion, hypotension, hypothermia, hypoxia, use of vasopressors, tissue edema, and sensor compression. A number of other factors require further research regarding their impact on measurement accuracy. During the use of CGMS in hospital wards, problems specific to a given medical device may also occur. These include the lack of compatibility of mobile phones owned by patients with applications for receiving data from the sensor in the absence of dedicated readers in the hospital ward. In the case of scan-based CGMS, the problem may be that unconscious patients cannot read the results themselves. Periodic in-hospital calibration should be recommended, especially for critically ill patients, including those systems that are not mandatory to calibrate at home (e.g., Dexcom G6). It is also necessary to confirm the indications of the CGMS with a glucometer not only in typical cases, such as clinical suspicion of hypo- or hyperglycemia, but also in a number of other cases that may occur in a hospital ward, for example, a change in the patient's mental or hemodynamic status.

Policies should be laid down for the transmission of CGMS readings to medical personnel. If the patient has a compatible mobile device (e.g., mobile phone or tablet), the patient should be encouraged to register an account on the system manufacturer's website and share the real-time CGMS measurement results with the medical staff. If the patient does not have a device enabling data transfer or it is not possible to use it (e.g., a patient in a severe clinical condition, unconscious), the ward should use the equipment it has (e.g., a mobile phone). The ward staff should be trained in the implementation of these activities.

In order to prepare for the wide use of CGMS in hospitals, it is necessary to train the medical staff, in particular nurses from various specialist departments, in the field of putting on and using these tools. Due to the large variety of available systems and the different specifics of using each of them, the selection of a uniform system within the entire medical facility should be considered.

In the process of developing the rules for the use of CGMS in hospital wards, the issues of medical imaging procedures should be taken into account. Currently, none of the systems are approved for use with the exposure to any radiation or magnetic field, including those associated with X-ray, CT or MRI imaging. Currently, the medical staff of hospital wards most often order patients to remove CGM before these procedures.

A potential problem in the use of CGMS in hospital wards is the reduced accuracy of their individual types when delivering some drugs commonly used in hospital wards. Examples include dopamine, heparin or mannitol.

Previous publications on the use of CGMS in hospitals concerned older generation systems and were carried out on small groups of patients. Newer systems are more accurate, with hypo- or hyperglycemia alerts, and predictive alerts in advance of such episodes. In addition, the simultaneous availability of current glucose measurement, trend and retrospective recording more than compensates for the problems resulting from inferior accuracy compared to the reference glucometer method. Further research on the use of new generation CGMS in critically ill patients, in particular in the ICU, should be recommended. They should be carried out on large groups of patients with different clinical characteristics in randomized control studies. Only such studies can establish the effectiveness and safety of the exclusive use of CGMS in ICUs and in critically ill patients in general. At the current stage of technological development of these products, it may also be advisable to develop algorithms for hybrid use of CGMS and glucometers in selected hospital wards. Groups of clinicians and researchers should be encouraged to exchange experiences from the COVID-19 pan-

demic on the use of CGMS and hybrid models in inpatient healthcare.

There are no uniform glycemic goals for ICU patients. Most experts recommend a glucose range of 140–180 mg/dl for patients treated in these wards. Diabetes Poland indicates such a range for patients in the acute phase of stroke, indicating at the same time a range of 100–180 mg/dl in the first day of acute coronary syndrome. Such ranges should also be recommended during pandemic periods. However, it should be remembered that they refer to glucometric measurements. Specific clinical situations, such as pregnancy, patient age, comorbidities, and prognosis and life expectancy, should also be considered when formulating goals. In general, however, glucose concentrations exceeding the renal glucose secretion threshold should be avoided as they are associated with fluid and electrolyte shifts and impaired immune function.

III. Blood glucose monitoring during future pandemics

Glucose monitoring is a field of diabetology in which particularly dynamic progress is being made. It should be assumed that in subsequent pandemics, the use of CGMS in outpatient and hospital conditions will increase significantly, displacing traditional glucometric measurements. CGMS were originally registered and recommended for home use, and their use in hospital wards, especially during the COVID-19 pandemic, requires further evidence gathering. Further research should be recommended in order to unambiguously determine the benefits and risks resulting from the replacement of blood glucose measurements in hospital conditions with CGMS. They should cover all aspects of the hospital use of CGMS – clinical effects and patient safety (glycemic control, risk of hypoglycemia, length of stay, mortality), workload of medical teams, costs, etc. Such studies should be the basis for amending registration records and recommendations of clinical societies, in particular in the area of diabetology. Attention should also be paid to factors potentially interfering with the precision of measurements, for example, hypoperfusion, sensor compression or the use of certain medications. In addition, research is needed on the optimal use of CGMS when performing imaging procedures, as currently the sensor is most often removed regardless of its degree of use. There is also a need for extensive education of staff and healthcare professionals in the field of implementation of CGMS in hospital conditions. Development research should concern data transmission to recorders located outside the patient's room. Integration of CGMS with electronic medical records should be planned. After all, it should be anticipated that in periods of future viral pandemics, access to fully automated, closed insulin delivery systems integrated with CGMS will be significantly expanded. It is necessary to develop not only a position on the continuation of this therapy in hospital conditions during the pandemic, but also connecting such tools for the first time in hospitalized patients with diabetes.

To sum up, the medical community, producers of CGMS as well as regulatory institutions and decision makers in the field of healthcare should cooperate in order to obtain new medical data, expand registration records and modify clinical recommendations towards the safe increase of the use of CGMS in hospital wards. Such action is one of the elements of preparing health systems for new viral pandemics.

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