Standards of Care in Diabetes. The position of Diabetes Poland – 2024

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Standards of Care in Diabetes – 2024. Diabetes Poland: Summary of Revisions

We are pleased to introduce the latest edition of the Clinical Standards of Care by the Diabetes Poland (PTD). The medical experts in charge of the 2024 Standards of Care aspires to further enhance the management of diabetes care for individuals in our country. Initiated in 2005, the Diabetes Poland has consistently been at the forefront, formulating and disseminating clinical standards for diabetes management. This initiative was originally proposed by Prof. Jacek Sieradzki, who was the PTD president at the time, back in 2004. The inaugural chair of the PTD Team for Standards of Care was the esteemed Prof. Władysław Grzeszczak, MD, PhD, serving from 2005 until his passing in 2011. Thereafter, the role of PTD Board Delegates for Clinical Standards of Care was successively assumed by Prof. Leszek Czupryniak, MD, PhD, (2011–2015), Prof. Dorota Zozulińska-Ziółkiewicz, MD, PhD, (2015–2019), and Prof. Irina Kowalska, MD, PhD, (2019–2023).
The current standards are a culmination of the collective efforts of nearly 50 experts across different medical specialties, alongside the foundational work laid by their predecessors.
These standards, refreshed annually, strive to stay abreast of the newest clinical research findings and to assist physicians in their everyday clinical practice.

Here is an overview of the key updates included in the PTD Standards of Care for 2024:

CHAPTER 3 unified the concept of glucose monitoring, moving away from the previous differentiation between real-time systems and scanning methods. Standards for the individualization of glucose monitoring approach were added, as well as examples of substances that can interfere with glucose readings using glucometers and CGM (Continuous Glucose Monitoring) systems.

CHAPTER 4 includes new recommendations for target lipid levels in people with diabetes, introducing non-HDL-C reduction as a secondary goal and removing the concept of extreme risk. Target blood pressure levels were modified. The text was supplemented with a figure representing a holistic approach to strategies leading to the reduction of diabetes complications risk. For glycemic control goals, enriched with graphics, in the case of elderly people with long-standing diabetes and significant macroangiopathy complications (history of heart attack and/or stroke) and/or numerous comorbidities, where the expected survival time is less than 10 years, the target HbA_{1c} level was modified to 8.0–8.5% (64–69 mmol/mol).

CHAPTER 5 changed recommendations for monitoring adults with diabetes and moved the organizational requirements for specialized diabetic departments and clinics. The standards of care for individuals with diabetic foot syndrome are described in the newly created Annex 8.

CHAPTER 6 introduced a recommendation that CGM systems play a very important educational role in optimizing diet, particularly in terms of the glycemic effect of meals, in all types of diabetes and modified detailed recommendations regarding sweetening substances.

CHAPTER 7 modified the paragraph on glycemia monitoring during physical activity in people treated with insulin and the principles of undertaking physical activity by people treated with insulin, indicating that the reduction of basal NPH insulin or long-acting analogue should be considered with multi-hour or all-day endurance exercise, whereas pre-reduction of the dose of ultra-long-acting insulin analogues can be considered before multi-day activities.

CHAPTER 8 in line with the latest state of knowledge, updated the values of results obtained using online tools for screening diagnosis of depression, indicating the need for further diagnostic evaluation.

CHAPTER 9 has been developed in a new concept and form.

CHAPTER 10 emphasized that hybrid closed-loop insulin pumps (HCL) are most effective in optimizing metabolic control and improving the quality of life. Furthermore, it was reiterated that the treatment of adult individuals with type 1 diabetes using a personal insulin pump should take place in centers that have at least one specialist with a current certificate from the Diabetes Poland Pump School. It was also pointed out that in the case of using HCL, the knowledge of the impact

of proteins and fats on glycemia, used for insulin dosing, is of less significance. Additionally, when implementing HCL pumps in individuals who have no previous experience with pump therapy, the focus should be on issues related to the pump's hybrid mode operation, rules of switching to manual mode in emergency situations, and technical aspects. Training in other issues, important in the treatment with traditional insulin pumps, which will not be applicable in the case of HCL, should be minimized.

CHAPTER 11. The guidelines for therapy in individuals with type 2 diabetes have been modified, including in the treatment algorithm the role of a dual GIP/GLP-1 receptor agonist and new categories of cardiovascular risk in diabetic individuals based on the SCORE2-Diabetes scale, in the context of recommended antihyperglycemic treatment. It is emphasized that currently, as first-line drugs, SGLT2 inhibitors, GLP-1 receptor agonists, and metformin should be primarily considered.

CHAPTER 12. The title has been changed, according to its content in 2024, to "**Insulin therapy in type 2 diabetes and other specific types of diabetes**," transferring issues related to insulin therapy in type 1 diabetes to the chapter "**Type 1 Diabetes**." It is indicated that before starting insulin therapy in type 2 diabetes, it is important to use the antihyperglycemic potential of GLP-1 receptor agonists and the dual GIP/GLP-1 receptor agonist, which should be the first injectable therapy in type 2 diabetes (considering the individuals financial possibilities). The possibility of considering a fixed ratio combination (FRC) of basal insulin and GLP-1 receptor agonist (this drug may be the first injectable therapy) in the model of starting and/or intensifying insulin therapy is highlighted. A new figure presenting a practical algorithm for insulin treatment in type 2 diabetes is also proposed.

In **CHAPTER 13** the target values for arterial blood pressure have been modified according to the ESH guidelines from 2023, and a figure presenting the management scheme for hypertension in individuals with type 2 diabetes according to the ESC 2023 recommendations has been added.

In **CHAPTER 14** highlighting the most important recommendations, those that cover therapeutic goals and used therapies were included. The table specifying the categories of cardiovascular risk and recommended target lipid concentrations according to the ESC 2023 guidelines was changed. Also, in line with these recommendations, the category of extreme cardiovascular risk was removed from the most important recommendations. The chapter added a table with secondary causes of hyperlipidemia, a table with criteria for the diagnosis of familial hypercholesterolemia (FH) on a point scale (according to The Dutch Lipid Score), and a table containing the management scheme for hypertriglyceridemia depending on TG concentration. In addition, the subsection on pharmacological treatment of dyslipidemia in diabetic individuals was modified and updated. A paragraph on statin intolerance was added, indicating that in cases of total statin intolerance, ezetimibe monotherapy or in combination with PCSK9 inhibitors should be considered, and the alternative use of bempedoic acid was mentioned. It was also recommended that in individuals with hypertriglyceridemia (TG: 150–499 mg/dl; 1.7–5.6 mmol/l), the use of high-dose eicosatetraenoic acid (EPA) (2 g twice daily) in combination with a statin can be considered. The chapter also addresses the management of dyslipidemia in individuals with type 1 diabetes.

In **CHAPTER 15** in the recommendation regarding the need to consider changing the method of diabetes treatment in the event of episodes of severe hypoglycemia and unawareness of hypoglycemia, the level of scientific evidence was updated from expert opinion to level **B**, while in the indication for the use of CGM systems in individuals with diabetes and unawareness of hypoglycemia treated with intensive insulin therapy, the category of scientific evidence increased to level **A**.

CHAPTER 16 states, among the most important recommendations, that the treatment of acute hyperglycemic states should be conducted according to the developed standards of management for fluid and electrolyte replenishment and insulin therapy, as it shortens the treatment time. In the paragraph on intravenous insulin therapy, it was added that a parenteral insulin bolus should be administered in adults with severe DKA who have not previously received subcutaneous insulin (no subcutaneous insulin depot), and it was noted that in the case of DKA in individuals previously treated with an ultra-long-acting insulin analogue, it is recommended to continue therapy during the resolution of DKA. It was also noted that the administration of basal insulin or the connection of a personal insulin pump should be timed so that after the discontinuation of intravenous insulin infusion, the individual is not exposed to a deficit of insulin.

In **CHAPTER 17** a subsection on the principles of diagnosis and treatment of individuals with chronic heart failure and concomitant diabetes was added, and the title of the entire chapter was

accordingly changed to "**Principles of Diagnosis and Treatment of Individuals with Chronic Coronary Syndrome and Chronic Heart Failure and Concomitant Diabetes**." The content of the subsection on management of acute coronary syndrome was also updated based on the latest knowledge and current guidelines.

CHAPTER 19 was enriched with a figure illustrating a holistic approach to cardiorenal risk consistent with the current KDIGO guidelines, and the table including recommendations for dosing oral antihyperglycemic drugs and GLP-1 receptor agonists depending on the stage of kidney disease in type 2 diabetes was updated.

In **CHAPTER 21** in the section on the principles of testing for neuropathy, the necessity of considering periodic measurements of vitamin B_{12} levels in individuals treated with metformin was indicated, especially when symptoms of neuropathy appear or worsen. Moreover, in the section covering the principles of recognizing distal symmetric polyneuropathy, information about the possibility of using the Michigan scale (Michigan Neuropathy Screening Instrument – MNSI) was added due to its documented accuracy and established cut-off points for the Polish population. This chapter was also enriched with a figure and table containing a scheme for the symptomatic treatment of neuropathic pain in somatic diabetic neuropathy.

In **CHAPTER 22** in the part concerning the prevention and systematic annual examination for sensory disturbances, it was pointed out that it should be performed using a 10 g monofilament and a 128 Hz tuning fork, and if they are not available, the examination can be conducted by a light, 2-3 second touch of the examiner's index finger on the person's foot toes. The importance of evaluating the individuals' footwear and any deformities, as well as the evaluation of knowledge regarding the risk of ulceration, was also emphasized. In the section on infections in diabetic foot, a recommendation was added that in case of doubt in the clinical assessment of the presence of infection signs, plasma inflammatory markers (CRP, procalcitonin) should be evaluated. In the subsection on antibiotic therapy, for infections at stage 4 according to PEDIS, in the part concerning the duration of antibiotic use, it was recommended to continue their administration for 3 weeks after a low amputation performed due to osteomyelitis, with simultaneous confirmation of pathogens in the bone material culture from the wound edge, and for 6 weeks in case of osteomyelitis, when the bones involved in the inflammatory process were not removed or amputation was not performed. It was also mentioned that the extension of antibiotic therapy should also be considered when there is a reduction in the intensity of infection signs, but due to the extent of the procedure on the foot, this occurs slower than assumed. In the paragraph covering the diagnostics of Charcot's neuroosteoarthropathy (Charcot foot), abnormalities in imaging studies were added to the causes that require exclusion. It was also indicated that if abnormalities are not visualized in a standard radiological examination (standing position under load), an MRI or, if unavailable, a CT scan should be performed. Additionally, it was recommended that if these methods are not available, the individual should be treated and managed as having probable neuroosteoarthropathy.

In **CHAPTER 23** within the main recommendations, it is emphasized to use automated insulin delivery systems from the onset of the disease. It is also indicated that other systems should be considered only if it is not possible to use the automated ones and that systems with an automatic insulin suspension feature in anticipation of hypoglycemia are preferred.

Information was added that it is recommended to measure antibodies against pancreatic islet cells in individuals with a family history of type 1 diabetes to detect diabetes at the preclinical stage, which, combined with annual monitoring for disease progression, significantly reduces the risk of hyperglycemia consequences, eases the introduction of insulin therapy, and allows participation in research projects aimed at preventing the progression of diabetes to the clinical stage.

It was also stressed that in children with type 2 diabetes, after the acute metabolic disturbances have been managed and initial glycemic normalization has been achieved, insulin treatment should be withdrawn and metformin should be used, and if ineffective, a second antihyperglycemic drug (GLP-1 receptor agonist and/or SGLT-2 inhibitor) should be added.

The necessity of using CGM (continuous glucose monitoring) in individuals with type 1 diabetes with hypoglycemia unawareness or frequent hypoglycemia was also highlighted. It is further emphasized that the use of automated insulin delivery systems is optimal in this group of individuals.

Additionally, it was added that in the nutrition of children and adolescents with diabetes, attention should be paid to the intake of adequate amounts of fluids.

It was pointed out that in terms of psychological care, the stress associated with diabetes should

also be assessed in parents/caregivers. Figure 23.1 presents the modified principles of management in CKK (Chronic Kidney Disease) in children. A new subsection was added, which describes in detail the principles of management during procedures under sedation or general anesthesia in children with diabetes.

In **CHAPTER 24**, among the most important recommendations, it was added that all pregnant women with pregestational diabetes are recommended to use CGM systems, and women with type 1 diabetes are preferred to use systems integrated with pump therapy with as much automation as possible. The need to consider the CGM system to achieve better glycemic control in all pregnant women with hyperglycemia, especially those treated with insulin therapy or with unstable glucose levels, was also underlined. Attention was also drawn to the fact that metformin crosses the placenta and to the lack of unequivocal results of long-term observations in children exposed to metformin in utero. Therefore, the recommendation was maintained that if dietary treatment is ineffective, insulin remains the pharmacological fort-line treatment for hyperglycemia in pregnancy. The recommendation was supported by the results of a recent meta-analysis, which showed that exposure to metformin in pregnancy with GDM caused some newborns to have a lower birth weight with accelerated postnatal growth, resulting in higher BMI in childhood.

In **CHAPTER 26**, among the most important recommendations, the record concerning therapy with non-insulin antihyperglycemic drugs was changed, indicating that for most individuals with type 2 diabetes and well-controlled glycemic levels, the mentioned therapy can be continued up to the day of the procedure, except for SGLT-2 inhibitors, which should be discontinued 2 days before the surgical procedure. It was also emphasized that in the case of using long-acting or ultra-long-acting analogs, their administration should be continued on the day before and after the procedure at a dose reduced to 80% of the pre-surgery dose.

In **CHAPTER 28**, information was added that an endocrinologist, as part of the consultation for certification purposes, should also consider the skills and the possibility of consistent use of CGM systems.

In **CHAPTER 30**, in the paragraph concerning the principles of qualification for metabolic surgery procedures, an indication was added, according to which after considering the patient's preferences, surgical treatment of obesity can also be considered for the treatment of type 2 diabetes in individuals with obesity class I0 (BMI 30.0–34.9 kg/m^2), in whom stable body weight reduction and improvement in the control of co-morbidities, including hyperglycemia, is not achieved by non-surgical methods (i.e., mainly pharmacotherapy using GLP-1 and GLP-1/GIP analogs). The chapter was also enriched with a figure describing the multidisciplinary approach to qualification for metabolic surgery and a table containing recommended auxiliary examinations and consultations before the planned metabolic surgery procedure.

In **ANNEX 2**, the paragraph concerning the examination of drivers dedicated to insufficient hypoglycemia awareness in the context of contraindications to driving vehicles was modified and updated. The paragraph on glycemic control during driving was supplemented with a recommendation that vehicle operation can continue only after normalization of glycemia and reversal of the downward trend. It was emphasized that in cases of higher hypoglycemia risk, it is necessary to use a CGM system during driving. The annex also updated the attached forms.

ANNEX 4, concerning screening for thyroid function disorders in type 1 and type 2 diabetes, and **ANNEX 7**, which includes recommendations of the Diabetes Poland and the Polish Society of Sports Medicine regarding consent for sports participation by individuals with type 1 diabetes, were also updated and modified.

In **ANNEX 6**, recommendations regarding the principles of diabetes treatment using a personal insulin pump funded by the National Health Fund were updated.

Additionally, **ANNEX 8** was created, which collects and summarizes organizational requirements in diabetology care.

We would like to express our heartfelt thanks to all those who contributed to the creation of another edition of Standards of Care in Diabetes – 2024

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Research evidence classification system adopted by the American Diabetes Association (ADA) in the Standards for the Therapeutic Management of Diabetes

Level of evidence	Description
A	Unambiguous evidence from properly conducted, generalizable randomized controlled clinical trials that are adequately powered, including: • evidence from a properly conducted multicenter clinical trial • evidence from a meta-analysis that incorporated quality ratings in the analysis Compelling non-experimental evidence, i.e., the "all-or-nothing" rule developed by the University of Oxford's Center for Evidence-Based Medicine Supportive evidence from properly conducted, randomized controlled clinical trials that are adequately powered, including: • evidence from a properly conducted, single-center or multicenter clinical trial • evidence from a meta-analysis that incorporated quality ratings in the analysis
B	Supportive evidence from properly conducted cohort studies, including: • evidence from a properly conducted prospective cohort study or registry • evidence from a properly conducted meta-analysis of cohort studies Supportive evidence from a properly conducted case-control study
C	Supportive evidence from poorly controlled or uncontrolled trials • evidence from randomized clinical trials with ≥ 1 major or ≥ 3 minor methodologic caveats which could invalidate the results obtained • evidence from observational studies with a high potential for bias (such as case series compared with a historical control group) • evidence from case series or single case reports Conflicting evidence, most of which supports a given recommendation
E	Expert position or clinical experience

List of Abbreviations

ABI – Ankle-Brachial Index
ABPM – Ambulatory Blood Pressure Monitoring
ACE – Angiotensin-Converting Enzyme
ACEI – Angiotensin-Converting Enzyme Inhibitors
ACS – Acute Coronary Syndrome
ACR – Albumin-to-Creatinine Ratio
ACS – Acute Coronary Syndrome
ADA – American Diabetes Association
AER – Albumin Excretion Rate
AF – Atrial Fibrillation
AID – Automated Insulin Delivery
ALT – Alanine Aminotransferase
anti-GAD – Glutamic Acid Decarboxylase Antibodies
Anti-HBs – Hepatitis B Surface Antibody
apo-B – Apolipoprotein B
APS – Artificial Pancreas System
APTT – Activated Partial Thromboplastin Time
ARB – Angiotensin Receptor Blockers
ARNI – Angiotensin Receptor Neprilysin Inhibitors
ASA – Acetylsalicylic Acid
ASCVD – Atherosclerotic Cardiovascular Disease
AST – Aspartate Aminotransferase
AT-1 – Angiotensin 1
ATP – Adenosine Triphosphate
BCVA – Best Corrected Visual Acuity
BE – Base Excess
BGM – Blood Glucose Monitoring
BMI – Body Mass Index
BP – Blood Pressure
CAD – Coronary Artery Disease
CCB – Calcium Channel Blockers
CCS – Chronic Coronary Syndrome
CFRD – Cystic Fibrosis-Related Diabetes
CGM – Continuous Glucose Monitoring
CK – Creatine Kinase
DKA – Diabetic Ketoacidosis
CHO Exchange – Carbohydrate Exchange
CME – Diabetic Macular Edema, Cystoid Form
CKD – Chronic Kidney Disease
CRT – Cardiac Resynchronization Therapy
CSII – Continuous Subcutaneous Insulin Infusion (often referred to as an "insulin pump")
CV – Coefficient of Variation
CVOT – Cardiovascular Outcome Trial
DAPT – Dual Antiplatelet Therapy
DASH – Dietary Approaches to Stop Hypertension
DBP – Diastolic Blood Pressure
DFS – Diabetic Foot Syndrome
DIY Pump – Do It Yourself Insulin Pump
DME – Diabetic Macular Edema
DPP-4 – Dipeptidyl Peptidase-4
DPP-4i – Dipeptidyl Peptidase-4 Inhibitor
DRIL – Disorganization of the Retinal Inner Layers
DRT – Diabetic Macular Edema, Diffuse Form
DSMES – Diabetes Self-Management Education and Support
EASD – European Association for the Study of Diabetes
ED-NOS – Eating Disorders Not Otherwise Specified
eGFR – Estimated Glomerular Filtration Rate
EKG – Electrocardiography
EPA – Eicosapentaenoic Acid
ESC – European Society of Cardiology
ESH – European Society of Hypertension
ETDRS – Early Treatment Diabetic Retinopathy Study
FGM – Flash Glucose Monitoring
Frailty – Frailty Syndrome
FRC – Fixed Ratio Combination Therapy
GDM – Gestational Diabetes Mellitus
GI – Glycemic Index
GIP – Glucose-Dependent Insulinotropic Polypeptide
GL – Glycemic Load
GLP-1 – Glucagon-Like Peptide-1
GLP-1 RA – Glucagon-Like Peptide-1 Receptor Agonist
GMI – Glucose Management Indicator
HAV – Hepatitis A Virus
HbA_{1c} – Glycated Hemoglobin
HCL – Hybrid Closed Loop
HDL-C – High-Density Lipoprotein Cholesterol
HF – Heart Failure
HFmEF – Heart Failure with Mildly Reduced Ejection Fraction
HFpEF – Heart Failure with Preserved Ejection Fraction
HFrEF – Heart Failure with Reduced Ejection Fraction
HTG – Hypertriglyceridemia
HTN – Hypertension
Hz – Hertz
IA-2 – Insulinoma-Associated-2 Autoantibodies
IAA – Insulin Autoantibodies
ICA – Islet Cell Autoantibodies
ICD – Implantable Cardioverter-Defibrillator
IFG – Impaired Fasting Glucose
IgA – Immunoglobulin A
IGT – Impaired Glucose Tolerance
IIT – Intensive Insulin Therapy
INR – International Normalized Ratio
iPCSK9 – PCSK9 Inhibitors

KCl – Potassium Chloride
KDIGO – Kidney Disease: Improving Global Outcomes
LADA – Latent Autoimmune Diabetes in Adults
LDL-C – Low-Density Lipoprotein Cholesterol
L-DOPA – Levodopa, L-3,4-Dihydroxyphenylalanine
Lp(a) – Lipoprotein(a)
LVEF – Left Ventricular Ejection Fraction
LVH – Left Ventricular Hypertrophy
MDCT – Multi-Detector Computed Tomography
MDI – Multiple Daily Injections
MODY – Maturity Onset Diabetes of the Young
MRA – Mineralocorticoid Receptor Antagonists
MRI – Magnetic Resonance Imaging
MRSA – Methicillin-Resistant *Staphylococcus aureus*
Na – Sodium
NaCl – Sodium Chloride
$NaHCO_3$ – Sodium Bicarbonate
NFG – Normal Fasting Glucose
NGSP – National Glycohemoglobin Standardization Program
non-HDL-C – Non-High-Density Lipoprotein Cholesterol
NPDR – Nonproliferative Diabetic Retinopathy
ns-MRA – Non-Steroidal Mineralocorticoid Receptor Antagonist
OCT – Optical Coherence Tomography
OGTT – Oral Glucose Tolerance Test
PAD – Peripheral Arterial Disease
PCI – Percutaneous Coronary Intervention
PCOS – Polycystic Ovary Syndrome
PDR – Proliferative Diabetic Retinopathy
PET – Positron Emission Tomography
PGDM – Pregestational Diabetes Mellitus
PHQ-9 – Patient Health Questionnaire-9
POCT – Point-Of-Care Testing
PPAR-g Agonist – Peroxisome Proliferator-Activated Receptor Gamma Agonist
RAA System – Renin-Angiotensin-Aldosterone System
RAS – Renin-Angiotensin System
SADI – Single Anastomosis Duodeno-Ileal Bypass
SBP – Systolic Blood Pressure
SGLT-2 – Sodium-Glucose Co-Transporter 2
SGLT-2i – Sodium-Glucose Cotransporter 2 Inhibitor
SI – International System of Units
siRNA – Small Interfering RNA
SMBG – Self-Monitoring of Blood Glucose
SNRI – Serotonin-Norepinephrine Reuptake Inhibitor
SPECT – Single Photon Emission Computed Tomography
SU – Sulfonylureas
T1DM – Type 1 Diabetes Mellitus
T2DM – Type 2 Diabetes Mellitus
TAR – Time Above Range
TBR – Time Below Range
TCA – Tricyclic Antidepressants
$TcPO_2$ – Transcutaneous Partial Pressure of Oxygen
TG – Triglycerides
TIR – Time in Range
TOD – Target Organ Damage
UACR – Urine Albumin-Creatinine Ratio
ULN – Upper Limit of Normal
USG – Ultrasonography
VEGF – Vascular Endothelial Growth Factor
WHO – World Health Organization
ZnT8 – Zinc Transporter 8 Autoantibodies

1. Diagnosing Glucose Tolerance Disorders

CHAPTER HIGHLIGHTS
· Glucose tolerance disorders are identified based on random glycemia, fasting glycemia, the 120-minute oral glucose tolerance test (OGTT) as well as glycated hemoglobin (HbA_{1c}) results. [**A**]
· Screening for early diagnosis of pre-diabetes / type 2 diabetes should be undertaken in all individuals over the age of 45 and, regardless of age, in all individuals with at least one risk factor of diabetes. [**B**]
· In women who have not previously been diagnosed with diabetes, an oral glucose tolerance test should be performed between the 24th and 28th week of pregnancy for gestational diabetes diagnosis. [**A**]
· The diagnosis of diabetes in children in the first 9 months of life requires genetic testing for neonatal diabetes. [**A**]
· In individuals with cystic fibrosis, an annual oral glucose tolerance test should be conducted after the age of 10 for diabetes diagnosis. [**A**]

Diabetes describes a complex metabolic disorder characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action and both. Chronic hyperglycemia leads to damage, dysfunction, and failure of various organs, notably the eyes, kidneys, nerves, heart, and blood vessels.

I. Symptoms indicating the possibility of diabetes with significant hyperglycemia:

- polyuria,
- excessive thirst,
- unexplained weight loss,
- other, less common symptoms like fatigue, increased sleepiness, skin infections and genitourinary organs inflammation.

II. Diagnostic criteria of glucose tolerance disorder:

- if diabetes symptoms are present, a random venous plasma glucose measurement is required – a result of ≥ 200 mg/dl (≥ 11,1 mmol/l) is a basis for diabetes diagnosis,
- in the absence of symptoms or with coexisting symptoms with random glycemia < 200 mg/dl (< 11,1 mmol/l) diabetes can be diagnosed based on:
  - » two fasting glycemia measurements in the morning (each test performed on a different day) – two results ≥ 126 mg/dl (≥ 7,0 mmol/l) and/or
  - » a single measurement of glycated hemoglobin (HbA_{1c}) – level ≥ 6,5% (≥ 48 mmol/mol);
  - » if the result of one or two fasting glycemia measurements is 100–125 mg/dl (5,6–6,9 mmol/l) or HbA_{1c} is 5,7–6,4% (39–46 mmol/mol) in a person with a reasonable suspicion of impaired glucose tolerance or diabetes, a glucose tolerance test (OGTT) should be performed – a glycemia at the 120th minute of OGTT ≥ 200 mg/dl (≥ 11,1 mmol/l) is a basis for diabetes diagnosis, and 140–199 mg/dl (7,8–11,0 mmol/l) – indicates impaired glucose tolerance (IGT).

Fasting blood glucose measurements, 120th minute OGTT blood glucose test and HbA_{1c} measurement can be considered equally diagnostic, despite the fact that they diagnose diabetes in different individuals. Compared with fasting blood glucose and HbA_{1c}, the 120th minute OGTT blood glucose test has a greater rate of diagnosing diabetes and pre-diabetic conditions (Table 1.1).

III. Diagnostic tests performance:

- the oral glucose tolerance test (OGTT) should be performed without restricting carbohydrate intake prior to the test, during morning hours, on a fasting and well-rested individual after an overnight sleep; the test person should remain at rest for 2 hours at the testing site after drinking a solution containing 75 g of glucose; all glucose levels measurements must be performed on venous plasma in a laboratory,
- if an OGTT needs to be performed in a person with glucose intolerance (i.e., a pre-diabetic state) who is therefore using metformin, the medication should be discontinued at least one week prior to the test:
  - » glycemia measurements for diagnostic purposes should be conducted in a laboratory; using glucometers for this purpose is not permitted,
  - » HbA_{1c} measurements should be performed in the laboratory using methods certified by the National Glycohemoglobin Standardization Program (NGSP); HbA_{1c} measurements should not be performed for diagnostic purposes using point-of-care testing analyzers (POCT), even those certified by the NGSP.

Tabela 1.1. Guidelines of diagnosing glucose tolerance disorders.

Venous plasma glucose level measured in the laboratory			HbA_{1c} level measured in a laboratory using a NSGP-certified method
Random blood glucose – measured in blood sample collected at any time during the day, regardless of the timing of the last meal	Fasting blood glucose- measured in a blood sample collected 8-14 hours after the last meal	Blood glucose at 120 minutes during an oral glucose tolerance test (OGTT) according to WHO	
≥ 200 mg/dl (11.1 mmol/l) → diabetes (if symptoms of hyperglycemia are present, such as excessive thirst, polyuria, fatigue)*	70-99 mg/dl (3.9-5.5 mmol/l) → normal fasting glucose (NFG)	< 140 mg/dl (7.8 mmol/l) → normal glucose tolerance (NGT)	
	100-125 mg/dl (5.6-6.9 mmol/l) → impaired fasting glucose (IFG)	140-199 mg/dl (7.8-11.1 mmol/l) → impaired glucose tolerance (IGT)	
	≥ 126 mg/dl (≥ 7.0 mmol/l) → diabetes*	≥ 200 mg/dl (11.1 mmol/l) → diabetes*	≥ 6.5% (48 mmol/mol) → diabetes*

NFG – normal fasting glucose IFG – impaired fasting glucose, IGT – impaired glucose tolerance, NGT – normal glucose tolerance, NGSP — National Glycohemoglobin Standardization Program, WHO – World Health Organization

**To diagnose diabetes, it is necessary to find abnormalities as described in the text.*

To diagnose diabetes, it is necessary to find one of the abnormalities, except for fasting blood glucose, when double confirmation of the abnormality is required; when determining blood glucose, it is necessary to consider the possible influence of factors unrelated to the test (time of the last meal consumed, exercise, time of day).

- HbA_{1c} measurements should not be performed for diabetes diagnosis in individuals with conditions/diseases that affect the correlation between the HbA_{1c} value and average blood glucose level, such as anemia, certain hemoglobinopathies, pregnancy and postpartum period, hemodialysis treatment, use of erythropoietin, HIV infection and use of antiretroviral drugs. In such cases, diagnostic criteria based on plasma glucose levels should be used.

IV. World Health Organization (WHO) classification of hyperglycemic states:

- normal fasting glucose: 70-99 mg/dl (3.9-5.5 mmol/l),
- impaired fasting glucose (IFG): 100-125 mg/dl (5.6-6.9 mmol/l),
- normal glucose tolerance: OGTT 120-minute glucose < 140 mg/dl (< 7.8 mmol/l),
- impaired glucose tolerance (IGT): OGTT 120-minute glucose 140-199 mg/dl (7.8-11.0 mmol/l),
- prediabetes – IFG and/or IGT,
- diabetes – one of the following criteria:
  - » symptoms of hyperglycemia and random glucose ≥ 200 mg/dl (≥ 11.1 mmol/l),
  - » fasting glucose ≥ 126 mg/dl (≥ 7.0 mmol/l) (twice-each test performed on a different day),
  - » OGTT 120-minute glucose ≥ 200 mg/dl (≥ 11.1 mmol/l),
  - » HbA_{1c} ≥ 6,5% (≥ 48 mmol/mol).

V. Screening for type 2 diabetes

Screening for type 2 diabetes is necessary in at-risk groups, as most patients do not have symptoms of hyperglycemia. Diabetes screening should be carried out once every three years in every person over the age of 45. In addition, regardless of age, this test should be performed annually in people in the following risk groups:

- overweight or obese (BMI ≥ 25 kg/m^2 and/or waist circumference ≥ 80 cm in women or ≥ 94 cm in men),
- with a family history of diabetes (parents or siblings),
- physically inactive individuals,
- from an environmental or ethnic group characterized by increased diabetes incidence,
- with a previous diagnosis of prediabetes,
- in women with a history of gestational diabetes,
- in women who have given birth to a child weighing > 4000 g,
- with hypertension,
- with dyslipidemia,
- in women with polycystic ovary syndrome,
- with cardiovascular disease.

In those taking antihyperglycemic drugs for reasons other than type 2 diabetes, the basis for

the diagnosis of the disease is an HbA_{1c} ≥ 6.5% (≥ 48 mmol/mol).

VI. Etiological classification of diabetes:

- type 1 diabetes – autoimmune destruction of pancreatic β cells, usually leading to absolute insulin deficiency,
- type 2 diabetes – progressive loss of β cells leading to relative insulin deficiency with accompanying insulin resistance,
- other specific types of diabetes including:
  - genetic defects in beta cells function,
  - genetic defects in insulin action,
  - diseases of the exocrine pancreas,
  - endocrinopathies,
  - drug- or chemical-induced,
  - infections,
  - uncommon forms of immune-mediated diabetes,
  - other genetic syndromes sometimes associated with diabetes;
- hyperglycemia first identified during pregnancy:
  - diabetes in pregnancy,
  - gestational diabetes mellitus (GDM).

The current classification of diabetes does not distinguish type LADA, which is considered to be one of clinical forms of type 1 diabetes.

Since the differential diagnosis of type 1 diabetes, especially when diagnosed in adults, can be challenging, a standardized diagnostic algorithm has been proposed in the recent ADA/EASD consensus.

If the diagnosis in an adult is in doubt, it is necessary to determine the presence of autoantibodies and/or low C-peptide levels. Antibodies to glutamic acid decarboxylase (anti-GAD) should be measured first. If negative, antibodies to tyrosine phosphatase 2 (anti-IA2) and/or zinc transporter 8 (anti-ZnT8) should be measured next if these tests are available.

Monogenic diabetes

Monogenic diabetes is 1-2% of all diabetes cases and it results from mutations in a single gene. Most of its forms are related to insulin secretion defects. The most common types include:

- MODY (maturity onset diabetes of the young),
- mitochondrial diabetes,
- permanent neonatal diabetes.

Including monogenic forms in the differential diagnosis of diabetes can help optimize treatment and provide accurate prognoses for patients and their families. A definitive diagnosis of monogenic diabetes is established through genetic testing. Centers with extensive experience in this area should handle qualification for genetic testing and make any subsequent therapeutic decisions based on the diagnosis.

Permanent neonatal diabetes mellitus is defined as having developed before the age of 9 months. Genetic testing is recommended for all patients with this condition to identify mutations particularly in the KCNJ11 gene, which encodes the Kir6.2 protein. Such mutations are commonly associated with permanent neonatal diabetes. Most patients with KCNJ11 gene mutations can be effectively and safely treated with sulfonylurea drugs. Further genetic analysis may involve looking for mutations in insulin genes, the ABCC8 that encodes the SUR1 protein and the glucokinase gene. Insulin treatment is necessary for carriers' insulin gene mutations or double mutations in the glucokinase gene. Decisions on searching for mutations in other genes related to diabetes should be made by diabetologists with extensive experience in the genetics of diabetes.

In families with autosomal dominant early-onset diabetes resulting from impaired insulin secretion, which in most cases is not accompanied by obesity, MODY diabetes and the search for mutations in the genes responsible for its formation should be considered in the differential diagnosis. The most common form of MODY is associated with mutations in the HNF1A and glucokinase genes.

The typical clinical profile of diabetic MODY patients due to HNF1A gene mutations includes:

- early onset of diabetes (typically before age 25),
- independence from insulin and a low tendency towards ketoacidosis, with minimal insulin requirements and detectable C-peptide levels even after several years of the disease,
- a family history of diabetes spanning at least 2 generations, with at least two family members experiencing early-onset diabetes; an OGTT performed at an early stage of diabetes often shows a significant increase in postprandial glycemia, sometimes with normal fasting values,
- absence of autoantibodies typically associated with type 1 diabetes,
- glycosuria higher than would be expected based on glycemic levels.

A significant proportion of patients with HNF1A MODY develop chronic diabetes complications, hence it is crucial to strive for optimal disease management from the onset. The preferred treat-

ment, except during pregnancy or the presence of typical contraindications, is the implementation of sulfonylurea derivatives. Once their efficacy is exhausted, a combination therapy with insulin, metformin or DPP-4 inhibitors or insulin monotherapy may be considered.

Searching for mutations in the glucokinase gene is indicated in the following cases:

- persistently elevated fasting glycemia in the range of 99-144 mg/dl (5.5-8.0 mmol/l),
- glycemic increase during OGTT less than 83 mg/dl (4.6 mmol/l), and in most cases less than 54 mg/dl (3 mmol/l),
- one parent with diagnosed diabetes; however, the absence of a family history does not rule out this condition.

The approach for a glucokinase defect caused by a single mutation is a healthy dietary management excluding simple sugars as pharmacotherapy is usually ineffective. The characteristic HbA_{1c} value of a glucokinase defect does not exceed 7.5% (59 mmol/mol).

Decisions regarding the search for mutations in other MODY genes should be made on a case-by-case basis at centers experienced in performing such tests.

The most common cause of mitochondrial diabetes is the A3243G mutation in the leucine tRNA gene. This mutation should be investigated in cases of maternal inheritance of early-onset diabetes within a family, particularly if some members also suffer from deafness. Therapeutic approaches for mitochondrial diabetes may include dietary changes and the use of sulfonylurea derivatives or insulin, tailored to the level of insulin secretion impairment. Metformin therapy is typically avoided in mitochondrial diabetes.

Cystic fibrosis-related diabetes (CFRD)

Diabetes in individuals with cystic fibrosis (CFRD) affects approximately 20% of adolescents and 40-50% of adults, representing the most common comorbidity. CFRD is, among other specific types of diabetes, associated with diseases of the exocrine pancreas and typically develops slowly and asymptomatically over many years. Diabetic ketoacidosis is rare, most likely due to preserved endogenous insulin secretion or concomitant impaired glucagon secretion. Hyperglycemia initially occurs in situations that exacerbate insulin resistance, such as acute and chronic infections, steroid therapy, or high carbohydrates intake (oral, intravenous, via gastric probe or percutaneous gastrostomy). Insulin therapy is the treatment of choice.

For individuals over > 10 years of age with cystic fibrosis, an annual OGTT during periods of good health is recommended for diabetes detection.

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2. Prevention or Delay of Diabetes

CHAPTER HIGHLIGHTS
• Patients with prediabetes should receive guidance on a healthy lifestyle (at least 150 minutes of physical activity per week, in overweight and obese patients- weight reduction of at least 7% per year and maintenance of that weight loss) and be informed about the effectiveness of such measures in preventing the progression to diabetes. [**A**]
• For those with prediabetes, especially those with both impaired fasting glucose (IFG) and impaired glucose tolerance (IGT), and/or a body mass index (BMI) ≥ 35 kg/m^2, and/or under 60 years of age, as well as women with a history of gestational diabetes (GDM), pharmacological prevention of diabetes with metformin should be considered alongside lifestyle modification. [**A**]
• Screening tests are conducted by measuring fasting glycemia, performing an oral glucose tolerance test, or measuring HbA_{1c}. [**C**]

Type 1 diabetes

Currently, there is no clinically effective method of preventing type 1 diabetes, either in the general population or in people at risk.

Type 2 diabetes

1. Screening tests are carried out by measuring random glucose, fasting glucose, performing an oral glucose tolerance test, or measuring HbA_{1c}.
2. For risk factors of type 2 diabetes, refer to Chapter 1.
3. Review of recommendations for preventing or delaying the onset of type 2 diabetes includes:

- individuals at high risk should receive education on the importance of a healthy lifestyle in preventing type 2 diabetes,
- those with prediabetes should be advised on a healthy lifestyle, including weight loss of at least 7% per year and maintaining it, along with patient-tailored physical activity (minimum 150 minutes per week) and appropriate diet, with information provided on the effectiveness of such measures in reducing diabetes risk,
- in prediabetic individuals, particularly those with concurrent impaired fasting glucose and impaired glucose tolerance and/or a body mass index (BMI) ≥ 35 kg/m^2, and/or under 60 years of age, as well as women with prior gestational diabetes, pharmacological prevention of type 2 diabetes with metformin should be considered alongside lifestyle modification,
- if non-pharmacological interventions for obesity do not result in adequate weight loss, implementation of pharmacotherapy or bariatric surgery should be considered,
- the benefits of increased physical activity accrue to all individuals, regardless of age, noting the highest effectiveness of such an intervention in those over 60,
- repeating lifestyle advice at each patient visit is crucial for effective prevention of glucose metabolism disorders,
- regular assessments for other cardiovascular risk factors (e.g., obesity, smoking, hypertension, lipid disorders) in those with prediabetes should be conducted, and if present, appropriate treatment should be initiated; treatment goals for comorbid diseases in individuals with prediabetes are the same as for the general population,
- prescribing of diabetogenic medications should be avoided.

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3. Glycemic Monitoring

CHAPTER HIGHLIGHTS
· Most people on intensive multi-dose insulin therapy should self-monitor blood glucose (SMBG) both before and after meals, at bedtime, before planned physical activity, when low glucose is suspected, and before activities where hypoglycemia poses a particular risk (e.g., driving). [**B**]
· As part of a comprehensive educational program, SMBG can assist individuals on less frequent insulin injection regimens [**B**] and those with diabetes not on insulin therapy in making independent therapeutic decisions. [**E**]
· When recommending SMBG, continuous education of individuals with diabetes is crucial, along with periodic assessment of the correctness of self-monitoring techniques, their results, and their impact on therapeutic decisions. [**E**]
· Continuous glucose monitoring (CGM) combined with intensive insulin therapy can be a useful tool for lowering HbA_{1c} in individuals with type 1 diabetes. [**A**]
· CGM may also be beneficial for people with hypoglycemia unawareness and those experiencing recurrent episodes of hypoglycemia. [**B**]

Current monitoring and retrospective assessment of glucose are integral parts of effective diabetes management. Proper self-monitoring of glucose requires systematic education of individuals with diabetes, especially in mastering the use of glucometers and continuous glucose monitoring (CGM) systems, and in interpreting self-monitoring results. This includes using the data to make daily adjustments to diet, physical activity, and doses of anti-hyperglycemic medications. Another essential element of diabetes treatment monitoring is the regular measurement of glycated hemoglobin (HbA_{1c}), and for those using CGM systems, the analysis of glycemic control reports.

I. Self-monitoring of glucose

Self-monitoring of blood glucose is an integral part of diabetes treatment.

Individuals with diabetes treated with multiple daily insulin injections or via continuous subcutaneous insulin infusion should use CGM systems, which increase the safety and effectiveness of insulin therapy and improve the comfort of life and the quality of care for people with diabetes.

The use of glucose monitoring systems is particularly advisable for individuals with type 1 diabetes with a history of unstable glycemia levels, with coexisting frequent episodes of hypoglycemia and lack of awareness of it, as this improves the safety and effectiveness of treatment.

Self-monitoring of blood glucose is also recommended to achieve therapeutic goals in individuals treated with single insulin injections, oral anti-hyperglycemic drugs, and/or GLP-1 receptor agonists (Table 3.1). All individuals with diabetes, regardless of the treatment method, should check their glycemia more frequently in case of ill health or a sudden deterioration in health.

For proper self-monitoring of blood glucose, individuals with diabetes should be trained in the use of a blood glucose meter, CGM system, interpretation of results, and further actions (Figure 3.1).

For glycemic control, it is recommended to use glucometers that present plasma glucose levels as the test result, and which have a declared determination error of no more than 15% for glucose concentrations ≥ 100 mg/dl (5.6 mmol/l) and 15 mg/dl (0.8 mmol/l) for glucose concentrations < 100 mg/dl (5.6 mmol/l), as confirmed in publications and manufacturer's materials. In patients taking ≥ 4 measurements per day, it may be helpful to analyze the results using a computer program dedicated to this purpose. Monitoring the accuracy of glucose meter measurements, along with assessing the correctness of their use, should be carried out when abnormalities are suspected and at least

Table 3.1. Recommended frequency of self-monitoring of blood glucose using a glucometer.

Diabetes treatment	Frequency of glycemic measurements
Multiple (i.e., at least 3 times a day) insulin injections, intensive functional insulin therapy, regardless of diabetes type.	Multiple measurements per day (i.e., at least 4 times a day, recommended 8 times a day) according to established treatment regimen and patient needs.
People with type 2 diabetes treated with fixed doses of insulin.	Daily 1-2 glucose measurements, additionally once a week a shortened glucose profile (fasting and postprandial) and once a month a 24-hour glucose profile.
People using non-insulin antihyperglycemic drugs.	Once a week a shortened glucose profile or measurements depending on the patient's clinical needs.

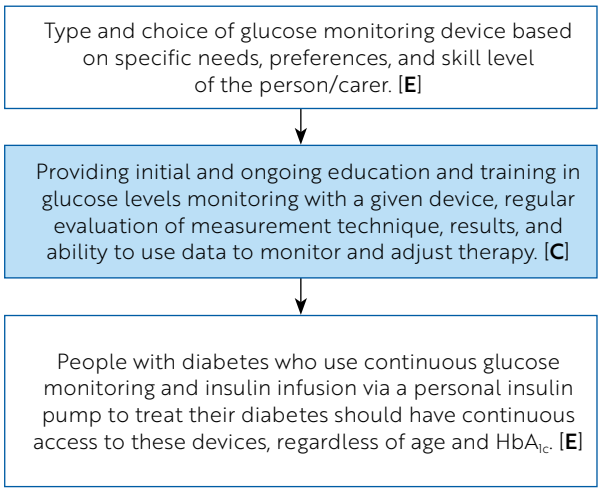

Figure 3.1. Recommendations for individualizing the approach to glucose levels monitoring [10]

once a year at the facility at which the person with diabetes is treated on an outpatient basis. The control should consist of glucose determinations on the same material with a glucometer using a comparative method - laboratory - or point of care testing (POCT) consistent with the laboratory method. The difference in results should not exceed the above-mentioned limits of acceptable error.

Tables 3.2 and 3.3 present examples of substances that can disrupt the reading of glucose concentration using blood glucose meters and CGM systems.

Table 3.2. Examples of substances that can interfere with blood glucose readings using glucometers [10]

Glucose oxidase strips
Uric acid
Galactose
Xylose
Acetaminophen
L-DOPA
Ascorbic acid
Glucose dehydrogenase strips
Icodextrin (used in peritoneal dialysis)

II. Hemoglobin A_{1c} (HbA_{1c})

The hemoglobin (HbA_{1c}) reflects the average blood glucose levels over the approximately 3 months preceding the measurement, and approximately 50% of the HbA_{1c} present in the blood is formed in the last month prior to the measurement.

HbA_{1c} should be measured once a year in people with well-managed diabetes achieving treatment goals. HbA_{1c} should be performed at least quarterly in individuals who do not achieve treatment goals, or those in whom a change in treatment has been made.

HbA_{1c} should be measured using analytical methods certified by NGSP (http://www.ngsp.org). It is possible to perform HbA_{1c} measurements

Table 3.3 Examples of substances that can interfere with glucose readings using CGM systems [10]

Substance	System	Result
Acetaminophen > 4 g/day Any dose	Dexcom G6 Medtronic Guardian	Higher sensor readings than actual glucose levels. Higher sensor readings than actual glucose levels.
Alcohol	Medtronic Guardian	Sensor readings may be higher than actual glucose levels.
Ascorbic acid > 500 mg/day (vit. C)	Freestyle Libre	Higher sensor readings than actual glucose levels.
Hydroxyurea	Dexcom G6, Medtronic Guardian	Higher sensor readings than actual glucose levels.
Mannitol	Senseonics Eversense	Discrepancy between sensor measurements and actual glucose levels within therapeutic drug concentration ranges.
Tetracycline	Senseonics Eversense	Discrepancy between sensor measurements and actual glucose levels within therapeutic drug concentration ranges.

outside the laboratory, in POCT mode, provided that the method and analyzer certified by NGSP are used. Diagnostic laboratories report the HbA_{1c} result as a percentage (%) and in SI units.

While interpreting the HbA_{1c} levels, interfering factors such as changes in erythrocyte survival time, hemoglobinopathies, chemical hemoglobin modifications, which may hinder or prevent their use, should be considered.

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4. Therapeutic Diabetes Goals

CHAPTER HIGHLIGHTS
• In individuals with diabetes, the overall goal for glycemic control, expressed as an HbA_{1c} is no more than 7.0% (53 mmol/mol). [**A**]
• Low-density lipoprotein cholesterol (LDL-C) levels < 55 mg/dl (< 1.4 mmol/l) and a reduction of at least 50% from the baseline in individuals with diabetes at very high cardiovascular risk, and as a secondary goal, reducing non-high-density lipoprotein cholesterol (non-HDL-C) levels < 85 mg/dl (< 2.2 mmol/l). [**A**]
• LDL-C levels < 70 mg/dl (1.8 mmol/l) and a reduction of at least 50% from the baseline in individuals with diabetes at high cardiovascular risk, and as a secondary goal, reducing non-HDL-C levels < 100 mg/dl (< 2.6 mmol/l). [**A**]
• LDL-C levels < 100 mg/dl (< 2.6 mmol/l) in individuals with diabetes at moderate cardiovascular risk, and as a secondary goal, reducing non-HDL-C levels < 130 mg/dl (< 3.4 mmol/l). [A]
• Recommended blood pressure ≤ 130/80 mm Hg. [**A**]

I. General remarks

1. Therapeutic goals for diabetes should be understood as the achievement of targets for blood glucose, blood pressure, lipids, and body weight.
2. In the elderly individuals and in the presence of comorbidities, if the life expectancy is less than 10 years, the criteria for glycemic control should be adjusted downwards to a degree that will not impair the patient's quality of life.
3. In modern diabetology, there is a principle of far-reaching individualization of goals and intensification of therapy. In each person with diabetes, especially type 2 diabetes, when setting goals and choosing a therapeutic strategy, one should consider the patient's attitude and expected involvement in treatment (also from their surrounding), the degree of risk of hypoglycemia and its potential consequences (more serious in the elderly, with impaired cardiovascular and/or nervous systems), the duration of diabetes, life expectancy, the presence of serious vascular complications of diabetes and significant co-

morbid diseases, the level of education of the person with diabetes, and the benefit-risk ratio of achieving specific therapeutic target values. In some situations (e.g. in the presence of advanced complications, elderly age), the established treatment goals should be achieved gradually, over a period of 2 to 6 months.

II. Glycemic targets

General goals: HbA_{1c} ≤ 7% (≤ 53 mmol/mol).

Individual goals:

1. HbA_{1c} ≤ 6,5% (≤ 48 mmol/mol):
   - in relation to type 1 diabetes, when striving for the goal is not associated with an increased risk of hypoglycemia and a deterioration in quality of life – fasting glycemia and pre-meal, also in self-monitoring: 70-110 mg/dl (3.9-6.1 mmol/l), and 2 hours after starting a meal in self-monitoring 140 mg/dl (7.8 mmol/l),
   - in the case of short-term type 2 diabetes (duration < 5 years),
   - in children and adolescents – regardless of the type of disease, when striving for the goal is not associated with an increased risk of hypoglycemia and a deterioration in quality of life.

When assessing the glycemic profile in relation to the target HbA_{1c}, one should be guided by the converter provided in Table 4.1, relating the HbA_{1c}

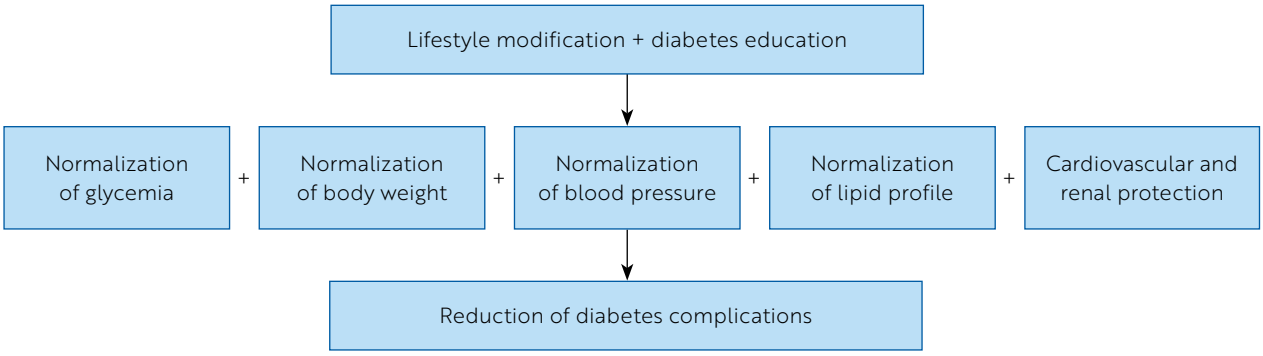

Figure 4.1. A holistic approach to strategies leading to the reduction of the risk of diabetes complications

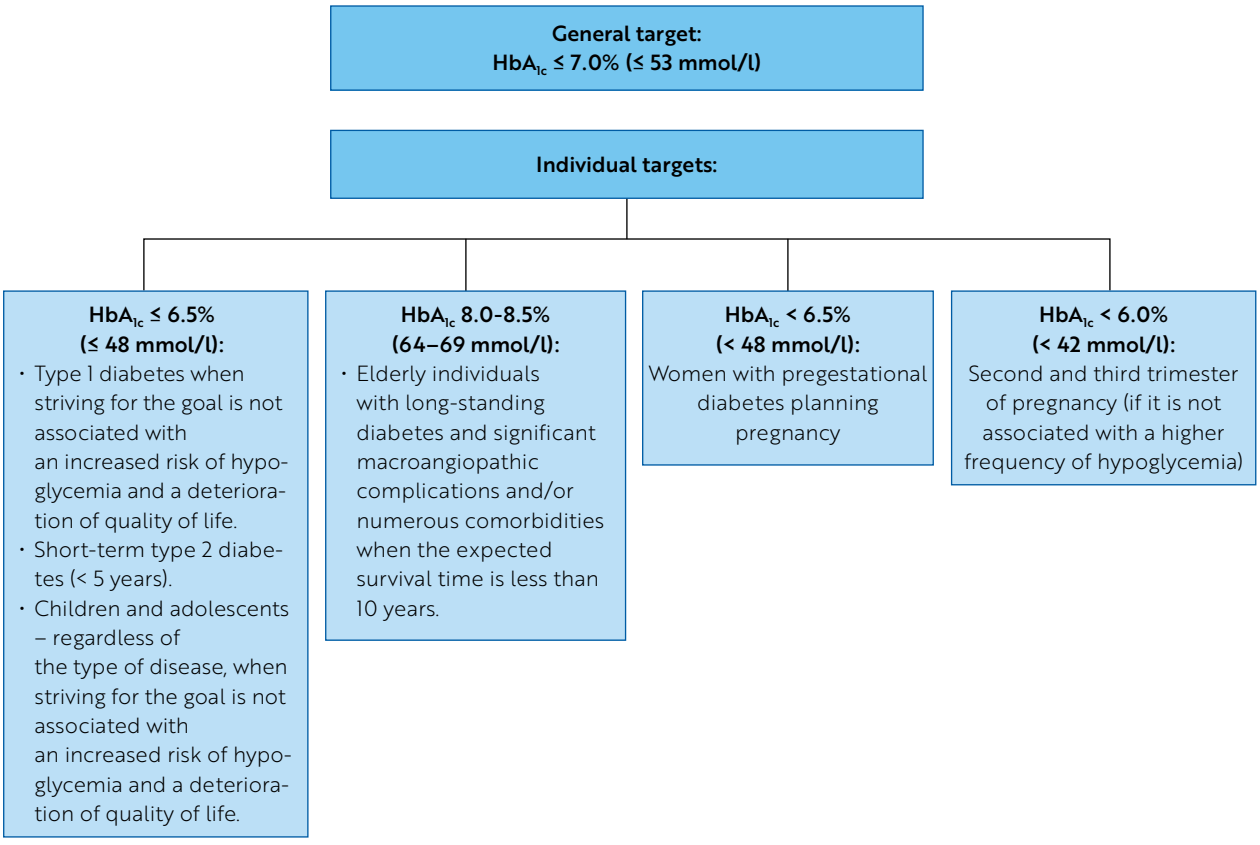

Figure 4.2. Glycemic targets

Table 4.1. The relationship between HbA_{1c} and average plasma glucose level [7]

HbA_{1c}	Average plasma glucose levels [mg/dl]	Average plasma glucose levels [mmol/l]	Average fasting glucose levels [mg/dl]	Average pre-prandial glucose levels [mg/dl]	Average postprandial glucose levels [mg/dl]
6,0	126	7.0			
< 6.5			122	118	144
6.5-6.99			142	139	164
7.0	154	8.6			
7.0-7.49			152	152	176
7.5-7.99			167	155	189
8.0	183	10.2			
8.0-8.5			178	179	206
9.0	212	11.8			
10.0	240	13.4			
11.0	269	14.9			
12.0	298	16.5			

Correlation between HbA_{1c} and mean glycemic values 0.92.

Table 4.2. Target glycemic parameters in people with type 1 and type 2 diabetes and pregnant women using a continuous glucose monitoring system on a regular basis [1]

	TIR		TBR		TAR	
	% of readings; time per day	Target values	% of readings; time per day	Values below target	% of readings; time per day	Values above target
Type 1 diabetes / Type 2 diabetes	> 70%; > 16 hours, 48 minutes	70-180 mg/dl (3.9-10.0 mmol/l)	< 4%; < 1 hour < 1%; < 15 minutes	< 70 mg/dl (< 3.9 mmol/l) < 54 mg/dl (< 3.0 mmol/l)	< 25%; < 6 hours < 5%; < 1 hour, 12 minutes	> 180 mg/dl (> 10.0 mmol/l) > 250 mg/dl (> 13.9 mmol/l)
Elderly/ individuals at high risk of hypoglycemia	> 50%; > 12 hours	70-180 mg/dl (3.9-10.0 mmol/l)	< 1%; < 15 minutes	< 70 mg/dl (< 3.9 mmol/l)	< 50%; < 12 hours < 10%; < 2 hours, 24 minutes	> 180 mg/dl (> 10.0 mmol/l) > 250 mg/dl (> 13.9 mmol/l)
Pregnant women with type 1 diabetes	> 70%; > 16 hours, 48 minutes	63-140 mg/dl (3.5-7.8 mmol/l)	< 4% < 1 hour < 1% < 15 minutes	< 63 mg/dl (< 3.5 mmol/l) < 54 mg/dl (< 3.0 mmol/l)	< 25% < 6 hours	> 140 mg/dl (> 7.8 mmol/l)

TAR – time above range: hyperglycemia, TBR – time below range: hypoglycemia, TIR – time in range

to the average daily and range of blood glucose levels.

2. HbA_{1c} value 8.0-8.5% (64-69 mmol/mol) – for elderly individuals with long-standing diabetes and significant complications of macroangiopathy (a history of heart attack and/or stroke) and/or numerous comorbidities, when the expected survival time is less than 10 years; if a person with diabetes over the age of 65 is expected to live longer than 10 years, while realizing general treatment goals, one should aim for a gradual diabetes management, adopting a target HbA_{1c} value of ≤ 7%;
3. HbA_{1c} value < 6.5% (48 mmol/mol) in women with pregestational diabetes planning pregnancy, and < 6.0% (42 mmol/mol) in the second and third trimesters of pregnancy, if it is not associated with a higher frequency of hypoglycemia.

In patients using a continuous glucose monitoring (CGM) system, one of the fundamental parameters for assessing diabetes management should be the time in range (TIR). Detailed recommendations regarding TIR depending on the type of diabetes are presented in Table 4.2.

III. Lipid targets:

- LDL-C levels < 55 mg/dl (< 1.4 mmol/l) and a reduction of at least 50% from the baseline in people with diabetes at very high cardiovascular risk,
- LDL-C levels < 70 mg/dl (1.8 mmol/l) and a reduction of at least 50% from the baseline in people with diabetes at high cardiovascular risk,
- LDL-C levels < 100 mg/dl (2.6 mmol/l) in individuals at moderate cardiovascular risk (young individuals < 35 years of age with type 1 diabetes without chronic complications and other cardiovascular risk factors, or individuals with type 2 diabetes < 50 years of age, with a diabetes duration of < 10 years, without other risk factors),
- non-HDL cholesterol levels < 85 mg/dl (2.2 mmol/l) in individuals with diabetes at very high cardiovascular risk,
- non-HDL cholesterol levels < 100 mg/dl (2.6 mmol/l) in individuals with diabetes at high cardiovascular risk.
- non-HDL cholesterol levels < 130 mg/dl (3.4 mmol/l) in individuals with diabetes at moderate cardiovascular risk.
- triglyceride levels < 150 mg/dl (< 1.7 mmol/l).

IV. Blood pressure targets:

- systolic pressure ≤ 130 mm Hg, if tolerated, but not < 120 mm Hg, [IA]
- diastolic pressure < 80 mm Hg.

For individuals ≥ 65 years of age, maintaining systolic pressure in the range of 130-139 mm Hg is recommended. [IA]

For detailed criteria: see Chapter 13.

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5. Organization of Medical Care for Individuals with Diabetes

CHAPTER HIGHLIGHTS

- Contemporary diabetes management necessitates a multidisciplinary approach that includes the expertise of medical professionals, diabetes educators, and dietitians. Care should be personalized, considering each patient's unique circumstances, needs, and preferences. Furthermore, given the complex nature of diabetes, which often presents with various complications and comorbidities, it is essential for specialists from diverse fields to collaborate closely. [**B**]

I. Outpatient care

Modern diabetes treatment primarily requires competencies in treating, monitoring its effectiveness, and educating people with diabetes to gain the necessary knowledge and motivation to follow recommendations. Cooperation between primary health care physicians (PHC) and specialist care physicians is also necessary.

I.1. Primary health care goals

Health promotion, identification of risk factors, prevention of carbohydrate metabolism disorders, and education on prediabetes and type 2 diabetes.

1. Diagnosis of carbohydrate metabolism disorders.
2. Referral to a diabetes clinic for continuous treatment in case of:
- type 1 diabetes,
- other specific types of diabetes,
- when diagnosis of type of diabetes is in doubt,
- any type of diabetes in children and adolescents, women planning pregnancy and pregnant women.
3. Treatment of prediabetes.
4. Treatment of type 2 diabetes, including insulin regimen that requires the patient to use basal insulin in combination with other non-insulin antihyperglycemic medications.
5. Referral for diabetologist consultation (less frequently for continuous treatment) in case of:
- not achieving therapeutic goals; referral primarily for intensification of insulin therapy,
- occurrence of comorbidities complicating treatment,
- occurrence of diabetes complications,
- occurrence of pharmacotherapy complications,
- other special situations.

I.2. Specialist health care goals:

- reviewing the treatment outcomes and setting treatment targets for people with diabetes managed in PHC as part of annual check-up,
- management of people with diabetes treated with injections (insulin, GLP-1 receptor agonists),
- management of people with diabetes treated with continuous subcutaneous insulin infusion (CSII),
- conducting differential diagnosis of types of diabetes, including monogenic diabetes and diabetes associated with other diseases,
- diagnosis, prevention, and management of people with diabetes in terms of late complications,
- diabetes education,
- diagnosis and management of diabetes in women during pregnancy,
- diagnosis and treatment of comorbidities with diabetes,
- annual check-up in accordance with the current recommendations of the Diabetes Poland (Table 5.1).

II. Specialized inpatient care

1. Cases of newly diagnosed type 1 diabetes and type 2 diabetes with clinical symptoms of hyperglycemia, when outpatient treatment is not possible.
2. Acute complications of diabetes (severe, recurrent hypoglycemia and hyperglycemia, diabetic ketoacidosis, and comas).
3. Aggravation of chronic complications.
4. Modification of the therapy scheme for patients who cannot achieve therapeutic goals in outpatient settings.
5. Implementation of intensive insulin therapy using a personal insulin pump and/or continuous

Table 5.1. Recommendations for monitoring adults with diabetes

Parameter	Comments
Dietary and therapeutic education	At every visit.
Physical examination, blood pressure measurement, and body weight	At every visit.
HbA_{1c}*	Once a year, more often if there is doubt in maintaining normoglycemia or if there is a need to verify the effectiveness of treatment after its modification.
Serum total cholesterol, HDL and LDL cholesterol, triglycerides	Once a year, more frequently in case of dyslipidemia.
Albuminuria	Once a year in people not treated with ACE inhibitors, AT1 receptor antagonists, SGLT2 inhibitors, GLP-1 RA, or ns-MRA (in case of type 1 diabetes 5 years after the onset)
Urinalysis (with urine sediment examination)	Once a year.
Serum creatinine and calculation of eGFR	Once a year (in case of type 1 diabetes 5 years after the onset).
Serum creatinine, sodium, potassium, calcium, phosphorus	Every six months in people with elevated serum creatinine.
Fundoscopic exam	In people with type 1 diabetes 5 years after the onset; in people with type 2 diabetes – from the moment of diagnosis (details: see Chapter 20).
Examination of the feet for diabetic neuropathy	Once a year at very low risk of wound formation (details: see Chapter 22).

**More often in people with badly managed diabetes after anti-hyperglycemic treatment adjustment.*

glucose monitoring system; when outpatient treatment is not possible.

6. Implementation of insulin therapy in gestational or pre-gestational diabetes not previously treated with insulin when outpatient treatment is not possible.
7. Difficulties in achieving normoglycemia in pregnant women with pre-gestational diabetes when outpatient treatment is not possible.

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6. Behavioral Therapy

CHAPTER HIGHLIGHTS
· All individuals with diabetes should be educated on the general principles of proper nutrition in diabetes by health care professionals (doctor, dietitian, diabetic nurse, diabetes educator) using various methods and techniques, including telemedicine. Detailed dietary recommendations should be individualized based on the patient's needs and capabilities. [**A**]
· Continuous Glucose Monitoring (CGM) systems play a very important educational role in optimizing the diet, especially in terms of the glycemic effect of meals, in all types of diabetes. [**B**]
· The primary macro-nutrient in the diet that determines postprandial insulin requirements is carbohydrates. A key element of dietary education for individuals with type 1 diabetes should be training in the recognition and estimation of carbohydrate content in meals for optimal insulin dosing. Individuals with type 2 diabetes should be educated about portion control and the proportion of carbohydrates in individual meals and the overall diet. [**A**]
· There is no universal diet for all individuals with diabetes. Optimal macro-nutrient proportions for this patient group should be established individually, considering age, physical activity, the presence of diabetes complications, additional diseases, and the dietary preferences of the person with diabetes. [**E**]
· Physical activity, due to its multifaceted benefits, is an integral part of proper, comprehensive management in the treatment of diabetes. To achieve the optimal effect, physical activity should be regular, undertaken at least every 2-3 days, but ideally daily. [**A**]
· Individuals with diabetes should limit the time spent without breaks in a seated position. [**B**]

Behavioral therapy is a necessary element of treatment for all individuals diagnosed with diabetes (both type 1 and type 2) at any age. Proper nutrition and physical activity are crucial in improving overall health and in the prevention and treatment of chronic diabetes complications. All individuals with diabetes should be educated on the general principles of proper nutrition in diabetes by authorized persons (doctor, dietitian, diabetic nurse, diabetes educator) using various methods and techniques, including interactive methods and telemedicine. The treatment of individuals with diabetes should consider a therapeutic lifestyle that includes a varied diet, regular physical activity, avoiding smoking and alcohol consumption, optimal sleep time, and avoiding stress. Education about a therapeutic lifestyle, tailored to the needs and capabilities of individuals with diabetes, allows for the achievement of the therapeutic goal and reduces the costs associated with the treatment of diabetes complications.

It should be emphasized that one of the priorities of behavioral treatment of diabetes, regardless of its type, should be maintaining the proper body weight of the person with diabetes.

Medical nutrition therapy

I. General recommendations

The goal of dietary treatment for individuals with diabetes is to achieve and maintain:

- proper (normoglycemia) blood plasma glucose levels to prevent diabetes complications,
- optimal serum lipid and lipoprotein levels,
- optimal blood pressure values to reduce the risk of vascular diseases,
- desired body weight.

Dietary treatment includes guidelines on:

- individually calculated caloric intake,
- distribution of calories among daily meals,
- food sources providing necessary energy, vitamins, minerals, and phytochemicals,
- products of which consumption should be limited.

When planning a diet, individual nutritional and cultural preferences, age, gender, physical activity level, and economic status should be considered. An important part of dietary education should be practical information delivery, allowing direct application in daily life. Meal consumption is an important aspect of life comfort and quality for people with diabetes, and they should be informed about the wide range of individual diet choices and composition. Information on the need to limit or eliminate certain foods should be directed to individuals only in specific situations, for example when the reduction is scientifically justified. Dietary education should be provided at diagnosis and patient knowledge on dietary treatment of diabetes should be annually examined with possible re-education.

Dietary management strategy for individuals with diabetes should include:

- assessment of usual eating habits,
- nutritional diagnosis,

- setting plan and targets of dietary intervention,
- nutritional intervention (individual and/or group counseling),
- monitoring eating habits and evaluating therapy effects,
- change of dietary plan if the therapeutic goal is not met.

Individuals with diabetes should be encouraged to follow the principles of proper nutrition for healthy people and additionally to:

- control portion sizes of commonly consumed foods,
- control the quantity of carbohydrates in the overall diet and individual meals,
- limit foods containing easily digestible carbohydrates, including added and free sugars,
- regularly consume meals, including breakfast,
- eat meals at a slow pace.

There is no universal diet for all individuals with diabetes. Various nutritional strategies such as the Mediterranean diet, DASH diet, flexitarian diet, and plant-based diets may be used in diabetes treatment.

These dietary models assume a significant intake of non-starchy vegetables, maximum reduction of added sugars and refined grains, and an increase in minimally processed foods.

Individuals with type 1 diabetes should avoid easily digestible carbohydrates and follow the general principles of a properly balanced diet. Diet assumptions and insulin therapy should be individually determined. Insulin therapy should be adapted to the eating habits of the individual with diabetes, the composition of consumed meals (content of carbohydrates, proteins, and fats), and their lifestyle and physical activity. Recognizing and estimating the content of digestible carbohydrates in a meal, such as in the carbohydrate exchange system (CE), is a priority when developing diet assumptions. The glycemic index (GI) and glycemic load (GL) values can also be helpful in food selection. There is significant variation in individual glycemic responses to consuming the same meal or product (e.g., dairy products). The order of consuming products from different food groups within a meal can significantly affect postprandial glycemia. It is beneficial to consume vegetables and protein-containing products (meat, fish) before starchy products.

For individuals with diabetes in the oldest age groups, dietary education should be simple and understandable. The diet should be individualized, ensuring adequate protein intake.

Although carbohydrates are the primary macronutrient determining postprandial insulin requirements, individuals with type 1 diabetes should also be educated on the glycemic effect of proteins and fats. Continuous glucose monitoring systems are effective tools for assessing the impact of the quantity and quality as well as mutual proportions of dietary macronutrients on glycemia.

Dedicated applications can also facilitate postprandial glycemia control. Their selection should be primarily based on indications and recommendations from leading diabetes associations.

In type 2 diabetes, the primary goals of therapy are maintaining optimal metabolic control of the disease, reducing excess body weight, and maintaining desired body weight. Therefore, besides the above recommendations, the total caloric content of the diet adjusted for age, current body weight, and physical activity is of fundamental importance. The energy deficit should be individually established to allow for slow, systematic body weight reduction (about 0.5-1 kg/week). A reduction in body weight of at least 5%/year compared to the initial weight brings measurable improvement in glycemic control, but ideally, the body weight reduction should be at least 7%/year. A daily caloric deficit of 500-750 kcal is considered safe.

Weight reduction can be achieved by using diets with reduced caloric value and different macronutrient proportions (proteins, fats, carbohydrates), but long-term use of diets with significantly reduced carbohydrate intake and fasting is not recommended. All individuals with diabetes and overweight/obesity are advised to control portion sizes.

II. Detailed recommendations

Diet composition.

1. Carbohydrates:

- there is insufficient scientific evidence to determine one optimal amount of carbohydrates for individuals with diabetes,
- carbohydrates should make up about 45% of total energy; if they come from low GI products and are high in fiber, their proportion may be increased (up to 60%); high carbohydrate intake should be recommended for very physically active individuals, whereas a lower intake of less than 45% (25-44%) might be temporarily recommended for those with limited physical activity, e.g., due to coexisting diseases,,
- the main source of carbohydrates should be whole grain products, especially those with a low GI (< 55),

- the primary limitation should be on simple carbohydrates (mono- and disaccharides), which individuals with diabetes should minimize; it's also recommended to limit added sugars and free sugars, primarily from sugar, sweets, as well as honey, juices, and fruit drinks,
- sweeteners should be consumed in moderation, within the manufacturer's recommended doses,
- daily fructose intake should not exceed 50 g; it's advised not to use fructose as a sugar substitute,
- The minimum daily fiber intake should be 25 g or 15 g/1000 kcal of diet; efforts should be made to increase fiber intake by including at least 2 servings of whole grain products and 3 servings of high-fiber vegetables; if the recommended amount of dietary fiber cannot be met, fiber supplements should be considered, especially soluble fiber. It is advisable to increase the supply of resistant starch (a fiber fraction) in the diet.

2. Fats:
- in the dietary treatment of diabetes, the fat content should be similar to those without diabetes and can range from 25% to 40% of the dietary energy value,
- the quality of fat is more important than the total amount; with high fat intake, the proportion of different types of fatty acids is especially important,
- saturated fats should account for less than 10% of the dietary energy value
- polyunsaturated fats should account for about 6-10% of the dietary energy value
- dietary cholesterol should not exceed 300 mg/day, and for those with dyslipidemia < 200 mg/day,
- to lower LDL-C levels, the intake of saturated fats should be reduced and/or replaced with low-glycemic-index carbohydrates and/or monounsaturated fats,
- for individuals with hypercholesterolemia, introducing foods containing 2-3 g/day of plant sterols/stanols can be beneficial
- trans fatty acid isomers intake, especially from processed foods, should be limited to the maximum,
- vegetable fats are recommended, except for palm and coconut fats.

3. Proteins:
- the amount of protein should be set individually; there is no evidence of adverse effects of high-protein diets in the dietary treatment of diabetes; for most people with diabetes, as in the general population, the energy from protein should be 15-20% (about 1-1.5 g/kg body weight/day); for individuals with type 2 diabetes and excessive body mass, a reduced-calorie diet containing 20-30% protein provides greater satiety and helps with weight reduction and maintenance; patients with chronic kidney disease should maintain a protein intake of about 0.8-1 g/kg body weight/day,
- there is no need to limit animal protein, although for some, replacing animal protein with plant protein (e.g., soy) may be beneficial.

4. Vitamins and minerals:
- supplementation with vitamins or minerals is not recommended for those without deficiencies,
- exceptions are vitamin D_3 (supplementation according to general population guidelines), folic acid (400 µg supplementation for pregnant and breastfeeding women), and vitamin B_{12} for individuals treated long-term with metformin who have confirmed deficiencies,
- multivitamin supplementation may be necessary for elderly individuals, vegetarians, vegans, and those on very low-calorie diets.

5. Alcohol:
- alcohol consumption is not recommended for individuals with diabetes,
- individuals with diabetes should be informed that alcohol inhibits the release of glucose from the liver and thus its consumption (especially without a snack) may lead to hypoglycemia,
- the consumption of pure ethyl alcohol (in equivalent) should not exceed 20 g/day for women and 30 g/day for men.

Alcohol should not be consumed by individuals with dyslipidemia (hypertriglyceridemia), neuropathy, and a history of pancreatitis.

6. Sodium:
- the amount of sodium (from all sources – products and seasoning) should not exceed 5 g/day (2300 mg of sodium/day),
- greater sodium intake restrictions are recommended for those with sodium-sensitive hypertension, in line with DASH diet principles, although data on reducing sodium intake below 1500 mg/day in individuals with diabetes are ambiguous.

Dietary recommendations for individuals with diabetes in special situations, such as during pre-

gnancy, for children and adolescents, or for those with advanced nephropathy, are provided in the relevant chapters. Detailed practical guidelines on the dietary treatment of diabetes can be found in the Recommendations of the Polish Society of Dietetics, which are accessible on their website www.ptd.org.pl.

Physical activity

Physical activity, due to its multifaceted benefits, is an integral part of proper, comprehensive diabetes management. It enhances insulin sensitivity, improves glycemic control, lipid profile, aids weight reduction, and positively affects mood, including in those with depression.

1. Principles of engaging in physical activity:
- initial recommendations should be moderate and based on the individual capacity for exercise,
- for optimal effects, physical activity should be regular, at least every 2-3 days, preferably daily,
- when starting intensive physical activity, perform warm-up exercises lasting 5-10 minutes, followed by calming exercises at the end,
- physical activity can increase the risk of severe or delayed hypoglycemia,
- alcohol can heighten the risk of post-exercise hypoglycemia,
- one should pay attention to preventing dehydration in high temperature conditions,
- it is important to keep in mind the risk of foot damage during exercise (especially with coexisting peripheral neuropathy and lowered pain threshold), the need for foot care and comfortable footwear.

2. Intensity of physical activity.

The doctor decides the appropriate intensity based on the full clinical picture.

An appropriate form of exercise in people with diabetes (with co-morbid overweight/obesity) of any age is nordic walking.

The most appropriate form of exercise in people with type 2 diabetes aged > 65 years and/or overweight is brisk (up to breathless) walking, 3-5 times a week (about 150 minutes/week).

Individuals without significant contraindications, especially in younger age groups, should be encouraged to engage in increased physical activity, including sports. Such individuals require additional education about the glycemic effect caused by different types of physical activity (e.g., aerobic, resistance, interval training).

An excellent tool to facilitate glycemic control before, during and after physical activity are continuous glucose monitoring systems, used both in real time and for retrospective assessment of the effects of exercise and therapeutic interventions undertaken on glycemia.

Dedicated applications can also facilitate glycemia control before, during and after exercise; their selection should primarily follow indications and recommendations from leading diabetes societies.

A simple yet effective recommendation is to limit uninterrupted sitting time, especially for adults with type 2 diabetes, aiming to avoid sitting for longer than 30 minutes continuously for glycemic benefits.

3. Risks of physical activity in people with diabetes.

Physical activity without proper preventive measures can result in hypoglycemia or, less frequently, hyperglycemia and metabolic decompensation in individuals with diabetes. Guidelines for peri-exercise management to avoid extreme glycemic values are presented in Chapter 7.

Moderate and intense physical activity may negatively impact the overall condition of patients in certain clinical situations such as:
- proliferative diabetic retinopathy – the risk of hemorrhagic events within the vitreous body of the eye that may lead to retinal detachment,
- diabetic kidney disease – increased albumin excretion and proteinuria,
- autonomic neuropathy – presence of orthostatic hypotonia,
- the risk of myocardial ischemia.

4. Physical activity in the COVID-19 pandemic.

It's important to note that individuals with diabetes should maintain the recommended level of physical activity regardless of the epidemiological situation. When restrictions due to the epidemiological context limit movement or access to sports facilities, alternative forms of physical activity that can be performed within existing constraints, such as at home, should be sought. Because this may involve changes to the nature of the exercise and its glycemic effects, as well as necessary precautions, each such situation requires consultation with the leading physician.

Tobacco control

For any current or past smoker, it is important to determine:
- age at the time the person started smoking,
- the duration of smoking,
- the number of cigarettes smoked daily,
- whether there have been any attempts to stop smoking and how long they lasted,

- the time at which the person with diabetes stopped smoking.

Counseling:

- raising awareness of the risks of smoking and the use of e-cigarettes to people with diabetes who have not previously smoked,
- persuading people to stop smoking altogether and use e-cigarettes,
- supporting a person with diabetes in the decision to stop smoking,
- psychological support and, if necessary, also pharmacological support,
- discussion about smoking at each medical visit,
- written annotation in medical records if a person with diabetes refuses to stop smoking.

Sleep

Proper sleep hygiene is an essential element of a healthy lifestyle. In patients with diabetes, the duration/quality of sleep can be disrupted due to the pathophysiology of the disease, behavioral factors, and treatment-related factors. On the other hand, poor sleep quality and inappropriate duration can lead to a worsening of metabolic control. Care for the right duration/quality of sleep should be an important part of diabetes treatment, and it can be aided by guidelines concerning the timing and quality of the last meal, self-monitoring of glycemia (with appropriate alarm settings for patients using CGM), avoiding factors that lead to hyperglycemia/hypoglycemia, and preferring treatments that ensure stabilization and optimization of nocturnal glycemia.

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7. Physical Activity and Glycemic Management

CHAPTER HIGHLIGHTS
• Individuals with type 1 diabetes without clinically significant chronic diabetes complications can undertake any kind of physical activity, including those of maximum intensity. [**E**]
• Aerobic efforts carried out until shortness of breath are safe and can be recommended to all people with diabetes without contraindications. [**B**]
• People with type 2 diabetes are advised to add resistance exercise elements to aerobic exercises. [**B**]
• Severe hypoglycemia is a contraindication for undertaking physical activity for 24 hours. [**E**]
• Post-exercise hypoglycemia can occur up to 24 hours after the end of physical activity. [**B**]
• Proliferative retinopathy is a contraindication to undertaking physical activity until stabilization of the retinal image is achieved. [**E**]
• Hyperglycemia > 250 mg/dl without confirmed ketonemia and/or ketonuria is not a contraindication to undertaking physical activity, provided the patient feels well and knows the cause of the hyperglycemia. [**E**]
• The rules for undertaking effort in competitive sports and during competitions differ significantly from amateur sports and require individually developed solutions. [**E**]

I. Recommended duration and intensity of physical activity

The undertaking of physical activity by a person with diabetes should be assessed by a diabetologist based on the assessment of the person's activity level (type, time, intensity of effort), any contraindications, and their expectations, knowledge, and skills in the prevention of hypoglycemia and previous training. For individuals with type 2 diabetes over the age of 65 and/or overweight, as well as patients who have had a cardiovascular incident and with cardiovascular diseases, it is recommended to monitor the pulse and assess the intensity of physical activity using the Borg scale. The ranges of heart rate and intensity of physical activity can be determined during an electrocardiographic exercise test. In this group of patients, aerobic effort (until shortness of breath) is safe and should be recommended for at least 150 minutes per week. Obese individuals are advised to engage in 200-300 minutes of physical activity per week, leading to an energy deficit of 500-750 kcal/day. Younger individuals with diabetes (without significant contraindications) are recommended to engage in daily intensive physical activity, including active sports participation.

II. Contraindications to physical activity

Contraindications to recreational sports are discussed in Chapter 6. The diabetologist's decisions may require consultations with other specialists, including an ophthalmologist, cardiologist, nephrologist, and neurologist.

Annex 7 of the Diabetes Poland recommendations includes contraindications for participation in training and sports competitions.

III. Glycemia monitoring during physical activity

In physically active individuals treated with insulin, the use of continuous glucose monitoring systems (CGM) is recommended. The therapeutic

team's task is to assist in selecting a CGM, educate on the interpretation of results, individual programming of higher hypoglycemia alarm thresholds, and securing the CGM during sports. In the case of self-monitoring of glycemia using a glucometer, blood glucose should be measured up to 15 minutes before starting physical activity, during it, and after completing physical activity. Informing accompanying persons about the diabetes during physical activity significantly facilitates self-monitoring of glycemia.

IV. Hypoglycemia and hyperglycemia in relation to physical activity

Changes in glycemia during physical activity are illustrated in Figure 7.1.

Severe hypoglycemia is a contraindication to engaging in physical activity for 24 hours.

In case of a hypoglycemia alert ≤ 70 mg/dl, it is recommended to consume simple carbohydrates, preferably in liquid form, and physical activity can be continued after the symptoms of hypoglycemia subside.

In case of severe hypoglycemia in a person with type 1 diabetes, the action of glucagon after intense physical activity may be weaker, but an attempt should always be made to administer the drug.

Post-exercise hypoglycemia can occur up to 24 hours after the end of physical activity, and the risk of their occurrence is higher in untrained individuals and those engaging in physical activity irregularly. This group of individuals should particularly apply the prevention of nocturnal hypoglycemia.

Anaerobic effort may cause hyperglycemia and correcting it with rapid-acting insulin should be cautious due to the risk of hypoglycemia occurring several hours after the end of physical activity.

If there is hyperglycemia > 250 mg/dl and additionally ketonuria and/or ketonemia ≥ 1.5 mmol/l are detected, physical activity is contraindicated.

If hyperglycemia > 250 mg/dl is not accompanied by ketonuria and/or ketonemia, and/or the cause of the hyperglycemia is known, light to moderate exercise may be undertaken.

V. Undertaking physical activity by an individual with type 2 diabetes not on insulin regimen

In individuals with diabetes who are not on insulin regimen or sulfonylurea derivatives, there is a very low risk of hypoglycemia. Blood glucose levels < 100 mg/dl do not require the consumption of additional carbohydrate servings. Self-monitoring of glycemia in connection with physical activity should only be performed periodically.

Regular physical activity improves insulin sensitivity and thus increases the chance of delaying the start of insulin therapy. An important complement to aerobic training is the addition of resistance strength exercises. It is recommended to load large muscle groups and perform 8-12 repetitions 2-3 times a week.

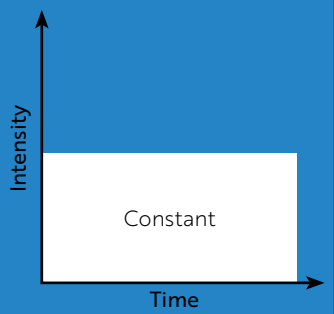
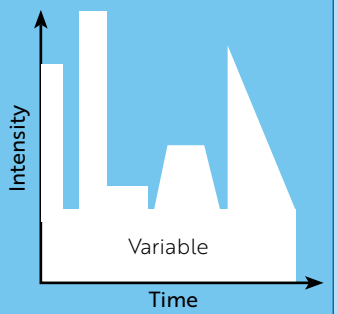
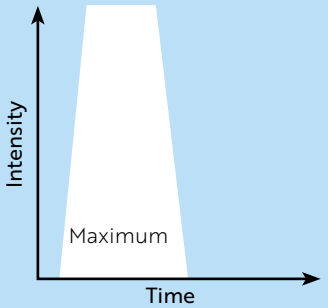
Type of exercise	Aerobic Examples: walking, nordic walking, light cycling, jogging	Mixed (aerobic-anaerobic) Examples: team games, fast-paced running, swimming, interval cycling	Anaerobic Examples: sprints, strength training with maximum load
Intensity			
Heart rate range	< 55 (60) % HR_{max}	60–75 (80) % HR_{max}	> 75 (80) % HR_{max}
Borg scale	7-11	12-15	16-20
Expected change in glycemia	Decrease	Decrease and/or increase	Increase
Risk of hypoglycemia	High	Increased	Low

Figure 7.1. Types of physical activity and their impact on glycemia changes

VI. Undertaking physical activity by an individual on insulin regimen

Physical activity undertaken up to 2 hours after the administration of a rapid-acting insulin analog requires a reduction in the insulin dose if the physical activity lasts at least 30 minutes.

The bolus reduction can range from 25-75% and depends on the timing and intensity of the physical activity.

Physical activity requires the consumption of an additional portion of carbohydrates in the amount of:

- 1.0-1.5 g/kg body weight per hour of intense physical activity during the peak action of an insulin bolus that has not been reduced,
- 0.2-0.5 g/kg body weight per hour of intense physical activity during the peak action of an insulin bolus that has been reduced or that was administered more than 2 hours before starting physical activity

Detaching the insulin pump during physical activity is recommended for up to 3 hours. The condition for detaching the insulin pump is the presence of active insulin, the amount of which should be monitored using a bolus calculator.

A reduction of NPH or long-acting analog basal insulin should be considered during multi-hour or all-day endurance effort. A preceding reduction in the dose of ultra-long-acting insulin analogs can be considered before multi-day activities.

During treatment with an insulin pump, it is recommended to reduce the basal insulin flow by 20–80%, depending on the intensity and duration of the effort, preferably 2 hours before starting it.

VII. Undertaking physical activity by individuals on a hybrid closed-loop system

The use of a hybrid closed-loop system during physical activity requires the patient to make multiple decisions and modify the therapy. Separate education in this area is indicated.

Recommended therapy modifications:

- setting a higher target glucose level 90-120 minutes before starting physical activity lasting longer than 30 minutes, especially for aerobic exercise,
- meals consumed up to 2 hours before exercises require a reduction in the insulin dose by 25-75%,
- intake of additional portions of carbohydrates:
  - they should not be entered into the system,
  - it is recommended to consume carbohydrates 5–10 minutes before starting the exercises, and these amounts will usually be smaller than in the case of therapy using a traditional insulin pump,
  - consuming carbohydrates earlier than 20 minutes before physical activity will cause the hybrid closed-loop system to increase insulin delivery, which may result in hypoglycemia;
- suspending insulin delivery:
  - if the insulin pump is detached during physical activity, it is necessary to suspend the pump's operation,
  - stopping the pump for longer than 90-120 minutes may require an additional dose of insulin using a pen or insulin pump.

VIII. Undertaking physical activity by women with hyperglycemia during pregnancy

It is recommended that all women with hyperglycemia during pregnancy and postpartum (without medical contraindications) engage in physical activity during this time. Moderate physical activity contributes to the reduction of the percentage of gestational diabetes, pregnancy hypertension, preterm births, and cesarean sections.

Aerobic physical activity of moderate intensity is recommended for at least 150 minutes per week (3-4 times a week – exercise time 30-60 minutes). Exercises should be performed with an intensity less than 60-80% of the maximum heart rate for the mother's age, most often not exceeding 140 beats per minute. It is also possible to perform static aerobic exercises and muscle strengthening. Adding stretching exercises may also be beneficial.

Preferred physical activities include walking, stationary cycling, dancing, water aerobics, stretching exercises, and lifting light weights. Lifestyle change and physical activity are essential components of management in gestational diabetes mellitus (GDM) and may be sufficient therapeutic management for many women.

In patients treated with insulin for pregestational diabetes mellitus (PGDM), physical activity requires a reduction in the dose of basal insulin and/or insulin boluses, considering the principles applicable before pregnancy.

Undertaking additional physical activity (beyond daily activity) requires consultation with a gynecologist.

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8. Psychological Management in Diabetes

CHAPTER HIGHLIGHTS
• The mental state of the individual with diabetes should be assessed at the onset of diabetes treatment and then at each medical visit. [**B**] Depression often co-occurs with diabetes and significantly increases the risk of developing diabetes complications. [**A**]
• In individuals with diabetes, the presence of anxiety symptoms, addiction, eating disorders, and a weakening of cognitive processes should be assessed. These conditions can significantly weaken adaptation to the disease. [**B**]
• Psychological and social care should be integrated with an approach focused on cooperation with the patient and available to all individuals with diabetes to optimize treatment outcomes and quality of life. [**A**]

The mental state of the person with diabetes (his/her well-being) affects almost all aspects of the therapeutic management. Improper adherence to recommendations is very often associated with psychological problems, which require diagnosis and appropriate psychotherapeutic interventions. Therefore, education that merely involves transferring information about prescribed treatment and recommended behavior is ineffective. The mental state of the person with diabetes should be assessed at the start of diabetes treatment and then during each medical visit. The use of appropriately prepared questionnaires and tests for this purpose is recommended.

I. Psychological assistance should include:

- appropriate communication technique with the patient,
- constant assessment (monitoring) of their mental state and adherence to medical recommendations, as well as psychological interventions.

II. The individualized approach aims to:

- consider the patient's psychosocial situation and determine a treatment plan that, in their opinion, is possible to follow in their current life situation (which is important in establishing an optimal and simultaneously realistic therapy strategy),
- develop motivation for optimal management,
- avoid scaring the person with diabetes with the consequences of not properly fulfilling medical recommendations, which in most cases is both ineffective and counterproductive,
- apply an optimal method of education based on psychological diagnosis.

III. Assessment of mental state (psychological diagnosis) in medical practice for diabetes patients:

1. Social and psychological (life) situation.
2. Quality of life of the individual with diabetes.
3. Attitudes, beliefs, and concerns, as well as responsibilities associated with diabetes – unwarranted fears and concerns can weaken the ability to cope with the disease. Ask the following question: To what extent are you worried about the future and the possibility of developing serious complications? Answers: 0 – it's not a problem, 1 – it's a minor problem, 2 – it's a moderate problem, 3 – it's quite a serious problem, 4 – it's a serious problem. Three points or more indicate a significant risk of developing psychosocial problems.
4. Sense of control over the course of the disease – a lack of proper sense of influence over the course of diabetes leads to the use of coping styles with stress associated with the disease, characterized by avoiding thinking about the disease and/or reducing emotions caused by the fact of the disease.
5. Assessment of coping style with the disease – there is a decrease in the tendency to seek an optimal strategy for coping with the disease and a style focused on solving problems caused by the disease.
6. Assessment of depressive symptoms – depression often co-occurs with diabetes and significantly increases the risk of developing diabetes complications:
   - use free online tools for screening diagnosis of depression, e.g., Well-Being Index (WHO-5, www.who-5.org; a score ≤ 12 indicates screening for depression) or Patient Health Questionnaire (PHQ-9, www.phqscreeners.com/overview.aspx; a score ≥ 7 indicates the need for further diagnosis towards depression)
   or
   - ask two questions: In the last month, have you often been bothered by feeling down, depressed, or hopeless? In the last month, have you often been bothered by little interest or pleasure in doing things? A positive response to one of the questions has a sensitivity of 97% and a specificity of 67% in diagnosing depression. In such a case, refer the patient for psychiatric consultation.
7. Assessment of anxiety symptoms, addiction, eating disorders, weakening of the level of cognitive processes – these can significantly hinder adaptation to diabetes.

IV. Psychological interventions in a person with diabetes include:

- developing a sense of control over the course of the disease by:
  - » providing patient-understandable information about the disease and its treatment,
  - » joint formulation of goals and therapeutic plans that are, in their opinion, realistic,
  - » gradually achieving the optimal level of adherence to recommendations (strategy of small steps),
  - » helping in case of failures in implementing the established plans (so that the patient knows the doctor will help determine the cause of failure and will not have a negative attitude towards them);
- shaping and maintaining a problem-solving-oriented coping style with diabetes.

V. Clinically severe depression and psychiatric consultation

The occurrence of clinically severe depression (depressive episode, dysthymia) and other mental disorders requires psychiatric consultation. In the case of adaptive disorders related to adjusting to the disease, psychotherapeutic interventions can be undertaken by the primary care physician or specialist. In more difficult cases, the help of a clinical psychologist or psychotherapist may be needed.

VI. Teamwork

A consistent attitude of the entire therapeutic team is an essential condition for the effectiveness of therapy. Effective communication among team members is necessary. In diabetes clinics, a psy-

chologist is an essential member of the specialist treatment team.

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9. Therapeutic Education

CHAPTER HIGHLIGHTS
· Education and continuous re-education of all individuals with diabetes are key elements of effective disease management and efficient prevention. [**A**]
· Every person with diabetes, as well as their caregivers, should have assured and guaranteed access to diabetes education to acquire the necessary knowledge and skills for self-managing the disease. [**A**]
· The key goals of education are to achieve clinical effects, optimize metabolic control and health status, and improve the well-being and quality of life of the patient and their family. Goals should be measured during routine visits. [**C**]
· There are four critical moments to assess the need for self-monitoring, education, and support to promote/acquire skills in implementing a treatment plan, medical nutritional therapy, and the well-being of a person with diabetes: at diagnosis, annually and/or when treatment goals are not being met, when complicating factors of the disease develop (medical, physical, psychosocial), and when there are changes in the patient's life and care. [**E**]
· Structured (also at the national level), regularly evaluated, and methodologically improved educational programs are required. [**B**]
· Tailoring education to the individual needs of the person with diabetes and their family. [**B**]
· The coordinated stand of an interdisciplinary therapeutic team, consisting of a physician, nurse/midwife, diabetes educator, dietician, psychologist, social worker, IT specialist and others, has a positive impact on metabolic control and psychological aspects of treatment. [**B**]
· Education incorporating digital capability and digital self-management interventions can be an effective method of providing knowledge and support for diabetes self-management. [**B**]

I. General recommendations

- Education targeted at individuals at risk of developing diabetes, with prediabetes, and treated for diabetes, as well as their caregivers and families, is an integral part of treatment and should be regularly conducted during medical and nursing visits, including midwifery appointments, and regularly updated according to patient needs.
- An educational program, coordinated with therapy, is created with the active participation

of the patient and their family, and the interdisciplinary therapeutic team.
- The key goals of education are to provide knowledge and support the patient in self-management of the disease, lifestyle modification, healthy eating, physical activity, so as to improve their health, minimize the risk of acute and chronic complications of the disease, and improve well-being.
- Behavioral strategies should be used to support diabetes self-management and engagement in health behaviors (e.g., medication adherence, use of technology in therapy, physical activity, healthy eating) to promote optimal health outcomes in diabetes.
- The most effective educational programs are those tailored to the individual experiences and needs of the participants.
- The therapeutic team collaborates with the patient's surrounding, ensuring continuity of care, confidentiality of information, and conveying the latest therapeutic recommendations.
- The person carrying out the education is responsible for checking the degree of achievement of the planned educational effects.

II. Detailed recommendations

- Integrating diabetes self-management education with health-promoting habits.
- Conducting simultaneous individual and group education (6-10 people) by a trained team. It is important to educate not only the person with diabetes but also their family, caregivers, children, elderly adults, and pregnant women.
- Introducing and utilizing digital teaching methods, such as tele-education (including webinars and mobile applications). Remote methods should complement and support traditional forms of education.
- Setting individual therapeutic goals in educational programs is crucial.
- Diabetes education for children, adolescents, and young adults should be age-appropriate and adapted to their level of intellectual development.
- Programs for seniors and their caregivers should meet their needs, with an emphasis on reducing the risk of complications.

III. Framework educational program for individuals with diabetes

- Emotional support: help in accepting the diagnosis, strengthening motivation, developing autonomy and self-determination.
- Individual therapeutic goals: tailoring goals to the particular context of the patient's diabetic life.
- Medical foundations: information about the disease, treatment, medication action, and self-monitoring techniques.
- Principles of a healthy lifestyle: concerning nutrition – practical advice on eating habits (nutrition therapy) and its impact on glucose changes; the role of physical activity – motivation for regular exercises and their impact on health and metabolic control of diabetes; sleep; oral hygiene; intimate life; substance use; smoking; risky behaviors – explanation of the impact of appropriate actions to maintain good health.
- Self-control: techniques for monitoring health indicators, including target glucose values, time in target range, glycated hemoglobin, lipid levels, blood pressure, body weight, well-being.
- Glucose monitoring: benefits of continuous glucose monitoring, selection of CGM systems for an individual with diabetes (pros and cons), ability to interpret data from CGM.
- Pharmacotherapy: insulin administration and other subcutaneous medications, and information on types of devices (insulin pumps, injectors, CGM systems) – their advantages and disadvantages.
- Technique and comprehensive management of injectors (pens), CGM systems, insulin pumps, medical applications.
- Education and implementation of the planned insulin therapy model.
- Interpretation of self-monitoring data as well as glucose alarms and trends.
- Diabetes complications: recognition, treatment, and prevention.
- Four key special situations: 1) at diagnosis; 2) when treatment goals are not being met; 3) when additional factors arise: infections, co-existing diseases, vaccinations, risky behaviors, contraception; 4) when changes occur in the patient's life: pregnancy planning, pregnancy, travel, time zone changes.
- Psychological support: how to cope with the new challenge of having diabetes and burnout related to living with diabetes; diabetes care teams should implement screening protocols that may include attitude towards diabetes and the risk of family members becoming ill, expectations regarding treatment and its outcomes, general and diabetes-related mood,

stress, depression, eating disorders, and/or quality of life.
- Vaccinations: the role, importance, and types of vaccinations in diabetes.
- Social rights: information about the rights of people with diabetes.
- Using healthcare: principles for patient preparation for visits (including device memory readings, data transmission, formulating a health problem), regularity of visits, and adherence to medical recommendations.
- Additional resources: current information on clinical trials, new drugs or new technologies, and support for people with diabetes.

IV. Organizational recommendations

- Education time: depending on the treatment model – 5-11 hours of education, with 9-11 hours for those using insulin therapy; each person with diabetes may require individually determined education time, including the unique educational needs of children, elderly people, their caregivers, and pregnant women.
- Re-education and assessment: periodic, annual assessments of the knowledge of patients and their caregivers performed both in person and electronically.
- Personalization: the number of visits and time of education are determined according to the individual needs of the patient and their caregivers.
- Diabetes education school requires the preparation of a framework program consistent with current diabetes care guidelines and incorporating systematic meetings/webinars as part of the diabetes school.
- Team and funding: Education should be funded separately, in parallel with treatment.
- Communication: Emphasis should be placed on professional relationships between the therapeutic team and the patient, caregivers, and building full trust.
- Accessibility of procedures: In the place of education; maintaining clear and accessible educational procedures.

V. Standards (requirements) of the facility providing education.

- Educational infrastructure: a thoroughly equipped educational room that will enable the achievement of the set goals and the attainment of diabetes education outcomes.
- Documentation and monitoring: comprehensive educational documentation including the framework training program, individual educational plans for patients, information about the person coordinating education, and the scope of duties of employees, along with periodic (preferably annual) checking of patient knowledge and collecting feedback.
- Quality assessment and evaluation: quality assessments of education made by patients and their caregivers; these should be part of evaluation programs conducted at least once a year.
- Communication within the therapeutic team: outlining mechanisms for consulting educational decisions within the therapeutic team and ensuring the continuity of information flow regarding therapeutic goals and progress in education.
- Professional development and support for the therapeutic team: the employer facilitates and creates favorable conditions for raising professional qualifications and self-education of members of the diabetes therapeutic team, including those employed as diabetes educators.

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10. Type 1 Diabetes

CHAPTER HIGHLIGHTS
· The recommended treatment model is intensive functional insulin therapy using multiple subcutaneous insulin doses or continuous subcutaneous insulin infusion (CSII) administered by a personal insulin pump, with the greatest effectiveness in optimizing metabolic control and improving quality of life being characterized by hybrid closed-loop insulin pumps (HCL). [**A**]
· A key element of type 1 diabetes therapy is the individuals' ability to adjust insulin doses based on the carbohydrate content of meals, initial glycemia, and planned physical activity. Knowledge of the impact of proteins and fats on glycemia is also important for the optimization of insulin dosing. [**E**]
· In individuals with type 1 diabetes, the use of insulin analogs is preferred due to the lower risk of hypoglycemia and greater quality of life. [**A**]
· For those using continuous glucose monitoring systems (CGM), one of the fundamental parameters for assessing diabetes management should be the time in range (TIR), optimally over 70%. [**E**]
· All therapeutic decisions regarding the treatment of type 1 diabetes should be made in consultation with the individual with diabetes and after obtaining their acceptance. [**E**]

I. Type 1 diabetes treatment

1. Individuals with type 1 diabetes absolutely require insulin treatment. Insulin therapy should be maintained even during periods of disease remission.
2. The recommended treatment model is intensive functional insulin therapy using multiple subcutaneous insulin injections or continuous subcutaneous insulin infusion (CSII) administered via a personal insulin pump. A requirement for effective treatment is properly conducted education (according to the guidelines in Chapter 9), enabling a person with diabetes to modify insulin doses independently on the basis of systematically performed self-monitoring of blood glucose levels using a glucometer or other devices registered for this purpose (according to the guidelines in Chapter 3). Treatment of adults with type 1 diabetes with a personal insulin pump should be administered by physicians experienced in therapy with such pumps. It is recommended to have a certificate from the Pump School of the Diabetes Poland.
   In individuals with type 1 diabetes, being on insulin analogs is preferred because of their lower risk of hypoglycemia and greater comfort.
3. In insulin therapy for type 1 diabetes, it is important to optimize insulin dosage. Prolonged use of supra-physiological amounts of insulin without diagnosing the causes of high demand for the hormone and attempting to act causally – aside from justified cases (additional disease, medications that increase insulin demand, stress) – may lead to adverse metabolic consequences, as well as excessive weight gain.
4. A key element of type 1 diabetes therapy is the individuals' ability to modify insulin doses depending on the carbohydrate content of meals, initial glycemia, and planned physical activity. For optimizing insulin dosing, it is also important to understand the impact of proteins and fats on glycemia, although this is less significant in the case of using hybrid closed loop (HCL) insulin pump.
5. The use of continuous glucose monitoring systems (CGM) is the preferred method of self-monitoring in type 1 diabetes.
6. Particularly effective is the combination of CSII and CGM technologies in devices that automatically suspend insulin delivery in hypoglycemia or impending hypoglycemia (predictive insulin suspension) and in HCL pumps that autonomously normalize hyperglycemia as well.
7. HCL pumps can be used at any stage of diabetes treatment, regardless of the individuals' previous technological experience. Although there is a positive correlation between the initial degree of metabolic control and the results obtained using HCL pumps, it should be noted that significant glycemic improvement can be expected in every individual with type 1 diabetes regardless of the results obtained before implementing this technology. It must be emphasized that for many individuals with type 1 diabetes who for various reasons cannot achieve good or even acceptable glycemic control, the use of HCL may be the only way to improve metabolic control and limit the risk of disease complications.
8. Devices operating on a similar principle to HCL are pumps based on the open APS (arti-

ficial pancreas system), known as DIY (do it yourself) pumps. Thanks to such systems, many people can significantly improve metabolic control, but it should be emphasized that these are not certified systems, and the individuals with diabetes bears the responsibility for using them.

9. Individuals treated with semi-automatic pumps (predictive insulin suspension), HCL pumps, or DIY systems require appropriately specialized education that considers the specificity of these devices. One of the clinically important differences is the management of hypoglycemia, in which case smaller amounts of glucose (5-15 g) are usually sufficient for normalization of glycemia.
   When implementing HCL pumps in individuals with no prior experience with CSII, focus should be on issues related to the operation of the pump in hybrid mode, principles of switching to manual mode in emergency situations, and technical matters. Training in other issues, important when treating with traditional insulin pumps, which will not be applied in HCL, should be minimized. From the individual education perspective using HCL, it is important to emphasize that with these devices, the administration of a mealtime bolus is based on estimating the carbohydrate content of the meal. There is no need for precise estimation of proteins, fats, or calories in the meal.
10. Telemedicine is an important tool for optimizing diabetes control. For all individuals with type 1 diabetes, the therapeutic team should work with the individual to develop a system that allows for an effective remote medical visit. The development of such a system should be based on individual's education and encouraging them to use appropriate technological solutions. Remote medical visits for persons with type 1 diabetes can be both a part of regular diabetes care and used in an epidemiological emergency.
11. Medications that, in combination with insulin therapy, can lead to improved glycemic control and weight reduction in type 1 diabetes are SGLT-2 inhibitors and GLP-1 receptor agonists, but medications in this group are not currently registered for adjunctive treatment of type 1 diabetes. In some individuals with type 1 diabetes and features of insulin resistance, the possible use of metformin may be associated with some clinical benefit.
    The general principles of antihyperglycemic management in individuals with type 1 diabetes are shown in Figure 10.1.
12. At every stage of treatment, a person with type 1 diabetes must be provided with psychological counseling. The diabetologist in charge of the individual's treatment should refer the patient for psychological consultation both at the individual's request and personally proactively offer him/her such consultation if necessary, keeping in mind that psychological problems can affect up to half of individuals with type 1 diabetes.

II. Organization of care for an individual with type 1 diabetes

1. From the very beginning of the diagnosis and during the further course of the treatment, a person with type 1 diabetes should be under the care of a specialist diabetologist. This approach ensures continuous cooperation with the educational team (according to the principles given in Annex 8) and access to necessary consultations.
2. Cases of new onset of type 1 diabetes, as well acute complications of diabetes that are difficult to manage, require hospitalization in a reference unit.

III. Treatment goals for type 1 diabetes

1. Metabolic control and maintaining blood glucose levels as close to normal as possible. The primary therapeutic goal is to achieve HbA_{1c} < 7%. Striving for lower HbA_{1c} (≤ 6.5%) is justified if it does not increase the risk of hypoglycemia or worsen the quality of life of the person with diabetes.
2. Achieving treatment goals from the beginning of the disease can prevent the occurrence of acute and chronic complications and enable leading a normal, active family, professional, and social life.
3. For individuals systematically using CGM (Continuous Glucose Monitoring), the primary therapeutic goal is to achieve a high (over 70%) percentage of time spent in the therapeutic range, understood as glycemia values in the range of 70-180 mg/dl. It should be emphasized that one of the priorities of treatment should be the avoidance of hypoglycemia (the permissible time spent at values lower than 70 mg/dl and 54 mg/dl is respectively a maximum of 4% and 1% of the time). The target glycemia parameters for people using CGM are given in Table 4.2.

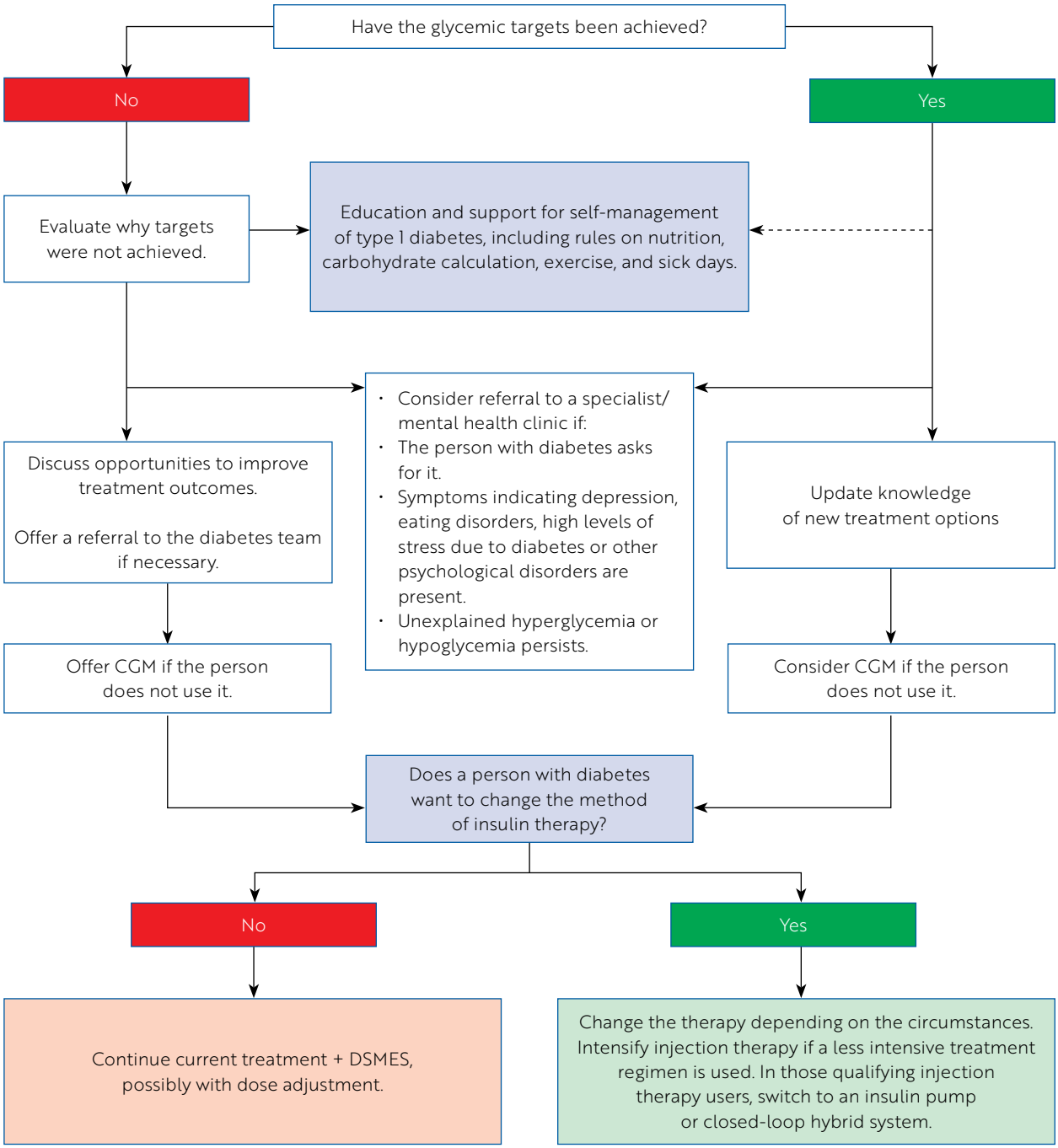

Figure 10.1. General principles of antihyperglycemic management in individuals with type 1 diabetes [12]

4. It should be emphasized that one of the key goals of type 1 diabetes treatment is also to maintain the highest possible quality of life for the individual.

IV. Early detection of chronic complications of diabetes

1. Possible based on screening tests for nephropathy, retinopathy, and diabetic neuropathy. The principles of conducting these tests in people with type 1 diabetes are discussed in Chapters 19, 20, and 21. In people with type 1 diabetes and a long duration of the disease, especially those who became ill at a young age, large vessel disease (diabetic macroangiopathy) may manifest earlier than in the healthy population. This can take the form of coronary heart disease, cerebrovascular disease, or peripheral artery disease. The principles of diagnosis and treatment of coronary heart disease are discussed in Chapter 17, while the approach to stroke and acute coronary syndrome is consistent with those presented in Chapters 18 and 17.1.
2. Diagnosis and treatment of acute complications. A properly educated person with type 1 diabetes must know the principles of managing severe, moderate, and mild hyperglycemia and hypoglycemia and should be able to cope independently in such situations. More severe conditions require medical assistance, in accordance with the principles presented in Chapters 15 and 16. Special situations in people with type 1 diabetes:
   a) a person with type 1 diabetes (metabolically well-balanced) treated with intensive insulin therapy may undergo "one-day" surgery (minor surgical procedures),
   b) in hospital conditions, a person with type 1 diabetes who has previously effectively used advanced technologies such as CGM systems or personal insulin pumps should be able to continue self-treatment based on these systems, provided it takes place under appropriate supervision and the individuals' general condition allows it,
   c) a well-educated individual with type 1 diabetes who has achieved satisfactory treatment results before hospitalization should participate in making therapeutic decisions regarding diabetes treatment in hospital conditions; in selected cases, the individual may conduct this treatment independently, provided that the glycemic therapeutic goals are achieved; the principles of perioperative management in people with type 1 diabetes are presented in Chapter 26,
   d) type 1 diabetes more often than in the general population is accompanied by endocrinopathies, especially autoimmune thyroid diseases (Hashimoto's disease, Graves' disease) and adrenal cortex diseases (Addison's disease), as well as celiac disease, vitamin B_{12} deficiency anemia, and collagen vascular diseases; their coexistence can significantly worsen the course of type 1 diabetes,
   e) a person with type 1 diabetes may have obesity with accompanying indicators of insulin resistance – this increases the daily insulin dose and worsens metabolic control; diagnosis and management in such a situation require specialist diagnosis and treatment,
   f) an increasing problem among young people with type 1 diabetes is eating disorders characterized by bulimia or anorexia as well as a phobia of hypoglycemia; diagnosis and treatment of such conditions require specialist psychiatric treatment in close cooperation with a diabetologist,
   g) an increasing problem among young people, in most cases undiagnosed and causing significant glycemic fluctuations, is the use of narcotics and psychoactive substances,
   h) some older individuals with type 1 diabetes may require liberalization of therapeutic goals; in this case, the main guide should be biological age, not chronological age; in older individuals with type 1 diabetes who are in good biological condition, there should not be a priori a resignation from the continuation of treatment using advanced technologies or the implementation of such treatment; a well-educated person with type 1 diabetes, treated with intensive insulin therapy and metabolically well-balanced, is capable of the same physical activity and achieving similar professional goals as people of similar age without diabetes.

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11. Oral Antihyperglycemic Medications, Injectable GLP-1 Receptor Agonists, and GIP/GLP-1 in Type 2 Diabetes

CHAPTER HIGHLIGHTS
• Pharmacotherapy of type 2 diabetes should be accompanied by comprehensive and structured education, proper nutritional management and planned physical activity. The choice of medications should consider all individual features of the patient, including his or her priorities, lifestyle and health behaviors, comorbidities, motivation, cognitive impairment, and social aspects. [**E**]
• SGLT2 inhibitors (flozines) or GLP-1 receptor agonists, or metformin, should be considered as the first-choice medications for initiating pharmacological treatment in type 2 diabetes. In patients with documented atherosclerotic cardiovascular disease, heart failure, chronic kidney disease, or the coexistence of multiple cardiovascular risk factors, the choice should prioritize the cardiovascular and nephroprotective effects of the drugs. [**A**]
• Combination therapy in newly diagnosed type 2 diabetes should be regarded in patients in the risk groups listed above and in severe hyperglycemia (HbA_{1c} ≥ 8.5%). [**A**]
• If treatment started with monotherapy becomes insufficient to achieve or maintain the target HbA_{1c} value, a second antihyperglycemic drug should be added. This decision should not be delayed for longer than 3-4 months. [**A**]
• In patients with atherosclerotic cardiovascular disease, heart failure, chronic kidney disease, or numerous cardiovascular risk factors, drugs with proven beneficial effects on the risk of progression of these diseases and on total and cardiovascular mortality should be used first when intensifying treatment. [**A**]
• In patients with chronic kidney disease and heart failure, the use of flozins should be recommended, and in case of contraindications to their use, GLP-1 receptor agonists should be prescribed. [**A**]
• In patients with diagnosed atherosclerotic cardiovascular disease or numerous risk factors, the use of both groups of drugs should be considered. Early combined therapy with metformin and/or flozins, and/or GLP-1 receptor agonists should be considered in the above cases for every patient regardless of achieving the therapeutic goal. [**A**]
• All patients with type 2 diabetes should aim to achieve individually defined goals - normoglycemia and body weight. [**B**]
• The progressive nature of type 2 diabetes means that insulin therapy in individually tailored models is recommended for many people with the disease. [**B**]
• All therapeutic decisions regarding the treatment of type 2 diabetes should be made in agreement with the patient and after obtaining their acceptance. [**E**]

Individually tailored pharmacological reduction of hyperglycemia, which is accompanied by behavioral management in the multifactorial treatment of type 2 diabetes (along with treatment of obesity, arterial hypertension, dyslipidemia), is crucial in preventing and slowing the progression of chronic diabetes complications (macrovascular and microvascular).

I. Hyperglycemia reduction

Hyperglycemia is reduced by correcting the pathogenetic mechanisms of type 2 diabetes – insulin resistance, impaired insulin secretion, and impaired incretin effect. A separate therapeutic mechanism of antihyperglycemic drugs is the glycosuric action. The treatment of type 2 diabetes must be progressive and adjusted in stages to the progressive nature of the disease and consider accompanying diseases. If the therapy used at a given stage ceases to be effective (the target HbA_{1c} for a given patient is not achieved), it should proceed to the next stage after 3–4 months. Avoiding therapeutic inertia is one of the foundations of effective treatment of type 2 diabetes.

II. Stages of type 2 diabetes treatment

1. Initiation of therapy:
   - lifestyle modification involving reducing the caloric content of meals and increasing physical activity to a minimum of 30-45 minutes per day to reduce body weight,
   - pharmacological treatment can be initiated through monotherapy or combination therapy; SGLT-2 inhibitors, GLP-1 receptor agonists and metformin should be considered first as first choice medications when initiating pharmacological treatment in type 2 diabetes,
   - GLP-1 receptor agonists and SGLT-2 inhibitors with proven benefits should be preferred in people with cardiovascular diseases, numer-

ous risk factors, or chronic kidney disease; in patients with chronic kidney disease and heart failure, the choice of flozins should be preferred, and in the case of contraindications to their use, GLP-1 receptor agonists should be used; in patients with diagnosed atherosclerotic cardiovascular disease or numerous risk factors, the use of both groups of drugs should be considered; PPAR-γ agonists and saxagliptin should not be used in people with heart failure,

- the therapeutic effectiveness of the implemented oral treatment can be evaluated only after several weeks of use,
- the decision to initiate combination therapy in newly diagnosed diabetes should be particularly considered in patients with a very high cardiovascular risk, and with severe hyperglycemia (HbA_{1c} > 8.5%). In patients in the aforementioned risk groups, the combination model should include an SGLT-2 inhibitor and/or a GLP-1 receptor agonist.

2. Intensification of therapy with oral drugs or GLP-1 receptor agonists, or dual GIP/GLP-1 receptor agonists:

- Lifestyle modification and addition to monotherapy or dual-medication combination therapy of a medication from a class that was not previously used: metformin or SGLT-2 inhibitor, or an incretin drug (DPP-4 inhibitor or GLP-1 receptor agonist, or dual GIP/GLP-1 receptor agonist), or sulfonylurea derivative, or PPAR-γ agonist. The choice of the drug at each stage should consider comorbidities, primarily diagnosed cardiovascular disease and chronic kidney disease, as well as the coexistence of obesity, the risk of hypoglycemia, and the patient's financial ability. Patients with atherosclerotic cardiovascular disease, heart failure, chronic kidney disease, or numerous cardiovascular risk factors, should be prioritized for agents with proven beneficial effects on the risk of progression of these conditions and on total and cardiovascular mortality. This effect has been demonstrated for some SGLT2 inhibitors and some drugs from the group of GLP-1 receptor agonists. Early combined therapy with flozins and/or some GLP-1 receptor agonists, and/or metformin should be considered in the above cases for every patient regardless of achieving the therapeutic goal. Also, in the case of coexisting obesity, preference should be given to GLP-1 receptor agonists or dual GIP/GLP-1 receptor agonists, or SGLT-2 inhibitors. With a high risk of hypoglycemia,

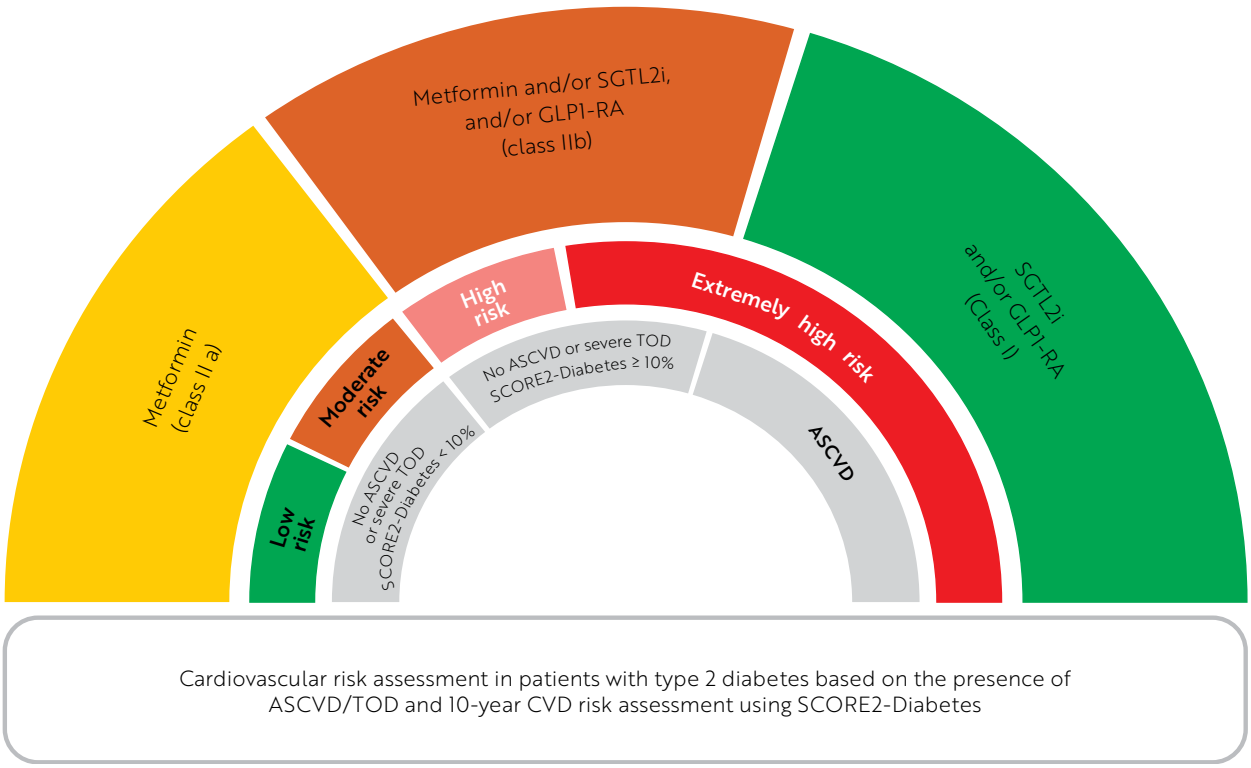

Figure 11.1. Cardiovascular risk categories and recommended antihyperglycemic therapy in patients with type 2 diabetes according to the ESC [13].

Table 11.1. List of drugs used in the treatment of type 2 diabetes*

	Metformin	SGLT-2 inhibitors	GLP-1 receptor agonist	GIP/GLP-1 receptor agonist	DPP-4 inhibitors	Sulfonylurea derivatives	PPAR-γ agonist
Effect/mechanism	Reduction in hepatic glucose production. Increased peripheral sensitivity to insulin	Induction of glycosuria	Increase in insulin secretion dependent on the intensity of hyperglycemia, inhibition of appetite	Increase in insulin secretion dependent on the intensity of hyperglycemia, inhibition of appetite	Increase in insulin secretion depending on severity of hyperglycemia	Increased insulin secretion	Increase in peripheral insulin sensitivity
Strength of hypoglycemic effect	High	High	High	High	Medium	High	High
Beneficial cardiovascular effect		Yes[#, A]	Yes[#]				
Plasma insulin	↓	↓	↑↑	↑↑	↑	↑↑	↓
LDL cholesterol	↓	↔ or ↑	↓	↓	↓ or ↔	↔	↔
HDL cholesterol	↑	↑	↑	↑	↑	↔	↑
Triglycerides	↓	↔	↓	↓	↔	↔	↓
Body weight	↓ or ↔	↓	↓↓	↓↓	↔	↑	↑
Risk of hypoglycemia	↔	↔	↔	↔	↔	↑	↔
Side effects	Gastrointestinal disorders	Infections of the external genital organs, dehydration, especially in older people	Gastrointestinal disorders (nausea, vomiting)	Gastrointestinal disorders (nausea, vomiting)	Significant does not occur	Hypoglycemia, weight gain	Fluid retention (edema), weight gain, increased risk of long bone fractures
Contraindications	Organ failure (heart, brain, liver, kidney**, respiratory), alcoholism		Gastrointestinal neuropathy, history of unexplained episode of acute pancreatitis	Gastrointestinal neuropathy, history of unexplained episode of acute pancreatitis	Hepatic failure	Heart, liver, kidney failure	Heart failure, liver failure, bladder cancer

**Insulin: see chapter 12.*

*** See Table 19.4.*

[#]Proven for some drugs in the class, according to currently published results of randomized trials.

[A]In the case of empagliflozin and canagliflozin, no differences were found in CVOT (Cardiovascular Outcome Trials) studies between doses of 10 and 25 mg for empagliflozin and 100 and 300 mg for canagliflozin.

Individuals with type 2 diabetes previously not treated with pharmacological agents

AT EACH STAGE OF TREATMENT, STRIVE TO ACHIEVE AN INDIVIDUALLY DEFINED GLYCEMIC TARGET AND BODY WEIGHT

Education and behavioral treatment

Atherosclerotic CV disease, heart failure, chronic kidney disease, extremely high CV risk associated with multiple CV risk factors

+

SGLT-2 inhibitor and/or GLP-1 agonist with or without metformin

If HbA_{1c} above target

Consider adding one and then a second drug from a class which has not been used before:

- metformin
- GLP-1 receptor agonist
- SGLT-2 inhibitor
- GIP/GLP-1 receptor dual agonist
- DPP-4 inhibitor
- Sulfonylurea derivatives
- TZD
- basal insulin

–

Monotherapy or dual-drug therapy with metformin and/or another drug

If HbA_{1c} above target

Consider adding one and then a second drug from a class that has not been used before:

- metformin
- GLP-1 receptor agonist
- SGLT-2 inhibitor
- GIP/GLP-1 receptor dual agonist
- DPP-4 inhibitor
- Sulfonylurea derivatives
- TZD
- basal insulin

If HbA_{1c} above target

Basal insulin (if not previously implemented) or a fixed ratio combination formulation of basal insulin and a GLP-1 receptor agonist, or combination insulin therapy with either oral medications or an injectable GLP-1 receptor agonist.

Figure 11.2. Treatment regimen scheme for people with type 2 diabetes previously untreated with pharmacotherapy

CV – cardiovascular system, TZD – thiazolidinediones (PPAR agonist-γ)

Individuals with type 2 diabetes previously treated in a single- or dual-drug model with metformin and/or another drug or drugs

AT EACH STAGE OF TREATMENT, STRIVE TO ACHIEVE AN INDIVIDUALLY DEFINED GLYCEMIC TARGET AND BODY WEIGHT

Education and behavioral treatment

Atherosclerotic CV disease, heart failure, chronic kidney disease, extremely high CV risk associated with multiple CV risk factors

+

Add an SGLT-2 inhibitor or GLP-1 receptor agonist*, if not previously used

If HbA_{1c} above target

Consider adding one and then a second drug from a class that has not been used before:

- metformin
- GLP-1 receptor agonist
- SGLT-2 inhibitor
- dual GIP/GLP-1 receptor agonist
- DPP-4 inhibitor
- Sulfonylurea derivatives
- TZD
- basal insulin

–

Treatment continuation

If HbA_{1c} above target

Consider adding one, and then a second drug from a class which has not been used before:

- GLP-1 receptor agonist
- SGLT-2 inhibitor
- dual GIP/GLP-1 receptor agonist
- DPP-4 inhibitor
- Sulfonylurea derivatives
- TZD
- basal insulin

If HbA_{1c} above target

Basal insulin (if not previously implemented) or a combination formulation with a fixed ratio of basal insulin. and a GLP-1 receptor agonist, or combination insulin therapy with oral medications or an injectable GLP-1 receptor agonist

Figure 11.3. Therapeutic management scheme for people with type 2 diabetes previously treated with a single or dual drug model using metformin and/or another drug or drugs

CV – cardiovascular system, TZD – thiazolidinediones (PPAR agonist-γ)

**Flozins (SGLT-2 inhibitor) or a GLP-1 receptor agonist should be added regardless of the complexity of the model (e.g., triple, and quadruple therapy, complex insulin therapy model) in every patient at very high cardiovascular risk who has not previously received drugs from these groups.*

the same groups of drugs and the DPP-4 inhibitor or PPAR-γ agonist should be considered,
- Lifestyle modification and triple or quadruple drug therapy using drugs with different mechanisms of action from the following groups: metformin, SGLT2 inhibitors, GLP-1 receptor agonists, dual GIP/GLP-1 receptor agonist, sulfonylurea derivatives, DPP-4 inhibitors, PPAR-γ agonist. The choice of drugs at this stage is based on the same considerations as at the earlier stage and on the general principles of antihyperglycemic drug combination.

3. Intensification of treatment with implementation of insulin regimen:
- Lifestyle modification and simple insulin therapy, primarily using basal insulin (NPH insulin, long-acting analog, ultra-long-acting analog; see Chapter 12 for various formulations), with continued administration of metformin and other oral medications or infectable GLP-1 receptor agonist, or a dual GIP/GLP-1 receptor agonist, especially with coexisting obesity. For patients on the first injectable therapy, such as basal insulin or a GLP-1 receptor agonist, intensification is possible by using compound formulations with a fixed ratio of basal insulin and GLP-1 receptor agonist. These formulations can also be the first injectable therapy,
- Lifestyle modification and complex insulin therapy with the recommended continuation of metformin and other oral drugs (metformin, incretin drug, PPAR-γ agonist, SGLT-2 inhibitor) or a GLP-1 receptor agonist in injections, or a dual GIP/GLP-1 agonist, especially with persistent excessive body weight (see Chapter 12).

At every stage of treatment, the goal should be to achieve individually defined glycemic targets, body weight, and other goals of multifactorial therapy.

4. Simplification of the antihyperglycemic treatment model:
- many patients with type 2 diabetes need to reduce the complexity and burden of treatment, particularly insulin therapy, and consider liberalizing the glycemic target; this includes, for example, patients with a high risk of hypoglycemia, cognitive impairment, nonadherence to medication, a short, expected survival time or the negative impact of a complex treatment regimen on quality of life,
- The tool for this type of procedure is to reduce the number of insulin injections and its administered dose by individually tailored combination with non-insulin antihyperglycemic drugs.

The lack of simplification of antihyperglycemic therapy in patients with indications for this type of procedure is a form of therapeutic inertia.

III. List of medications

Medications used in the therapy of type 2 diabetes are presented in Table 11.1.

When selecting therapy and combining drugs, their impact on non-glycemic parameters should be considered (risk of death, cardiovascular diseases, chronic kidney disease, body weight, risk of hypoglycemia, lipid metabolism, etc.) and therapy should be individualized (see Subchapter 4.1.3). Results of randomized clinical trials indicate benefits in terms of reduction in total and cardiovascular mortality as well as cardiovascular and renal endpoints as a result of using certain drugs from the group of GLP-1 receptor agonists and SGLT-2 inhibitors.

IV. Practical algorithm for pharmacotherapy of type 2 diabetes mellitus

The algorithm is shown in Figures 11.2 and 11.3.

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12. Insulin Therapy in Type 2 Diabetes and Other Specific Types of Diabetes

CHAPTER HIGHLIGHTS
· For individuals with type 2 diabetes, insulin analogs are preferred due to the lower risk of hypoglycemia. [**A**]
· Type 2 diabetes is progressive. The accumulation of pathophysiological disturbances underlying it, especially the β-cell defect, necessitates the gradual intensification of treatment, including the initiation of insulin therapy. [**B**]
· The use of CGM (Continuous Glucose Monitoring) systems improves the effectiveness and safety of insulin therapy. [**B**]

I. Indications for initiating insulin treatment in type 2 diabetes:

- newly diagnosed diabetes (with the possibility of returning to the typical algorithm and discontinuing insulin): blood glucose ≥ 300 mg/dl (16.7 mmol/l) with concurrent clinical symptoms of hyperglycemia,
- ineffectiveness of treatment without insulin (HbA_{1c} exceeding target values despite therapy intensification) (Figure 12.1).

II. Indications for changing the current antihyperglycemic treatment method

Shift from oral antihyperglycemic drug therapy to insulin combination therapy when glycemic control is found to be uncontrolled:

- confirmation of a continued state of hyperglycemia,
- poor tolerance of oral medications,
- unsuccessful attempts to eliminate potentially fixable causes of hyperglycemia, such as:

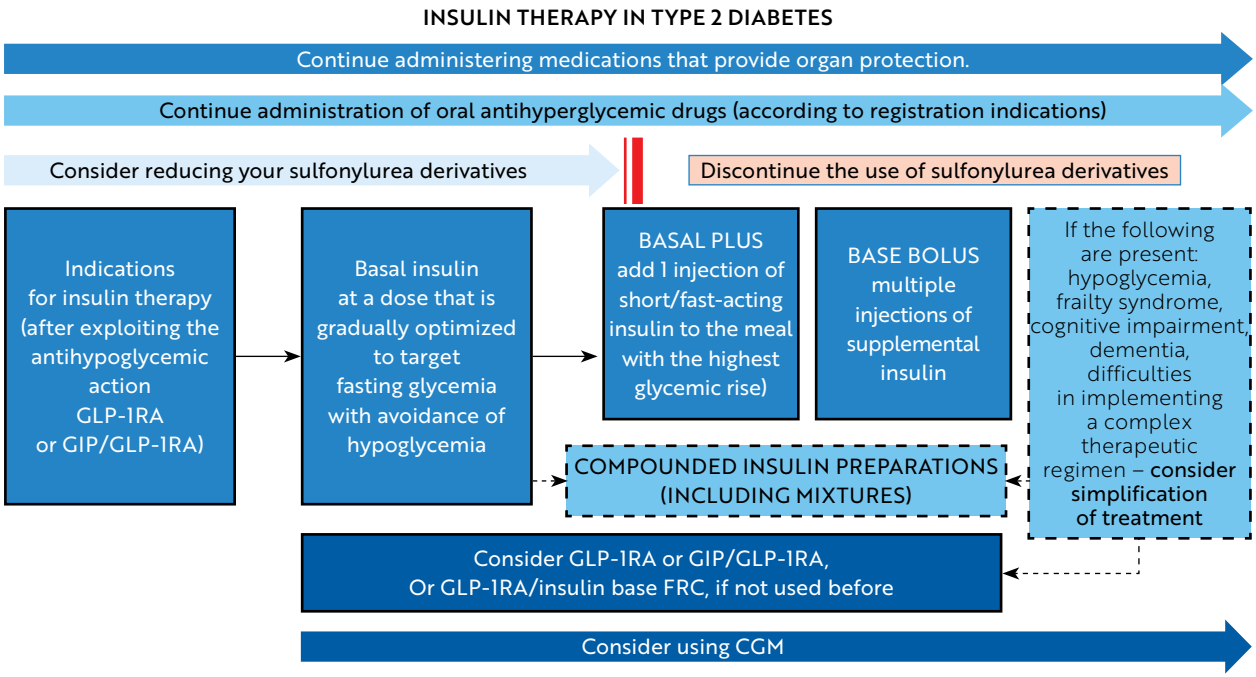

Figure 12.1. Practical algorithm for insulin treatment of type 2 diabetes. Models for initiation and intensification of insulin therapy

  - » dietary errors,
  - » insufficient physical activity,
  - » irregular intake of oral antihyperglycemic drugs (lack of cooperation),
  - » infections,
  - » incorrect dosage of oral medications,
- utilization of the antihyperglycemic potential of GLP-1 receptor agonists, which should be the first injectable therapy in type 2 diabetes (considering the financial possibilities of the patient and drug tolerance).

III. Indications for starting insulin therapy regardless of glycemic values:

- diabetes associated with cystic fibrosis,
- carriers of mutations in insulin genes and double mutation in glucokinase gene,
- reasonable request of the patient.

IV. Indications for temporary insulin therapy:

- diabetes decompensation due to temporary causes (infection, trauma, corticotherapy, etc.),
- surgical procedure (see Chapter 26),
- stroke (see Chapter 18),
- percutaneous transluminal coronary angioplasty procedure (PTCA),
- acute coronary syndrome,
- other severe conditions requiring hospitalization in an intensive care unit.

V. Algorithm of insulin therapy in type 2 diabetes

1. Long-acting analog insulin or NPH isophane insulin in a single injection:
   - for morning hyperglycemia – in the evening; the use of long-acting analogs reduces the risk of nocturnal and severe hypoglycemia,
   - for fasting normoglycemia and daytime hyperglycemia – in the morning (multiple injections of a short-acting/fast-acting insulin preparation for postprandial hyperglycemia are also to be considered).
2. The initial dose of basal insulin is 0.1-0.2 units/kg body weight or 10 units.
3. In some cases, when the introduction of insulin has been delayed for too long, as a result of which the patient develops severe hyperglycemia and the HbA_{1c} value significantly exceeds the therapeutic target (usually by 1.5% or more), the introduction of more intensive models of insulin therapy can be considered immediately (see Section 6.), which should be particularly considered in patients of relatively young age and long expected survival. The final choice of agent should be individual, considering the patient's preferences, daily activity, number of meals and cost of therapy.
4. Oral antihyperglycemic drugs and injectable incretin drugs can be used according to registration in people treated with insulin:

- continued therapy with drugs with proven cardiovascular risk-reducing effects is recommended,
- in cases of coexisting overweight or obesity, combination therapy with an SGLT-2 inhibitor or incretin drug (receptor agonist for GLP-1, dual GIP/GLP-1 agonist or DPP-4 inhibitor) with metformin should be preferred,
- in all patients, the goal should be to maintain metformin therapy as long as it is tolerated and there are no contraindications to its continuation.

5. Glycemic control reviewing over 4-5 days with gradual dose increases of 2-4 units based on self-monitoring results until time in range is achieved.
6. In the case of basal insulin requirements > 0.3-0.5 IU/kg per day and lack of glycemic control, and the situations described in point 3, treatment intensification can be considered by:
   a) gradually adding short-acting insulin/fast-acting analog injections to basal insulin (given 1 or 2 times a day), initially with the meal after which glucose levels rise the most, and then with the following meals ("basal plus", intensive insulin therapy). Recommended initial doses of post-meal insulins are 4 units or 10% of the daily dose of basal insulin,
   b) inclusion of an injectable GLP-1 receptor agonist or a dual GIP/GLP-1 agonist, if not already used, including a fixed ratio combination (FRC) formulation, with a fixed ratio of basal insulin and GLP-1 receptor agonist (this preparation may be the first injectable therapy),
   c) use of complex insulin preparations, i.e. insulin mixtures, including analogs.

   At this stage of therapy, discontinuation of insulin-stimulating drugs should be considered.
7. When using high doses of insulin, more than 100 IU per day (proving insulin resistance), the reasons for this should be considered and the potential for side effects should be considered. It is recommended to try to reduce the degree of insulin resistance by using 72-96-hour subcutaneous or intravenous continuous insulin infusion.

VI. Intensive insulin therapy

Intensive insulin therapy is implemented according to similar principles in all types of diabetes with multiple insulin injections per day or using a personal pump for continuous subcutaneous insulin infusion.

1. Principles of intensive insulin therapy:
- the use of CGM or multiple blood glucose readings per day,
- independent decision-making by the patient on modification of insulin dose and possible additional doses depending on the glycemia, caloric intake and physical activity,
- accurate determination of individualized target glycemic values,
- proper therapeutic and nutritional education and motivation of the patient,
- the possibility of quick communication between the patient and the therapeutic team,
- In type 2 diabetes, subcutaneous insulin delivery using a personal insulin pump is not a standard procedure.

2. Algorithms for multiple injections:
- short-acting insulin or rapid-acting analogue before meals, and
- long-acting insulin analogue or isophane insulin (NPH) to provide a steady basal insulin concentration before sleep and/or during the morning hours.

In some cases of type 2 diabetes, with normal fasting glycemia, it is sufficient to use only prandial insulin.

3. Therapy with personal insulin pumps should be conducted in centers that have experience in this type of treatment, and which qualify for this type of procedure.

VII. Simplification of therapeutic regimens

In individuals who have achieved satisfactory parameters of glycemia, but the implementation of the insulin therapy algorithm encounters difficulties (in the elderly, those with frailty syndrome, cognitive impairments, or requiring third-party care), or significantly increases the risk of hypoglycemia, efforts should be made to simplify the insulin therapy regimen. The failure to simplify such a regimen is currently considered a manifestation of therapeutic inertia.

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13. Arterial Hypertension

CHAPTER HIGHLIGHTS
• The overall goal for blood pressure control in people with diabetes is ≤ 130/80 mm Hg (in people > 65 years of age it is < 140/80 mm Hg). [**A**]
• Hypertension treatment should be initiated with a combination of two drugs: an angiotensin-converting enzyme inhibitor (ACEI) or an angiotensin AT1 receptor antagonist with a calcium antagonist or a thiazide or thiazide-like diuretic. [**A**]
• Pharmacotherapy of hypertension should be continued continuously, as only then is cardiovascular risk reduction achieved. [**A**]
• In the treatment of hypertension in people with diabetes, the goal should be not only to achieve target blood pressure values, but also to maintain or restore normal daily blood pressure variability as assessed by 24-hour monitoring, especially in pregnant women with diabetes. [**B**]

In people with diabetes, it is recommended to start pharmacotherapy when blood pressure values are above 140/90 mm Hg. The therapeutic target is to optimally reduce the overall risk of cardiovascular complications by lowering the systolic blood pressure ≤ 130 mm Hg, as long as this is well tolerated (such lowering carries the benefit of reducing the risk of stroke). In people > 65 years of age, the target systolic blood pressure values are 130-139 mm Hg. In terms of diastolic pressure, values below 80 mm Hg are optimal. Hypertension can be diagnosed on the basis of the results of 24-hour blood pressure measurement by automatic blood pressure monitoring (ABPM).

I. Blood pressure measurement

Blood pressure should be measured at each visit, also while upright position to assess for orthostatic hypotonia. Self-monitoring at home is recommended for all individuals diagnosed with hypertension. In individuals with systolic blood pressure values of not less than 140 mm Hg or diastolic blood pressure values of not less than 90 mm Hg, the measurement should be repeated on another day and blood pressure control should be ordered outside the doctor's office. A repeated detection of blood pressure values of not less than 140 mm Hg or diastolic pressure of not less than 90 mm Hg confirms the diagnosis of hypertension. Nocturnal hypertension, as well as masked hypertension (when blood pressure values in the doctor's office are lower than at home), is often found in people with diabetes, so it is recommended that 24-hour ambulatory blood pressure monitoring be performed in these individuals, as well as that the person with diabetes take blood pressure measurements at home (so-called home, self-measurements).

II. Hypertension treatment:

- considering the above treatment targets for hypertension in people with diabetes, simultaneously it should be avoided to lower systolic blood pressure below 120 mm Hg, and in individuals with chronic kidney disease below 130 mm Hg,
- diastolic blood pressure should not be lowered below 70 mm Hg,
- in any case of diagnosed hypertension, pharmacological management should be combined with lifestyle changes,
- as a general rule, initiating therapy should involve a combination of two medications: an angiotensin-converting enzyme inhibitor (ACEI) or an angiotensin receptor antagonist (AT1 antagonist) with a calcium antagonist or thiazide diuretic, or thiazide-like diuretic. How-

ever, in the presence of specific comorbidities (e.g., ischemic heart disease, chronic kidney disease, etc.), the combination of two medications may vary,
- due to the above recommendations, it is advisable to use combination medications that improve therapeutic compliance,
- the presence of proteinuria does not change the target blood pressure,
- in the therapy of individuals with hypertension and heart-related complications (such as ischemic heart disease and heart failure), the combination of an ACE inhibitor and a beta-blocker is commonly used,
- combinations of drugs with similar mechanisms of action or similar side effects have limited value because the hypotensive effect is smaller than additive, or there is an increased risk of adverse effects,
- if, despite the use of two drugs, the target blood pressure value has not been reached, another drug from another group should be included – one of the drugs used should be a diuretic,
- in individuals with no nocturnal drop in blood pressure (non-dipping) or excessive morning surge, modification of the time of administration of hypotensive drugs should be considered,
- long-acting antihypertensive medications that provide 24-hour effectiveness when administered once a day should be preferred,
- when using ACE inhibitors, ARBs, or diuretic medications, it is important to monitor serum creatinine levels, eGFR (estimated glomerular filtration rate), and potassium levels in the blood,
- in people > 65 years of age, blood pressure should be lowered gradually to avoid complications of therapy,
- in people with very advanced age (> 80 years) or frailty syndrome, it is reasonable to start therapeutic hypotensive therapy with monotherapy.

III. Choice of hypotensive drug

Effective therapeutic treatment to achieve normal blood pressure values is more important for preventing vascular complications than the type of drug used:
- antihypertensive treatment can be initiated with ACE inhibitors, ARBs, diuretics, β-blockers (preferably vasodilatory β-blockers in the absence of specific indications), or calcium channel blockers,
- in the presence of albuminuria/proteinuria, drugs that inhibit the renin-angiotensin-aldosterone (RAA) system should be favored in the selection,
- pairing an ACEI with an ARB is contraindicated,
- drugs used in combination therapy can be selected from the above-mentioned or other groups, keeping in mind the principles of combination,
- therapeutic treatment of hypertensive individuals with coexisting renal dysfunction or structure is described in Chapter 19,
- in people > 55 years of age, which have other cardiovascular risk factors, ACEIs should be considered to reduce the risk of cardiovascular incidents, regardless of blood pressure values,
- ACEIs or ARBs are not recommended in normotensive subjects with normoalbuminuria for primary prevention of diabetic kidney disease,
- ACEIs or ARBs are recommended for normotensive individuals with albuminuria ≥ 30 mg/g to prevent the onset and progression of diabetic kidney disease,
- in individuals with coronary artery disease and a history of heart attack, especially in cases of heart failure, it is advisable to use β-blockers and ACE inhibitors as first-line medications to reduce the risk of death,
- in the presence of peripheral artery disease, it is advisable to avoid using non-selective β-adrenergic receptor blockers,
- Thiazide or thiazide-like diuretics should be used when GFR is ≥ 30 ml/min/1.73 m^2. In cases where GFR is < 30 ml/min/1.73 m^2, loop diuretics should be considered.

Clinical studies indicate that in the majority of individuals it is necessary to use three different antihypertensive medications to achieve therapeutic goals. Often, this requires the use of drugs from groups not mentioned earlier, including α-blockers, centrally acting agents, and vasodilators.

In diabetes, the development of resistant hypertension often occurs, requiring the concurrent use of multiple medications. In such situations, considering the use of spironolactone is recommended. In individuals with diabetes and resistant hypertension, it is advisable to consider conducting a sleep apnea assessment.

Among the antihyperglycemic medications, SGLT-2 inhibitors and GLP-1 receptor agonists have

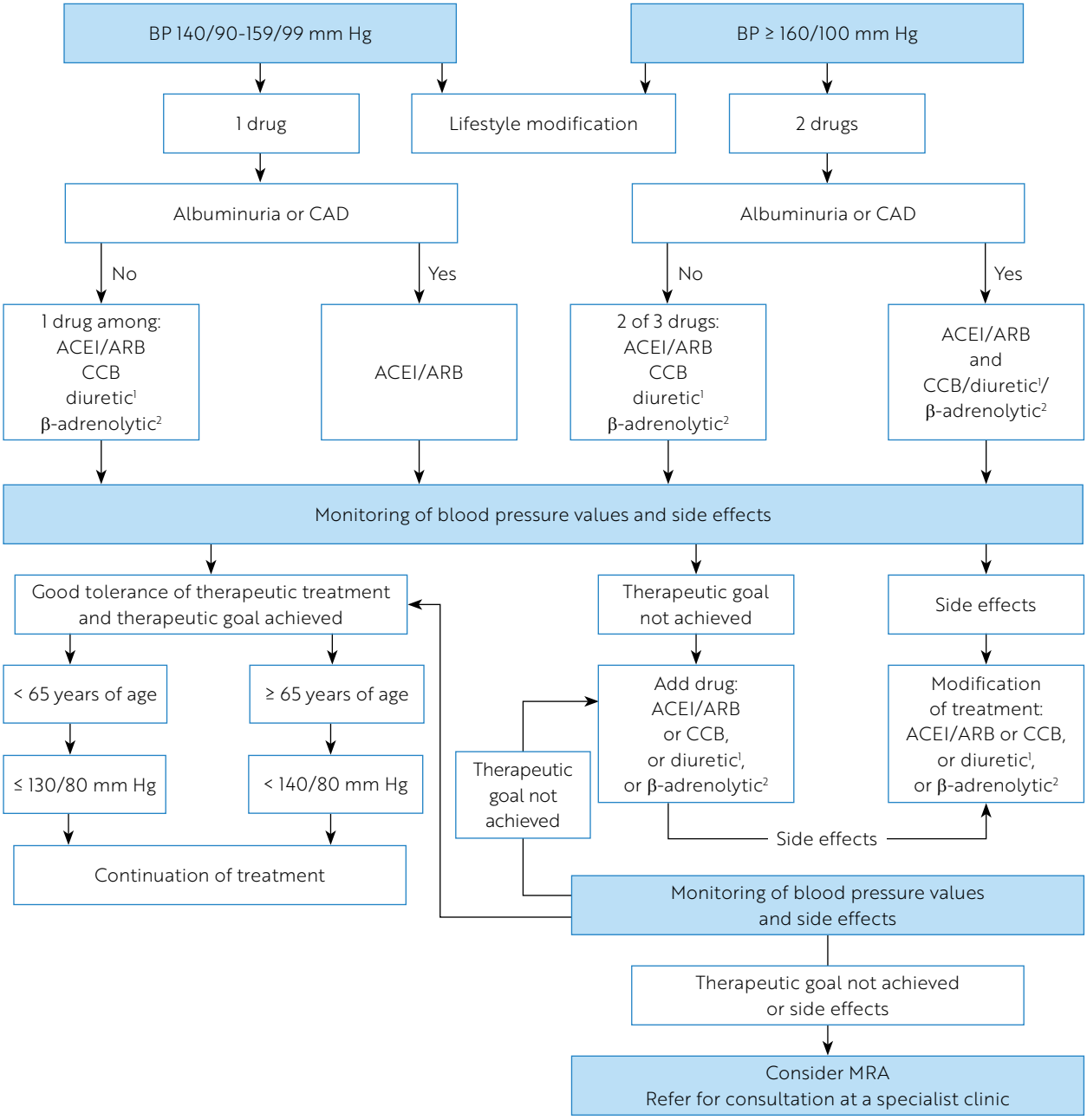

Figure 13.1. Therapeutic principles of hypertension in individuals with diabetes [4, 8]

[1]Thiazide or thiazide-like diuretic.

[2]Beta-blockers in individuals with heart failure, chronic coronary syndrome, atrial fibrillation, and in women who are pregnant or planning pregnancy.

BP – blood pressure, ACEI – angiotensin-converting enzyme inhibitors, ARB – angiotensin receptor blocker, CAD – coronary artery disease, CCB – calcium channel blockers, MRA – mineralocorticoid receptor antagonist

a hypotensive effect and can be recommended for diabetes treatment for this reason as well.

For the principles of diabetes treatment in children and adolescents, women planning or being pregnant, and individuals over 65 years of age, please refer to the relevant chapters.

IV. Specific management for hypertension in pregnant women

Target blood pressure values for pregnant women with diabetes are systolic 110-139 mm Hg and diastolic 81–85 mm Hg. In pregnant women with diabetes and vascular complications, the target blood pressure value is < 130/80 mm Hg.

In pregnant women with non-severe hypertension, the preferred oral medications are (in order): methyldopa, labetalol, and calcium channel blockers. In life-threatening situations, labetalol, or nitroglycerin (parenterally) are the preferred agents. In the absence of these options, hydralazine may be used parenterally, but there have been reports of an increased incidence of adverse effects in the peripartum period.

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14. Dyslipidemia

CHAPTER HIGHLIGHTS – THERAPEUTIC GOALS
• LDL-C levels < 55 mg/dl (< 1.4 mmol/l) with at least a 50% reduction from baseline values in individuals with diabetes at very high cardiovascular risk. As a secondary target, non-HDL-C levels should be lowered to < 85 mg/dl (< 2.2 mmol/l). [**A**]
• LDL-C levels < 70 mg/dl (< 1.8 mmol/l) with at least a 50% reduction from baseline values in individuals with diabetes at high cardiovascular risk. As a secondary target, non-HDL-C levels should be lowered to < 100 mg/dl (< 2.6 mmol/l). [**A**]
• LDL-C levels < 100 mg/dl (< 2.6 mmol/l) in individuals with diabetes at moderate cardiovascular risk. As a secondary target, non-HDL-C levels should be lowered to < 130 mg/dl (< 3.4 mmol/l). [**A**]

CHAPTER HIGHLIGHTS – TREATMENT
• Statins are the first-choice lipid-lowering medications. In individuals at very high and high cardiovascular risk, it is recommended to use statins at the highest recommended or tolerated doses to achieve therapeutic goals. [**A**]
• If the treatment goal is not achieved, combining a statin with ezetimibe is recommended. [**A**]
• In individuals at very high cardiovascular risk who do not reach the target LDL-C level despite optimal statin and ezetimibe therapy or who cannot tolerate statins, the addition of PCSK9 inhibitors is recommended. [**A**]
• In cases of complete statin intolerance, consider ezetimibe as monotherapy [C] or in combination with PCSK9 inhibitors. [**B**] Alternatively, bempedoic acid may be used. [**B**]
• For individuals with hypertriglyceridemia (TG: 150-499 mg/dl; 1.7-5.6 mmol/l), the use of high-dose eicosatetraenoic acid (EPA) (2 g twice daily) in combination with a statin may be considered [**B**]

LDL-C is the primary target of lipid-lowering therapy. In individuals with diabetes and high triglyceride levels (TG), obesity, and low LDL-C levels, it is recommended to measure non-HDL-C or apo-B. Treatment goals vary for individuals with type 2 diabetes depending on their cardiovascular risk (see Table 14.1). Non-HDL-C should be considered as a secondary treatment target.

I. Diagnosing lipid disorders

1. The individual history should include:
   a) the presence of cardiovascular diseases related to atherosclerosis: coronary heart disease, ischemic stroke, peripheral artery disease (PAD),
   b) assessment of secondary causes of hyperlipidemia, such as diet, coexisting conditions, and medications (see Table 14.2),
   c) the presence of a family history with an initial LDL-C level > 190 mg/dl, indicating lipid disorders and premature cardiovascular disease. Calculate the likelihood of familial hypercholesterolemia according to the Dutch Lipid Clinic Network (DLCN) scale and refer individuals with a score of ≥ 6 points to specialized centers with a lipid-lowering program (see Table 14.3).
2. Lipid profile testing can be performed in non-fasting individuals, but in individuals with hypertriglyceridemia (TG > 150 mg/dl, > 1.7 mmol/l), the test should be performed after an 8-12 hour fast from their last meal.
3. Consider measuring Lp(a) levels at least once in a person's lifetime to identify individuals with very high Lp(a) levels (> 430 nmol/l, > 180 mg/dl), whose cardiovascular risk is similar to that of familial hypercholesterolemia individuals. Measurement of Lp(a) should be considered in all individuals with premature cardiovascular disease (heart attack, ischemic stroke), persons with aortic stenosis, familial hypercholesterolemia, and to refine the risk assessment in individuals at the borderline of moderate/high cardiovascular risk.

II. Lipid control and monitoring

Lipid testing should be performed at the time of diabetes diagnosis, and thereafter, lipid levels should be monitored annually or more frequently based on their levels.

If lipid levels are above therapeutic targets, it is recommended to monitor them every 8-12 weeks from the start of therapy until the recommended levels are achieved. This recommendation excludes individuals after an acute coronary syndrome, where lipid testing should be performed within 4-6 weeks after treatment initiation.

Before initiating lipid-lowering therapy, ALT, CK, and TSH levels should be measured.

If lipid levels are within the desired range, follow-up lipid profile testing should be conducted annually, and ALT and CK should only be assessed if symptoms arise.

Table 14.1. Cardiovascular risk categories in people with type 2 diabetes and recommended target lipid levels according to ESC 2023 guidelines

Cardiovascular risk	Criteria	Recommended target lipid levels
Extremely high	Type 2 diabetes and atherosclerotic cardiovascular disease* or target organ damage**, or a 10-year cardiovascular risk > 20% according to the SCORE2-Diabetes calculator	Primary objective: LDL-C < 55 mg/dl (< 1.4 mmol/l) and LDL-C reduction of ≥ 50% Secondary target: non-HDL < 85 mg/dl (< 2.2 mmol/l) apoB < 65 mg/dl
High	Type 2 diabetes without criteria for very high risk and a 10-year cardiovascular risk of 10% to < 20% according to the SCORE2-Diabetes calculator	Primary objective: LDL-C < 70 mg/dl (< 1.8 mmol/l) and LDL-C reduction of ≥ 50% Secondary target: non-HDL < 100 mg/dl (2.6 mmol/l) apoB < 80 mg/dl
Moderate	Type 2 diabetes without criteria for very high risk and a 10-year cardiovascular risk of 5% to < 10% according to the SCORE2-Diabetes calculator	LDL-C < 100 mg/dl (< 2.6 mmol/l) Non-HDL-C < 130 mg/dl (< 3.4 mmol/l) apoB < 100 mg/dl
Low	Type 2 diabetes without criteria for very high risk and a 10-year cardiovascular risk of < 5% according to the SCORE2-Diabetes calculator	Target lipid levels have not been established due to lack of sufficient data

**Atherosclerotic cardiovascular disease– coronary artery disease, heart attack, peripheral artery disease (PAD), carotid artery disease, aortic aneurysms, ischemic stroke, transient ischemic attack (TIA), revascularization of arteries due to atherosclerosis.*
***Severe target organ damage: eGFR < 45 ml/min/1.73 m² regardless of albuminuria or eGFR 45-59 ml/min/1.73 m² and albuminuria [urinary albumin-to-creatinine ratio (UACR) 30-300 mg/g; stage A2], or proteinuria (UACR > 300 mg/g; stage A3), or the presence of microvascular disease in at least three different sites, e.g., albuminuria (stage A2) plus retinopathy, plus neuropathy.*
SCORE2-Diabetes refers to individuals aged 40-69 with type 2 diabetes, without atherosclerotic vascular disease and/or severe organ damage.

Table 14.2. Secondary causes of hyperlipidemia

Diet	Comorbidities	Drugs
High in fat High in carbohydrates Alcohol	Hypothyroidism Diabetes Obesity Lipodystrophies Kidney diseases – nephrotic syndrome, uremia Liver diseases – primary cholangitis, primary sclerosing cholangitis, post-alcoholic cirrhosis, MAFLD Mental anorexia Cushing's syndrome Systemic lupus erythematosus Psoriasis HIV Pregnancy – third trimester: increase in TG	Glucocorticosteroids (ICS) Oral estrogens Oral retinoids Ion exchange resins Protease inhibitors (lopinavir with ritonavir, saquinavir, fosamprenavir) Nucleoside reverse transcriptase inhibitors (stavudine, zidovudine) Non-nucleoside reverse transcriptase inhibitors (efavirenz) Thiazide diuretics Non-cardio selective β-blockers (except carvedilol) Tamoxifen Cyclophosphamide Cyclosporine Sirolimus Everolimus L-asparaginase Second-generation antipsychotics (clozapine, olanzapine)

MAFLD – metabolic dysfunction associated fatty liver disease

III. Non-pharmacological treatment of dyslipidemia

1. Lifestyle changes include:
- increased physical activity,
- weight reduction in individuals with overweight or obesity,
- smoking cessation.

2. Dietary modifications should involve:
- limiting saturated fat intake to < 10% of total energy intake,
- cholesterol intake < 300 mg/day or < 200 mg/day in the presence of elevated LDL cholesterol levels,
- maximum restriction of trans unsaturated fats,
- consuming 4-8% of energy from n-6 polyunsaturated fatty acids,
- a daily intake of 2 g of α-linolenic acid and 200 mg of very-long-chain fatty acids from n-3 polyunsaturated fats.

IV. Pharmacological treatment of dylipidemia in individuals with diabetes

1. **Statins:**

a) statins remain first-choice therapy to lower LDL-C levels in individuals with type 1 or type 2 diabetes and dyslipidemia due to their effectiveness in preventing cardiovascular events and reducing cardiovascular mortality, regardless of gender;

b) statins with strong lipid-lowering effects (such as rosuvastatin and atorvastatin) are indicated in individuals with diabetes at high or very high cardiovascular risk because they reduce LDL-C levels by 40-63% and significantly decrease the occurrence of major cerebrovascular and coronary events. High doses of statins are recommended for these individuals: rosuvastatin 20-40 mg/day, atorvastatin 40-80 mg/day;

c) the beneficial effects of statins outweigh their potential diabetogenic effects, estimated as a 9% increased risk of developing diabetes, especially in older persons and those at risk of diabetes development;

d) statins are generally safe and well-tolerated. Subjective side effects (such as fatigue, muscle pain, and neurological symptoms) are more common than objective adverse effects due to a nocebo effect. Women experience adverse effects more frequently than men. In most cases of myopathy or rhabdomyolysis, they are associated with drug interactions, especially when used with higher doses of statins or in combination with gemfibrozil. Risk factors for myopathy include advanced age, intense physical activity, hypothyroidism, and drug interactions;

e) contraindications to statin use:
- pregnancy and breastfeeding,
- reproductive age if a woman is not using effective contraception,
- initial ALT values three times above the upper limit without an established cause,
- initial creatine kinase (CK) values four times above the upper limit,
- active viral hepatitis,
- liver failure (Child-Pugh class B and C),
- choroideremia;

f) assessment of statin therapy safety:
- ALT should be checked before starting treatment, after 8-12 weeks of therapy, and after each statin dose increase or if symptoms occur,
- CK levels should be determined before starting treatment but do not require ongoing monitoring, except in the case of myalgia during therapy;

Table 14.3. Criteria for the diagnosis of familial hypercholesterolemia (FH) – point scale (according to the Dutch Lipid Clinic Network scale)

Physical examination	Points
Tendon jaundice	6
Corneal seam	4
LDL-C	
> 330 mg/dl (> 8.5 mmol/l)	8
250-329 mg/dl (6.5-8.4 mmol/l)	5
190-249 mg/dl (5.0-6.4 mmol/l)	3
155-189 mg/dl (4.0-4.9 mmol/l)	1
Genetic testing	
Mutation in *LDLR, APOB, PCSK9* genes	8
Family history	
First-degree relatives with premature coronary or vascular disease	1
First-degree relatives with LDL-C levels > 190 mg/dl	1
First-degree relatives with yellow deposits on tendons and/or corneal arcus.	2
Children and adolescents aged < 18 years with LDL-C levels > 155 mg/dl	2
Clinical history	
Premature coronary artery disease*	2
Premature cerebrovascular or peripheral vascular disease*	1

Certain diagnosis: > 8 points, probable diagnosis: 6-8 points, possible diagnosis: 3-5 points, unconfirmed diagnosis: < 3 points.
**Premature cardiovascular disease: age < 55 years in men, < 60 years in women.*

g) statin intolerance:

- **total intolerance:** Statin intolerance means an inability to use the drug due to clinically significant adverse effects and/or a significant increase in biomarkers (ALT/AST > 3 × ULN or CK > 5 × ULN) without other factors increasing the risk of side effects, such as hypothyroidism, drug interactions, physical exertion, or muscle diseases.

Total statin intolerance should apply to at least two different statins, including one irrespective of the dose and the other at the lowest dose (rosuvastatin 5 mg/day, atorvastatin 10 mg/day, simvastatin 10 mg/day, pitavastatin 2 mg/day).

In case of total statin intolerance, consider monotherapy with ezetimibe or combination therapy with PCSK9 inhibitors. Alternatively, bempedoic acid, a prodrug that reduces cholesterol synthesis by inhibiting adenosine triphosphate (ATP) citrate lyase, with very limited musculoskeletal side effects, may be used. In individuals at high cardiovascular risk intolerant to statins, the use of bempedoic acid (180 mg once daily) was associated with a reduction in cardiovascular events, although there was a higher incidence of gout and gallstone formation.

- intolerance to high statin doses: if a person experiences adverse effects during treatment with high-dose statins (fatigue, muscle pain, or neurological symptoms), several strategies can be considered:
  - » discontinue the statin and attempt re-introduction of the same statin at a lower dose in combination with ezetimibe or
  - » switch to another statin at a lower dose in combination with ezetimibe.

Table 14.4. Management of hypertriglyceridemia according to TG levels

	Mild to moderate Increased VLDL-TG Increased cardiovascular risk	Severe Chylomicrons and VLDL-TG present Increased risk of acute pancreatitis
TG levels	Mild: 150-499 mg/dl (1.7-5.7 mmol/l) Moderate: 500-880 mg/dl (5.7-10 mmol/l)	> 880 mg/dl (> 10 mmol/l)
Primary goal of therapy	Target LDL-C levels	TG reduction
Secondary goal of therapy	Target non-HDL-C levels	Target LDL-C and non-HDL-C if the risk of acute pancreatitis is reduced.
Non-pharmacological treatment	Reduction in consumption or alcohol abstinence. Weight reduction, if overweight, obesity. Reduction of carbohydrate intake, especially fructose and sucrose. Increasing physical activity. Replacing saturated fats with polyunsaturated fats.	Alcohol abstinence. Restrictive low-fat diet: limit fat intake below 20% of calories, 10-20 g of fat per day (2000 kcal diet). Use of MCT-triglycerides of medium chain length (C6-12). Reduce intake of total carbohydrates, especially fructose and sucrose. Reducing body weight, if overweight, obesity. Increasing physical activity.
Pharmacological treatment	Statin (atorvastatin, rosuvastatin). Consider adding fibrate if target LDL-C is achieved and TG still > 200 mg/dl (> 2.3 mmol/l) in individuals at high cardiovascular risk. Consider including EPA at a dose of 2 × 2 g.	Fenofibrate + omega 3 acids (4 g/day). In acute conditions, rapid TG reduction can be achieved with plasmapheresis. In non-insulin-treated diabetics, insulin therapy should be initiated, usually intravenously using an infusion pump, so as to achieve optimal glycemic control. This management can reduce triglyceridemia within 2-5 days. In addition to insulin, the use of low-molecular-weight or unfractionated heparin should be considered.
Genetic tests	No indication for genetic testing in most cases, except for suspected familial dysbetalipoproteinemia*.	Genetic diagnosis for FCS or MCS.

FCS – familial chylomicronemia syndrome, MCS – multifactorial chylomicronemia syndrome

**Familial dysbetalipoproteinemia (TG – rich lipoprotein remnant disease) – should be suspected at TG levels of 300-1000 mg/dl; apoB < 120 mg/dl, non-HDL-C/apoB > 3.69 mmol/g (1.43 mg/dl) in individuals with a burdensome family history of premature atherosclerotic cardiovascular disease (myocardial infarction, stroke, PAD).*

Evidence suggests that even a low dose of statin (atorvastatin or rosuvastatin) administered every 2-3 days can have a favorable lipid-lowering effect.

Approximately 70-90% of individuals who report statin intolerance (fatigue, muscle pain, neurological symptoms) can tolerate statin therapy upon re-introduction.

2. **Combination hypolipidemic therapy:**
   a) **statin + ezetimibe:** if the target LDL-C level is not achieved with statin therapy, combination therapy with a statin and ezetimibe is recommended. In individuals after acute coronary syndrome (ACS), consider initiating combination therapy with a high-dose statin (atorvastatin 80 mg or rosuvastatin 40 mg) and ezetimibe 10 mg from the outset;
   b) **statin + ezetimibe + PCSK9 inhibitors (alirocumab, evolocumab) or statin + ezetimibe + inclisiran:** in individuals at very high cardiovascular risk who do not achieve the target LDL-C levels despite optimal statin and ezetimibe therapy, the addition of PCSK9 inhibitors (alirocumab or evolocumab) or inclisiran is recommended.

   Evolocumab and alirocumab are monoclonal antibodies that bind to PCSK9 protein and significantly lower LDL-C levels by 60% when used as monotherapy, and by 85% when combined with a high-dose statin and ezetimibe. They have substantially reduced cardiovascular events (death from cardiovascular causes, heart attack, stroke, hospitalization due to unstable angina, or coronary revascularization) in subgroups of individuals with diabetes and atherosclerotic cardiovascular disease. Besides LDL, they also significantly reduce other atherogenic lipids (TG, non-HDL-C, apo-B-containing particles) in individuals with diabetes and mixed dyslipidemia. There is no significant association between the use of these antibodies and the risk of developing diabetes. They are recommended for use in individuals with eGFR > 30 ml/min/1.73 m^2. Evolocumab is administered subcutaneously at a dose of 140 mg every 2 weeks, while alirocumab is administered subcutaneously at a dose of 150 mg every 2 weeks or 300 mg once a month.

   Inclisiran-siRNA is a small interfering RNA molecule that inhibits PCSK9 synthesis in the liver. When added in a high-dose to statin, it reduces LDL by an additional 50-55% in individuals with or without diabetes. It is recommended for use in individuals with eGFR > 15 ml/min/1.73 m^2 and is administered subcutaneously at a dose of 284 mg every 6 months. Studies evaluating the impact of inclisiran on cardiovascular events are ongoing.

   In Poland, treatment with PCSK9 inhibitors or inclisiran is possible through the B.101 therapeutic program in specialized clinics. Individuals suspected of familial hypercholesterolemia (according to the DLCN scale, with a score of at least 6 points) and individuals who have had an acute coronary syndrome in the last 2 years can be referred to the program.

   c) **statin + fibrate:** in high cardiovascular risk groups of individuals who achieve target LDL-C levels but have persistently high TG levels (> 200 mg/dl or > 2.3 mmol/l), consider adding fenofibrate to statin therapy. Combination therapy of statin + fibrate (especially gemfibrozil) is associated with an increased risk of abnormal liver function tests, myopathy, and rhabdomyolysis, particularly in individuals with underlying chronic kidney disease and with the use of high-dose medications. Kidney function should be evaluated before therapy, after 3 months, and after 6 months. Combination therapy should not be recommended for individuals with a GFR < 30 ml/min/1.73 m^2. If a decrease in GFR < 30 ml/min/1.73 m^2 is observed during fenofibrate therapy, discontinue the treatment;
   d) **statin + icosapent ethyl (EPA):** in individuals with hypertriglyceridemia (TG: 150-499 mg/dl or 1.7-5.6 mmol/l), consider using icosapent ethyl (ethyl ester of eicosatetraenoic acid) in high doses, i.e., 2 × 2 g, in combination with a statin. EPA lowers TG levels and has a favorable effect on cardiovascular events. However, at the highest dose (4 g/day), it increases the risk of atrial fibrillation.

V. Hypertriglyceridemia

The risk of acute pancreatitis (AP) occurs when TG levels are > 880 mg/dl (> 10 mmol/l) and is dependent on the presence of chylomicrons in the serum. Hypertriglyceridemia is the cause of approximately 10% of AP cases.

Hypertriglyceridemia can be classified based on TG levels into:

a) mild degree – TG: 150-499 mg/dl (1.7-5.7 mmol/l);

b) moderate degree – TG: 500-880 mg/dl (5.7-10 mmol/l),

c) severe degree – TG > 880 mg/dl (> 10 mmol/l).

The management of hypertriglyceridemia is presented in Table 14.4.

VI. Type 1 diabetes

In type 1 diabetes, high LDL-C values are observed in individuals with uncontrolled glycemia. High HDL-C levels can be pro-inflammatory and therefore atherogenic.

Determining cardiovascular risk in individuals with type 1 diabetes is less investigated than in individuals with type 2 diabetes. Based on the Scottish-Swedish Diabetes Registry, a tool has been developed to predict 10-year cardiovascular risk in individuals with type 1 diabetes: https://diabepi.shinyapps.io/cvdrisk/.

Statins are the basis of lipid-lowering treatment in type 1 diabetes.

In individuals with type 1 diabetes who are above 40 years old and without coronary artery disease, statin therapy should be considered to reduce cardiovascular risk.

In younger individuals with type 1 diabetes below 40 years old, early initiation of statin therapy may be justified by the presence of other cardiovascular risk factors, microvascular complications, or a 10-year cardiovascular risk > 10% calculated using the Scottish-Swedish model.

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15. Hypoglycemia

CHAPTER HIGHLIGHTS
· A person with diabetes should be asked about symptoms and the frequency of hypoglycemia at each visit. [**C**]
· Every person at high risk of clinically significant hypoglycemia (< 54 mg/dl, < 3.0 mmol/l) should have a prescription for glucagon. Family members and caregivers of individuals with diabetes, as well as teachers of children and adolescents with diabetes, should be familiar with how to administer glucagon. [**E**]
· A change of the method of diabetes treatment in the presence of severe hypoglycemic episodes and hypoglycemia unawareness should be considered. [**B**]
· In the treatment of hypoglycemia in conscious individuals (with a glucose level ≤ 70 mg/dl, 3.9 mmol/l), it is crucial to administer 15 g of glucose or other simple carbohydrates orally. If glucose levels continue to indicate hypoglycemia after 15 minutes, the administration of glucose/carbohydrates should be repeated. After hypoglycemia has subsided, if there is a possibility of recurrence, the person with diabetes should eat a snack/meal. [**E**]
· For individuals with diabetes treated with insulin and experiencing hypoglycemia unawareness or severe hypoglycemic episodes, the therapeutic goal should be to maintain slightly higher glucose levels for at least several weeks to partially restore the awareness of hypoglycemia symptoms and prevent future episodes. [**A**]
· For individuals with diabetes and hypoglycemia unawareness undergoing intensive insulin therapy, continuous glucose monitoring (CGM) is recommended. [**A**]

I. Definition

Hypoglycemia is diagnosed when the blood glucose level is below 70 mg/dl (3.9 mmol/l), regardless of the presence of clinical symptoms. Some individuals, especially those with long-standing type 1 diabetes, may only experience symptoms at lower glucose levels. The value of 70 mg/dl (3.9 mmol/l) is considered an alert level, requiring the consumption of carbohydrates or adjustment of medication doses to prevent further glucose decline, regardless of the presence or absence of symptoms. This justifies setting the threshold for threatening hypoglycemia at 70 mg/dl (3.9 mmol/l). Clinically significant hypoglycemia is defined as a value less than 54 mg/dl (3.0 mmol/l). Hypoglycemia symptoms can also occur at higher glucose values, even > 100 mg/dl (5.6 mmol/l), when there is a rapid decrease in glucose levels. The so-called hypoglycemia unawareness, characterized by the inability to perceive pathologically low (≤ 70 mg/dl or ≤ 3.9 mmol/l) glucose levels, is a significant complication of frequent hypoglycemic episodes.

The classification of hypoglycemia according to the International Hypoglycemia Study Group (2017) is presented in Table 15.1. Severe hypoglycemia is an episode that requires assistance from another person to administer carbohydrates, glucagon, or take other actions. Blood glucose values during the episode may not be available, but the subsidence of symptoms after the administration of glucose and/or glucagon is considered sufficient evidence that the episode was caused by low blood glucose levels.

Recurrent severe hypoglycemia refers to two or more cases of severe hypoglycemia in the past 12 months.

II. General remarks

1. Individuals with diabetes should not be automatically considered at risk of hypoglycemia, and employment and social consequences arising from this should not be imposed on them.
2. The risk of hypoglycemia increases in the following situations:

Table 15.1. The classification of hypoglycemia according to the International Hypoglycemia Study Group [5]

Glucose levels	Criteria	Comment
Alert glucose levels (level 1)	≤ 70 mg/dl ≤ 3.9 mmol/l	Glucose levels requiring therapeutic treatment with simple carbohydrates – dose adjustment of glucose-lowering drugs indicated.
Clinically significant hypoglycemia (level 2)	< 54 mg/dl < 3.0 mmol/l	Sufficiently low glucose levels indicating clinically significant hypoglycemia.
Severe hypoglycemia (level 3)	No specific blood glucose threshold	Hypoglycemia accompanied with severe cognitive impairment requiring third-party assistance.

- use of insulin as monotherapy or in combination with other antihyperglycemic drugs,
- use of sulfonylurea derivatives as monotherapy or in combination with other antihyperglycemic drugs,
- improper dosing of these drugs in situations of increased physical exertion, reduced calorie intake, or alcohol consumption,
- pursuit of rapid normalization of HbA_{1c} values,
- coexistence of other conditions that predispose to hypoglycemia (such as kidney failure, thyroid insufficiency, adrenal cortex insufficiency, eating disorders, diseases with impaired intestinal absorption, cognitive disorders),
- hypoglycemia unawareness,
- episodes of severe hypoglycemia in recent weeks.

3. Hypoglycemia can, in certain situations (e.g., in the elderly, individuals with ischemic heart disease), pose a direct threat to life.

III. Management of recurrent hypoglycemia involves:

- conducting a thorough analysis of the habits of individuals with diabetes, their diabetes treatment, and any other health conditions,
- providing education to individuals with diabetes on hypoglycemia prevention (e.g., recommending a reduction in insulin dose before planned physical activity),
- modifying diabetes therapy to reduce the risk of hypoglycemia (e.g., replacing sulfonylurea derivatives with medications that carry a lower risk of hypoglycemia, changing the insulin therapy model, using insulin preparations with a lower risk of hypoglycemia, implementing insulin pumps, preferably with automatic insulin delivery suspension in cases of hypoglycemia risk),
- frequent self-monitoring and using continuous glucose monitoring (CGM) systems if available to the individual.

IV. Management of hypoglycemia unawareness

In addition to the steps taken for recurrent hypoglycemia, the following measures should be implemented:

- educating individuals with diabetes and their close contacts on recognizing subtle and atypical signs of hypoglycemia (hypoglycemia awareness training),
- considering this condition in their professional activities and when operating vehicles,
- modifying therapy to significantly reduce the frequency of hypoglycemia as the primary method to improve hypoglycemia awareness.

V. Emergency management of hypoglycemia

1. In a conscious individual:

- it is recommended to consume 15 g of glucose or other simple carbohydrates and check blood glucose after 15 minutes. If hypoglycemia continues, it is advisable to consume another 15 g of glucose or simple carbohydrates and check blood glucose after 15 minutes,
- in cases where there is a risk of recurrent hypoglycemia, such as after an excessive insulin dose, alcohol consumption, or prolonged physical activity, it is recommended, in addition to the above intervention, to consume complex carbohydrates and monitor blood glucose.

2. In an unconscious individual or someone with impaired consciousness who cannot swallow:

- administer intravenously 10% or 20% glucose solution (initial bolus dose of 0.2-0.5 g of glucose per kg of body weight) and then, if necessary, continue a continuous intravenous infusion of 10% glucose with glucose control,
- if there is a risk of recurrent hypoglycemia, maintain the infusion of 10% glucose under glucose control,
- in cases of difficulty in accessing veins, administer 1 mg of glucagon intramuscularly or subcutaneously (0.5 mg in children weighing < 25 kg and 1 mg in children weighing ≥ 25 kg); glucagon can also be administered intranasally at a dose of 3 mg in individuals with diabetes aged 4 years and older, regardless of body weight,
- after regaining consciousness, and in cases where there is a risk of recurrence of hypoglycemia, it is recommended to provide 10-20 g of oral carbohydrates and monitor blood glucose,
- individuals with diabetes treated with insulin or sulfonylurea derivatives may experience prolonged episodes of hypoglycemia, sometimes requiring multi-hour glucose infusions,
- in the event of a severe hypoglycemia incident, consider hospitalizing the individual due to life-threatening conditions associated with the possibility of irreversible changes in the central nervous system, especially in cases of possible recurrent severe hypoglycemia,

- in ambulatory settings, trained individuals from the person's environment should be recommended to administer intramuscular or subcutaneous glucagon or intranasal glucagon.

3. In individuals treated with intensive insulin therapy, using insulin analogs or a personal insulin pump, the approach to managing hypoglycemia typically involves administering 15 g of glucose orally and checking blood glucose after 15 minutes. If low blood glucose continues, repeat glucose administration and check blood glucose after another 15 minutes (the 15/15 rule). In cases of hypoglycemia or hypoglycemia risk with personal insulin pump therapy, it is advisable to suspend the basal insulin infusion and recheck blood glucose.
4. In the case of an excessive dose of long-acting insulin (human or analog) administered, consider the possibility of delayed recurrence of hypoglycemia after the initial recovery from hypoglycemia.

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16. Acute Diabetes Complications in Hyperglycemia

CHAPTER HIGHLIGHTS
· Treatment of acute hyperglycemic conditions should follow established guidelines for fluid and electrolyte replacement and insulin therapy. Adhering to a protocol for managing diabetic ketoacidosis (DKA) shortens the treatment duration. [**C**]
· In diabetic ketoacidosis, crystalloids, which have advantages over colloid fluids, are preferred in supplementing the body's water deficit. [**C**]
· In acute hyperglycemic states, particularly in DKA, continuous intravenous insulin infusion is recommended. The initial insulin dose should be calculated based on the current body weight, not blood glucose levels. [**C**]
· In acute hyperglycemic states, especially in DKA, potassium should be replaced, with serum potassium levels being monitored. [**B**]
· Administration of bicarbonates is not recommended in DKA when the pH is > 6.9. [**B**]

I. Classification

1. Diabetic ketoacidosis (DKA) – mortality rate: 0.2-2%; risk of death is increased in individuals with recurring episodes.
2. Hyperglycemic hyperosmolar state – mortality rate about 15%.
3. Lactic acidosis – historically, the mortality rate was about 50%, but currently, it largely depends on the experience of the treating center, the advancement of the underlying disease, and the coexistence of comorbidities.

II. Diabetic ketoacidosis (DKA)

1. Causes of DKA:
- discontinuation or errors in insulin therapy,
- late diagnosis of type 1 diabetes,

- alcohol abuse, cigarette smoking,
- acute inflammatory states (such as bacterial, viral, fungal infections),
- pregnancy,
- diabetic kidney disease,
- others.

2. Diagnosis: see Table 16.1.
3. Differential diagnosis:

- starvation ketosis,
- alcoholic ketoacidosis [blood glucose rarely > 250 mg/dl (13.9 mmol/l), bicarbonate usually ≥ 18 mmol/l],
- metabolic acidosis with an anion gap > 20 mEq/l (poisoning by ethylene glycol, methanol, paraldehyde, and salicylates),
- lactic acidosis (it's important to note that in ketoacidosis, lactate levels in the blood can increase),
- other comatose conditions leading to hyperglycemia and ketosis, or situations where they are accompanied by, for example, a stroke or uremic coma.

4. Monitoring of DKA:

- assessment of blood pressure, heart rate, respiratory rate, level of consciousness: every 1-2 hours,
- fluid balance: every 1-2 hours,
- body temperature assessment: every 8 hours,
- blood glucose measurement: every 1 hour,
- measurement of serum or plasma sodium and potassium levels every 4 hours [the corrected serum sodium concentration should be calculated according to the formula: for every 100 mg/dl (5.6 mmol/l) of blood glucose above 100 mg/dl (5.6 mmol/l), add 2 mmol/l to the current serum Na^+ result],
- in cases of hyperkalemia > 5.5 mmol/l, when potassium is not administered: check after 2 hours; with a kalemia < 5.5 mmol/l and potassium supplementation: check every 4 hours,
- blood gas analysis: every 4 hours,
- initial determination of blood and/or urine ketones.

5. Treatment:

A. Hydration of the patient

The water deficit (on average 100 ml/kg body weight) should be replenished intravenously over 24-48 hours with cardiovascular status monitoring:

- 1000 ml of 0.9% NaCl solution in the first hour, then:
- 500 ml/hour of 0.9% NaCl solution for 4 hours, then:
- 250 ml/hour of 0.9% NaCl solution until the acid-base balance is restored,
- after reducing blood glucose below 250 mg/dl (13.9 mmol/l), a 5% glucose solution infusion at a rate of 100 ml/hour should be initiated; if glucose is added after 24 hours of fluid therapy, the amount of 0.9% NaCl solution should be reduced to 150 ml/hour,
- in states of increased energy demand (e.g., infection accompanying ketoacidosis, hyperthyroidism, pregnancy), it is recommended to administer a 10% instead of a 5% glucose solution at an infusion rate of 70 ml/hour,
- for body weight < 50 kg, hydration should be conducted according to pediatric recommendations (see Figure 23.1).

B. Managing hyperglycemia

Intravenous insulin therapy:

- an initial bolus dose of insulin is 0.1 units/kg body weight; this is given to adults with severe DKA who have not previously received subcutaneous insulin (lack of subcutaneous insulin depot),

Table 16.1 Diagnosis criteria with severity assessment for ketoacidosis

Parameters	Diabetic ketoacidosis		
	Mild	Moderate	Severe
Plasma glucose levels*	≥ 200 mg/dl (11.1 mmol/l)	≥ 200 mg/dl (11.1 mmol/l)	≥ 200 mg/dl (11.1 mmol/l)
Blood pH	7.25-7.30	7.00-7.24	< 7.00
Blood bicarbonate concentration [mEq/l].	15-18	10-15	< 10
Ketone bodies in urine**	Present	Present	Present
Ketosis (beta-hydroxybutyrate) [mmol/l].	3-6	3-6	> 6
Serum osmolality [mOsm/kg/H2O].	Variable	Variable	Variable
Anion gap***	> 10	> 12	> 12
Disturbance of consciousness	Consciousness	Consciousness/ disorientation	Stupor/sleep

**Does not apply to individuals who are being treated with SGLT2 inhibitors (flozins), in which the glycemic value may be lower (euglycemic diabetic ketoacidosis). **Method using nitroprusside. ***Following the formula: Na^+ (mEq/l) – [Cl^- (mEq/l) + HCO^{3-} (mEq/l).*

- then continue intravenous insulin infusion at a rate of 0.1 IU/kg b.w./hour under glycemic control; in individuals who have subcutaneous insulin deposition after previous injections, intravenous insulin therapy should be started with an infusion of 0.1 IU/kg b.w./hour without a preceding bolus,
- the infusion speed should be adjusted according to the current blood glucose levels, monitored hourly,
- the reduction in glycemic values per hour should not be greater than 100 mg/dl (5.6 mmol/l),
- if plasma glucose levels do not decrease by 50-70 mg/dl (2.8-3.9 mmol/l) from baseline within the first hour, increase (usually double) the rate of intravenous insulin infusion every hour until a steady decrease in glycemia of 50-70 mg/dl/hr (2.8-3.9 mmol/l/hr) is achieved.

NOTE: In the case of DKA in individuals previously treated with an ultra-long-acting insulin analog, it is recommended that therapy not be discontinued for the duration of recovery from DKA. The administration of basal insulin or the connection of a personal insulin pump should be timed appropriately so that the individual is not exposed to an insulin deficit when the intravenous insulin infusion is disconnected.

C. Compensation of electrolyte abnormalities:

- the potassium deficit in a person with ketoacidosis is 3-5 mmol/kg b.w.,
- potassium supplementation should be administered according to the following rules.

Serum potassium levels:

- K^+ > 5.5 mmol/l → do not administer KCl,
- K^+ 5-5.5 mmol/l → 5-10 mmol/hr KCl,
- K^+ 4-5 mmol/l → 10-15 mmol/hr KCl,
- K^+ 3-4 mmol/l → 15-20 mmol/hr KCl,
- K^+ < 3 mmol/l → suspend insulin administration, use intravenous infusion of 25 mmol/hr KCl.

Potassium supplementation of > 15 mmol/hr should be administered into a vena cava after central venipuncture or into two peripheral veins.

D. Use of bicarbonate – consider only if pH < 6.9 is found in arterial blood (in low doses, not more than 1 mmol/kg b.w.); finding elevated lactate levels in the course of ketoacidosis (during which there is often a slight increase in lactate due to tissue hypoxia) is not an indication for bicarbonate administration.

E. Low-molecular-weight heparin – consider a prophylactic dose in individuals with severe diabetic ketoacidosis (DKA).

6. Adverse effects and complications of the treatment for DKA:

- hypokalemia associated with insulin administration and acidosis compensation using bicarbonates,
- hypernatremia mainly related to unjustified administration of $NaHCO_3$, which may lead to complications like pulmonary edema or cerebral edema; in cases of cerebral edema, intravenous mannitol infusion at a dose of 1-2 g/kg body weight over 20 minutes is recommended,
- hyperglycemia caused by discontinuing intravenous insulin without timely transition to subcutaneous administration,
- hypoglycemia due to aggressive insulin therapy,
- hyperchloremia from excessive use of saline solution.

7. Complications of DKA:

- hypovolemic shock,
- acute renal failure,
- cerebral edema, more common in children.

8. The specifics of managing acute ketoacidosis in children are presented in Figure 23.1.

III. Hyperglycemic hyperosmolar state (HHS)

1. Causes:

- HHS typically develops due to delayed diagnosis or inadequate treatment of type 2 diabetes,
- cardiovascular events like stroke or myocardial infarction,
- alcohol consumption,
- certain diuretic medications,
- chronic renal failure,
- mental illnesses, and infections.

2. Diagnosis

Diagnostic criteria of HHS include:

- extremely high blood glucose levels (> 600 mg/dl or > 33.3 mmol/l),
- pH > 7,30,
- serum bicarbonate > 15.0 mmol/l,
- corrected hypernatremia (calculated according to the formula) ≥ 150 mmol/l,
- absent or trace ketone bodies in serum,
- effective osmolality > 320 mOsm/kg H_2O.

Effective molality (mOsm/kg H_2O) =
= 2 [Na^+ (mmol/l)] + glycemia (mmol/l)
{2 [measured Na (mEq/l)] + [glycemia (mg/dl)]/18}

The normal plasma molality is 280-300 mOsm/kg H_2O.

3. Differential diagnosis:

- ketone coma,
- coma states in the course of diseases of the central nervous system,

- uremic coma,
- comas in the course of poisoning.

4. Treatment
Similar to DKA treatment, it includes:
- lowering blood glucose (similar doses of insulin as in ketoacidosis treatment),
- normalizing plasma osmolality – gradual reduction of osmolality (not more than 3 mOsm/kg H_2O/hr),
- administering low-molecular-weight heparin subcutaneously,
- correcting water and electrolyte deficits: significantly higher water loss than in individuals with ketoacidosis,
- use of a hypotonic solution (0.45% NaCl or emergency rehydration fluid), and after achieving normal plasma osmolality, switch to a 0.9% NaCl intravenous infusion under the control of the cardiovascular system; the infusion rate of the NaCl solution should be determined based on the concentration of sodium in the serum and the osmolality of the plasma,
- monitoring of blood glucose every hour and electrolytes every 4-6 hours.

IV. Lactid acidosis

1. Causes:
- type A arises from cardiogenic shock, severe bleeding, septic shock, acute and chronic respiratory failure; it may occur in individuals with diabetes.
- type B acidosis occurs for reasons other than hypoxia and is found in diabetics, those with liver diseases, proliferative diseases, and after intake of ethyl alcohol, biguanides, salicylates, and methyl alcohol.

2. Laboratory diagnostic criteria:
- blood glucose moderately elevated, but may be normal,
- decreased blood pH (< 7.30), bicarbonate concentration < 10 mmol/l, anion gap > 16 mmol/l,
- lactate levels > 5 mmol/l,
- serum sodium levels unchanged (may be lowered in alcoholics),
- usually increased serum potassium levels.

3. Treatment includes:
- counteracting shock (rehydration and hypovolemia correction, moderate administration of vasoconstrictors),
- counteracting hypoxemia and hypoxia,
- preventing excessive lactic acid production (glucose and insulin infusion under glycemic control),
- alkalization by administering sodium bicarbonate (requirement: BE × 0.3 × body weight [in kg]),
- in justified cases (biochemical and/or clinical indications), renal replacement therapy may be necessary.

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17. Diagnosis and Therapeutic Management of Individuals with Chronic Coronary Syndrome, Chronic Heart Failure and Coexisting Diabetes

CHAPTER HIGHLIGHTS
· In diabetic individuals with chronic coronary syndrome (CCS) and no contraindications, acetylsalicylic acid and a statin should be used [A] and treatment with RAA system blockers should be considered. [**B**]
· After myocardial infarction, the use of a beta-blocker is recommended indefinitely. [**A**]
· After myocardial infarction, drugs with documented cardioprotective action (SGLT2 inhibitors, GLP1 receptor agonists) should be included indefinitely. [**A**]

Coronary artery disease (CAD) is a pathological process involving the formation of atherosclerotic plaques in the epicardial arteries, which may or may not lead to their narrowing and/or closure. It is a chronic and usually progressive disease, which is why it is considered serious even during seemingly stable periods. The dynamic nature of CAD is associated with a variety of clinical manifestations, which can be practically divided into acute coronary syndromes (ACS) and chronic coronary syndromes (CCS).

In the suspicion or diagnosis of CCS, we most often encounter the following clinical situations:

- an individual with suspected CCS and "stable" angina and/or shortness of breath,
- an individual with newly diagnosed heart failure or left ventricular dysfunction and suspected CCS,
- an asymptomatic individual or with stable symptoms in the 1st year after diagnosis of the disease or revascularization,
- an individual with symptoms of angina and suspected vasospastic or microvascular disease,
- an asymptomatic individual who was diagnosed with CCS during screening tests.

All of the above situations are classified as CCS, but each of them is associated with a different risk of future cardiovascular events, which may change over time.

I. Clinical course

Differences in the clinical course of chronic coronary syndromes in people with diabetes indicate the necessity of performing at least annual control examinations to assess the presence of risk factors for this disease.

II. Indications for testing for chronic coronary syndromes

Indications for diagnostic, functional, and anatomical tests aimed at diagnosing CCS and risk stratification in diabetic individuals (cardiological consultation):

1. Presence of typical or atypical symptoms from the cardiovascular system.
2. Abnormal resting ECG.
3. Coexistence of atherosclerotic changes in the peripheral arteries, including the carotid arteries.
4. Planned commencement of intensive physical exercises in people over 35 years of age, who have previously led a sedentary lifestyle.
5. Type 1 diabetes lasting more than 15 years.
6. Presence – apart from diabetes – of two or more CCS risk factors:

- abnormal lipid metabolism parameters,
- hypertension,
- smoking,
- family history of premature atherosclerosis,
- presence of albuminuria,
- presence of autonomic neuropathy (Figure 17.1).

III. Treatment of individuals with diabetes and chronic coronary syndrome according to the new terminology of the European Society of Cardiology

1. Implementation of a healthy lifestyle (see Chapter 6).
2. Antihyperglycemic treatment aimed at achieving therapeutic goals (see Chapter 4).
3. Limitation or normalization of coronary disease risk factors:

- normalization of blood pressure (see Chapter 13),
- treatment of lipid disorders (see Chapter 14).

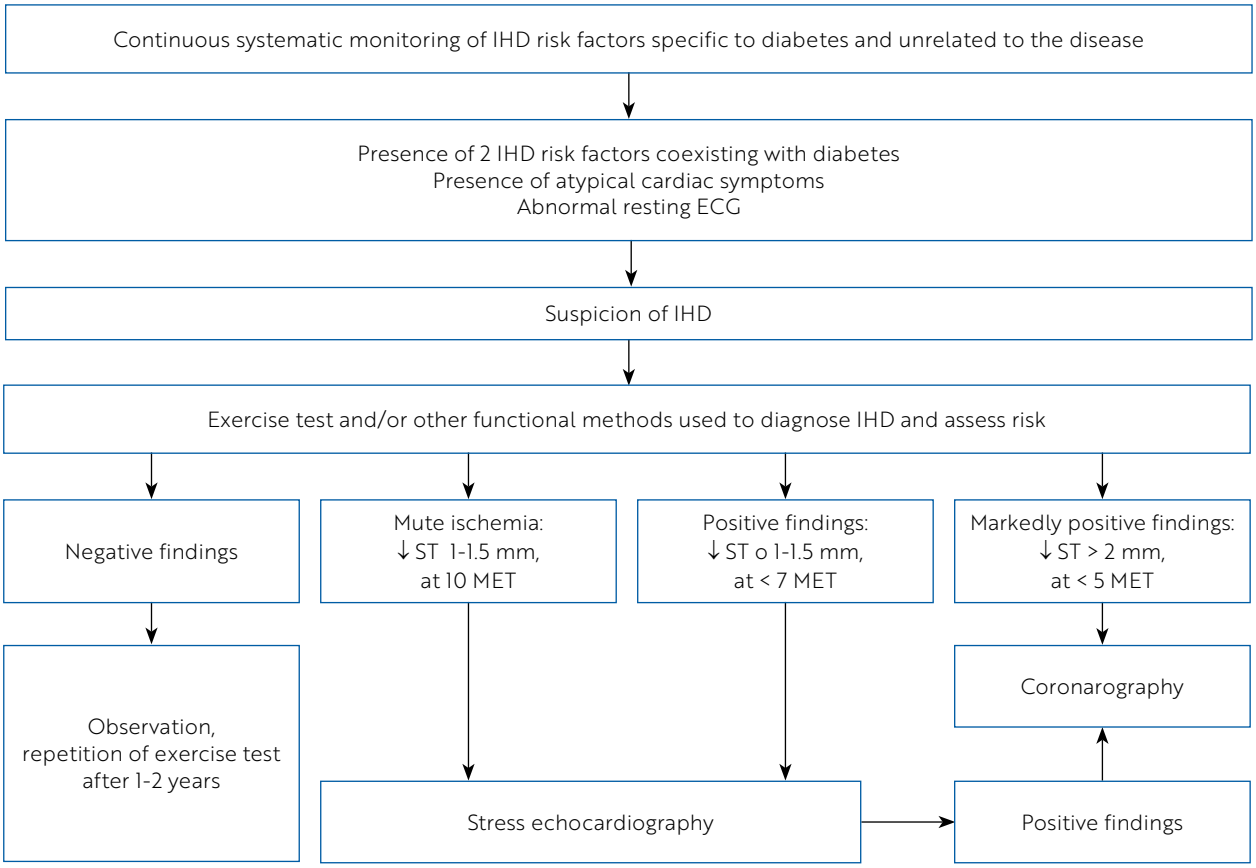

Figure 17.1. Algorithm of diagnostic management to confirm the diagnosis and risk stratification of ischemic heart disease (IHD) in diabetic individuals

IHS – ischemic heart disease

4. Specifics of CCS pharmacotherapy in diabetes:
- antiplatelet therapy – acetylsalicylic acid (ASA); it should also be used in individuals with type 2 and type 1 diabetes > 40 years of age who are at increased risk of cardiovascular incidents (> 5% risk of developing coronary heart disease within 10 years); the effectiveness of ASA in primary prevention in individuals with diabetes with low cardiovascular risk has not been confirmed:
  - » the recommended dose of ASA is 75-100 mg/day,
  - » in case of contraindications to the use of ASA, administration of clopidogrel at a dose of 75 mg/day may be appropriate and indicated,
  - » after percutaneous coronary intervention (PCI), it is recommended to use ASA at a dose of 75-100 mg/day and clopidogrel at a dose of 75 mg/day for 6 months; in cases of increased risk of bleeding complications, it is advisable to shorten treatment to 1-3 months; in situations of high risk of coronary complications, such as: high risk associated with planned stent implantation (e.g., suboptimal stent implantation or other situations during the procedure associated with a high risk of stent thrombosis, narrowing of the left coronary artery trunk with high anatomical complexity or implantation of stents into many vessels) or if dual antiplatelet therapy (DAPT) cannot be used due to ASA intolerance, consideration may be given to using a second drug, in place of clopidogrel, prasugrel or ticagrelor;
- use of cardio selective beta-blockers or multifunctional beta-blockers blocking α1 and β1 receptor,
- medications blocking the renin–angiotensin–aldosterone system (RAA): ACE inhibitors/sartans.

In case of pharmacotherapy failure, revascularization therapy should be considered.

Exercise tests and other functional methods are used to: confirm the diagnosis, document ischemia, stratify risk, as well as facilitate the choice of treatment methods and assess their effective-

ness. Given its still the easiest access, the exercise test is the most commonly performed test, however, its sensitivity and specificity in detecting ischemia are limited, especially in women. Other functional methods include stress echocardiography, perfusion scintigraphy, magnetic resonance imaging, and positron emission tomography. Among anatomical methods, invasive coronary angiography remains the gold standard, and multidetector computed tomography may also be useful. It should be noted that people with diabetes are most often classified as high and very high risk for coronary artery disease. In the high-risk group, functional tests are recommended in the first place, while among individuals with very high risk, the basis of diagnostics, already at the first stage, is coronary angiography. Multidetector computed tomography has a high negative predictive value, so it is rather useful to exclude significant narrowing in the coronary arteries. It is not recommended for use in high-risk individuals, as it constitutes an unnecessary burden related to the use of contrast and exposure to radiological exposure.

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17.1. Acute Coronary Syndrome in Individuals with Diabetes – Antihyperglycemic Treatment

CHAPTER HIGHLIGHTS

- When an individual is hospitalized with acute coronary syndrome, it is essential to assess their glycemic levels. For those with diabetes who do not have recent test results, an HbA_{1c} test is also required. [**A**]
- In the first 24 hours of acute coronary syndrome, intravenous insulin infusion is recommended under glycemic control with target blood glucose levels of 100-180 mg/dl. [**C**]

In acute coronary syndrome, in states of unspecified relative hyperglycemia, normalization of glycemia with intravenous insulin infusion is recommended. Relative hyperglycemia should be considered as glycemia above 140 mg/dl (7.8 mmol/l) in individuals with previously diagnosed diabetes or over 180 mg/dl (10.0 mmol/l) in individuals without previously diagnosed diabetes. Intravenous insulin administration is the only way to quickly normalize glycemia and improve prognosis after acute coronary syndrome. Treatment of ischemic heart disease in people with carbohydrate metabolism disorders should be conducted with the involvement of a diabetologist specialist whenever possible.

I. The first 24 hours of acute coronary syndrome

1. Oral antidiabetic medications should be discontinued.
2. In every case of acute coronary syndrome, glycemia should be measured upon admission.
3. If the glycemia exceeds 140 mg/dl (7.8 mmol/l) in individuals with previously diagnosed diabetes or 180 mg/dl (10.0 mmol/l) in individuals without previously diagnosed diabetes, intravenous insulin infusion should be administered at the rate specified in Table 17.1.1. The recommended frequency of glycemia checks throughout the day is hourly, and after achieving normoglycemia, every two hours.

The glucose level should be maintained within 100-180 mg/dl (5.6-10 mmol/l), adjusting the insulin infusion rate accordingly.

4. Potassium levels should be monitored during insulin infusion.

In cases where glycemia rises above 180 mg/dl (10.0 mmol/l), the intravenous glucose infusion should be temporarily stopped and restarted after glycemia has been lowered to 180 mg/dl (10.0 mmol/l), with a simultaneous increase in the rate of insulin infusion.

5. If meals are consumed, additional short-acting/rapid-acting insulin should be injected intravenously.
6. In the case of diabetic ketoacidosis, follow the recommendations for acidosis therapy (see Chapter 16).

II. From the second day of acute coronary syndrome to the end of hospitalization

1. Hypoglycemic treatment must ensure glycemia values within the range of 100-180 mg/dl (5.6-10.0 mmol/l) throughout the day. Therefore, it must be individualized, preferably conducted in cooperation with a diabetologist.
2. In individuals without indicators of ketoacidosis, with carbohydrate metabolism disorders diagnosed on the first day of acute coronary syndrome or earlier successfully treated with metformin, good metabolic control of diabetes during this period can be ensured by an appropriate diet (see Chapter 6). In other cases, insulin therapy in a multiple injection model should be applied according to previously given principles (see Chapter 12).
3. In individuals with type 2 diabetes with overweight or obesity directly before the end of hospitalization, even already on the third day after intervention, metformin, SGLT2 inhibitors, and/or GLP-1 receptor agonists can be additionally applied if there are no contraindications to their administration. After 2-3 days of metformin treatment, there may be a possibility to reduce the insulin dose.

III. After the hospitalization

In every individual with type 2 diabetes after an acute coronary syndrome, SGLT2 inhibitors and/or GLP-1 receptor agonists, and/or metformin should be implemented unless there are contraindications or drug intolerance.

In individuals with type 2 diabetes who achieved good metabolic control (II.1) on the day of discharge from the hospital, with a daily insulin requirement not exceeding 30 units, it is possible to return to the therapy used before the occurrence of acute coronary syndrome. In individuals in whom diabetes was diagnosed during hospitalization and who achieved good metabolic control (II.1) on the day of discharge from the hospital, with a daily insulin requirement not exceeding 30 units, but who are characterized by obesity or overweight, oral therapy with metformin can be conducted with the possible combination with other drugs. If it is not possible to achieve good metabolic control of diabetes or the daily insulin requirement exceeds 30 units, insulin therapy should be continued. Each individual, who has disorders of carbohydrate metabolism after an acute coronary syndrome, should be urgently referred to a diabetologist specialist.

NOTE 1: In every individual with acute coronary syndrome, apart from those with previously diagnosed diabetes, before leaving the hospital, hba_{1c} should be measured or a glucose tolerance test should be performed after discharge from the hospital (Chapter 1, point iii, Table 17.1.1). In the case of diagnosing glucose intolerance or diabetes, a diabetological consultation is indicated.

NOTE 2: Before planned coronary angiography performed for diagnostic or therapeutic purposes, metformin should be discontinued at least

Table 17.1.1. Approximate insulin infusion rate according to glucose levels

Glycemia	10% glucose solution [ml/hr]	Insulin [IU/hr]
< 100 mg/dl < 5.5 mmol/l	50	Stop the infusion for 15-30 minutes
100-140 mg/dl 5.5-7.8 mmol/l	50	0.5-1.0
140-180 mg/dl 6.7-10 mmol/l	50	1.0-2.0
180-250 mg/dl 10-13.9 mmol/l	Stop the infusion until the glycemia decreases < 180 mg/dl (10.0 mmol/l)/hour, then 50	2.0-4.0
250-300 mg/dl 13.9-17.4 mmol/l	Stop the infusion until the glycemia decreases < 180 mg/dl (10.0 mmol/l)/hour, then 50	4.0-6.0

48 hours before the procedure. It can be resumed 24 hours after performing coronary angiography.

NOTE 3: Randomized trial results indicate an additional cardioprotective effect of drugs from the group of sglt2 inhibitors and glp1 receptor agonists. Their inclusion in therapy should be considered in individuals with high or very high cardiovascular risk.

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17.2. Chronic Heart Failure

I. Introduction

Heart failure (HF) is a clinical syndrome manifested by several main subjective symptoms (e.g., dyspnea, ankle swelling, and fatigue), which may be accompanied by objective symptoms (e.g., signs of elevated jugular venous pressure, crackles over lung fields, and peripheral edema). This syndrome is caused by structural and/or functional cardiac disorders that lead to increased intracardiac pressure and/or inadequate cardiac output at rest and/or during exertion.

II. Classification of heart failure based on left ventricular ejection fraction

Chronic HF is classified based on the measured left ventricular ejection fraction (LVEF). The European Society of Cardiology has introduced the following HF classification:

- HF with reduced LVEF is defined as values ≤ 40%, i.e., significant impairment of LV contractile function – this condition is referred to as HFrEF,
- HF with mildly reduced LVEF (41-49%) – this condition is referred to as HFrEF,
- HF with preserved LVEF ≥ 50% – HFrEF; in individuals with this form, subjective and objective symptoms of HF are present, abnormalities in heart structure and/or function are identified, and/or elevated levels of natriuretic peptides are observed.

III. Main principles of HF diagnosis

In the diagnosis of individuals with HF, in addition to subjective and objective examination, it is advisable to perform a standard 12-lead ECG and determine the levels of natriuretic peptides (BNP or NT-proBNP). If HF is strongly suspected or natriuretic peptide measurements are not available, an echocardiographic examination is indicated. In cases where the diagnosis is confirmed, this examination is the basis for classification into the respective types of HF.

A regular ECG interpretation makes the diagnosis of HF unlikely. The ECG can reveal abnormalities such as atrial fibrillation (AF), Q waves, left ventricular hypertrophy (LVH), and widened QRS complexes, which increase the likelihood of HF diagnosis and may also provide therapeutic clues.

Normal levels of natriuretic peptides make the diagnosis of HF unlikely.

Echocardiography is recommended as the primary examination to assess heart function. In addition to determining LVEF, echocardiography also provides information about other parameters, such as the size of the heart chambers, eccentric or concentric LVH, regional contractile function abnormalities (which may indicate CAD, takotsubo cardiomyopathy, or myocarditis), right ventricular (RV) function, pulmonary hypertension, valve function, and diastolic function indicators.

Moreover, in the diagnosis of HF, the performance of basic laboratory blood tests is recom-

mended, such as serum creatinine and electrolytes, complete blood count, as well as liver and thyroid function tests, to differentiate between HF and other conditions, as well as to obtain prognostic information and treatment guidance.

A chest X-ray is recommended to assess other potential causes of dyspnea (e.g., lung disease). It may also provide evidence supporting the diagnosis of HF (e.g., congestion in the pulmonary circulation or an enlarged heart).

In the next step, determining the etiology and implementing treatment, including causal treatment, is recommended.

IV. General principles of pharmacotherapy for heart failure with reduced ejection fraction

It has been shown that modulation of the renin-angiotensin-aldosterone system (RAA) and the sympathetic nervous system using angiotensin-converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB) with neprilysin inhibitor (ARNI), β-blockers, and mineralocorticoid receptor antagonists (MRA) increases survival, reduces the frequency of hospitalizations due to HF, and alleviates symptoms in individuals with HFrEF. These medications, unless contraindicated or poorly tolerated, form the basis of pharmacotherapy in individuals with HFrEF and should be invariably used.

An important factor affecting prognosis is that doses of ACEI or ARNI and β-blockers should be systematically increased to the highest tolerable doses. ARNI can and should be considered as first-line treatment instead of ACEI.

Sodium-glucose co-transporter 2 inhibitors (SGLT2i), such as dapagliflozin and empagliflozin, added to the treatment with ACEI/ARNI, β-blocker, and MRA, reduced the risk of death from cardiovascular causes and exacerbation of HF in individuals with HFrEF. If these drugs are not contraindicated or intolerated, their use is recommended in all individuals with HFrEF already treated with ACEI/ARNI, β-blocker, and MRA, regardless of whether they have diabetes or not.

Diuretics, among which loop diuretics are preferred, are recommended to reduce subjective and/or objective symptoms of congestion in individuals with HFrEF.

ARBs are currently recommended for individuals who do not tolerate ACEI or ARNI. Ifunny channel inhibitor – ivabradine – slows the heart rate and should be considered for use in individuals with HFrEF with sinus rhythm and a heart rate ≥ 75 beats per minute, with LVEF ≤ 35%. Before considering ivabradine, all efforts should be made to start β-blocker treatment and increase its dose to the guideline-recommended or maximum tolerated dose.

V. Automatic cardioverter-defibrillator in the prevention of sudden death in individuals with HFrEF

An important component of the therapy for individuals with HFrEF is the use of automatic cardioverter-defibrillators (ICD) in primary prevention of sudden cardiac death due to malignant ventricular arrhythmias. In the population of individuals with ischemic etiology HF, **ICD is recommended** to reduce the risk of sudden death and overall mortality in individuals with symptomatic HF (NYHA class II-III) and LVEF ≤ 35% despite ≥ 3 months of optimal conservative (pharmacological) treatment, if a life expectancy longer than one year in good functional condition can be expected. Among individuals with post-myocardial infarction, qualification for ICD should be carried out at least 40 days after the infarction.

On the other hand, in the population of individuals with HF of other, non-ischemic etiologies, ICD has a lower recommendation class – **implantation should be considered** to reduce the risk of sudden death and overall mortality in individuals with symptomatic HF (NYHA class II-III) of etiology other than ischemic and LVEF ≤ 35% despite ≥ 3 months of optimal conservative treatment, if a life expectancy longer than one year in good functional condition can be expected.

VI. Resynchronization therapy in individuals with HFrEF (CRT/CRT-D)

Cardiac resynchronization therapy (CRT) in appropriately selected individuals reduces the need for hospitalization due to the progression of HF symptoms, improves heart function, quality of life, and most importantly reduces overall mortality. This type of cardiac stimulation is used in the population of individuals with HF who have a delay in activation and consequently a delay in the contraction of the left ventricle relative to the right ventricle, leading to a significant reduction in LV stroke volume. This is particularly important in individuals with significantly reduced LVEF, where the LV stroke volume is already compromised at baseline. A symptom/parameter indicating this delay in activation and consequently contraction of the left ventricle relative to the right ventricle is the widening of the QRS complexes duration on

the ECG, particularly the pattern of left bundle branch block (LBBB) in the ECG.

Current guidelines indicate which individuals with HFrEF and LVEF ≤ 35% should consider CRT therapy. A precondition is the prior use of causal therapy and optimal pharmacotherapy for at least 3 months.

Also important is the assessment of indications and the use of CRT with or without defibrillator function – CRT-D or CRT-P. Indications for CRT apply to individuals with significantly reduced LVEF, thus also with an indication for ICD. The decision on the type of device, CRT-P or CRT-D, belongs to the cardiology center ultimately qualifying the individual with HFrEF for these therapy forms.

Current recommendations for CRT:

1. CRT is recommended in symptomatic individuals with HF, sinus rhythm, QRS complexes ≥ 150 ms duration, and LBBB morphology,
2. CRT should be considered in symptomatic individuals with HF, sinus rhythm, QRS complexes ≥ 150 ms duration, and non-LBBB morphology,
3. CRT should be considered in symptomatic individuals with HF, sinus rhythm, QRS complexes duration of 130–149 ms, and LBBB morphology,
4. CRT can be considered in symptomatic individuals with HF, sinus rhythm, QRS complexes duration of 130-149 ms, and non-LBBB morphology.

Individuals with HFrEF after CRT require strict cardiological supervision conducted by specialized cardiology centers.

VII. Chronic heart failure in people with diabetes

Individuals with diabetes are particularly at risk for developing HF. Diabetes predisposes to the development of HF through associated macroangiopathic complications, including coronary artery disease.

Optimal pharmacotherapy in treating HF in individuals with and without diabetes is similar. However, antihyperglycemic drugs differ in their action in individuals with HF, so those drugs that are both safe and reduce the frequency of HF-related incidents should be preferred.

VIII. Heart failure with preserved left ventricular ejection fraction

HFrEF differs from HFrEF in many respects. Individuals with HFrEF are often older, there is a higher percentage of women, and they frequently have numerous comorbidities, including atrial fibrillation, chronic kidney disease, and other non-cardiovascular diseases.

Criteria and principles for diagnosing this form of HF have been presented above. The basic criteria for diagnosing HFrEF are:

1. Subjective and objective symptoms of HF.
2. LVEF ≥ 50%.
3. Objective features of structural and/or functional abnormalities in the heart corresponding to the presence of LV diastolic dysfunction/increased LV filling pressure, including elevated natriuretic peptides.

Until 2021, no treatment was shown to unequivocally reduce mortality and morbidity in this individuals' population. After the publication of the ESC guidelines on the diagnosis and treatment of individuals with heart failure in 2021, publications evaluating the impact of dapagliflozin and empagliflozin on the prognosis of individuals with HFrEF in terms of the need for hospitalization and mortality from cardiovascular causes emerged. These studies demonstrated a clear beneficial impact of these drugs on the prognosis of individuals with HFrEF, regardless of the coexistence of diabetes (DELIVER and EMPEROR – Preserved). These studies have been included in the 2023 update of the European Society of Cardiology guidelines, changing the therapy principles in the population of individuals with HFrEF.

Dapagliflozin and empagliflozin are recommended and should be used (if there are no contraindications to their use) in the therapy of individuals with HFrEF. Similarly high recommendation class applies to the therapy of comorbidities and conditions predisposing to the development of this form of HF. This includes modulation of the RAA system, sympathetic nervous system using ACEI or ARB with ARNI, β-blockers, and MRA.

Diuretics, among which loop diuretics are preferred, should be used in cases with fluid retention.

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18. Stroke in Individuals with Diabetes

CHAPTER HIGHLIGHTS
• Hyperglycemia observed upon hospital admission in the acute phase of stroke is associated with higher mortality, more severe stroke course, and greater neurological deficit in both individuals with and without diabetes. [**A**]
• Interventional studies conducted to date do not provide evidence that maintaining normoglycemia in the acute phase of stroke achieved through intravenous insulin therapy improves individual's prognosis. Such therapy, however, is associated with a higher risk of hypoglycemia. [**A**]
• Current guidelines regarding the correction of hyperglycemia during stroke are based only on the recommendations/ opinions of experts. [**E**]

Diabetes is a strong risk factor for both ischemic and hemorrhagic stroke. Elevated glucose levels are found in over 60% of individuals hospitalized for acute stroke. About 20% of hyperglycemia cases concern individuals with previously diagnosed diabetes, 16-24% are individuals with previously undiagnosed diabetes, and in the remainder is transient (stress-induced) hyperglycemia.

Diabetes is a strong risk factor for both ischemic and hemorrhagic stroke. Elevated glucose levels are found in over 60% of individuals hospitalized for acute stroke. About 20% of hyperglycemia cases concern individuals with previously diagnosed diabetes, 16-24% are individuals with previously undiagnosed diabetes, and the remainder is transient (stress-induced) hyperglycemia.

Few interventional studies with randomization conducted in the acute phase of stroke (up to 72 hours) do not provide evidence that maintaining normoglycemia achieved through intravenous insulin therapy reduces mortality or improves neurological deficit. The recommended target glucose values for individuals diagnosed with acute stroke are similar to those recommended for other severe, acute conditions. Insulin therapy should be initiated at glycemia values ≥ 180 mg/dl (10 mmol/l), and then glycemia should be maintained in the range of 140-180 mg/dl (7.8-10 mmol/l), avoiding the risk of hypoglycemia.

Insulin should be administered intravenously in a 0.9% NaCl solution using an infusion pump, under strict glycemic control. The rate of insulin infusion should be modified depending on the glycemia values measured at the patient's bedside every 1 hour, and after achieving normoglycemia, every 2 hours. An approximate scheme for modifying the rate of intravenous insulin infusion depending on the observed glycemia is presented in Table 26.1. During the insulin infusion, potassium levels should be checked 2-3 times a day.

The administration of insulin in the form of an intravenous GIK (glucose, insulin, potassium) infusion is not recommended. In the first days after stroke and in individuals who remain unconscious for longer, insulin should not be administered subcutaneously.

A specific algorithm for dosing insulin administered in an intravenous infusion, considering changes in the infusion rate depending on glycemia values, should be followed in the unit treating strokes. The therapeutic team of doctors and nurses should be trained in hyperglycemia therapy.

When the patient's condition improves and they start consuming meals, the intravenous insulin infusion should be discontinued, and subcutaneous insulin administration should be started. The disconnection of the intravenous insulin infusion should be preceded by a subcutaneous administration of short-acting or rapid-acting insulin about an hour before stopping the intravenous infusion. The recommended treatment scheme with subcutaneously administered insulin is short-acting insulin or its rapid-acting analog administered before meals and extended-acting insulin administered once or twice a day. In some cases, administering only short-acting or rapid-acting insulin before a meal may be sufficient. Insulin should be administered before meals based on glycemia measurements made directly before them.

Due to the high probability of undiagnosed diabetes in individuals with fresh ischemic brain stroke, it is necessary to perform diagnostics in this direction after stabilizing the patient's condition.

Recommendations regarding blood pressure and other aspects of managing patients with ischemic brain stroke are the same as for individuals without diabetes, as there is no data indicating benefits from different or special management in individuals with diabetes.

Secondary prevention after stroke is consistent with generally accepted principles.

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19. Diabetic Kidney Disease: Prevention, Diagnosis, and Treatment

CHAPTER HIGHLIGHTS
· Screening for increased urinary albumin excretion should be performed annually in individuals with type 1 diabetes starting from the 5th year of the disease, in those with type 2 diabetes from the time of diagnosis, and in all patients with diabetes with concomitant hypertension. [**B**]
· To reduce the risk of diabetic kidney disease and/or slow its progression, glycemic, blood pressure, and lipid control should be optimized. [**A**]
· In cases where increased urinary albumin excretion is detected, therapy with ACE inhibitors or angiotensin AT1 receptor antagonists should be used, as they reduce the risk of diabetic kidney disease progression (considering contraindications to their use). [**A**]
· SGLT2 inhibitors, GLP-1 analogs, and the nonsteroidal mineralocorticoid receptor antagonist (ns-MRA) reduce the risk of chronic kidney disease progression and cardiovascular complications in individuals with type 2 diabetes and chronic kidney disease. [**A**]
· When using ACE inhibitors, angiotensin AT1 receptor antagonists, mineralocorticoid receptor antagonists, and/or diuretics, monitoring of serum creatinine, sodium, and potassium levels is necessary. [**E**]

In individuals with diabetes, to detect or assess the severity of diabetic kidney disease, it is necessary to determine urinary albumin excretion, serum creatinine concentration, and estimated glomerular filtration rate (eGFR).

Albuminuria and eGFR are independent predictors of cardiovascular and renal risk in people with diabetes. A reduction in eGFR without preceding or accompanying albuminuria occurs in about half of the cases of diabetes regardless of type.

I. Screening for albuminuria

Screening should be performed annually in the case of:

- individuals with type 1 diabetes from the 5th year of the diagnosis,
- individuals with type 2 diabetes from the time of diagnosis.

To assess urinary albumin excretion, the albumin/creatinine ratio (ACR) should be determined based on quantitative measurements in a single urine sample, ideally collected in the morning (for interpretation of results see Table 19.1). The diagnosis of increased urinary albumin excretion is justified by obtaining two positive ACR results.

II. Creatinine levels

In individuals with diabetes, blood creatinine levels should be determined at least once a year, regardless of the level of urinary albumin excretion. The creatinine levels should be used to determine the eGFR value.

III. Glomerular filtration

The CKD-EPI formula should be used to determine the glomerular filtration value.

Table 19.1. Definition of abnormal urinary albumin excretion*

Category	AER [mg/day]	ACR (random urine sample) [mg/day or mg/g of creatinine]*, **
A1: normal albuminuria or slightly increased albuminuria	< 30	< 30
A2: moderately increased albuminuria	30-299	30-299
A3: overt proteinuria	≥ 300	≥ 300

ACR – albumin/creatinine ratio, AER – albumin excretion rate

**The amount of albumin excreted in urine in relation to 1 g of creatinine approximately corresponds to daily albuminuria, while also avoiding errors associated with 24-hour urine collection.*

*** If the ACR is received from the laboratory in mg/mmol of creatinine, the result should be multiplied by 8.85 to obtain the value in mg/g of creatinine.*

$$eGFR = 141 \times \min(Scr/k, 1)^{\alpha} \times \max(Scr/k, 1)^{-1.209} \times 0.993^{Age} \times 1.018 \text{ [for women]},$$

where: Scr – serum creatinine levels, k – 0.7 for women and 0.9 for men, a = –0.329 for women and –0.411 for men, min – the minimum of Scr/k or 1, max – the maximum of Scr/k or 1.

If it is not possible to use the CKD-EPI formula, trends in eGFR should be monitored using other methods of assessment (e.g., using the MDRD formula).

IV. Chronic kidney disease

The stages of chronic kidney disease progression are defined in Table 19.2.

V. Nephrological consultation

A nephrological consultation should be considered if:

- eGFR decreases to < 60 ml/min/1.73 m² and non-diabetic kidney disease is suspected,
- eGFR decreases to < 30 ml/min/1.73 m².

Table 19.2. Stages of chronic kidney disease

Category	Description	eGFR [ml/min/1.73 m²]
G1	Kidney damage* with normal or elevated eGFR	≥ 90
G2	Kidney damage* with mildly decreased eGFR	60-89
G3a	Moderate decrease in eGFR	45-59
G3b	Moderate to severe decrease in eGFR	30-44
G4	Significant decrease in eGFR	15-29
G5	End-stage renal failure	< 15

**Renal damage is said to occur if there are abnormalities in the biochemical composition and/or urine sediment, and/or abnormal values in blood indicators of kidney damage, and/or in imaging studies of the kidneys or urinary tract that continues for more than 3 months.*

Table 19.3. Risk of progression of chronic kidney disease, frequency of visits and need for nephrology consultation according to eGFR and albuminuria [2]

	A1: normal albuminuria or slightly increased albuminuria < 30 mg/g < 3 mg/mmol	A2: moderately increased albuminuria 30-299 mg/g 3-29 mg/mmol	A3: overt proteinuria ≥ 300 mg/g ≥ 30 mg/mmol
G1: ≥ 90 ml/min/1.73 m²	Control 1	Treatment 1	Treatment and referral to nephrologist 3
G2: 60-89 ml/min/1.73 m²	Control 1	Treatment 1	Treatment and referral to nephrologist 3
G3a: 45-59 ml/min/1.73 m²	Treatment 1	Treatment 2	Treatment and referral to nephrologist 3
G3b: 30-44 ml/min/1.73 m²	Treatment 2	Treatment and referral to nephrologist 3	Treatment and referral to nephrologist 3
G4: 15-29 ml/min/1.73 m²	Treatment and referral to nephrologist 3	Treatment and referral to nephrologist 3	Treatment and referral to nephrologist 4+
G5: < 15 ml/min/1.73 m²	Treatment and referral to nephrologist 5+	Treatment and referral to nephrologist 4+	Treatment and referral to nephrologist 4+

■ *Low risk (if there are no other markers of kidney disease, without CKD),* ■ *moderate risk,* ■ *high risk,* ■ *extremely high risk.*

The numbers in the boxes describe guidelines for screening or monitoring frequency per year. Suggested frequency of monitoring ranges from once a year (■) to 4 times or more per year (i.e., every 1-3 months, (■)) depending on the risk of progression of CKD and complications of CKD.

VI. Preventive recommendations

1. To reduce the risk of diabetic kidney disease and/or slow its progression, glycemia control, blood pressure, and lipidemia should be optimized.
2. Tobacco smoking is an independent factor in the development and progression of diabetic kidney disease.

VII. Treatment

1. To slow the progression of diabetic kidney disease, it is necessary to aim for the therapeutic targets for glycemia, lipidemia, and arterial pressure presented in Chapter 4.
2. In the case of detected albuminuria, therapy with ACE inhibitors or angiotensin AT1 receptor antagonists should be administered, as

Table 19.4. Dosage recommendations for oral antihyperglycemic drugs, GLP-1 receptor agonists and dual GIP/GLP-1 receptor agonist according to the severity of kidney disease in type 2 diabetes [2]

	Chronic kidney disease (CKD) categories (stages) according to KDIGO (eGFR)				
	Stage G1 and G2 (eGFR > 60 ml/min/1.73 m²)	Stage G3a (eGFR 45-59 ml/min/1.73 m²)	Stage G3b (eGFR 30-44 ml/min/1.73 m²)	Stage G4 (eGFR 15-30 ml/min/1.73 m²)	Stage G5 (eGFR < 15 ml/min/1.73 m²)
Metformin		Reduce the dose to a maximum of 2,000 mg/day	More frequent eGFR monitoring Dose reduction to a maximum of 1,000 mg/day		
Sulfonylurea derivatives		Increase risk of hypoglycemia if eGFR < 60, consider reducing dose; glycoside is preferred drug because it is metabolized by the liver			
Pioglitazone	Avoid using the drug in dialysis patients				
Linagliptin					
Saxagliptin	No dose modification required				
Sitagliptin			Dose reduction to 50 mg/day	Dose reduction. up to 25 mg/day	
Wildagliptin		Reduce dose to 50 mg/day if eGFR < 50			
Canaglifosin	Initial dose of 100 mg, gradually increasing the dose to 300 mg, if required	Initiation or continuation 100 mg/day		Continuation of 100 mg/day, Treatment should not be initiated, Discontinue drug in dialysis patients; may continue if well tolerated (cardiovascular and renal protection)	
Dapagliflozin	No dose modification required to eGFR < 25				Can be continued if well tolerated (cardiovascular and renal protection)
Empagliflozin	No dose modification required to eGFR < 20				Can be continued if well tolerated (cardiovascular and renal protection)
Dulaglutide	No dose modification required to eGFR < 15				
Exenatide (administered 2× daily)		Gradual dose escalation at eGFR 30-50			
Exenatide (administered 1× week)	No dose modification required to eGFR < 30				
Liraglutide	No dose modification required				
Lixisenatide	No dose modification required to eGFR < 15				
Semaglutide	No dose modification required				
Thirzepatide	No dose modification required				

No dose adjustment necessary depending on eGFR, recommended dose adjustment of drug depending on eGFR, not recommended to use drug at given eGFR

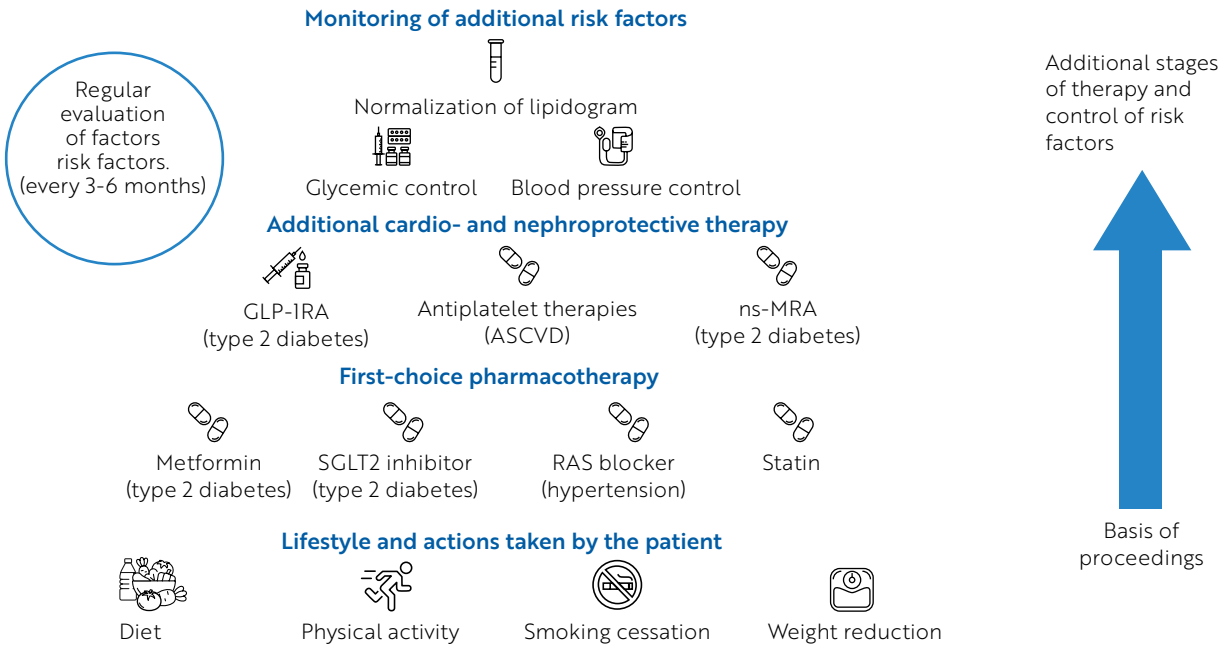

Figure 19.1. Holistic approach to cardio-renal risk [2]

they reduce the risk of chronic kidney disease progression (considering contraindications to their use).

3. When using ACE inhibitors, angiotensin AT1 receptor antagonists, mineralocorticoid receptor antagonists, and/or diuretics, it is essential to monitor levels of creatinine, sodium, and potassium in the blood serum. An increase in serum creatinine levels/a decrease in eGFR of ≤ 30% within 4 weeks after initiating or increasing the dose of the aforementioned medications does not indicate their discontinuation but rather calls for more thorough monitoring of renal function and serum potassium levels, as well as identifying other causes of decreased eGFR/hyperkalemia (e.g., dehydration, diet, others).
4. The combined use of ACE inhibitors with angiotensin AT1 receptor antagonists is contraindicated
5. Metformin should not be used in patients with an eGFR < 30 ml/min/1.73 m². The dose of metformin should be reduced to 1000 mg/day in patients with an eGFR of 30-44 ml/min/1.73 m² and in patients with an eGFR of 45-59 ml/min/1.73 m² who are at high risk of lactic acidosis.
6. In individuals with type 2 diabetes and chronic kidney disease with an eGFR ≥ 20 ml/min/1.73 m² and an ACR ≥ 200 mg/g of creatinine, the use of a sodium-glucose cotransporter-2 inhibitor (SGLT2i) with proven effects in reducing the risk of progression of diabetic kidney disease and the risk of cardiovascular complications is recommended, regardless of HbA_{1c} values, to reduce the progression of chronic kidney disease and cardiovascular events. Creatinine level monitoring is not required after initiating SGLT2i therapy.
7. The use of a glucagon-like peptide-1 receptor agonist (GLP-1) with proven cardiovascular benefits is recommended in individuals with type 2 diabetes and chronic kidney disease who do not achieve individual therapy goals with SGLT2i or in whom SGLT2i is contraindicated or not tolerated.
8. The application of a nonsteroidal mineralocorticoid receptor antagonist (ns-MRA) with proven cardiovascular and nephroprotective benefits should be considered in patients with type 2 diabetes and an eGFR ≥ 25 ml/min/1.73 m², normal serum potassium levels, and albuminuria, despite the use of the maximum tolerated dose of a renin-angiotensin system (RAS) inhibitor.
9. SGLT2i, GLP-1 analogs, and ns-MRA reduce the risk of progression of chronic kidney disease and cardiovascular complications in individuals with type 2 diabetes and chronic kidney disease.

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20. Diabetic Retinopathy

CHAPTER HIGHLIGHTS
· Optimization of glycemic, blood pressure, and lipidemia control reduces the risk of development and progression of diabetic retinopathy. [**A**]
· Fundus examination after pupil dilation should be performed no later than 5 years after the onset in adults with type 1 diabetes and immediately upon diagnosis of type 2 diabetes. [**B**]
· Laser photocoagulation reduces the risk of vision loss in patients with proliferative retinopathy. [**A**]
· Intravitreal anti-VEGF injections in patients with macular edema may improve vision. [**A**]
· Aspirin therapy for cardio protection is not contraindicated in patients with retinopathy and does not increase the risk of vitreous hemorrhage. [**A**]

Diabetic complications affect nearly all anatomical structures in the visual system. The most common and severe complication, threatening vision loss, is diabetic retinopathy and associated diabetic macular edema. Retinopathy is a highly specific neurovascular complication of both type 1 and type 2 diabetes. Among the extra-retinal complications of diabetes, cataract and secondary glaucoma have the most clinical significance. The following recommendations consider the new classification of diabetic retinopathy.

I. Natural history and classification of diabetic retinopathy

1. No signs of diabetic retinopathy.
2. Mild non-proliferative diabetic retinopathy (NPDR) – only microaneurysms present.
3. Moderate non-proliferative diabetic retinopa-

thy – more changes than in the mild form and fewer than in the severe form.
4. Severe non-proliferative diabetic retinopathy:
- hemorrhages (> 20) in 4 quadrants of the retina and/or
- venous beading in at least 2 quadrants and/or
- intraretinal microvascular abnormalities in at least 1 quadrant.
5. Proliferative diabetic retinopathy (PDR) (neovascularization and connective tissue growth in the retina) leading to vision loss through mechanisms:
- recurrent vitreous hemorrhages from newly formed vessels,
- retinal detachment due to traction by proliferative membranes,
- development of glaucoma.

II. Natural history and classification of diabetic macular edema

1. No diabetic macular edema.
2. Mild diabetic macular edema – changes away from the center of the macula.
3. Moderate diabetic macular edema – changes near the center of the macula.
4. Severe diabetic macular edema – changes involving the center of the macula.

III. Risk factors for development and progression of diabetic retinopathy

1. Duration of diabetes – the strongest prognostic factor for the development and progression of diabetic retinopathy.
2. Metabolic imbalance of diabetes:
- intensive treatment reduces the risk of development and progression of retinopathy in type 1 diabetes patients,
- intensive treatment of type 2 diabetes reduces the frequency of microangiopathy complications, and a 1% reduction in HbA_{1c} significantly reduces the risk of developing microangiopathy.
3. Arterial hypertension.
4. Lipid metabolism disorders.
5. Diabetic kidney disease.
6. Pregnancy in women with diabetes.
7. Adolescence.
8. Cataract surgery.
9. Post kidney and pancreas transplantation or kidney only.

IV. Diagnosis of diabetic retinopathy

1. Visual acuity examination.
2. Color vision testing.
3. Fundus examination (ophthalmoscopy, always after pupil dilation).
4. Digital, color photographs of the fundus mainly used in screening studies (do not replace a full ophthalmologic examination).
5. Fundus fluorescein angiography – indications:
- detection of changes in the course of moderate and severe non-proliferative retinopathy,
- detection of initial foci of neovascularization in proliferative retinopathy,
- assessment of the effectiveness of laser photocoagulation,
- clarification of the cause of unjustified deterioration of visual acuity.
6. Wide-angle scanning laser ophthalmoscopy.
7. Optical coherence tomography – the basic method for the diagnosis and monitoring of macular edema.
8. Ultrasound, especially in patients with vitreous hemorrhage.
9. Confocal microscopy (evaluation of the cornea as an early indicator of neuropathy).

V. Indications for ophthalmic examinations in patients with diabetes

1. First examination:
- in type 1 diabetes, it should be conducted within the first 5 years from the onset of the disease,
- in type 2 diabetes, it must be done at the time of disease diagnosis or shortly thereafter.
2. Follow-up examinations and possible treatment:
- indicated due to the initially asymptomatic nature of retinopathy,
- the frequency of examinations depends on the severity of diabetic retinopathy:
  - » without retinopathy – every 1-2 years,
  - » mild and moderate non-proliferative retinopathy – every 6-12 months,
  - » severe non-proliferative retinopathy – laser treatment; follow-up examination at least every 3-6 months,
  - » proliferative retinopathy – urgent laser treatment or other ophthalmic surgery (e.g., vitrectomy),
  - » diabetic macular edema – if outside the macular center, laser treatment; if involving the macular center, intravitreal anti-VEGF injections are indicated, which may be supplemented by laser treatment,
  - » after retinal laser procedures – one month after the procedure,

» after vitrectomy surgery, the timing of examination is determined individually, depending on the condition of the fundus,
» n pregnant women with diabetes: every 1-3 months throughout the pregnancy depending on the eye condition, in women planning pregnancy – before conception and then, if necessary, retinal laser procedures are performed.

3. Urgent indications for ophthalmic examination:

- risk of vision loss:
  » presence of proliferative retinopathy,
  » presence of advanced ocular complications (neovascularization in the iris, hemorrhage into the vitreous body, fresh retinal detachment),
- presence of changes potentially threatening vision loss:
  » severe non-proliferative retinopathy,
  » non-proliferative retinopathy with diabetic macular edema,
  » other abnormalities present in the fundus, difficult to interpret or unexplained deterioration in visual acuity,
  » pregnancy.

The recommended frequency of ophthalmic examinations in different patient groups is presented in Table 20.1.

VI. Screening tests

Screening for diabetic retinopathy is performed by an ophthalmologist or a trained individual with pupil dilation using an ophthalmoscope or through the use of a fundus camera based on color photography of the fundus. Screening can also be conducted using telemedicine utilizing a fundus camera and assessment of photos by qualified personnel or with appropriate image analysis software. Color photography of the eye has great potential for providing check-up services in areas where access to qualified specialists is limited. Hence, retinal photography may serve as a screening tool in retinopathy, but it does not replace a comprehensive vision examination, which should be performed no later than 5 years after the onset in adults with type 1 diabetes and at the time of diagnosis for type 2 diabetes. Subsequent examinations should be carried out at intervals recommended by the ophthalmologist.

In individuals with type 1 diabetes, if no changes in the retina are found in the first 2 consecutive years, the fundus examination can be performed every 2 years, and in those with type 2 diabetes and good metabolic control, without changes in the fundus – every 2-3 years.

In women with type 1 and type 2 diabetes, ophthalmic examinations should be conducted before pregnancy or in the first trimester of pregnancy,

Table 20.1. Recommended frequency of eye examinations by patient group

First-time examination	
Type 1 diabetes	**Type 2 diabetes**
The first 5 years after the onset of disease (when diagnosed during puberty- shortly after diagnosis)	At the time of diagnosis
Follow-up examinations and possible treatment	
Severity of retinopathy	Frequency of examinations and treatment
No retinopathy	Every 1-2 years
non-proliferative mild and moderate	Every 6-12 months
non-proliferative severe	Not less frequently than every 3-6 months
Proliferative	Urgent laser therapy
Diabetic macular edema: • extrafoveal • intrafoveal	Laser therapy Intravitreal injections (anti-VEGF + optional laser therapy)
Follow-up after ophthalmic procedures in special situations	
After laser treatment	Depending on the condition of the eye
Post vitrectomy	Depending on the condition of the eye
Pregnant women	Depending on the condition of the eye every 1-3 months
In women planning a pregnancy	Prior to pregnancy – then laser treatments
With badly managed diabetes, hypertension, or proteinuria	Every 1-6 months, depending on the condition of the ocular fundus

then repeated each trimester and for a year postpartum, assessing the degree of retinopathy.

Regular fundus monitoring and treatment can prevent vision loss due to diabetic retinopathy by up to 98%.

Developed screening strategies significantly reduce the risk of blindness and lower the costs of treating patients with diabetic complications of the visual system.

VII. Treatment of diabetic retinopathy

1. Intensification of treatment in patients with poor metabolic control of diabetes, intensive treatment of arterial hypertension, initially with the use of ACE inhibitors and AT1 receptor blockers, and management of lipid profile abnormalities (fenofibrate, statins). Aspirin – given for cardioprotective purposes – is not contraindicated in patients with retinopathy and does not pose a threat of vitreous hemorrhage.

A meta-analysis of cardiovascular outcomes using GLP-1 receptor agonists did not show an association with diabetic retinopathy per se, except for a correlation between diabetic retinopathy and the average reduction of HbA_{1c} values in three-month and one-year observations. The long-term impact of improved glycemia has not been studied. Studies assessing the impact of SGLT2 inhibitors are more promising. Recent randomized trials indicate a beneficial effect of flozins on the incidence of diabetic retinopathy in patients with a duration of diabetes less than 10 years. Although current data indicate the pleiotropic action of new antihyperglycemic drugs, there is still a lack of clinical trials to determine their impact on the prevention and development of diabetic retinopathy.

2. Treatment of diabetic macular edema includes administration of aflibercept, bevacizumab, dexamethasone in the form of an implant, and ranibizumab.

If the patient has not previously been treated for diabetic macular edema, the attending physician qualifies the patient for the drug program.

Treatment of first-time patients or patients previously treated unsuccessfully begins with 5 doses of bevacizumab.

Qualification criteria:

- presence of clinically significant diffuse macular edema (DME) involving the fovea in the course of diabetes (DRT – sponge-like form, diffuse, CME – cystoid form, or SRD – serous form),
- age over 18 years,
- best corrected visual acuity (BCVA) in the treated eye between 0.2-0.8 as determined by the Snellen chart (or the equivalent ETDRS),
- patient consent for intravitreal injections,
- HbA_{1c} level ≤ 9% for continuation of treatment with aflibercept/ranibizumab or dexamethasone,
- bevacizumab treatment should start regardless of the HbA_{1c} level, if after 5 doses of bevacizumab the HbA_{1c} value is > 9%, and continue with the same drug until the HbA_{1c} level ≤ 9% is reached, the coordinating team may change the drug in case of treatment ineffectiveness,
- no dominant pre-retinal membrane,
- no active fibrovascular tractions that could affect retinal detachment or have a prognostically adverse effect on treatment in the program,
- no retinal detachment in the course of diabetic retinopathy,
- no vitreous hemorrhage requiring surgical treatment,
- no iris neovascularization,
- no neovascular glaucoma,
- regulated intraocular pressure,
- no cataract affecting the monitoring of treatment efficacy in the program,
- no significant and permanent retinal disturbances in the macula that are not expected to improve after anti-VEGF treatment, such as:
  - » extensive photoreceptor atrophy (in OCT, atrophy of the outer retinal layers),
  - » DRIL in the sub foveal area,
  - » ischemic maculopathy;
- Consultations with a diabetologist or internal medicine specialist every 6 months from the moment of qualification for the program.

All criteria must be met concurrently.

3. Retinal laser therapy (possible if the eye's optical centers are clear):

- appropriately early conducted retinal laser therapy inhibits the progression of advanced diabetic retinopathy,
- types of retinal laser therapy:
  - » subthreshold (mainly micro pulse) – without tissue coagulation, used in macular edema without significant thickening and without worsening of visual acuity,
  - » focal – recommended for initial changes in diabetic macular edema without involvement of the fovea,
  - » grid type – in diffuse macular edema when first-choice treatment was ineffective,

   - » pan retinal photocoagulation – recommended in severe non-proliferative and proliferative retinopathy.
4. Intravitreal or periocular injections of steroids with anti-angiogenic and anti-edematous effects, such as triamcinolone, dexamethasone, or fluocinolone acetonide in an extended-release form, may be considered as first-line treatments when contraindications to VEGF inhibitors are present or if the frequency of monthly visits cannot be maintained.
5. Vitrectomy – indications:
   - non-resorbing vitreous hemorrhages despite other treatment methods,
   - vitreoretinal traction running vertically towards the macula,
   - advanced proliferative retinopathy with complications.
6. In cases of irreversible vision disorders, it is necessary to conduct consultations/rehabilitation for people with poor vision or those who have gone blind.
7. In mild and moderate forms of retinopathy with the presence of hard exudates, sulodexide can be used in a dose of 250 LSU twice a day.

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21. Diabetic Neuropathy: Prevention, Diagnosis, and Treatment

CHAPTER HIGHLIGHTS

- For individuals with type 1 diabetes, maintaining optimal glycemic control from the time of diagnosis is crucial for both primary and secondary prevention of peripheral and autonomic diabetic polyneuropathy of the cardiovascular system. [**A**]
- The diagnosis of diabetic neuropathy, in addition to a detailed medical history, should include an assessment of both small fiber function (pain and/or temperature sensation) and large fiber function (vibration sensation). Each patient should undergo an annual 10 g monofilament test to assess the risk of developing a diabetic foot ulcer. These examinations should be carried out for the first time after 5 years in patients with type 1 diabetes and at the time of diagnosis in patients with type 2 diabetes. [**B**]
- Pregabalin, gabapentin, or duloxetine should be considered as first-line medications for the treatment of neuropathic pain in individuals with diabetes. [**A**]

Distal symmetrical polyneuropathy is the cause of severe discomfort, significantly deteriorates the quality of life of patients, and is a recognized risk factor for the development of diabetic foot syndrome in the form of ulcers and Charcot's neuroarthropathy. Neuropathy increases the risk of amputations, fractures, and falls, as well as the costs of treatment and is a predictor of increased mortality risk. Cardiovascular autonomic neuropathy is an independent risk factor for increased mortality in diabetes. Neuropathy can develop as early as the prediabetic state; therefore, diagnostic evaluation should also be considered in individuals with prediabetes who exhibit symptoms of peripheral neuropathy.

I. Clinical classification of neuropathies:

- generalized symmetrical polyneuropathies:
  - chronic sensorimotor peripheral neuropathy,
  - autonomic neuropathy,
  - acute sensory neuropathy,
- focal and multifocal neuropathies:
  - cranial nerve neuropathies,
  - spinal nerve neuropathies (thoracic and lumbar),
  - focal limb neuropathies, including compression syndromes,
  - proximal motor neuropathy (amyotrophy).

II. Conducting examinations for neuropathy:

- frequency of examinations:
  - the assessment of symptoms in diabetic neuropathy should be performed at least once a year, for the first time:
    - in type 1 diabetes – 5 years after the onset of the disease, unless symptoms suggestive of neuropathy occur earlier,
    - in type 2 diabetes – at the time of disease diagnosis,
- another non-diabetic etiology of peripheral nervous system damage should be considered and possibly ruled out,
- it is advisable to consider periodic measurement of vitamin B_{12} levels in metformin-treated patients at the onset or worsening of neuropathy symptoms,
- in doubtful cases, neurological consultation is indicated.

III. Diagnostic criteria for diabetic neuropathy

Distal symmetrical polyneuropathy

A. Diagnostic methods:

- tactile sensation test with a monofilament of 10 g compression (Semmes-Weinstein 5.07),
- vibration sensory threshold test – using a neurotensiometer or calibrated 128 Hz reed,
- pain sensation test (sterile needle),
- temperature sensation test (test indicator with two ends – metal and plastic),
- examination of tendon reflexes,
- muscle strength testing,
- electronic neurophysiological tests.

B. Diagnostic principles:

- subjective symptoms: sensory disturbances, numbness, burning, tingling, pins and needles, spontaneous pain, muscle cramps, mainly in the area of the feet and lower legs, persisting for several months (intensify or mainly occur

at night; physical effort does not provoke or intensify the discomfort,
- objective symptoms: muscle strength weakness, weakened or absent tendon reflexes (knee, ankle), weakened or absent sense of touch, vibration, pain, and temperature, reduced muscle strength,
- Peripheral diabetic neuropathy is considered probable based on the presence of 2 out of 3 following clinical examination elements: subjective symptoms, weakened or absent sensation (touch, vibration, pain and/or temperature) and/or weakened or absent tendon reflexes,
- in the painful form, these objective examination elements may be normal, and neuropathy can be diagnosed in the case of typical discomfort even without abnormalities in the physical examination,
- in some individuals, an electro neurophysiological examination may be necessary for a definitive diagnosis of neuropathy and for the differential diagnosis of its etiology, especially in the case of rapid progression of symptoms, asymmetry, predominance of motor neuropathy, or when a non-diabetic cause is suspected,
- In the diagnosis of small fiber neuropathy, when there are doubts in the clinical picture, an assessment of the nerve fiber density in the cornea using confocal microscopy or in a skin biopsy can be additionally used,
- The Michigan scale (Michigan Neuropathy Screening Instrument – MNSI) can be used for the diagnosis of peripheral symmetrical neuropathy due to its documented accuracy and established cutoff points for the Polish population.

Autonomic neuropathy

The function of the autonomic nervous system is indirectly inferred based on the analysis of changes in the function of effector organs under the influence of certain stimuli. Due to the non-specificity of the occurring clinical symptoms, the diagnosis should be supported by specific tests. Other diseases of the effector organ should be excluded, considering both organic and functional disorders of a different nature, and excluding the influence of the treatment being used.

Clinically, autonomic neuropathy most commonly presents as unawareness of hypoglycemia, resting tachycardia, orthostatic hypotension, gastroparesis, constipation or diarrhea, erectile dysfunction, neurogenic bladder, or sweating disorders.

1. Cardiovascular system

Autonomic neuropathy of the cardiovascular system is diagnosed based on tests assessing heart rate variability.

Autonomic neuropathy is considered probable or early if one of the heart rate variability tests is abnormal, and confirmed when the results of two of the following heart rate variability tests are abnormal. A severe (advanced) form of cardiovascular neuropathy is diagnosed when abnormal heart rate variability tests are found, as well as an abnormal blood pressure response to standing:
- tests assessing the parasympathetic system:
  - » change in heart rate while deep breathing,
  - » change in heart rate in response to standing,
  - » change in heart rate in response to the Valsalva maneuver,
- Tests assessing the sympathetic system: change in blood pressure values in response to standing.

2. Digestive system:
- gastric function disorders – X-ray, radioisotope scintigraphy, breath tests, electrogastrography (EGG), manometry, ultrasonography,
- small intestine function disorders – lack of specific diagnostic tests, exclusion of other causes, manometry, wireless diagnostic capsule – small intestine motility disorders,
- large intestine function disorders – exclusion of other causes (endoscopy), passage after oral administration of contrast agent, manometry, wireless diagnostic capsule,
- gallbladder function disorders – functional ultrasound (USG).

3. Urinary and reproductive systems:
- bladder function disorders – cystometry (assessment of bladder filling before and after urination), sphincter electromyography, uroflowmetry, and urethral pressure profiling,
- erectile dysfunction – questionnaires (the International Index of Erectile Function – IIEF, and its abbreviated 5-question version – IIEF-5), vascular studies (Doppler ultrasound), cavern sonography, hormonal studies, psychological tests, regional assessment of vibration perception threshold, functional studies - monitoring of nocturnal erections.

4. Sweat disorders – simple sweat indicators (e.g., Neuropad), tests requiring complex apparatus (assessment of sudoriferous function using Sudoscan device).
5. Pupil function disorders – pupillometry.

IV. Treatment

Approximately 50% of diabetic neuropathy is asymptomatic. Causal treatment is glycemic control. Optimization of glycemic control should be implemented as soon as possible in individuals with type 1 and type 2 diabetes to prevent and/or delay the development of neuropathy. For patients with neuropathic pain, treatment is absolutely necessary, as it worsens the quality of life and functioning of patients and can lead to depression. There are various therapeutic options for symptomatic pain treatment. Treatment of autonomic neuropathy alleviates symptoms, improves the quality of life, and prognosis of patients, but is often demanding, and effectiveness varies individually.

1. Treatment targeting the pathomechanisms of diabetic neuropathy:
- optimal glycemic control is crucial in the treatment of diabetic neuropathy, with attention to avoiding hypoglycemia and large daily glycemic changes,
- control of blood pressure, lipid metabolism, cessation of smoking, alcohol consumption,
- supportive pharmacotherapy: α-lipoic acid, benfotiamine, angiotensin-converting enzyme inhibitors.

2. Symptomatic treatment of neuropathic pain in somatic diabetic neuropathy (the analgesic effect of treatment is specific to the patient) (Figure 21.1, Table 21.1).
3. Symptomatic treatment of autonomic diabetic neuropathy:
- cardiovascular system:
  - » heart rhythm control disorders – controlled, gradual physical exercise, ACE inhibitors, beta-blockers without intrinsic sympathomimetic activity,
  - » orthostatic hypotension – compression clothing on the lower limbs and abdomen, salting food, isometric exercises, mineralocorticoids (fludrocortisone), α1-adrenomimetics (midodrine),
- digestive system:
  - » gastroparesis – diet modification (frequent, small meals, in severe cases a semi-liquid or liquid diet), prokinetic drugs (cisapride, ito-

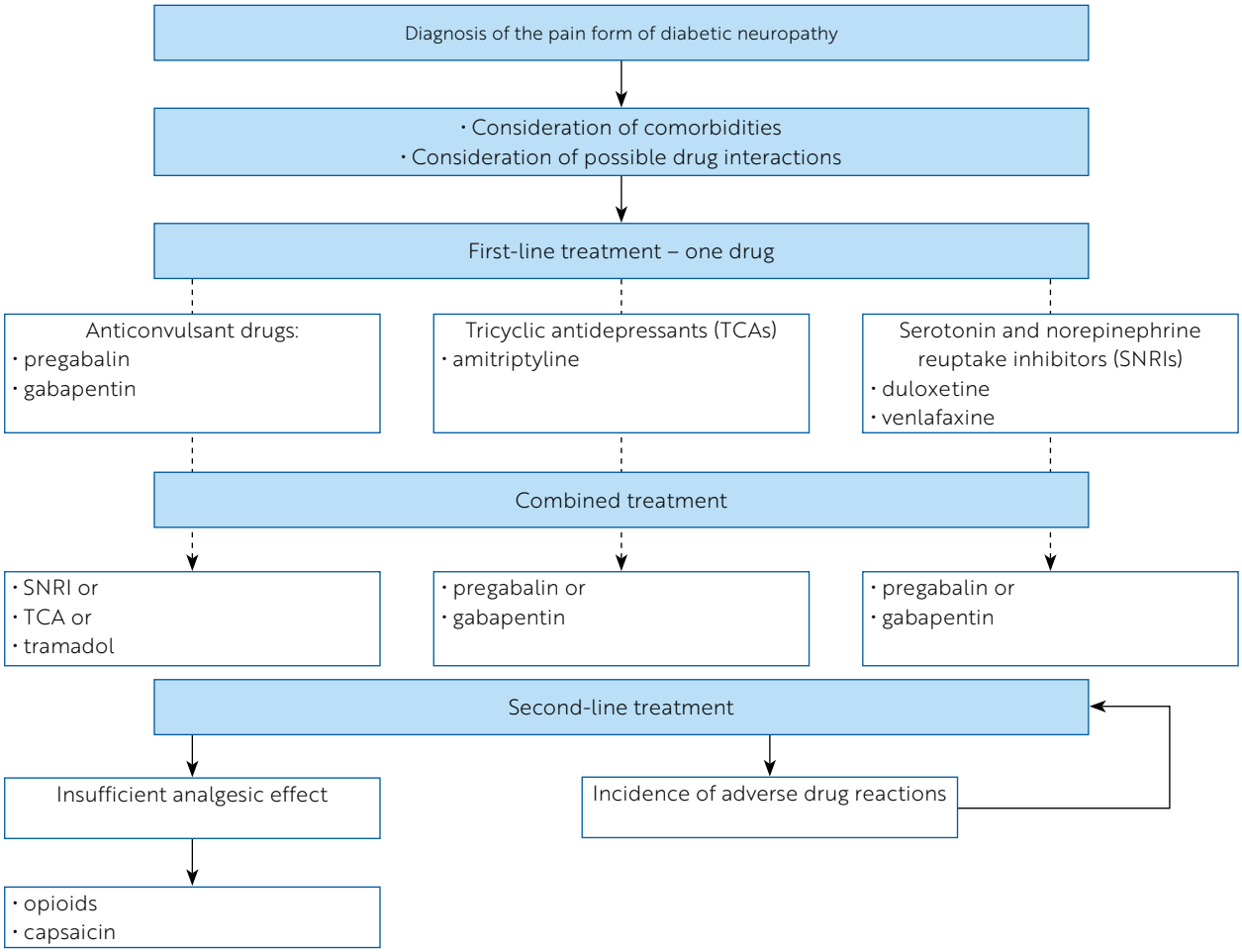

Figure 21.1. Therapeutic regimen for symptomatic neuropathic pain in somatic diabetic neuropathy

Table 21.1. Pharmacological algorithm for therapeutic management of symptomatic neuropathic pain in somatic diabetic neuropathy

First-line treatment- one of the following medications	Effective doses of drugs
Anticonvulsant drugs	
Pregabalin	300-600 mg/day
Gabapentin	900-3600 mg/day
Selective serotonin and norepinephrine reuptake inhibitors	
Duloxetine	60-120 mg/day
Venlafaxine	75-225 mg/day
Tricyclic antidepressants medications:	
Amitriptyline*	25-100 mg/day
Second-line treatment	**Effective doses of drugs**
Opioid drugs	
Tramadol	200 mg/day
Tapentadol	From 50 mg twice a day, max. 500 mg/day
Topical drugs	
Capsaicin, lidocaine	

Effective doses of drugs have been indicated. It is necessary to gradually increase the dose. If one of the first-line drugs is not effective, a change of preparation or combination therapy is recommended. Chronic use of opioids is not recommended. Non-pharmacological methods (physical therapy, acupuncture) can be used at any stage.

**In elderly patients and those with cardiovascular disease, the administration of amitriptyline should be started with a dose of 10 mg and increased carefully depending on response and tolerance.*

pride, erythromycin, trimebutine), drugs inhibiting gastric secretion (H_2 blockers, proton pump inhibitors), antiemetic drugs, surgical treatment, stimulation of gastric bioelectrical activity,
  - » Intestinal function disorders – diet modification (consideration of a gluten-free diet, lactose limitation), cholestyramine, clonidine, octreotide, constipating drugs (loperamide), pancreatic enzymes, antibiotics;
- urinary and reproductive systems:
  - » bladder function disorders – avoiding urine retention, regulated, systematic urination, cholinergic receptor agonists (bethanechol), external bladder massage before urination, bladder catheterization (intermittent, permanent),
  - » sexual function disorders in men – psychotherapy, phosphodiesterase type 5 inhibitors (sildenafil, vardenafil, tadalafil), vacuum erection devices, injections into the cavernous bodies (prostaglandin E1), penile prostheses,
  - » sexual function disorders in women – psychotherapy, mechanical sexual organ stimulators, local moisturizing drugs, flibanserin,
- Sweat disorders – botulinum toxin, vasodilating medications, moisturizing creams.

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22. Diabetic Foot Syndrome (DFS): Diagnosis and Treatment

CHAPTER HIGHLIGHTS
• Maintaining optimal control of glycemia, lipidemia, and blood pressure reduces the risk of developing diabetic foot syndrome. [**A**]
• Treatment of diabetic foot syndrome should take place within specialized, multidisciplinary clinics. [**B**]
• The gold standard for offloading a non-infected, neuropathic foot is a total contact cast that encompasses the foot and lower leg. [**A**]
• Key to the treatment of diabetic foot syndrome, in addition to maintaining optimal glycemic control, are surgical debridement of the wound, offloading, systemic antibiotic therapy in case of infection, and vascular interventions in ischemic foot. [**A**]

In regional diabetes centers, including provincial and university-affiliated facilities, it is recommended to establish multidisciplinary diabetic foot clinics, also referred to as reference clinics. Additionally, at diabetes clinics, there should be the establishment of basic diabetic foot clinics dedicated to the ongoing management of therapies initially formulated within the multidisciplinary settings. The structure and tasks should be in accordance with the Ministry of Health's Ambulatory Care Support Program for Diabetic Foot Syndrome (http://www.mz.gov.pl/health-and-prevention/health-programs/list-of-programs/program-of-ambulatory-support-treatment-of-diabetic-foot-syndrome/)

I. Definition

The diabetic foot is an infection and/or ulceration, and/or destruction of the deep tissues of the foot (e.g., bone) caused by damage to the peripheral nerves and/or blood vessels of varying degrees of severity. This definition leads to the classification of diabetic foot as neuropathic, vascular, or mixed. The diagnosis of diabetic foot syndrome (DFS) includes assessing the presence of peripheral polyneuropathy, lower limb circulation disorders, deformative changes, and other risk factors for foot damage. If a loss of protective pain sensation is detected, it is advisable for the physician to examine the patient's feet during each visit.

II. Risk factors for the development of diabetic foot syndrome

The most important risk factors for the development of DFS include:

- peripheral neuropathy and/or signs of lower limb ischemia,
- no patient awareness,
- long-term, poorly managed diabetes,
- improper foot hygiene,
- inappropriate footwear,
- presence of calluses,
- foot deformity,
- increased pressure on the plantar side of the foot,
- tobacco smoking.

Factors favoring ulcer recurrence:

- previous amputations,
- history of ulceration,
- Charcot's neuropathic foot.

III. Prevention:

- systematic foot examinations; an annual assessment for sensory disturbances (physical examination with a 10 g monofilament and a 128 Hz tuning fork; in the absence of a monofilament or tuning fork, testing for loss of sensation can be conducted by lightly touching the patient's toes with the index finger for 2-3 seconds) and ischemia (pulse assessment on the dorsalis pedis and posterior tibial arteries; if the pulse on these arteries is not palpable, consider ankle-brachial index testing) for all patients; the frequency of foot examinations depending on the risk assessment of wound formation is presented in Table 22.1,
- regular podiatric care (removal of calluses and hyperkeratosis),
- assessment of the patient's footwear and existing deformities, as well as knowledge concerning the risk of ulceration,
- treatment/elimination of other risk factors, such as smoking, overweight, hypertension, lipid disorders, diabetic metabolic regulation,
- early detection and treatment of limb ischemia,

Table 22.1. Frequency of preventive foot examinations according to risk (risk stratification system according to the International Diabetic Foot Working Group).

Category	Wound risk	Features	Frequency of testing
0	Very low	Preserved sensation, no ischemia	Once a year
1	Low	Sensory disturbance or ischemia found	Once every 6-12 months
2	Moderate	Identified sensory disturbance and ischemia, or Identified sensory disturbance + foot deformity, or stated ischemia + foot deformity	Once every 3-6 months
3	High	Identified sensory disturbance or ischemia and one of the following: • a history of ulceration • a history of amputation • end-stage renal failure	Once every 1-3 months

- Exercise walking may be recommended exclusively for patients without plantar surface ulceration using properly fitted footwear.

IV. Clinical classification of foot ulceration

The PEDIS classification [P – perfusion (circulation), E – extent (size), D – depth, I – infection, S – sensation] is recommended, considering both infection and ischemic factors (Table 22.2) as well as the SINBAD classification (Table 22.3).

V. Infections in diabetic foot

1. The diagnosis of infection is primarily based on clinical presentation (presence of at least two classic subjective and objective signs of infection), rather than solely on the results of microbiological and laboratory tests.
2. Assessment of the severity of the infection (refer to the PEDIS classification).
3. Microbiological testing (with antibiogram) and its interpretation (colonization, contamination, infection):

It is advisable to collect a sample from the cleansed wound, such as tissue fragments, aspirates, or scrapings for culture.

Necessary when there is a clinically infected wound.

Table 22.2. PEDIS classification

	Grade			
	1	2	3	4
Vascularization	Features of a normal blood supply: palpable pulse on the arteries of the feet or ABI > 0.9	Clinical signs of circulatory impairment: the presence of chromic lag, ABI < 0.9, $TcpO_2$ 30-60 mm Hg	Critical ischemia: rest pain, ABI < 0.4, $TcpO_2$ < 30 mm Hg	–
Size	The dimension of the wound is determined in square centimeters			
Drilling	Superficial ulceration not exceeding the dermis	Wound may involve all soft tissues	Penetration of infection into bone: visible on X-ray, features of osteolysis or bone palpable with probe	–
Severity of infection	No clinical signs of infection	The infection involves the skin and subcutaneous tissue. The area involved in the inflammation does not exceed 2 cm from the border of the ulceration	Topical intensification of inflammatory features The border exceeds 2 cm, but there are no features of generalized infection	Features of generalized infection: fever > 38°C, pulse > 90/min, respiratory rate > 20/min, leukocytosis > 12 thousand or < 4 thousand
Sensory neuropathy	No features of sensory neuropathy in basic tests: monofilament and camertone or neurotip examination	Presence of sensory neuropathy		

Table 22.3. SINBAD classifications

Category	Definition	Score
Location	Forefoot Midfoot/rear of the foot (heel area)	0 1
Ischemia	Blood supply to the foot normal – palpable pulse at least on one artery Clinical features of ischemia	0 1
Neuropathy	Retained sensation No feeling	0 1
Infection	No Present	0 1
Area	< 1 cm^2 ≥ 1 cm^2	0 1
Depth	Ulceration limited to the skin and subcutaneous tissue The ulceration involves muscles, tendons. or deeper structures	0 1
Total		6

Interpretation of cultures in infection assessment can be challenging – clinical presentation should be primarily considered.

Blood cultures are only recommended in the presence of systemic infection symptoms.

For clinically uninfected wounds, microbiological examination is not indicated; in cases of mild infection without prior antibiotic use, empirical antibiotic therapy may be initiated without culture.

4. Examination for osteomyelitis (should be performed in every case of infected ulceration, especially those with a prolonged duration):
- probe to bone test with a metal instrument,
- foot bone radiography (every 3-6 weeks); MRI is the preferred next imaging method, followed by SPECT, PET, or scintigraphy with labeled leukocytes,
- bone biopsy or culture from bone fragments and histopathological examination (recommended); bone biopsy is necessary if osteomyelitis diagnosis is uncertain, or pathogen identification is required,
- laboratory tests – ESR > 70 mm/hr increases the probability of osteomyelitis; lower values suggest a lower risk; CRP and leukocytosis measurements may also be helpful; normal laboratory test results do not fully rule out osteomyelitis.

5. The primary criterion for dressing selection is the nature of the wound – dry or exudative.

A. Guidelines for antibiotic therapy:
- use only in cases of confirmed infections (not prophylactically),
- do not delay the initiation of therapy,
- initially, use an antibiotic that covers the most common flora (staphylococci and streptococci):
  - for PEDIS grade 4 infections, consider the presence of Gram-negative bacteria and anaerobes,
- duration of antibiotic use – until clinical symptoms of infection subside (not until the wound heals):
  - for 3 weeks following a low amputation performed due to osteomyelitis and confirmed pathogens in bone material culture from the wound margin,
  - for 6 weeks in cases of osteomyelitis where affected bones were not removed or amputated,
  - consider extending antibiotic therapy if there is a reduction in infection severity but due to the extent of the foot procedure, it occurs slower than anticipated:
    - for PEDIS grade 2 infections – usually 1-2 weeks, although duration may be longer in some cases (especially in immunosuppressed patients or those with limb ischemia),
    - for PEDIS grades 3-4 infections – 2-4 weeks,
- route of administration:
  - intravenous – for PEDIS grade 4 infections and in selected cases of grade 3 (MRSA infection, *Pseudomonas aeruginosa*), intolerance to oral antibiotics,
  - oral – for PEDIS grades 2 and 3 infections and after improvement in grade 4,
  - topical – consider using a gentamicin-soaked collagen sponge (garamycin sponge) as adjunctive to systemic antibiotic therapy if the pathogen is sensitive to gentamicin,
  - intra-arterial – not recommended.

B. Selection of antibiotics:
- for severe infections:
  - intravenous treatment – ciprofloxacin + clindamycin, amoxicillin with clavulanic acid, or piperacillin with tazobactam, or carbapenem + vancomycin, or linezolid until MRSA is ruled out,
  - oral treatment continuation – amoxicillin with clavulanic acid + double-dose trimethoprim-sulfamethoxazole or ciprofloxacin 2 × 750 mg, or moxifloxacin + linezolid,
  - MRSA infection: linezolid, vancomycin,

- for less severe infections:
  - » usually, oral treatment using similar antibiotics as for severe infections:
  - – Gram-positive pathogen: semisynthetic penicillins/first-generation cephalosporins,
  - – recent antibiotic treatment, Gram-positive and Gram-negative pathogens: fluoroquinolones, beta-lactam antibiotics; for allergies: clindamycin, fluoroquinolone, sulfamethoxazole + trimethoprim;
- treatment of osteomyelitis (no uniform treatment model established):
  - » surgical – with removal of the affected bone (minor amputation),
  - » antibiotic therapy as for severe infections,
  - » monitoring the effectiveness of osteoarthritis treatment: laboratory tests (ESR, CRP), radiograph of the foot bones.

VI. Multidisciplinary treatment of diabetic foot syndrome

Treatment of Diabetic Foot Syndrome (DFS) should be conducted within the framework of specialized, multidisciplinary clinics. This concept encompasses an organizational structure that allows for patient access to required specialists who possess knowledge and experience in diabetic foot treatment and form a team in constant communication. The treatment of DFS includes:

- metabolic control of diabetes, considering the general principles of its treatment,
- offloading – the preferred method is non-removable offloading, which can only be recommended and applied by appropriately trained personnel, ideally extending to the knee, but if this is not possible or accepted by the patient, then at least to the ankle; temporary footwear offloading the forefoot or heel, compensatory shoes for the healthy limb, therapeutic insoles, crutches, a wheelchair, specialized footwear, and limited walking – including at home; in other locations (e.g., heel), with the presence of infection and/or ischemia, the first and subsequent choice are removable offloading; when deciding on the method of offloading, the patient's condition and mobility, coexisting diseases, patient preference, and team training should be considered; for many patients (especially those with loss of protective pain sensation, ischemia, and existing deformities), the use of appropriate, individually fitted insoles for footwear is indicated for the prevention of ulcers or their recurrence,
- antibiotic therapy (oral or intravenous): see above,
- surgical procedures – removal of necrotic tissues, drainage, incision; tenotomy of toe flexors may be considered if their deformation causes recurring ulcers, as well as lengthening of the Achilles tendon and resection of the metatarsal head if ulceration does not heal despite offloading,
- endovascular surgery and vascular surgery, hybrid procedures [diabetic foot characterized by a predominance of ischemic factor – patients with a low (< 0.5) ankle-brachial index (ABI), $TcPO_2$ values < 25 mm Hg and/or a history of intermittent claudication should be referred for further urgent vascular diagnostics, and then to a vascular surgeon or angiologist; imaging diagnostics and revascularization should also be considered – even when the results of the above tests are normal – if there is no progress in wound healing within 4 weeks; it should be noted that many patients with diabetes may have lower limb ischemia without typical pain symptoms]; the goal of revascularization should be to restore blood flow at least to one artery, preferably the one supplying the anatomical area of ulceration,
- podiatric procedures (regular wound debridement depending on local condition),
- conventional dressings and therapy providing a moist wound environment – the use of TLC-NOSF technology dressings in uninfected neuropathic-ischemic etiology wounds (but without critical/significant ischemia), not healing despite optimal standard treatment, should be considered,
- other – hyperbaric chamber meeting required standards (ischemic wounds, not healing despite standard procedures), negative pressure therapy (to be considered especially for post-operative wounds in parallel with standard procedures), drugs improving circulation (ischemic foot or with a predominance of vascular factor): low molecular weight heparin preparations (acute ischemic states, critical ischemia), acetylsalicylic acid, exercise walking; the use of preparations from autologous leukocytes, platelet-rich fibrin (ulcers without or with minor ischemia), local oxygen therapy, and dressings from human placenta as adjunctive therapies for the treatment of uninfected ulcers may also be considered; sulodexide treatment may also be considered.

The use of "artificial skin" grafts, growth factors, ozone therapy, and autologous platelet gel is not recommended. In justified cases, the use of Lucilia sericata larvae bred in sterile conditions in specialized laboratories may be considered for wound debridement.

Every patient with DFS should be educated on the prevention of ulcers.

Charcot neuroosteoarthropathy (Charcot Foot)

1. Diagnosis

The diagnosis is based on the patient's medical history and clinical presentation (most often unilateral swelling, redness, increased warmth of the foot, especially if there is no ulceration, in patients with features of diabetic polyneuropathy), after excluding other causes, particularly deep vein thrombosis, gout, and abnormalities on imaging studies. If these are not visible on a standard radiograph (weight-bearing position), an MRI should be performed, or if unavailable, a CT scan. In the absence of these methods, the patient should be treated as having probable neuroosteoarthropathy.

2. Treatment:

- active phase – round-the-clock offloading reaching the knee (lower levels are not recommended); bisphosphonate or calcitonin therapy is not recommended, and vitamin D and calcium supplementation should follow general principles; offloading should be maintained until the process stabilizes and enters the inactive phase; monitoring of the activity process through foot surface temperature measurements and comparison between both feet (no clear cutoff point) and radiological imaging indicating consolidation may be considered; the return to full limb loading should be very gradual,
- inactive phase – education, foot hygiene, specialized orthopedic footwear with therapeutic insoles to correct deformities, orthopedic surgical procedures for correction of deformations (ostectomy, arthrodesis); multidisciplinary specialist team management is recommended.

VII. Hospitalization – indications

For emergency admission:

- PEDIS grade 4 infection,
- PEDIS grade 3 infection, if intravenous antibiotic therapy is necessary,
- any case of critical ischemia – emergency intervention unit for urgent revascularization,
- admission to a department capable of performing urgent vascular imaging (CT angiography or MR angiography), followed by urgent consultation of the patient for revascularization qualification.

For elective admission:

- no improvement after two months of outpatient treatment,
- preparation for planned surgical procedures (minor amputation, skin graft, limited bone resections, revascularization procedures).

VIII. Amputation

Assessment of limb perfusion is necessary before any amputation.

1. "Major" amputation (above the ankle) should be considered when:

- life-threatening inflammation, extensive necrosis (absolute indication),
- debilitating pain resistant to treatment, especially as a result of ischemia (relative indication),
- loss of foot load-bearing functions (relative indication).

2. "Minor" amputation (below the ankle) should be considered when:

- necrosis,
- inflammation of the distal phalangeal bones of the toes (to avoid chronic antibiotic therapy – accelerates healing),
- inflammation within the metatarsophalangeal joints to perform their resection as a limb-sparing bone procedure,
- in the case of dry necrosis, waiting for autoamputation is advised.

The choice of amputation level depends on the state of perfusion, and the possibilities for reconstruction and rehabilitation. It is recommended that amputation be carried out as sparingly as possible.

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23. Children and Adolescents with Diabetes

CHAPTER HIGHLIGHTS
• From the moment of diagnosis, a care plan utilizing appropriate educational tools should be implemented to achieve individual therapeutic goals for children and adolescents with diabetes.
• For children and adolescents with diabetes, the goal should be to maintain Time in Range (TIR) ≥ 80% and Coefficient of Variation (CV) < 36%, with HbA_{1c}/GMI values ≤ 6.5%, while minimizing episodes of hypoglycemia and maintaining good quality of life. [**B**]
• During disease remission and when using automated insulin delivery systems, it is advisable to narrow the target range to 70-140 mg/dl and CV < 33%. [**E**]
• Children and adolescents with diabetes and their families should receive specialized psychological care from the moment of diagnosis.
• Continuous glucose monitoring systems should be used by children and adolescents with diabetes from the time of diagnosis. [**A**]
• Blood glucose should be interpreted at least eight times daily: fasting and before meals, before sleep, before, during, and after exercise, and when feeling unwell, as needed 1–2 hours post-meal and during the night. [**A**]
• Using continuous glucose monitoring in children and adolescents improves diabetes metabolic balance (increases TIR, lowers HbA_{1c} levels), reduces the risk of acute and chronic complications, and extends life expectancy. [**A**]
• Children and adolescents with type 1 diabetes should be treated with intensive insulin therapy from the onset of the disease – personal insulin pump therapy is preferred. Automated insulin delivery systems are recommended. If they are not available, systems with an automatic insulin suspension feature in anticipation of hypoglycemia are preferred. [**A**]

This chapter outlines differences in general recommendations due to the specificities of developmental age.

I. Diagnosis and forms of diabetes in developmental age

1. The same tests used for diagnosing diabetes in adults are applicable to children and adolescents. Without clear hyperglycemia, the diagnosis requires two abnormal test results from the same sample or two separate samples. HbA_{1c} < 6.5% does not exclude diabetes diagnosed with glucose tests. The role of HbA_{1c} alone in diagnosing type 1 diabetes in children is unclear.
2. Type 1 diabetes with autoimmune pathogenesis is the most common.
3. Screening tests (OGTT or HbA_{1c}) for type 2 diabetes should be performed in children at the onset of puberty or after the age of 10 who have a BMI ≥ 85th percentile for age and sex, and other risk factors for developing type 2 diabetes. If results are normal, they should be repeated at least every three years. Annual screenings are necessary if BMI increases, the cardiometabolic risk profile worsens, there is a strong family history of type 2 diabetes, or there are signs of prediabetes. Type 2 diabetes in children and adolescents is characterized by earlier development and faster progression of chronic complications than in adults.
4. It should be noted that in Poland, monogenic diabetes is the second most common form of diabetes in the pediatric population. Indications for testing for monogenic diabetes are presented in Chapter 1.
5. The number of children with glucose tolerance disorders or cystic fibrosis-related diabetes is increasing. Diabetes is usually asymptomatic. Children over 10 years of age with cystic fibrosis should undergo an annual OGTT with glucose measurement fasting, and at 30, 60, 90, and 120 minutes.
6. Initial diagnosis of hyperglycemia or revision of a diabetes diagnosis includes the detection of antibodies against glutamic acid decarboxylase (anti-GAD), islet cell antibodies (ICA), insulin (insulin autoantibodies – IAA), tyrosine phosphatases (insulinoma-associated autoantigen 2 – IA-2), and zinc transporter 8 (ZnT8) (testing should be performed in a reference laboratory). It is also recommended to determine these antibodies in individuals with a family history of type 1 diabetes. Currently, the introduction of population-based screening for type 1 diabetes is being considered in Poland, as in other countries. Detecting diabetes in the preclinical stage, combined with

annual monitoring for disease progression, allows for:

- significant reduction of hyperglycemia consequences (including diabetic ketoacidosis, central nervous system damage),
- gentler introduction of insulin therapy,
- lengthening of clinical remission.

Participation in research projects aimed at preventing the progression of diabetes to the clinical stage. The presence of two or more positive antibody titers indicates an active autoimmune process of β-cell apoptosis in the pancreas and allows for the diagnosis of stage 1 (preclinical) type 1 diabetes. Stage 2 is diagnosed with the addition of dysglycemia, which is:

- IFG (impaired fasting blood glucose) or
- IGT (impaired glucose tolerance) or
- HbA_{1c}: 5.7-6.4% or a 10% increase from its value.

Given the significant risk of developing stage 3 type 1 diabetes, patients in preclinical stages require health education regarding a healthy lifestyle (proper body weight and regular physical activity extend the preclinical period) and glucose value assessment. For children in the preclinical phase of the disease, to monitor disease progression, at least an annual OGTT (with glucose measurement also at 30, 60, and 90 minutes) and HbA_{1c} should be performed.

7. Keep in mind that a patient may have a mixed etiology of diabetes.

II. Goals of diabetes treatment

1. Prevention of acute and chronic complications of diabetes.
2. Achievement and maintenance of proper, harmonious physical development: growth and body mass, including composition (percentile values), as well as the progression of puberty, appropriate to age and gender, while ensuring comfort for the child and their family.
3. Target values for parameters to reduce the risk of vascular complications:

- aim for TIR ≥ 80%, CV < 36%, and HbA_{1c} ≤ 6.5%, while minimizing hypoglycemia episodes and maintaining a good quality of life; with automated insulin delivery systems, consider narrowing the target range to 70-140 mg/dl and CV < 33%,
- total cholesterol concentration < 170 mg/dl (< 4.4 mmol/l), LDL cholesterol < 100 mg/dl (< 2.6 mmol/l), triglycerides < 100 mg/dl (< 1.1 mmol/l),
- blood pressure value < 90th percentile for age, gender, and height (from age 13 < 120/80 mm Hg),
- BMI < 85th percentile for age and gender,
- physical activity of moderate or high intensity for at least one hour daily,
- sleep duration: children aged 5-13 years a minimum of 9 hours and aged 14-17 years a minimum of 8 hours per day,
- no tobacco uses.

III. Diabetes treatment

1. Pharmacotherapy: type 1 diabetes — insulin therapy:

- the method of insulin therapy should be tailored to the individual needs of the patient and accepted by the person with diabetes and their caregivers,
- the preferred method is functional intensive insulin therapy (IIT) which involves constant adaptation of insulin doses to current glycemic values and their trends, the amount of carbohydrates consumed (considering fat and protein content in meals), and physical and emotional activity, carried out as either:
  - » continuous subcutaneous insulin infusion (CSII) with a personal insulin pump, or
  - » multiple daily injections (MDI) using a pen injector with needles ≤ 6 mm in length.
- indications and contraindications for CSII — see the thematic chapter,
- standard practice should be the use of CSII from the onset of diabetes, if there are no contraindications, and this therapy method is accepted by the patient and their parents/caregivers; optimal is the use of automated insulin delivery (AID) systems; if they are not available, consider systems that automatically suspend insulin delivery in prediction of hypoglycemia,
- in CSII and MDI, the use of the bolus calculator function from the start of therapy is indicated, as it increases glycemic stability and reduces the risk of hypoglycemia and hyperglycemia; regular verification and modification of bolus calculator settings are important,
- the choice of rapid-acting or ultra-rapid-acting and long-acting or ultra-long-acting insulin analogs should be tailored to the individual needs of the patient, considering pharmacological differences between products and registered indications; ultra-long-acting analogs reduce the risk of hypoglycemia and allow for less strict adherence to insulin dosing times and usually do not require a dose reduction in the case of physical activity (see Chapter 7),
- in the pediatric population, daily insulin requirements are highly variable; the highest is

during puberty but should not exceed 1.5 U/kg body weight/day; high insulin requirements can often be associated with lack of physical activity, excessive carbohydrate intake, obesity, or coexisting disease; in cases of obesity, the addition of a GLP-1 receptor agonist may be considered; for patients with concomitant insulin resistance, the addition of metformin can be considered,
- in the functional IIT method, the size of the basal dose (20-50% of the daily dose) and its profile depend on the child's age and the type of personal insulin pump; in the case of AID systems, the size of the basal dose depends on the algorithm used,
- rapid-acting and short-acting insulin is preferably administered before a meal, respectively 15-20 minutes and 20-30 minutes, and ultra-rapid-acting analog 2-10 minutes before a meal; in very young children, due to the impossibility of planning the time and size of the meal, it is worth considering splitting the dose and administering half before the meal and half during or after the meal; administering the entire dose after the meal should only be done exceptionally,
- it is important to systematically rotate the insulin injection sites, while avoiding administering insulin in areas of hypertrophy or atrophy of subcutaneous tissue,
- for patients treated with CSII who have low insulin requirements, diluting the insulin is permissible.

Type 2 diabetes – In this age group, the following can be used: metformin, insulin, GLP-1 receptor agonists, and SGLT-2 inhibitors (age restrictions according to the Summary of Product Characteristics).

For newly diagnosed diabetes with:
- no symptoms of the disease, HbA_{1c} < 8.5%, and no ketoacidosis, pharmacotherapy in children can begin with metformin (gradually increased to 2 g/day or tolerated dose),
- symptoms of the disease and/or HbA_{1c} ≥ 8.5% and no ketoacidosis, treatment starts with metformin and basal insulin (at a dose of 0.25–0.5 U/kg body weight/day),
- ketoacidosis present – initial treatment as in type 1 diabetes (intravenous insulin).

After stabilizing acute metabolic disorders and initial normalization of glycemia, insulin treatment should be withdrawn (usually within 2-6 weeks).

In patients with longer disease duration without sufficient glycemic control and no normalization of body weight despite using metformin, a second hypoglycemic drug (GLP-1 receptor agonist and/or SGLT-2 inhibitor) should be added. If therapy is ineffective or the use of GLP-1 receptor agonists and/or SGLT-2 inhibitors is not possible, basal insulin should be introduced.

Bariatric treatment is permissible in selected cases.

Monogenic diabetes or diabetes associated with genetic syndromes – treatment depends on the type of disease (use of sulfonylurea derivatives is off-label).

Diabetes in cystic fibrosis – see Chapter 1.

2. Nutrition for Children and Adolescents with Diabetes

The basic principles of healthy eating for children with diabetes are the same as for their non-diabetic peers. It is recommended to maintain a proper caloric balance and to reduce carbohydrate content to a maximum of 40-50% of daily caloric needs. Limiting simple sugars to 10% of daily caloric intake and including vegetable portions in every meal is advised. Attention should be paid to the intake of adequate fluids.

3. Self-Monitoring:
- glucose monitoring should be conducted through self-measurements using continuous glucose monitoring systems (CGM); CGM is recommended for every child and adolescent from the onset of the disease,
- if CGM is not possible or accepted, glucose measurements should be performed with a glucometer,
- the frequency of glucose value interpretation is individualized, with functional IIT at least 8 times daily; glucose should be assessed fasting and before meals, 1-2 hours after a meal, before sleep, before, during, and after exercise; night-time glucose profiles should also be evaluated; in case of feeling unwell, glucose should be measured immediately.

CGM use requires diabetes education in terms of correct interpretation of current results, therapy modification according to glucose concentration dynamics (trend arrows), retrospective analysis of results according to TIR recommendations (see Chapter 4). With CGM, education should be expanded to include correct sensor calibration principles (if required), proper selection, and programming of alarm limits and notifications. If CGM glucose concentration values are not in line with clinical symptoms, glucose should be measured with a glucometer. The use of CGM systems en-

ables more effective adjustment of insulin doses to glucose trends, thus increasing glucose stability, reducing hypoglycemia incidents, improving metabolic balance, enhancing the quality of life for patients and their caregivers, and reducing the risk of cardiovascular complications. Only consistent CGM use is therapeutically effective (at least 70% of the time). For patients with hypoglycemia unawareness or frequent hypoglycemia, CGM use is necessary, optimally – automated insulin delivery systems or insulin pumps integrated with CGM with an automatic insulin suspension feature for hypoglycemia prediction. Measuring blood β-hydroxybutyrate concentration with strip tests is a more sensitive indicator of ketonemia than urine ketone testing.

4. Therapeutic education.

- It is a key element in diabetes treatment and should always involve the child and their caregivers.
- Patients and/or their parents/caregivers need education on the principles of diabetes self-management, including modern technologies in diabetes care, and regular re-education according to the patient's individual needs; everyone involved in the child's care must be educated.
- Educational methods and programs should be diversified and adapted to the child's age, intellectual capabilities, and the educational roles of parents/caregivers.
- In adolescents and young adults, special attention should be paid to prevention of chronic complications of diabetes, contraception, pregnancy, risky behaviors, and addictions.
- The process of acquiring self-management skills should be gradual; too early or too late a transfer of responsibility to children and adolescents with diabetes is associated with therapy failure.
- Workshops and camps for children, adolescents, and young adults with diabetes are a beneficial and effective educational tool.
- Members of the diabetes team caring for patients < 18 years of age at camps/colonies without parents should provide intensive medical care, including night shifts; legal and organizational support from the administrative units caring for the child with diabetes is expected.
- Conducting diabetes education and its continuation is the duty of the entire diabetes team, with a special role for the diabetes educator.

5. Psychological care.

- Continuous psychological care for children, adolescents, and young adults with diabetes and their families from the onset of the disease is essential.
- Subclinical and clinical depressive syndromes, eating disorders including anorexia nervosa (especially in girls during puberty), and other non-specific eating disorders (ED-NOS) are often observed.
- Care should be provided by an experienced psychologist specialized in developmental age diabetes issues, in collaboration with a child psychiatrist.
- Screening for depressive disorders, eating disorders, and diabetes-related stress should be performed in all patients over the age of 12 every 1-2 years and in any patient with unsatisfactory metabolic control of the disease; diabetes-related stress should also be assessed in parents/caregivers.

6. Additional remarks.

- Inclusion of the entire family in the treatment process of diabetes in children and adolescents is necessary; setting therapeutic goals together is recommended.
- Encouraging patients to be independent and take responsibility for their treatment, appropriate to their age, intellectual development, and emotional maturity, is necessary.
- Properly developing children > 10 years old should be able to independently measure glucose with CGM and glucometer and interpret results, administer insulin with an injector, change infusion sets for insulin pumps, and CGM sensors.
- Children > 13 years old should independently conduct daily self-monitoring of diabetes under parental supervision.

In cases of existing or suspected social problems, collaboration with a social worker is necessary.

IV. Coexisting diseases with type 1 diabetes

Common conditions include:

- autoimmune thyroiditis, celiac disease; typically presenting with scant or no symptoms such as glucose level fluctuations, or growth and sexual maturation issues,
- IgA deficiency.

Certain chronic diseases (e.g., epilepsy, Asperger's syndrome, mental or intellectual disorders) may impose additional requirements on diabetes therapy.

V. Acute and chronic complications of diabetes (refer to thematic chapters):

1. Acute complications:

- for blood glucose ≤ 70 mg/dl (3.9 mmol/l) or when clinical symptoms of hypoglycemia are present (without severe consciousness disorders), administer oral glucose at approximately 0.3 g/kg body weight, with the dose dependent on the blood glucose levels and active insulin (maximum dose usually does not exceed 15 g of glucose for a child weighing ≥ 50 kg); re-measure blood glucose after 15 minutes; with AID, consider treating hypoglycemia with a smaller amount of glucose (5 to 10 g),
- blood glucose < 54 mg/dl (3.0 mmol/l) is indicative of clinically significant hypoglycemia,
- with CGM, hypoglycemia is diagnosed when blood glucose levels < 54 mg/dl last for more than 15 minutes,
- severe hypoglycemia in small children is identified by consciousness disorders and/or seizures,
- severe hypoglycemia management is detailed in Chapter 14,
- biochemical criteria for acute hyperglycemic states in children and adolescents are in Table 23.1,
- Figure 23.1 shows the management principles in diabetic ketoacidosis (DKA) in children; it's emphasized that hydration can be carried out with 0.45% to 0.9% NaCl or Ringer's solution,
- management in hyperglycemic hyperosmolar state involves:
  - **fluid therapy:** rapid infusion of 0.9% NaCl at ≥ 20 ml/kg body weight/hour, subsequent fluid portions given until peripheral perfusion improves, then replace fluid deficits over 24-48 hours with 0.45-0.75% NaCl; optimal sodium level reduction rate – 0.5 mmol/l/hr, blood glucose – 75-100 mg/dl/hr and not more than 100 mg/dl/hr; if blood glucose lowers by > 100 mg/dl/hr in the initial hours of rehydration, consider adding a 2.5-5% glucose solution,
  - **insulin therapy:** include insulin when blood glucose does not decrease by at least 50 mg/dl/hr with fluids alone; initial insulin dose is 0.025-0.05 U/kg body weight/hr, then adjust the dose to decrease blood glucose by 50-75 mg/dl/hr,
  - **electrolytes:** deficiencies in sodium, potassium, phosphorus, and magnesium are greater than in DKA; begin potassium supplementation once renal function and urine output are stable; intravenous administration of 1 : 1 potassium phosphate and potassium chloride allow for adequate phosphorus supplementation; phosphorus administration can cause hypocalcemia; consider magnesium supplementation if hypomagnesemia is detected,
- each center treating children with diabetes should have a written DKA protocol, including local criteria for ICU admission, reflecting the diabetes department's capabilities, team training, and ICU availability,
- indications for intensive care within diabetes departments or ICUs include:
  - severe DKA (pH < 7.1) with prolonged symptom duration, circulatory disorders, reduced consciousness,
  - increased risk of cerebral edema (age < 5 years, rapidly developing acidosis, low pCO_2 levels, high blood urea nitrogen levels),
  - hyperosmolar DKA.

2. Chronic complications:

- regular examinations are necessary for complication prevention (refer to Table 23.2),
- upon diagnosing any chronic complication, screening for other disorders such as diabetic kidney disease, retinopathy, neuropathy, and macroangiopathy is essential,
- for persistent albuminuria above normal levels, ACE inhibitors or AT1 receptor antagonists are indicated to slow progression; effectiveness requires monitoring albuminuria levels,
- to normalize blood pressure, ACE inhibitors or AT_1 receptor antagonists are recommended; therapy effectiveness should be continuously monitored, targeting nocturnal blood pressure reduction as recorded during ambulatory blood pressure monitoring (ABPM),
- for lipid metabolism disorders, i.e., when LDL-C > 100 mg/dl (2.6 mmol/l), improved glycemic control and lifestyle modifications are required,
- for children > 8 years old, if previous lifestyle changes have not positively influenced the plasma lipid profile, or when other atherosclerosis risk factors are present with persistent LDL levels > 130 mg/dl, consider the possibility of using statins, and for LDL > 159 mg/dl (4.1 mmol/l), genetic testing for familial hypercholesterolemia is recommended.

Table 23.1. Biochemical criteria for the diagnosis of acute hyperglycemic conditions in children and adolescents with diabetes

Parameter	DKA*			Hyperglycemic-hyperemic state	Hypermolal DKA
	Light	Mild	Severe		
Plasma glucose levels [mg/dl]	≥ 200	≥ 200	≥ 200	> 600	> 600
pH of venous blood	< 7.3	< 7.2	< 7.1	> 7.25 arterial > 7.3	< 7.3
Bicarbonate concentration [mmol/l]	< 18	< 10	< 5	> 15	< 18
Ketosis β-hydroxybutyrate [mmol/l]	≥ 3	≥ 3	≥ 3	No or minor	≥ 3
Ketonuria	Moderate or high	Moderate or high	Moderate or high	No or minor	Moderate or high
Effective plasma osmolality [mOsm/kg/H_2O]	< 320	< 320	< 320	> 320	> 320

DKA – diabetic ketoacidosis

**All three biochemical criteria are required for the diagnosis of DKA: 1) hyperglycemia ≥ 200 mg/dl, 2) venous blood pH < 7.3 or bicarbonate < 18 mmol/l, 3) ketonemia or ketonuria.*

VI. Management during procedures under sedation or general anesthesia in children with diabetes

1. Collaboration between anesthesiology, surgery, and diabetes teams is essential. Guidelines for perioperative management in children and adolescents with diabetes should be available in the hospital.
2. Preoperative metabolic control assessment is recommended before elective surgery. If HbA_{1c} > 8.5% and/or TIR < 40%, reschedule the procedure until glycemic balance is achieved (in emergencies, manage immediately before the procedure in the pediatric diabetes department).
3. Management depends mainly on the procedure type:

- minor procedure – lasts up to 2 hours, with a return to typical eating within 2-4 hours after completion.
- major procedure – lasts more than 2 hours, with no return to normal meal intake within 4 hours, planned hospital stay after the procedure over 24 hours.

4. During the procedure:

- blood glucose monitoring at least hourly until 4 hours post-procedure is necessary,
- CGM systems can be used if there are no contraindications,
- target blood glucose levels are 90-180 mg/dl (5-10 mmol/l); if post-procedure ICU stay is needed, maintain blood glucose levels at 140-180 mg/dl (7.8-10 mmol/l).

5. **Major procedure under general anesthesia:**

- pPreoperative day admission: perform laboratory tests (including blood glucose, serum sodium and potassium levels, blood gases, and if blood glucose > 250 mg/dl, assess ketonemia or ketonuria); consider evening intravenous insulin therapy or modifying the basal insulin dose.
- schedule the procedure for the morning,
- on the day of the procedure: start intravenous insulin therapy at least 2 hours before the procedure – dose dependent on blood glucose levels (see Table 23.3),
- start intravenous fluid therapy with 0.9% NaCl with 5% glucose 2 hours before the procedure (if blood glucose > 250 mg/dl, use 0.9% NaCl) – dosages are detailed based on body weight,
- for significant blood glucose fluctuations and longer surgical procedures, monitor sodium and potassium levels perioperatively,
- maintain intravenous insulin and glucose-enriched fluid therapy until the patient awakens and can eat orally,
- for procedures with a high risk of infectious complications or ICU stays, maintain intravenous insulin therapy longer postoperatively.

6. **Minor procedure under general anesthesia:**

- hospital admission on the day of the procedure is permissible, with necessary lab tests performed,
- maintain subcutaneous insulin therapy or apply intravenous insulin (same protocol as for major procedures),
- if the procedure is in the morning, consider reducing the evening dose of long-acting insulin analog by 20-30% or reducing the basal rate in CSII to 70-90% if nighttime/morning blood glucose levels were low in the preceding days,

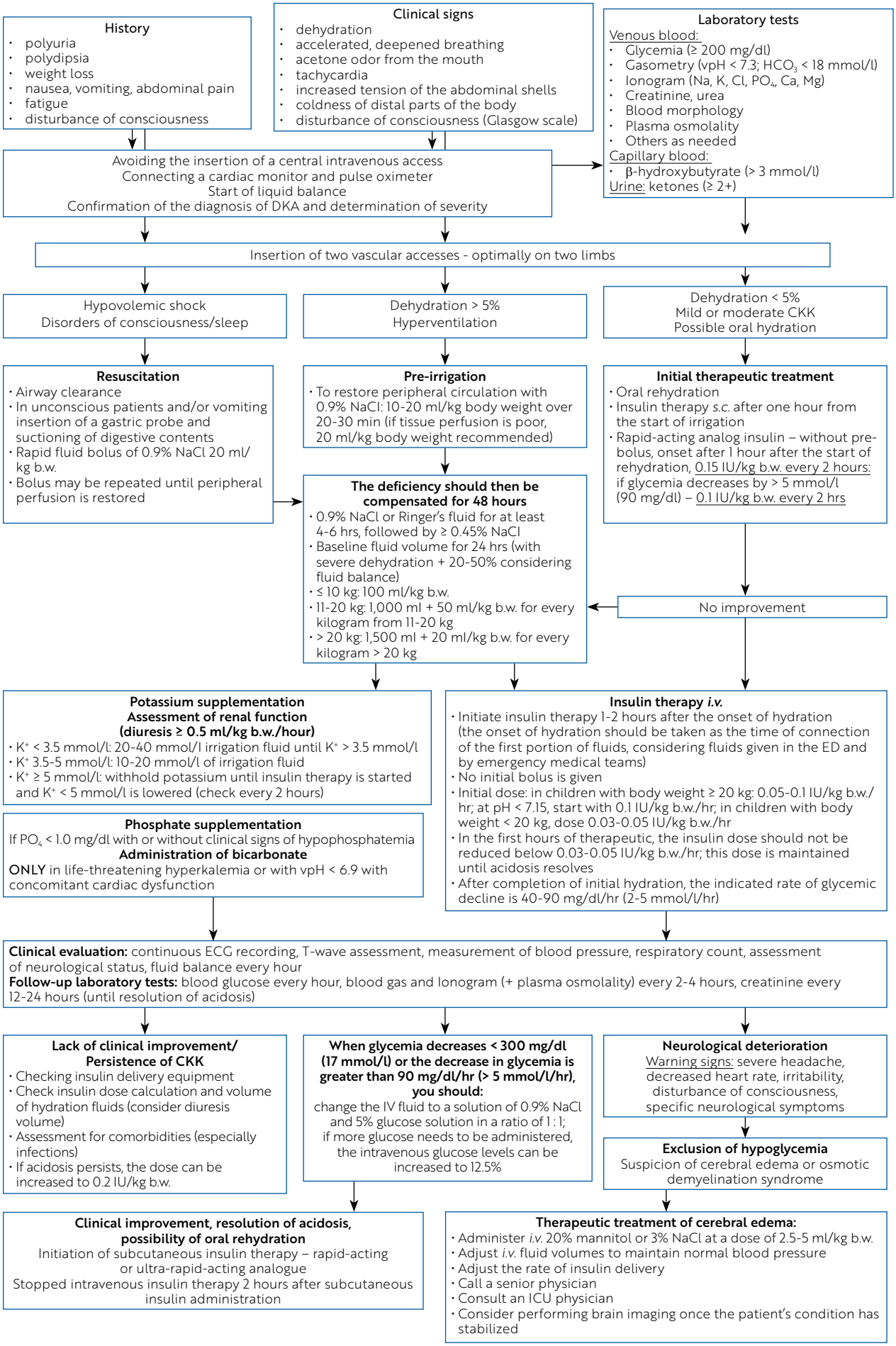

Figure 23.1. Management of diabetic ketoacidosis (DKA) in children

Table 23.2. Recommendations for diabetes care for children and adolescents with diabetes

Therapeutic education of a child with diabetes and his parents/guardians	At diagnosis and during the course of the disease; depending on the doctor's assessment or educational nurse
Nutrition education for children with diabetes and their parents/guardians	At diagnosis and during the course of the disease; depending on the doctor's assessment or educational nurse/dietitian
Psychological care of a child with diabetes and his/her parents/guardians	At diagnosis and during the course of the disease, depending on the assessment of the doctor or educational nurse or psychologist and the needs reported by the patient
Type of diabetes diagnosis	At diagnosis and at revision of diagnosis: clinical picture, family history, assessment of insulin secretion, determination of antipancreatic antibodies, determination of insulin sensitivity*, genetic testing*
HbA_{1c}	3-4 times a year; may be determined less frequently in patients using CGM regularly
Total cholesterol, HDL-C, LDL-C, non-HDL-C, serum triglycerides	First evaluation after stabilization of blood glucose after the diagnosis of diabetes, followed by: • in type 1 diabetes > 10 years of life with normal values, an unbroken family history of cardiovascular disease and no other risk factors besides diabetes – at least every 3 years • in type 2 diabetes – every year
Abdominal ultrasound	At the diagnosis of diabetes
Weight and height monitoring	At each visit according to age- and gender-specific centile grids
Monitoring maturation according to Tanner scale	At the doctor's decision, at least once a year; evaluation of menstrual regularity
Blood pressure test	At each visit; in children < 7 years of age at least twice a year, in children > 10 years of age 24-hour ambulatory blood pressure monitoring (ABPM) – every 2 years or in case of elevated blood pressure values in casual measurements
Celiac disease testing	According to the guidelines for the diagnosis of celiac disease according to ESPGHN, in the absence of symptoms of the disease screening every 2 years
Thyroid function assessment study/ diagnosis of disorders	At the time of onset: TSH, fT_4, anti-TPO and anti-TG (ultrasound if antibodies and/or thyroid dysfunction are positive), then every 2 years (at the doctor's discretion): TSH and anti-TPO, anti-TG
Investigations for chronic complications: creatinine concentration (calculation of eGFR), albuminuria, general urine examination, ophthalmologist consultation	Perform after glycemic stabilization, then: • in type 1 diabetes over 10 years of age or over 5 years of diabetes duration every 2 years • in type 2 diabetes – every year In the case of abnormal results, the frequency of subsequent examinations individualized according to needs
Liver steatosis test: ALT, AST, GGTP, abdominal ultrasound.	In type 2 diabetes, after glycemic stabilization, and every year thereafter
Specialist consultations	According to general pediatric indications and with the revision of the diagnosis

**As needed.*

- on the day of the procedure, if using subcutaneous insulin: for MDI, administer the full dose of long-acting insulin (or reduced by 20-30% if recent low blood glucose before noon) or ultralong-acting insulin (without dose reduction); for CSII, maintain typical basal insulin delivery, and if low blood glucose levels are a tendency in the morning, reduce the dose to 70-90%:
  - » if blood glucose ≤ 70 mg/dl, administer an intravenous bolus of 10% glucose (2 ml/kg body weight of the patient) and check blood glucose after 15 minutes,
  - » if blood glucose > 180 mg/dl, consider administering a correction bolus calculated for a target blood glucose of 150 mg/dl,
  - » if blood glucose > 250 mg/dl for more than 2 hours, in addition to a subcutaneous correction bolus, assess ketonemia or ketonuria and consider starting intravenous insulin therapy;
- start administering intravenous 0.9% NaCl with 5% glucose 1-2 hours before the procedure (or 0.9% NaCl if blood glucose > 250 mg/dl).

7. **Procedures in patients treated with continuous subcutaneous insulin infusion (CSII) via a personal insulin pump (PIP) – general remarks:**
- during intravenous insulin therapy, after disconnecting the infusion set from the body, remember to turn off insulin delivery from the PIP,
- use of PIP during a minor procedure is possible, provided that the infusion set insertion is not in the procedure area and the anesthesiologist accepts CSII and understands PIP operation basics,
- protect the PIP subcutaneous insertion from damage during the procedure,
- a break in subcutaneous insulin infusion (in case of hypoglycemia) should not exceed 30 minutes,
- subcutaneous correction boluses should not be given more frequently than every 2 hours,
- currently, there is no evidence that advanced hybrid closed-loop systems can be safely used perioperatively. Some pediatric diabetes centers, based on their experience, continue to use these systems with full functionality during some minor procedures.

VII. Recommendations for diabetes care for children and adolescents with diabetes (Table 22.1)

1. General recommendations:
- every new case of diabetes should involve hospitalization at a specialized pediatric diabetes ward, followed by regular care at a pediatric diabetes clinic until transition to an adult diabetes clinic (transition principles in Annex 1):
  - » ensure 24-hour access to diabetes information for children and adolescents with diabetes and their caregivers,
  - » consider hospitalization with any disease decompensation (persistent hyperglycemia, glucose fluctuations, recurring hypoglycemia),
  - » during every hospitalization and clinic visit, analyze and interpret data from insulin delivery devices and glucose monitoring devices in close cooperation with the patient and their caregivers.

2. Therapeutic team:
- hospital care – for 10 pediatric diabetes beds: 2 full-time physicians (pediatric diabetologists or pediatric endocrinology and diabetology specialists, or in their absence, pediatricians, or endocrinologists with pediatric diabetes experience), 2 full-time nurses or diabetes educators, a full-time dietitian and psychologist, and a social worker on a 1/4-time basis. Intensive supervision wards require a dedicated nurse,
- outpatient care – a team covering 300 children and adolescents: 1 full-time pediatric diabetologist or pediatric endocrinology and diabetology specialist (or pediatricians or endocrinologists with pediatric diabetes experience), 1-2 full-time nurses or diabetes educators, a 1/2-time dietitian, and a 1/2-time psychologist.

The therapeutic team must collaborate closely with a child psychiatrist, social worker, and IT specialist, who may be part of the diabetes team.

3. Outpatient consultations:
- unlimited diabetes visits recommended every 6–8 weeks, at least 4 times a year,
- some visits can be replaced by video consultations or teleconsultations, with remote data transfer capabilities,

Table 23.3. Intravenous insulin therapy (solution: 1 unit of human crystalline insulin/1 ml of 0.9% NaCl) in major procedures in children and adolescents with diabetes (based on ISPAD Clinical Practice Consensus Guidelines, 2022)

Blood glucose level mg/dl [mmol/l]*	Insulin solution flow rate of 1 unit/ml (ml/kg/hour)
≤ 70** [≤ 3.9]	0 (+10% intravenous glucose)
71-89 [4.0-5.0]	0-0.01
90-109 [5.0-6.0]	Up to 0.02 (approximately 0.01-0.02)
110-143 [6.1-7.9]	0.025 ("base flow")
144-215 [8.0-11.9]	0.05
216-270 [12.0-14.9]	0.075
> 270 [> 15.0]	0.1

**Monitor capillary blood glucose: hourly, after changing insulin dose every 30 minutes, if blood glucose < 80 mg/dl (5 mmol/l) – every 15 minutes; when blood glucose drops to 90-110 mg/dl (5-6.0), reduce insulin flow by 50%.*

***If glucose levels are ≤ 70 mg/dl (3.9 mmol/l), give an intravenous bolus of 10% glucose (2 ml/kg of the patient's body weight) and check the glycemia after 15 minutes, if the glycemia is still low – repeat the bolus of 10% glucose; if the glycemia is still ≤ 70 mg/dl (3.9 mmol/l) after another bolus of glucose, you can additionally stop the intravenous insulin infusion, but only for 10-15 minutes.*

- personal clinic visits should occur at least once every 6 months despite teleconsultations,
- advise clinic visits for patients with poorly controlled diabetes or additional health issues,
- recommended visit duration: 30 minutes for data analysis,
- educational, dietary, and psychological consultations should be separate from medical consultations and can also be conducted electronically,
- additionally, the therapeutic team oversees educational materials and activities for children with diabetes in educational institutions and camps/workshops.

4. Clinic and ward equipment:
- equipment: insulin pens, personal insulin pumps, glucometers, continuous glucose monitoring devices, blood pressure Holter monitors, ophthalmoscopes, monofilaments, food scales, and a computer system for data reading and printing,
- facilities and teaching aids for diabetes education, dietary counseling, and psychological care,
- ward: at least 1 intensive medical supervision station per 10 diabetes beds equipped with a pulse oximeter, EKG monitor, oxygen access, and an ultrasound machine for vascular flow assessment.

VIII. Child with diabetes in educational and care facilities

1. Collaboration among the diabetes treatment team, educational staff, school nurse, and family aims to ensure the child's safety at school and prevent stigmatization of children with diabetes:
- after diagnosis, provide educational staff with written information about diabetes, emergency care, and contact numbers for parents, doctor, and educational nurse,
- inform school staff about the child's need to have a mobile device with apps for CGM, insulin pumps, integrated systems, and therapy support (e.g., for carb counting),
- train educational staff in diabetes self-care,
- the school nurse or staff responsible for caring for the child with diabetes should be trained to use glucometers, CGM systems, and insulin pens or pumps,
- ensure that the facility has glucose and glucagon supplied by caregivers,
- diabetes is not a reason for individualized education or exemption from any activities (e.g., physical education, school trips).

2. Responsibilities of educational staff:
- provide immediate diabetic emergency aid,
- help children with newly diagnosed diabetes return to and integrate with the school environment quickly and safely,
- understand basic diabetes self-care,
- enable self-monitoring at educational facilities for all age groups; younger children may require staff supervision,
- allow children to use glucose monitoring and insulin administration devices during school activities, including tests and exams,
- work closely with the diabetes treatment team and child's caregivers.

IX. Travel

1. The child with diabetes and their caregivers should inform trip organizers about the condition, treatment, mealtimes, emergency care, and provide contact numbers for the diabetes care team.
2. For international trips, prepare a certificate of illness in English.
3. Secure insulin, glucagon, glucose, glucometer with test strips, insulin pens, spare equipment for insulin pumps, and CGM for the journey in carry-on luggage.

X. Physical activity, sports participation

1. Children and adolescents with diabetes:
- should be encouraged to achieve at least 60 minutes of moderate to intense physical activity daily,
- should regularly participate in physical education classes,
- can participate in sports, including competitive, like non-diabetic children.

2. The safe blood glucose range to start physical activity is 90-250 mg/dl (up to 270 mg/dl per ISPAD), and during exercise, strive for 90-180 mg/dl.
3. Management depends on:
- type, intensity, and duration of planned physical activity,
- method of therapy and blood glucose self-monitoring,
- ability to plan physical activity in advance.

4. Physical activity and sports guidelines are presented in Chapter 7 and Annex 7.

XI. Career choice

1. Emphasize education for youth with diabetes to achieve the best possible education.
2. The diabetes care team's role is to assist young people with diabetes in choosing a career by assessing their health status, presence of complications, intellectual and psychological abilities.

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24. Management of Diabetes in Pregnancy

CHAPTER HIGHLIGHTS

- Planning pregnancies in women with diabetes reduces adverse events for mother and child and should be part of standard diabetes care for reproductive-aged women. [**A**]
- Contraception using barrier methods or hormonal contraceptives should be utilized by women with diabetes as part of pregnancy planning to prevent developmental defects, starting from adolescence. [**A**]
- In Poland, universal screening for hyperglycemia in pregnancy is in place, with recognition criteria according to WHO guidelines. [**A**]
  Screening is recommended at the first pregnancy visit and between weeks 24-28.
- Satisfactory glycemic control can often be achieved in many women with gestational diabetes through behavioral management, and insulin pharmacotherapy should be introduced if therapeutic goals are not met. [**A**]

General principles of diabetes treatment in pregnancy

- Hyperglycemia in pregnancy increases risks for the mother and fetus; thus, optimization of glycemic control is essential in both pregestational diabetes and hyperglycemia first detected during pregnancy. [**A**]
- Self-monitoring of glucose is recommended as a primary way of assessing metabolic control in all types of pregnancy-complicating diabetes. Target glucose levels for self-monitoring with a glucometer are fasting and before meals: 70-90 mg/dl (3.9-5.0 mmol/l); maximum 1-hour post-meal: 110-140 mg/dl (6.1-7.8 mmol/l), 2-hour post-meal: 100-120 mg/dl (5.5-6.7 mmol/l), overnight 2:00-4:00 am: 70-90 mg/dl (3.9–5.0 mmol/l). [**A**]
- Continuous Glucose Monitoring (CGM) systems and achieved target glucose levels can help reach treatment goals in patients with pregestational diabetes. [**B**]
- All pregnant women with pregestational diabetes are advised to use CGM, with type 1 diabetes women preferring integrated pump therapy systems with the highest level of automation.
- Consider CGM systems for all pregnant women with hyperglycemia, especially those treated with insulin therapy or with unstable glucose levels, to achieve better glycemic control.
- HbA_{1c} measurement is a tool for assessing glycemic control in women with pregestational diabetes. Recommended glycemia should be as close to normal safe levels as possible, aiming for an HbA_{1c} < 6.5% (48 mmol/mol) when planning pregnancy and in the first trimester, and < 6.0% (42 mmol/mol) thereafter. [**B**]
- In addition to good glycemic management, proper nutrition and concurrent conditions and medications must be considered. [**B**]
- Insulin is the only antihyperglycemic medication recommended during pregnancy. Current knowledge does not support the use of other glucose-lowering drugs, whether oral or injectable. [**A**]
- Metformin use is only permitted if it provides the recommended metabolic balance in women with type 2 diabetes and polycystic ovary syndrome (PCOS) and insulin resistance in the preconception period. It should be discontinued by the end of the first trimester at the latest.
- Due to metformin crossing the placenta and the lack of definitive long-term observational results in children exposed to metformin in utero, insulin remains the pharmacological treatment of choice for hyperglycemia in pregnancy if dietary therapy is ineffective. Recent meta-analysis showed that metformin exposure in pregnancy with GDM resulted in a portion of newborns with lower birth weight and accelerated postnatal growth, leading to higher BMI in childhood. [**B**]

- Patients after GDM should be screened for diabetes before subsequent pregnancies and treated if diagnosed to reduce the risk of developmental defects in offspring. [**E**]

Pregnancy planning in all women with diabetes significantly impacts the course of the disease, reducing the occurrence of adverse events in both the mother and the fetus/newborn. In addition to focusing on achieving glycemic goals, standard preconception care should emphasize proper nutrition, diabetes education, and screening for coexisting diseases and complications of diabetes.

Diabetes in pregnancy can occur as:

- pregestational diabetes mellitus (PGDM) — when a woman already suffering from diabetes (regardless of the type) becomes pregnant,
- hyperglycemia first diagnosed during pregnancy.

I. Contraception

Women planning pregnancy should be informed that the risk of pregnancy complications increases with metabolic imbalance, presence of organ complications, and the duration of diabetes.

Pregnancy in a woman with poorly controlled diabetes exceeds the risk associated with any contraceptive method used.

Patients should be informed that diabetes per se is not a contraindication to hormonal contraception. Patients should be assessed for standard contraindications to hormonal contraception and should be able to choose their preferred effective method of contraception, being aware of the

risk associated with unplanned pregnancy. In patients with diabetes lasting more than 20 years or with microvascular complications (nephropathy, retinopathy, neuropathy), the use of intrauterine devices or progestogen-only preparations is recommended.

The use of estrogen-progestogen preparations containing less than 35 µg of ethinylestradiol, preferably 15 and 20 µg, which have a minor impact on carbohydrate and lipid metabolism, is recommended. The preferred progestogen component is levonorgestrel or norethisterone due to their weakest prothrombotic effect. The intrauterine device with a progestogen inserts (IUDG) is a particularly recommended method of contraception for obese women over 35 years of age and in the case of vascular complications.

II. Model of care for pregnant women with diabetes

1. All women with diabetes during pregnancy planning, during pregnancy, and during the postpartum period should remain under the care of a diabetological-obstetric (perinatological) team experienced in this field. Women with type 2 diabetes receiving oral medications already in the pregnancy planning period require insulin therapy to achieve proper glycemic control. The use of metformin is only allowed in women with type 2 diabetes in the preconception period in therapeutic doses in situations where it ensures recommended metabolic control. After conception, it should be discontinued until the end of the first trimester of pregnancy.
2. SGLT-2 inhibitors, GLP-1 receptor agonists, and GIP/GLP-1 receptor agonists currently do not have studies allowing for their use during pregnancy and should not be used during pregnancy planning and in the reproductive period if the patient does not use contraception.
3. Every doctor caring for a patient with type 2 diabetes should regularly discuss procreation plans with her and inform about the necessity of pregnancy planning due to the presence of complex risk factors for obstetric failure in this population of women, as well as due to often used antihypertensive drugs and statins (necessity to modify treatment).

   The goal of such management is to:

- optimize diabetes treatment,
- assess and possibly treat chronic complications of diabetes,
- diabetic education, including dietary,
- recommendation to quit smoking,
- thyroid function diagnostics (excluding hypothyroidism) – the upper normal ranges for TSH should be considered as values: 2.5 µIU/ml in the first trimester of pregnancy and 3 µIU/ml in the second and third trimesters of pregnancy,
- during pregnancy, visits to a diabetologist should take place at least once a month, in justified cases every 2-3 weeks; this is due to, among other things, changing insulin requirements and the need to monitor body weight, kidney function, vision, and blood pressure values,
- in women with pregestational diabetes, regardless of the type, an ophthalmological check should be carried out before pregnancy, or at the latest in the first trimester of pregnancy, then repeated in each trimester; routine vision checks are not performed in women with GDM,
- in the case of gestational hypertension, treatment should be initiated at blood pressure values > 140/90 mm Hg,
- in women with diabetes and chronic hypertension before pregnancy or with renal complications, the goal is to maintain systolic pressure < 135 mm Hg and diastolic pressure < 85 mm Hg (methyldopa is the first-line drug in pregnancy),
- in women with pregestational diabetes, the use of acetylsalicylic acid at a dose of 1 mg/kg of body weight (100-150 mg/day) from the 12th to the 36th week of pregnancy (pre-eclampsia prophylaxis) is recommended, although the decision to implement such a procedure is made by the obstetrician.

4. Pregnancy is not recommended for women with diabetes in the following clinical situations:

- nephropathy manifested by a creatinine clearance < 40 ml/min,
- proliferative retinopathy not responding to treatment,
- advanced ischemic heart disease not responding to treatment:
  - » hypertrophic cardiomyopathy or severe impairment of left ventricular function (LVEF < 30%, NYHA III/IV),
  - » history of peripartum cardiomyopathy with any residual impairment of left ventricular function;
- autonomic neuropathy affecting the heart's conduction system or the gastrointestinal tract,

The final decision regarding procreation belongs to the patient; however, she must be informed by specialists in the field about the health and life risks associated with pregnancy in these cases.

It does not seem that pregnancy is associated with a postpartum worsening of the course of chronic complications of diabetes. A woman with diabetes may freely plan the number of offspring as long as the contraindications listed above are not present.

III. Criteria for diagnosis and classification of hyperglycemia first recognized in pregnancy

All pregnant women should be screened for glucose tolerance disorders as soon as possible after pregnancy is confirmed. Pregnant women at risk should undergo an OGTT (described in Chapter 1.) at the first visit, while others should have a fasting glucose test. If abnormal glucose values are not found (see Figure 24.1), the diagnostic test should be repeated between the 24th and 28th week of pregnancy or when the first symptoms suggesting diabetes occur. Diagnosis in the group without risk factors and with normal glucose in the first examination of pregnancy should be conducted between the 24th and 28th week of pregnancy and is a one-step process, consisting of performing an OGTT.

Hyperglycemia first recognized during pregnancy should be diagnosed and classified according to WHO recommendations:

- diabetes in pregnancy – when general conditions for the diagnosis of diabetes are met, that is:
  - fasting glucose ≥ 126 mg/dl (7.0 mmol/l),
  - or glucose in the 2nd hour of OGTT ≥ 200 mg/dl (11.1 mmol/l),
  - or random glucose ≥ 200 mg/dl (11.1 mmol/l), accompanied by clinical symptoms of hyperglycemia.
- gestational diabetes (GDM) — when at least one of the criteria listed in Table 24.1 is met.

After delivery, glucose levels normalize in most women; however, all should be screened for glucose tolerance disorders, as having diabetes during pregnancy is a risk factor for overt diabetes in later years. An OGTT is recommended 6-12 weeks postpartum, followed by an annual screening test. Before planning another pregnancy, a glucose tolerance test (OGTT) should be performed. Women with a history of gestational diabetes should be considered a high-risk group for diabetes and cardiovascular diseases (management: see Chapter 2).

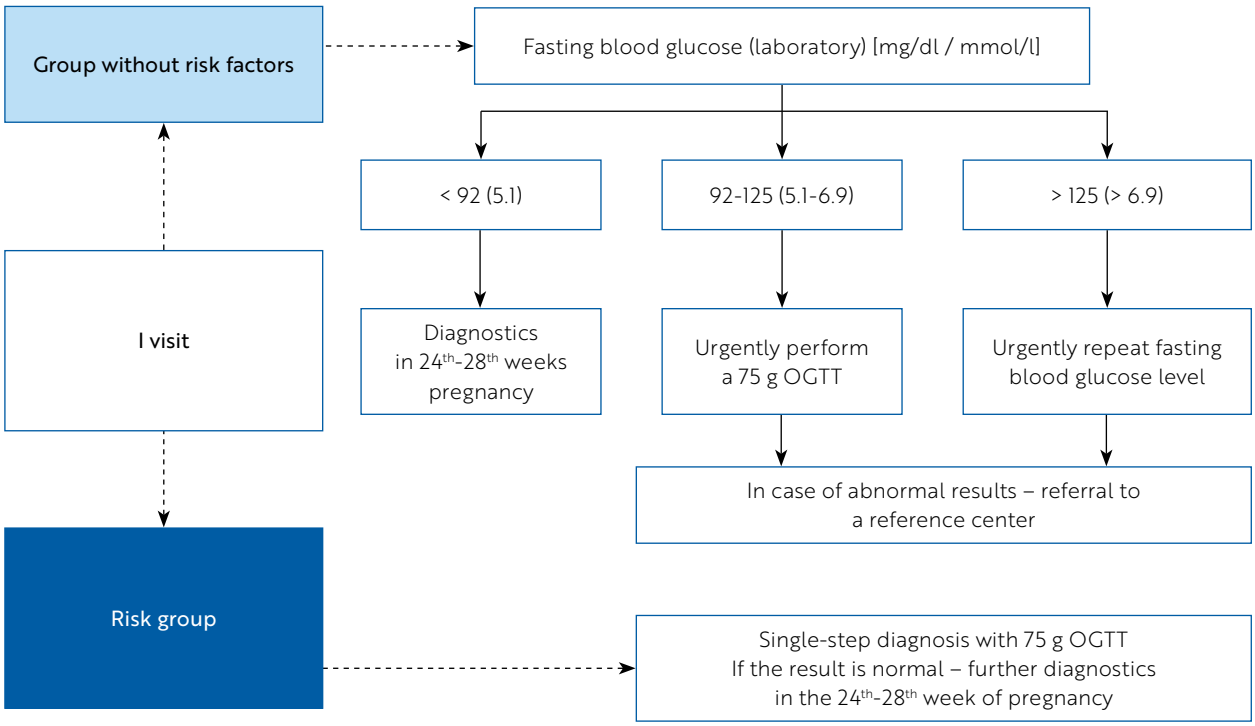

Figure 24.1. Schematic for the diagnosis of carbohydrate metabolism disorders in pregnant women

OGTT – oral glucose tolerance test

NOTE: A single fasting blood glucose in a pregnant woman in the first trimester of pregnancy > 92 mg/dl, and < 125 mg/dl cannot be the basis for the diagnosis of hyperglycemia in pregnancy.

Table 24.1. Criteria for the diagnosis of gestational diabetes mellitus based on the results of the oral glucose load test according to IADPSG 2010 and WHO 2013

	Plasma glucose levels	
	[mg/dl]	[mmol/l]
Fasting	92-125	5.1-6.9
60th minute	≥ 180	≥ 10.0
120th minute	153-199	8.5-11

IV. Multidisciplinary, integrated management in pre-pregnancy diabetes and hyperglycemia during pregnancy

Hyperglycemia during pregnancy increases the risk of obstetric complications for the pregnant woman and the developing fetus and affects the child's further development. Therefore, therapy should aim to achieve glycemic values found in healthy pregnant women. At the current stage of knowledge, the following self-monitoring of blood glucose (SMBG) targets are considered optimal during pregnancy regardless of the type of diabetes:

- fasting and before meals: 70-90 mg/dl (3.9-5.0 mmol/l),
- maximum glucose in the 1st hour after starting a meal: 110-140 mg/dl (6.1-7.8 mmol/l), in the 2nd hour after starting a meal: 100-120 mg/dl (5.5-6.7 mmol/l), with values between 2.00-4.00 AM ranging from 70 to 90 mg/dl (3.9-5.0 mmol/l). Pregnant women should perform glucose measurements themselves after appropriate training by a nurse experienced in caring for patients with diabetes. The number and timing of glucose determinations should be dependent on the severity of carbohydrate metabolism disorders and the treatment applied.

For women with type 1 diabetes and for women with type 2 diabetes and gestational diabetes treated with insulin, the use of Continuous Glucose Monitoring (CGM) is recommended. It is advised that in CGM, glucose values > 140 mg/dl (7.8 mmol/l) should constitute less than 25% of total daily measurements, values 63-140 mg/dl (3.5-7.8 mmol/l) > 70% of measurements, values < 63 mg/dl (3.5 mmol/l) less than 4%, and < 54 mg/dl (3.0 mmol/l) less than 1% of measurements. Pregnant women with type 2 diabetes and gestational diabetes should achieve > 90% of measurements within the target range of 63-140 mg/dl (3.5-7.8 mmol/l).

The HbA_{1c} value in women with pre-pregnancy diabetes should be measured every 6 weeks, aiming for < 6.5% (< 48 mmol/mol) in the first trimester, and < 6.0% (< 42 mmol/mol) in the subsequent trimesters. If patients cannot achieve these goals without significant hypoglycemic incidents, less stringent targets are suggested based on clinical experience and individualized care. Nevertheless, such patients should aim not to exceed an HbA_{1c} value > 7%. There is a lack of evidence for the usefulness of HbA_{1c} as a tool for monitoring metabolic control in gestational diabetes. When diagnosing diabetes in pregnancy, it is also recommended to determine the value of HbA_{1c}.

1. Recommendations for proper nutrition in pregnancy:

- 40-50% carbohydrates (about 180 g of carbohydrates/day) – preference for low glycemic index carbohydrates in the diet,
- 30% protein (1.3 g/kg body weight/day),
- 20-30% fats (including < 10% saturated fats),
- the number of calories should depend on body weight, height, physical activity, and age – the average daily caloric requirement is about 30 kcal/kg of appropriate body weight, i.e., 1500-2400 kcal,
- for overweight patients, a diet of 25-30 kcal/kg body weight is recommended,
- due to the very restrictive target glycemic values, pregnant women should consume consistent amounts of carbohydrates in meals at fairly constant times to adjust insulin doses and avoid both hyperglycemia and hypoglycemia,
- control of weight gain during pregnancy is necessary, as excessive weight gain in pregnant women with diabetes is associated with excessive fetal growth (see Table 24.2),
- fasting urine ketone testing may be useful for identifying women who severely restrict carbohydrates in their diet to control blood glucose levels,
- the use of artificial sweeteners is permitted, with the exception of saccharin, which crosses

Table 24.2. Recommendations for weight gain during pregnancy

Pre-pregnancy body mass index BMI [kg/m²]	Recommended weight gain [kg]	Recommended weight gain in the second and third trimester [kg/week]
< 18.5	12.5-18.0	0.51 (0.44-0.58)
18.5-24.8	11.5-16.0	0.42 (0.35-0.50)
25.0-29.9	7.0-11.5	0.28 (0.23-0.33)
≥ 30	5.0-9.0	0.22 (0.17-0.27)
Assuming weight gain in the first trimester of pregnancy 0.5-2.0 kg		

the placenta and its impact on the fetus has not been fully understood (see Annex 5),
- during the pregnancy planning period, it is recommended to implement supplementation with folic acid (min. 0.4 mg/day) for at least 6 weeks before becoming pregnant and to continue until the 12th week of pregnancy.

2. Physical exertion – unless contraindicated, moderate-intensity aerobic physical activity is recommended.
3. Insulin therapy.

In pre-pregnancy diabetes:
- human insulins have long been used in pregnancies complicated by diabetes, and their safety has been proven; the safety of using insulin analogs lispro, glargine, and ultra-rapid-acting aspart has been demonstrated in a series of observational studies, and insulin aspart, detemir, and degludec also in randomized trials; none of the studies have shown insulin analogs to cross the placenta,
- intensive insulin therapy using multiple injections, or a personal insulin pump is recommended; if possible, this treatment should be conducted in diabetes centers with experience in treating diabetes in pregnancy,
- therapy using pumps is best initiated at the planning stage or in early pregnancy (up to the 12th week); exceptionally later in a patient who cannot achieve satisfactory metabolic balance by multiple injections,
- in early pregnancy, insulin sensitivity may slightly increase, and thus, incidents of hypoglycemia may occur at the previously used insulin dose,
- from the 16th week of pregnancy, insulin resistance increases, which requires regular, adequate increases in insulin dose according to demand.

Insulin therapy in hyperglycemia diagnosed during pregnancy:
- after exhausting all possibilities of behavioral therapy, the initiation of insulin therapy is recommended,
- the recommended method is intensive insulin therapy using multiple injections or a personal insulin pump,
- due to increasing insulin resistance, around the 16th week of pregnancy, the demand for insulin begins to significantly increase, and for this reason, the total daily insulin requirement increases by about 5% weekly until the 36th week of pregnancy; usually, this leads to a doubling of the daily dose of insulin compared to pre-pregnancy requirements,
- the demand for insulin sharply decreases after delivery, and most women with hyperglycemia in pregnancy can discontinue insulin while maintaining glycemic control.

4. Oral antihyperglycemic drugs are currently not recommended for the treatment of diabetes in pregnancy. For women using oral antihyperglycemic drugs, it is recommended to start insulin therapy during pregnancy planning or as soon as pregnancy is diagnosed.

Metformin does not have a teratogenic effect on the fetus. Although many beneficial effects have been shown during pregnancy for patients with GDM (less weight gain, a lower percentage of newborns with excessive growth), **its use is not recommended for pregnant women** due to the lack of long-term data on children's development. Currently, the discontinuation of metformin by the end of the first trimester is recommended. If the patient refuses insulin therapy and wants to use metformin, it should not be unconditionally used in pregnant women with hypertension, pre-eclampsia, or in the case of fetuses with intrauterine growth restriction, due to the possibility of further growth restriction or acidosis under conditions of placental insufficiency.

5. Education system:
- clinical issues – sessions are conducted by a doctor, nurse, dietitian knowledgeable in personal insulin pump therapy,
- technical issues related to the operation of a personal insulin pump - sessions are conducted by a nurse or doctor who has a training certificate in technical training, or an employee of the company producing personal insulin pumps,
- the education program is implemented according to the training card, which is documentation of the treatment course, also using digital techniques,
- implementation of therapy is possible when the patient has mastered clinical and technical knowledge concerning CSII at a basic level (understanding the principles of therapy, technical operation relating to the main functions of the pump).

6. Breastfeeding should be widely promoted and recommended for women with pre-pregnancy diabetes and hyperglycemia during pregnancy, unless there are other contraindications.
7. Oral medications and lactation – available literary and clinical data show that metformin passes into human milk in very small amounts and does not exceed 1% of the maternal concentration; women with type 2 diabetes can therefore safely use metformin during lacta-

tion; the safety of using other antihyperglycemic drugs has not been sufficiently studied.

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25. Older Adults: Diabetes in People over 65 Years of Age

CHAPTER HIGHLIGHTS
· When initiating diabetes therapy in individuals over the age of 65, therapeutic goals should be individually assessed depending on the patient's health status, diabetes complications, cognitive abilities, and socio-economic conditions. [**B**]
· One of the main goals of diabetes treatment in individuals over the age of 65 is to achieve good metabolic control and prevent hypoglycemia by individualizing therapeutic goals and avoiding medications that are associated with a high risk of hypoglycemia. [**B**]
· In individuals over the age of 65 without significant complications, the therapeutic goal may be similar to that in the younger adult population. [**C**]
· In intensifying treatment, target values for glycemia, blood pressure, and lipids should be considered, considering the specifics of the age group and coexisting conditions. [**B**]

I. The prevalence of diabetes in the population over the age of 65 reaches 25-30%.

II. Symptoms of hyperglycemia in patients over the age of 65 may be less severe than in younger individuals, which can delay the diagnosis of the disease.

III. In elderly patients with diabetes, life expectancy is significantly shorter; therefore, when determining the treatment approach, it should be remembered that preventing complications that develop after several or more years of illness is less important than in younger people.

IV. Goals of diabetes treatment in individuals over the age of 65

1. The paramount goal of treating older individuals with diabetes is to improve or at least maintain the current quality of life, with a crucial focus on avoiding hypoglycemia while simultaneously reducing the symptoms of hyperglycemia.
2. If a patient with diabetes over the age of 65 does not have significant complications and comorbid diseases, while pursuing general treatment goals, one should aim for gradual diabetes control, adopting a target HbA_{1c} value of ≤ 7%.
3. For elderly patients with long-standing diabetes and significant complications of macroangiopathy (history of heart attack or stroke), the target HbA_{1c} value is 8.0-8.5%.
4. Conducting diagnostic tests for diabetes complications, preventing their progression, and recommending appropriate treatment.
5. Treating comorbid diseases to reduce functional impairment and improve the quality of life.

V. Physical activity

After initially determining the individual risk and capacity of the patient, it is recommended to encourage outdoor physical activity that starts slowly and ends slowly, avoiding exercises that are straining and holding breath, with attention to the risk of injury, especially the risk of developing diabetic foot syndrome.

VI. Dietary recommendations

There are no specific recommendations related to age, and diet modification is less effective due to established eating habits.

VII. Oral antihyperglycemic drugs, injectable GLP-1 and GIP/GLP-1

Receptor agonists the use of antihyperglycemic drugs in individuals over the age of 65 should follow the principles presented in Chapter 11. Drug groups with a low risk of hypoglycemia should be preferred.

1. Metformin – special caution should be exercised in patients with an eGFR of < 45 ml/min/1.73 m^2.
2. DPP-4 inhibitors, SGLT-2 inhibitors, GLP-1 receptor agonists, GIP/GLP-1 receptor agonists, PPAR-γ agonists – there are no specific contraindications for use in individuals over the age of 65; these drugs may be particularly beneficial in this age group due to the negligible risk of hypoglycemia; PPAR-γ agonists should not be used in individuals with heart failure and a high risk of fractures.
3. Sulfonylurea derivatives – treatment should start with small doses due to the risk of hypoglycemia; these drugs should not be used in individuals with frailty syndrome.

VIII. Insulin therapy

1. There are no specific indications or contraindications for insulin therapy in older adults.
2. One should not delay starting insulin if indicated, preferring simple models of insulin therapy (see Chapter 12).
3. When starting or modifying insulin therapy, choose preparations that have the lowest risk of hypoglycemia.
4. Being over the age of 65 is not a contraindication to intensive insulin therapy.
5. If an individual over the age of 65 has frailty syndrome, cognitive impairments, or difficulties in implementing the insulin therapy scheme, efforts should be made to simplify it, using non-insulin drugs (see Chapters 11 and 12).
6. In some elderly patients (> 80 years), administering small doses of short-acting insulin preparations or rapid-acting analogs before main meals may be effective, without the simultaneous use of long-acting (basal) insulin.
7. In situations where the volume of the meal is unpredictable (e.g., patients with lack of appetite, advanced dementia), it may be advisable to administer a rapid-acting insulin analog immediately after the meal in a dose adjusted to it.

IX. Diabetic education

Diabetic education should include both patients and their caregivers.

X. Antihypertensive treatment

1. Age does not constitute a criterion for the choice of a specific class of antihypertensive drugs.
2. The benefits of antihypertensive treatment in individuals over the age of 65 are comparable to those obtained in younger individuals.

XI. Lipid-lowering treatment

Despite the lack of objective data, it should be assumed that the benefits of lipid-lowering treatment both in primary and secondary prevention observed in younger individuals also apply to patients over the age of 65.

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26. Diabetes Care before Surgery

Prepared in collaboration with Prof. Dr. Wojciech Szczeklik, MD

CHAPTER HIGHLIGHTS
· Elective surgical procedures in individuals with diabetes should be postponed when the HbA_{1c} exceeds 8.5%. [**B**]
· In individuals treated with insulin prior to surgical procedures, insulin therapy should not be discontinued, and in most individuals with type 2 diabetes, well-controlled glycemic-wise, the continuation of non-insulin medications can be maintained up to the day of surgery, except for SGLT-2 inhibitors (flozins), which should be discontinued two days before the surgical procedure. [**B**]
· In individuals with diabetes in critical condition, receiving parenteral nutrition, insulin treatment administered intravenously in a dose dependent on glycemia is recommended. [**C**]
· Glycemic monitoring in diabetic individuals in the perioperative period reduces the risk of complications and death. [**B**]
· Recommended target glycemic values in the perioperative period are 100-180 mg/dl. [**C**]

I. Examinations that should be performed before a planned surgical procedure:

- daily glycemic profile – 7 measurements within a day and around 3:00 AM if treated with insulin; not necessary if the patient is using a continuous glucose monitoring system,
- HbA_{1c} value,
- blood morphology,
- serum concentrations: creatinine, electrolytes (Na^+, K^+), aminotransferase activities (AST, ALT),
- INR, APTT indexes,
- acid-base balance (blood gas analysis) in case of suspected disturbances,
- general urine test,
- retinal examination (current result),
- resting EKG (see Note 1),
- chest X-ray.

NOTE 1: In patients at high and very high cardiac risk, as well as when planning extensive procedures (e.g., operations on abdominal or hip vessels, cardiothoracic surgeries), extended non-invasive diagnostics should be performed (exercise test, echocardiography, Holter EKG monitoring).

NOTE 2: A surgical procedure in the so-called one-day system can be conducted in diabetic patients with good metabolic control, treated with intensive insulin therapy, and in patients with type 2 diabetes, where there is no need for periodic insulin treatment in the perioperative period. Withholding an antihyperglycemic drug on the day of the procedure will not cause an increase in glycemia > 180 mg/dl (10 mmol/l).

II. Management in the period before a planned surgical procedure

1. A patient with diabetes requiring periodic insulin treatment is recommended to be admitted to the hospital two days before the planned surgical procedure.
2. The planned procedure should be postponed in patients who exhibit insufficient metabolic control, i.e., a persisting daily profile glycemic value of > 250 mg/dl (13.9 mmol/l), HbA_{1c} > 8.5%, and/or the presence of glycosuria with accompanying ketonuria.
3. If a patient with type 2 diabetes treated with two or three antihyperglycemic drugs will not be consuming meals on the day of the procedure or will undergo a large operation with an increased risk of hemodynamic instability, it is recommended to discontinue current therapy and apply periodic insulin treatment.
4. The recommended model for periodic insulin treatment is multiple injections (basal bolus).
5. Daily insulin dose – 0.3-0.7 IU/kg body weight; 50-60% of the daily dose – short-acting (rapid-acting) insulin administered before main meals according to the scheme: 50-20-30% of the daily dose of short-acting (rapid-acting) insulin.
6. 40-50% of the daily dose – long-acting insulin (NPH) administered in two injections – at 7:00-8:00 AM (40%) and 10:00-11:00 PM (60%), or a long-acting analog administered in a single injection, usually in the evening. A well-trained and metabolically balanced patient with diabetes treated with intensive insulin therapy independently adjusts insulin doses to current needs, so in the hospital, they should not be deprived of this possibility and start treatment with rigid, non-modifiable doses of the preparation.
7. Individuals treated with a personal insulin pump should maintain current treatment up to the day of the procedure.

8. If preparation for surgery requires a strict diet on the day (days) preceding the operation, instead of a meal, it is recommended to use an intravenous infusion of a 10% glucose solution with 12 IU of short-acting (rapid-acting) insulin and 10 mmol of KCl. The potassium dose should be modified depending on the concentration of potassium in the blood.
9. Achieving glycemic control: in the perioperative period, blood glucose concentration should be maintained within the safe range of 100-180 mg/dl (5.6-10.0 mmol/l).
10. Notify the surgical-anesthesiological team of complications that increase the surgical risk (heart or kidney diseases, neuropathy, proliferative retinopathy).

NOTE 3: Patients undergoing so-called minor surgical procedures (tooth extraction, abscess incision, minor amputation performed on an outpatient basis, cataract surgery) do not require periodic insulin therapy, but only if the preparation for the procedure does not require a change in the current diet. If it is necessary to withhold meal intake for more than 12 hours in connection with the surgical procedure, an intravenous glucose solution with insulin and potassium is recommended [500 ml of a 10% glucose solution with 12 IU of short-acting (rapid-acting) insulin and 10 mmol of KCl], at a rate of 100-150 ml/hour. The dose of insulin and potassium should be modified depending on the concentration of glucose and potassium in the blood.

III. Management on the day of surgical procedure

1. An intravenous infusion of glucose, insulin, and potassium under glycemic control should be applied:

- algorithm 1 – for individuals with absolute insulin deficiency, a separate continuous intravenous insulin infusion is recommended (solution concentration: 1 IU of short-acting/rapid-acting insulin in 1 ml of 0.9% NaCl) and a glucose solution (5-10%) using infusion pumps; to balance 1 g of exogenous glucose, 0.2-0.3 IU of insulin is needed; if during the procedure the glycemic value increases by 30-50 mg/dl above 180 mg/dl, the insulin infusion rate should be increased by 1-2 IU/hour; in case of glycemia exceeding 250 mg/dl (13.9 mmol/l), the intravenous glucose solution should be stopped and resumed only after lowering the blood glucose concentration to 180 mg/dl (10 mmol/l); at the same time, it is recommended to increase the rate of intravenous insulin infusion; this procedure should be continued until oral feeding is resumed; during the intravenous insulin infusion, glycemic control every hour is recommended, and after stabilizing glycemia in the next 3 measurements every 2 hours,
- algorithm 2 – for patients with type 2 diabetes with preserved insulin secretion, an optional glucose, insulin, and potassium solution may be given (500 ml of 10% glucose containing 12-16 IU of short-acting insulin and 10-20 mmol of potassium chloride), the dose of potassium should be modified depending on the concentration of potassium in the blood:
  - » consider using a higher dose of insulin (≥ 16 IU) for obese individuals, in cases of severe infection, during cardiopulmonary surgery, for patients operated in hypothermia, or when the baseline glucose concentration is > 180 mg/dl (10.0 mmol/l),
  - » consider using a lower dose of insulin (< 12 IU) for lean individuals, as well as for those who were taking small doses of insulin or non-insulin antihyperglycemic drugs before the procedure.

2. The intravenous infusion of glucose, insulin, and potassium should be started at 8:00 AM and continued continuously at a rate of 80 ml/hour until normal eating is resumed.
3. During the administration of intravenous glucose, insulin, and potassium infusion, the plasma blood glucose concentration should be maintained within the range of 100-180 mg/dl (5.6-10.0 mmol/l):

- if the plasma blood glucose concentration decreases or remains at the lower recommended values, the insulin dose should be reduced by 2-4 IU,
- it is recommended to increase the insulin dose in the drip by 2 IU for every 30 mg/dl (1.6 mmol/l) of plasma blood glucose concentration > 180 mg/dl (> 10 mmol/l).

4. If there is a possibility of constant supervision of the operated patient with diabetes, algorithm 1 should be preferred.

IV. Postoperative management

1. Treatment with multiple insulin injections or via a personal insulin pump should be started with the patient's resumption of oral feeding and maintained (in the case of perio-

dic insulin therapy) until the end of hospitalization. If a long-acting or ultra-long-acting analog is used in insulin therapy, administration should continue on the day before the operation and after the operation at a dose reduced to 80% compared to that used before the operation.

2. In the case of individuals with type 2 diabetes who used non-insulin drugs before the procedure with good glycemic effect, it is possible to return to their use with the commencement of normal eating, provided there are no clinical contraindications.

NOTE 4: In patients with diabetes previously treated with insulin who are undergoing surgery for acute or chronic inflammatory conditions, the possibility of daily reduced insulin requirements should be considered.

NOTE 5: In the control of glycemia in the perioperative period, the use of continuous glucose monitoring systems reduces the risk of hypoglycemia.

V. Management related to the so-called minor surgical procedure

In the case of so-called minor procedures (lasting less than 2 hours) performed under general anesthesia or sedation, the patient who is well metabolically balanced should be admitted to the hospital in the morning of the day of the procedure or in the afternoon of the day before the procedure. Subcutaneous insulin therapy can be maintained, or alternatively, the algorithm for so-called major procedures (see Table 26.2) can be applied.

VI. Emergency surgery indications

In diabetic patients, sometimes it is necessary to perform surgical procedures on an emergency basis.

In these cases, it is necessary to exclude the possibility of peritoneal symptoms as a result of ketoacidosis accompanying the metabolic disorders of diabetes. Therefore, when symptoms of the so-called acute abdomen occur with accom-

Table 26.1. Principles of 10 and 5% glucose solution and insulin infusion according to glycemia

Glycemia	10% glucose solution [ml/hr]	5% glucose solution* [ml/hr]	Insulin [IU/hr]
< 90 mg/dl	50	100	Stop the infusion for 15-30 minutes
< 5.0 mmol/l			
90-120 mg/dl	50	100	0.5-2
5.0-6.7 mmol/l			
120-180 mg/dl	50	100	2-3
6.7-10 mmol/l			

**A 5% solution is preferred when better hydration and/or higher plasma osmolality is needed.*

Table 26.2. Subcutaneous insulin therapy for small procedures under general anesthesia or sedation

Basal-bolus therapy	Basal insulin: NPH insulin – 50% of the morning dose; long-acting analog – 100% of the morning dose
	Intravenous fluids should be started: patients with normal glycemia can initially be given glucose-free fluids. Then fluids containing 5-10% glucose in such amounts as to prevent hypoglycemia
	Treatment in the morning hours: • bolus – only as a possible corrective dose • initiation of intravenous fluids
	Treatment in the afternoon: • bolus – if the patient can eat breakfast, the usual dose of rapid-acting analogue or 50% of the dose of short-acting insulin, possibly an additional corrective dose • start intravenous fluids 2 hours before the procedure or no later than noon
Therapy with a personal insulin pump	Can only be continued if the anesthesiologist accepts this method of therapy and can administer it
	Continuation of insulin therapy at the base dose programmed in the OPI (base) appropriate for the time of day (modification of the base is usually not necessary)
	Hypoglycemia: discontinue administration of the base (for a maximum of 30 minutes)
	Hyperglycemia: correction bolus
	Start intravenous fluids 2 hours before the procedure
Hybrid closed loop therapy	It is recommended to continue therapy

panying diabetic acidosis (acetone in the urine and indicators of metabolic acidosis in the blood gas analysis), immediate action should be taken to correct the acid-base balance disorders.

In the case of ketoacidosis (when BE < –12; pH < 7.3) or hyperglycemic-hyperosmolar state, prior metabolic compensation is required, in accordance with generally accepted principles. If the surgical procedure cannot be postponed, the treatment of metabolic disorders should be conducted simultaneously with surgical actions. If there are no indicators of acute diabetic complications and the patient has taken their morning dose of insulin, an intravenous insulin infusion should be used during the procedure according to the above scheme.

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27. Vaccination

CHAPTER HIGHLIGHTS
• Every child with diabetes should be vaccinated according to the current immunization schedule (PSO – plan of preventive vaccination in Poland). [**C**]
• Annual vaccination against influenza is recommended for children above 6 months of age and adults. [**C**]
• It is recommended that all individuals with diabetes be vaccinated against Hepatitis B. [**C**]

Every child with diabetes should be vaccinated according to the current schedule of protective vaccinations (PSO). All children in Poland born after January 1, 2017, should routinely be vaccinated against pneumococcus. Vaccination status should be checked, and if necessary, missing doses of the vaccine should be administered. Children with diabetes born before February 1, 2017, should be mandatorily vaccinated against Streptococcus pneumoniae. As individuals at risk, they should be vaccinated until they turn 5 years old (with the 10- or 13-valent vaccine up to 5 years old, older children only with the 13-valent vaccine). Annual vaccination against influenza is recommended for children over the age of 6 months and adults. Both types of quadrivalent vaccines available on the Polish market can be used: intramuscular (inactivated) and intranasal (live). Non-immunized individuals should be vaccinated against chickenpox (2 doses 6 weeks apart), rubella, mumps, and measles, as contracting these diseases can cause serious decompensation of diabetes.

Since 1996, all children have been covered by vaccination against hepatitis B, and since 2000, adolescents in their 14th year of life have also been vaccinated. Vaccination is recommended for all patients. Active screening and vaccination of unvaccinated individuals of any age are required according to the 0, 1, 6-month schedule. In cases where previously vaccinated individuals have an anti-HBs antibody level < 10 IU/l, revaccination with 1-3 doses of the vaccine are recommended. If a protective antibody concentration is not achieved after 3 doses of the vaccine (4-12 weeks after the last vaccination), further vaccinations are discontinued. Routine, mandatory, and recom-

mended vaccinations before traveling to endemic areas are in line with the recommendations of the Ministry of Health from September 16, 2010 (Journal of Laws of 2010, No. 180, item 1215, and the CDC – Centers for Disease Control and Prevention) and WHO. A medical examination is mandatory before each vaccination.

Vaccination against COVID-19 is recommended for all individuals with diabetes.

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28. Professional Activity for People with Diabetes

Written in collaboration with Andrzej Marcinkiewicz, MD, PhD and Prof. Jolanta Walusiak-Skorupa, MD, PhD (Prof. J. Nofer Institute of Occupational Medicine, Łódź, Poland)

Living with diabetes cannot be a reason for discrimination or unequal treatment. Professional limitations should be imposed after a careful analysis of the individual situation and health condition. The role of the diabetologist in maintaining the professional activity of a person with diabetes, in addition to conducting effective therapy, is:

- health education aimed at shaping health awareness and understanding the limitations resulting from potential complications of diabetes,
- assistance in issuing an objective opinion on health predispositions to work by providing information to the doctor authorized to make medical decisions.

In assessing health for professional needs, the attitude of the person with diabetes should be crucial for the doctor's decision. Every person with diabetes, regardless of the type and method of therapy, must actively participate in the treatment of their disease. The doctor authorized to conduct preventive examinations or driver's examinations will issue an opinion on health predispositions to perform professional activities or drive vehicles. Due to the incidental form of contact with the patient (often during a one-time visit), in order to decide based on an individual health assessment, it is advisable for the person with diabetes to present an opinion from the treating doctor.

In the context of consultations for medical assessment purposes, the diabetologist should:

- assess the knowledge of the person with diabetes regarding their disease, treatment, and possible complications on a scale: high, sufficient, or insufficient,
- assess the ability to control glycemia on a scale: good, acceptable, or low,
- assess the awareness of hypoglycemia in a person with diabetes, the ability to prevent and counteract the development of hypoglycemia on a scale: good or insufficient,
- confirm the presence or indicate the absence of prodromal symptoms of hypoglycemia,
- determine the risk of hypoglycemia on a scale: low, acceptable, or high,
- indicate the presence of chronic complications of diabetes affecting the visual organ, nervous system, and cardiovascular system,
- consider skills and the possibility of consistent use of continuous glucose monitoring (CGM),

- enter additional remarks concerning chronic complications of diabetes and the diagnosed health condition of the person with diabetes important for assessing the risk to public safety.

The justification for occupational restrictions for a person with diabetes is twofold, resulting from:

- the possibility of an episode of hypoglycemia and associated consciousness disturbances,
- the possibility of developing late complications of diabetes that impair the ability to perform a given job.

Contraindications to driving divided by categories and contraindications to work in certain positions are presented in Annex 2. Individuals with advanced chronic complications of diabetes should not perform activities in which damage to a given organ, part of the diabetic complications' spectrum, could impact work safety. However, this should not prevent them from taking up other types of work, for which the given complication would not be relevant. At the same time, the nature of the work and its strenuousness should not hinder achieving metabolic control of diabetes, and thereby – protecting the individual with diabetes from the development and acceleration of chronic disease complications.

Diabetological consultation for driver or employee examinations should conclude with the issuance of a legible opinion in the form of structured consultation cards, the templates of which are presented in Annex 2. Health requirements for a person with diabetes should be divided into two categories depending on the professional activities they perform or their work position.

The first category (higher) will include activities and positions requiring full psychomotor fitness and associated with exposure to adverse psychosocial factors, whose performance is related to the safety of the employee and their environment (colleagues and other people not directly engaged in work but in their immediate vicinity or under the influence of their activities, such as road traffic participants or customers of large-area stores, etc.). More stringent health requirements should be discussed in the context of the possibility of consciousness disturbances, which in people with diabetes can be the result of severe hypoglycemia.

Professions requiring a higher category of health requirements, which particularly need to consider the fact that an employee has diabetes, include those related to public safety, namely:

- professional driving (passenger transport, freight transport, driving ground trains and underground railways, taxis),
- uniformed and rescue services: armed forces (land forces, navy, air force), police, fire brigade, municipal guards, rescue services, maritime navigation, prison service, licensed security workers,
- representatives of civil aviation: pilots and aviation engineers, cabin crew, air traffic controllers,
- particularly dangerous professions (work at heights, with moving machinery, at furnaces, at high temperatures, incinerators, steelworks, mining, places with high traffic intensity, and others associated with a high risk of accident).

The second category (lower) of health requirements will comprise activities and work positions as well as harmful factors and nuisances that may negatively affect the course of diabetes. In the case of the lower category of health requirements, one should rather talk about not recommended professions or job positions than about absolute contraindications. Therefore, additional attention and individual assessment of health predispositions in people with diabetes are required for the decision about the possibility of taking up or continuing work at positions:

- requiring increased physical effort, especially of a static nature (e.g., miner, steelworker),
- with shift and night work time,
- with exposure to carbon disulfide and pesticides – compounds of dichlorophenoxyacetic acid (e.g., dichlorprop, mecoprop).

The diabetologist should serve an advisory role in young individuals, where careful choice of profession is particularly required. In this case, not only the current state of health but above all the natural history of diabetes, which at different stages of its duration, due to health limitations, may prevent not only practical vocational training but primarily – the performance of work in the long term.

Annex 3 contains the document Card of Rights and Duties of the Employer and Employee, which aims to strengthen the sense of responsibility of people with diabetes and their position as employees on the one hand and to counteract the exclusion of people with diabetes from the labor market on the other hand.

29. Diabetic Care in Penitentiary Institutions

Individuals with diabetes who are incarcerated in penitentiary institutions (prisons, detention centers, reformatories) should be guaranteed access to the same level of medical care, including diabetic care, that is offered to the general population of patients.

The staff of the institution should be informed about the inmate's disease, as well as trained in recognizing states of hyperglycemia and hypoglycemia and how to act in case they occur or in other emergency situations.

30. Metabolic Surgery

CHAPTER HIGHLIGHTS

- Surgical treatment of obesity should be recommended for individuals with type 2 diabetes and a BMI > 35 kg/m², especially in the presence of other diseases and unsatisfactory glycemic control when using behavioral therapy and antihyperglycemic drugs. [**A**]
- Every individual after surgical treatment for diabetes should remain permanently under the care of a diabetologist and a general surgeon and should receive constant supplementation with vitamins and micronutrients to prevent their deficiencies. [**C**]

Metabolic surgery is an effective method for treating obesity and associated conditions, particularly type 2 diabetes. A multidisciplinary approach allows for the proper qualification of patients for metabolic surgery procedures and the selection of the appropriate technique.

I. Qualification for metabolic surgery procedures

1. A metabolic surgery procedure should be considered for every patient with type 2 diabetes and a body mass index (BMI) > 35 kg/m², especially when additional comorbid conditions such as hypertension and dyslipidemia are present. In particular, qualification for metabolic surgery procedures should be considered when type 2 diabetes and obesity do not adequately respond to pharmacological and behavioral therapy.
2. Qualification for a metabolic surgery procedure is recommended for every patient with a BMI > 40 kg/m² and type 2 diabetes.
3. Considering the preferences of patients with type 2 diabetes, surgical treatment of obesity may also be considered in patients with class I obesity (BMI 30.0-34.9 kg/m²), who do not achieve stable weight reduction and improved control of comorbidities with non-surgical methods, i.e., primarily pharmacotherapy using GLP-1 receptor analogs and GIP/GLP-1.
4. Patients between the ages of 18 and 65 are qualified for metabolic surgery procedures for type 2 diabetes. The upper age limit may be extended to 70 years in justified cases, provided that the individually considered risk of the surgical procedure is less than the potential benefits that can be achieved from the operation.
5. Qualification for bariatric surgery should be performed by a team of physicians, including at least a diabetologist and a general surgeon with extensive experience in metabolic surgery. It is recommended that the multidisciplinary

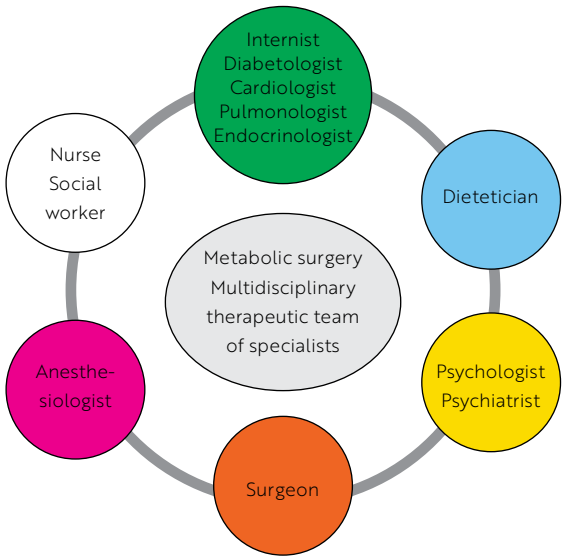

Figure 30.1. Multidisciplinary qualification for metabolic surgery

Table 30.1. Auxiliary tests and consultations before the planned procedure in the field of metabolic surgery

Laboratory tests	Blood group Blood morphology, serum levels of sodium, potassium, urea, creatinine, TSH and cortisol Coagulation system parameters Fasting blood glucose and glycated hemoglobin (HbA_{1c})
Endoscopic and imaging tests	Gastroscopy Abdominal ultrasound
Specialist consultations	Cardiology (with EKG and echocardiography) Pulmonology (with chest X-ray, spirometry and possibly polysomnography) Laryngology Endocrinology (in case of abnormal serum TSH or cortisol levels)

team of specialists involved in the qualification process also include a cardiologist, pulmonologist, psychologist/psychiatrist, anesthesiologist, and dietitian (Figure 30.1, Table 30.1).

II. Types of procedures in metabolic surgery

1. It is recommended that patients be qualified for surgical procedures performed using minimally invasive techniques (laparoscopy).
2. In light of the available study results in patients with type 2 diabetes, it is recommended to primarily qualify for the laparoscopic gastric bypass (laparoscopic Roux-en-Y gastric bypass), laparoscopic loop gastric bypass (mini gastric bypass), laparoscopic sleeve gastrectomy, laparoscopic biliopancreatic diversion, and the laparoscopic duodeno-ileal bypass with single anastomosis (single anastomosis duodeno-ileal bypass – SADI).
3. The decision on the type of procedure to be performed should be made after a surgical consultation and individual consideration of the advantages and disadvantages of each of the aforementioned methods of metabolic surgery.
4. It is recommended that before deciding on a metabolic surgery procedure, patients familiarize themselves with the informed consent forms prepared by the Association of Polish Surgeons.

III. Complications associated with metabolic surgery in type 2 diabetes

Within 30 days of the operation, mortality related to the performance of a metabolic surgery procedure is associated with a calculated risk of 0.1-0.3% mortality, which is identical to the risk of mortality for laparoscopic cholecystectomy and is considered low. Among the most common complications after metabolic surgery procedures include leakage along the suture line (3.1%), infection of the operated site (2.3%), respiratory system complications (2.3%), gastrointestinal bleeding (1.7%).

IV. Assessment of the outcomes of metabolic surgery in type 2 diabetes

Type 2 diabetes resolves in 40-95% of patients, depending on the duration of the disease, the degree of initial obesity, and the type of surgical procedure performed. The following method is recommended for assessing the outcomes of surgical treatment of type 2 diabetes:

1. Remission of the disease and comorbidities. Remission of the disease can be declared after the discontinuation of pharmacotherapy when:
- HbA_{1c} is < 6.5%,
- the patient does not experience episodes of hypoglycemia,
- total cholesterol level is < 4 mmol/l, LDL cholesterol < 2 mmol/l,
- triglyceride level is < 2.2 mmol/l,
- blood pressure values are < 140/90 mm Hg,
- weight loss is > 15% compared to the state at the time of qualification for surgery.

2. Improvement in disease course.

An improvement in the course of the disease after a metabolic surgery procedure can be declared when after reducing the doses of medications taken before the operation:

- HbA_{1c} value is reduced by > 20%,
- LDL cholesterol level is < 2.6 mmol/l,
- blood pressure values are < 140/90 mm Hg.

V. Recommendations after surgical treatment of type 2 diabetes

1. Every patient after surgical treatment for diabetes should remain permanently under the care of a diabetologist and a general surgeon.
2. Constant supplementation with vitamins and micronutrients is necessary to prevent their deficiencies.

VI. Pregnancy and metabolic surgery procedures

1. There are no contraindications to becoming pregnant for women after metabolic surgery procedures after 24 months from the date of the bariatric surgery.
2. Constant contact with the diabetologist managing the patient is recommended before becoming pregnant and during pregnancy.

VII. Contraindications for qualifying patients with type 2 diabetes for metabolic surgery procedures

1. Absolute contraindications:

- refusal by the patient of surgical treatment for type 2 diabetes,
- alcohol or drug addiction (qualification for surgical treatment of obesity can be considered in the case of at least one year of documented abstinence),
- psychiatric illnesses that are uncontrollable despite treatment and pharmacotherapy,
- high cardiovascular risk associated with the procedure,
- endocrinological diseases that are the underlying cause of obesity (e.g., Cushing's syndrome),
- inability to participate in constant, long-term postoperative control,
- the period of 24 months preceding the planned pregnancy, breastfeeding.

Relative contraindications:

- weight gain in the period immediately preceding the operation indicating lack of cooperation with the patient,
- active peptic ulcer disease – requires treatment before the surgical procedure; in the case of patients with asymptomatic *Helicobacter pylori* infection, eradication before surgery is recommended but not absolutely necessary,
- in the case of patients treated for cancer in the past, an oncological consultation documenting the effective cure of the cancer is necessary.

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31. Special Situations and Diseases

Developed in collaboration with Prof. Renata Górska, MD, PhD

I. Shift work

Shift work can be associated both with an increased risk of developing diabetes and with poorer glycemic control. It necessitates periodic changes to the timing of oral antihyperglycemic drugs or insulin administration.

1. For people with diabetes who work shifts, intensive self-monitoring is necessary, especially when work hours change.
2. For people with diabetes who work shifts, medications (oral and injectable antihyperglycemics, as well as insulin preparations) associated with a low risk of hypoglycemia are preferred, and those that allow for greater flexibility in administration.
3. People with diabetes, especially type 1, treated with insulin should have the ability to modify insulin doses (intensive functional insulin therapy method).

II. Changing time zones

Travel is not contraindicated for people with diabetes. People with diabetes, especially type 1 and type 2 treated with insulin, should prepare for travel, considering, among other things, the duration of travel, mode of transportation, change of time zone (in this case, the direction of travel — east or west — should be considered), and the climate of the destination country. A rapid change of time zones (air travel) can be particularly difficult for people with diabetes.

1. Individuals with diabetes, especially type 1 treated with insulin, should exercise particular caution during the period of adjusting to a new time zone (it is assumed that this period lasts as many days as the time difference in hours). During this time, frequent blood glucose monitoring is necessary.
2. People treated with basal-bolus insulin who travel by air to the west (day extension) should administer their usual dose of long-acting insulin in the evening of the new time. Any hyperglycemia resulting, for example, from consuming meals on board the aircraft can be corrected with additional doses of short-acting insulin/rapid-acting analog. In the case of eastward travel (day shortening), it may be necessary to reduce the dose of long-acting insulin administered in the evening.
3. People treated with a personal insulin pump do not have to adjust the pump's clock or modify insulin doses if the time change does not exceed 2 hours. However, if the time change is greater and the planned stay in a different time zone is long, it is recommended to gradually shift the time frame of the basal infusion by 2 hours per day.
4. Long-acting insulin analogs that provide a constant basal insulin level throughout the day can be administered at the same dose at the same time according to the new time.

III. Glucocorticoid therapy

Many medications have diabetogenic effects. The diabetogenic action of glucocorticoids seems particularly significant, both because of the strength of the diabetogenic effect and the frequency of use of these drugs. Glucocorticoids primarily cause an increase in postprandial glycemia.

1. Replacement doses of glucocorticoids (hydrocortisone at a dose of up to 20 mg/day) and inhaled glucocorticoids do not have a significant impact on carbohydrate metabolism.
2. The following factors contribute to the increased risk of steroid-induced diabetes: older age, obesity, impaired glucose tolerance, use of high doses of glucocorticoids, and concurrent use of other diabetogenic drugs.
3. In the treatment of glucocorticoid-induced diabetes, insulin administered in a model of intensive insulin therapy is preferred (short-acting/rapid-acting insulin preparations can also be administered before meals if fasting and premeal glycemia are acceptable). For steroid-induced diabetes, no superiority of any insulin preparation or its analog over others has been proven.
4. In individuals with type 2 diabetes treated with oral antihyperglycemic drugs, who require temporary use of glucocorticoids, especially in high doses, periodic treatment with insulin in a model of intensive insulin therapy is recommended.
5. In individuals with type 2 diabetes, when using combination therapy with basal insulin (NPH insulin, long-acting insulin analog), it is usually necessary to add short-acting/rapid-acting insulin before meals.

6. In individuals with diabetes treated with insulin, the use of glucocorticoids is associated with increased insulin requirements, mainly during the day.

IV. Periodontal diseases

Periodontal diseases and other oral diseases occur more frequently in people with diabetes. Periodontal disease adversely affects the metabolic control of diabetes and increases the risk of its complications. Treatment of periodontal diseases improves the metabolic control of diabetes.

1. Every person with diabetes should undergo an interview and physical examination focused on oral diseases.
2. Every person with diabetes should have a dental examination once a year.

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Annex 1.

Recommendations on the Transition of Type 1 Diabetes Patients from Pediatric to Adult Care

A. The transition period from pediatric diabetologist to adult diabetologist care is a particularly important moment in the life of a young person with type 1 diabetes. The overriding principle in transferring a patient to adult diabetic care should be to maintain continuity of medical care without significant interruption between leaving the pediatric clinic and starting treatment in the adult clinic. To ensure that this process goes smoothly, the following recommendations should be observed.

1. The moment of transferring care for a person with diabetes from a pediatric clinic to an adult diabetes clinic should be determined individually so that this process does not disrupt the course of therapy. Depending on the emotional development of the individual, his family and educational situation, and other circumstances, the optimal time to transfer care is between the ages of 18-21.
2. The individual should be prepared by the pediatrician for the transition to adult care for at least one year. During this time, it is advisable to perform control tests for chronic complications of the disease and co-morbidities.
3. At the last visit to the pediatric diabetes clinic, which should take place no later than 6 months before the transfer of care, the patient should be referred to an adult diabetes clinic in a coordinated manner, which specifically means:

- providing the person with diabetes with a Diabetes Care Information Card,
- issuance of a referral to the diabetic clinic.

4. The individua should come under adult care no later than 6 months after the end of pediatric care.
5. It is advisable to create regional networks of cooperating pediatric and adult clinics, between which the rules of constant contact and patient transfer would be established.
6. In the case of a large number of transferred patients, it is advisable to create the function of a care transfer coordinator in both pediatric and adult clinics, whose task would be to regulate the process of directing and taking over patients, scheduling appointments, ensuring efficient information flow, etc.
7. Creating separate reception days for patients transitioning to adult care is not necessary but can be helpful, e.g., for organizational reasons. In planning the work of the adult clinic, it should be considered that the visits of patients transitioning from pediatric care, especially if they are treated with a personal insulin pump (PI), are significantly more time-consuming.

B. In the event of the need to change a diabetic clinic (pediatric or adult) due to, for example, a change of residence, it is recommended to indicate to the patient the next diabetic clinic where they can receive appropriate care. It is required to fill out a Diabetes Care Information Card at the final visit to the clinic.

Prepared by the team: Leszek Czupryniak, Andrzej Gawrecki, Przemysława Jarosz-Chobot, Tomasz Klupa, Małgorzata Myśliwiec, Agnieszka Szadkowska, Bogumił Wolnik, Dorota Zozulińska-Ziółkiewicz

DIABETES CARE INFORMATION SHEET

PERSONAL DATA OF THE PATIENT

Surname and first name: ..... PESEL | | | | | | | | | | | |

Diagnosis: Diabetes mellitus type ..... Date of diagnosis (MM/YYYY): .....

CURRENT THERAPY

Multiple insulin injections ☐	Continuous subcutaneous insulin infusion ☐
Types of insulins.....	Insulin type:.....
Daily dose:.....	Pump report attached ☐*or:
Basal dose.....	Daily dose:.....
Supplemental doses:.....	Basal dose:.....
Corrective dose:.....	Supplementary conversions.....
	Corrective dose:.....
Antihyperglycemic drugs:	OPI refund date: ..... (please specify day/month/year)

Glucose monitoring: ☐ Glucometer ☐ CGM (name) .....

HbA_{1c} values over the past two years: .....

Last result (date-result): .....

Number of clinic visits in the last 12 months: .....

PREVIOUS HOSPITALIZATIONS FOR ACUTE COMPLICATIONS IN THE LAST 5 YEARS

Cause	Number
Ketoacidosis	
Severe hypoglycemia	

Severe hypoglycemia in the past 12 months (dates: .....)

Chronic complications of diabetes:		Grade/Remarks
Retinopathy	YES/NO	
Diabetic kidney disease	YES/NO	
Somatic neuropathy	YES/NO	
Autonomic neuropathy	YES/NO	

Comorbidities

Recognition		Date of recognition	Current therapeutics
Autoimmune thyroiditis:	YES/NO		
Celiac disease	YES/NO		
Hypertension	YES/NO		
Hyperlipidemia	YES/NO		

Level of education: requiring improvement ☐ satisfactory ☐ very good ☐

Attached:

Information sheet from inpatient therapeutic treatment: YES/NO

Follow-up test results from the last 12 months: YES/NO

Date of completion ..... Doctor's signature .....

PATIENT STATEMENT

I, the undersigned, declare that I have received an information sheet for therapeutic treatment in the diabetes clinic.

Date received: .....

Patient signature: .....

Parent's signature: .....

VOLUNTARY COMPLETION OF INFORMATION BY THE PATIENT FOR THE DIABETOLOGIST BEFORE THE FIRST VISIT

I believe that I would like to improve the therapeutic treatment of diabetes in the following areas:

- ☐ Frequency of blood glucose measurements
- ☐ Regular administration of insulin before meals and for correction of hyperglycemia
- ☐ Eating healthier, such as limiting sweets
- ☐ Counting carbohydrate exchangers
- ☐ Knowledge of index, glycemic load
- ☐ Knowledge of the effects of protein and fats on glycemia
- ☐ Knowledge of energy requirements
- ☐ Regular physical activity

Patients using insulin pumps.

- ☐ Regular replacement of infusion sets
- ☐ Using the bolus calculator
- ☐ More frequent use of the temporary base

Patients using continuous glycemic monitoring systems.

- ☐ Frequency of checking blood glucose values and trends
- ☐ Consider glycemic trends to modify insulin doses, glucose intake
- ☐ System calibration
- ☐ Programming alarms

Annex 2.

Medical Assessment Procedure for Drivers and Workers with Carbohydrate Tolerance Disorders and Diabetes

I. Driver assessments

1. The medical assessment procedure for drivers with diabetes is regulated by Annex No. 8 to the decree of the Minister of Health dated December 5, 2022, regarding medical examinations of people applying for the right to drive vehicles and drivers (Official Gazette of 2022, item 2503) entitled "Detailed conditions for medical examination in the scope of diabetes."
2. Based on the medical examination, results of additional tests, and conclusions from consultations, the doctor authorized to examine drivers assesses the risk to road safety, taking it into account in the medical certificate.
3. In accordance with points 4.1, 6.a, and 8 of the aforementioned annexes to the regulation, there is an obligation to obtain an opinion from a specialist in the field of diabetology or another doctor treating diabetes, including the absence of other health contraindications to driving vehicles related to diabetes; this applies to persons:

- applying for or holding a driver's license of categories C1, C1+E, C, C+E, D1, D1+E, D, D+E, or a tram driving permit,
- performing road transport within the meaning of the Road Transport Act regulations,
- driving a priority vehicle or transporting monetary values,
- driving instructors and examiners,
- applying for or holding a driver's license of categories AM, A1, A2, A, B1, B, B+E, or T – in the case of recurrent severe hypoglycemia.

4. The doctor authorized to examine drivers may also order a diabetological consultation in case of diagnostic-medical assessment doubts.
5. The diabetological consultation for driver examinations, to be considered by the certifying doctor, must end with the issuance of an opinion in the form of a diabetological consultation card, according to the template specified in Annex No. 8 to the aforementioned regulation of the Minister of Health dated December 5, 2022.
6. The diabetologist or another doctor treating diabetes, while filling out the consultation card, should assess the ability of the person with diabetes to drive a vehicle, which in consequence may have the following impact on the final medical decision issued by the doctor authorized to examine drivers:

- **no health contraindications** to driving motor vehicles:
  - **without time restrictions** resulting from the diagnosis of carbohydrate metabolism disorders,
  - **indicating time restrictions** resulting from diagnosed carbohydrate metabolism disorders (corresponding to low or increased risk for road safety);
- **health contraindications** to driving motor vehicles resulting from diagnosed carbohydrate metabolism disorders:
  - **relative** – indicating the next date after which the patient may again qualify for medical certification (corresponding to a high risk for road safety with the possibility of re-examination),
  - **absolute** health contraindications to driving motor vehicles (corresponding to a high risk for road safety without specifying the date of re-examination).

7. For drivers applying for or holding a driver's license of categories AM, A1, A2, A, B1, B, B+E, or T:

- An absolute contraindication to driving is inadequate awareness of hypoglycemia, defined as not feeling pathologically low blood glucose values and not responding to them, or not responding to alerts from a Continuous Glucose Monitoring (CGM) device, which could consequently lead to severe hypoglycemia and consciousness disorders.
- A relative health contraindication is recurrent severe hypoglycemia (i.e., at least two cases of severe hypoglycemia in the last 12 months).

8. In people with diabetes using CGM, the doctor authorized to conduct driver examinations may determine there are no contraindications to driving vehicles of categories AM, A1, A2, A, B1, B, B+E, or T, provided that a diabetological opinion indicates:

- consistent use of CGM in diabetes self-monitoring,
- at least sufficient patient knowledge regarding diabetes self-monitoring, including the interpretation of CGM readings,

- appropriate response to CGM device alerts,
- regular diabetological care (at least 3 visits to diabetic care per year, at regular intervals of every 3-4 months).

9. In cases of recurrent severe hypoglycemia in individuals applying for or holding a driver's license of categories AM, A1, A2, A, B1, B, B+E, or T, the doctor authorized to conduct driver examinations may decide there are no health contraindications to driving vehicles, provided that a diabetological opinion indicates that:
- at least 3 months have passed since the last incident of severe hypoglycemia during waking hours,
- diabetes is managed to the degree that ensures road safety,
- CGM is consistently used in diabetes self-monitoring, including mandatory use while driving,
- the patient has at least sufficient knowledge about diabetes self-monitoring, including the interpretation of CGM readings,
- a correct response to CGM device alerts is noted,
- regular medical check-ups are conducted at least 3 times a year, at regular 3-4-month intervals – subject to point 14.

10. For drivers applying for or holding a driver's license of categories C1, C1+E, C, C+E, D1, D1+E, D, D+E, or a tram driving permit, those performing road transport or driving a priority vehicle or transporting monetary values, as well as driving instructors and examiners, an absolute contraindication to driving is:
- any case of severe hypoglycemia during waking hours,
- unawareness of hypoglycemia during waking hours, defined in Annex No. 8 to the aforementioned decree of the Minister of Health dated December 5, 2022, as not feeling pathologically low blood glucose values, being a significant complication due to the frequent occurrence of hypoglycemia episodes,
- other diabetes-related complications that exclude the possibility of driving.

The condition for obtaining a positive opinion on the ability to drive vehicles is:
- regular blood glucose monitoring, at least four times a day for those taking insulin more than once a day; in other treatment models, once a day and at times of the day related to driving – recorded in a way that allows for the assessment of diabetes management,
- documentation of diabetes management control by the treating physician,
- demonstration by the examinee of full awareness of the risk of hypoglycemia during waking hours.

11. The completed diabetological consultation card should be passed on by the specialist diabetologist (or another doctor treating the diabetes) to the doctor authorized to examine drivers through the patient. In the case of a negative opinion regarding the ability to drive, it is recommended that the consulting doctor convey this information directly to the certifying doctor who referred the patient for the consultation.
12. During the consultation, the driver must be informed about the absolute necessity of undergoing a reassessment of their health predisposition to drive in the event of an episode of severe hypoglycemia during waking hours, even if not related to driving.
13. The appropriate doctor to conduct the diabetological consultation is a doctor specialized in diabetology or a doctor with another specialization who is treating the diabetes of the consulted patient.
14. In the following cases, it should be considered to send information to the relevant territorial communication department or local government unit about the necessity of performing a new medical examination for the patient to verify their health predispositions to drive – on a form referring to Art. 75 sec. 1 point 5 of the Act of January 5, 2011, on drivers (Official Journal of 2023, item 622 as amended):
- when there are rational indications that the patient drives a vehicle in a period shorter than 3 months from the last episode of severe hypoglycemia,
- when a person with diabetes declaring consistent use of CGM does not show up for scheduled medical check-ups (especially in the case of severe hypoglycemia episodes during waking hours) and all available forms of notifying the patient about the need for check-ups have proven ineffective,
- after each incident of severe hypoglycemia.

15. Every patient treated with insulin who has received a certificate of no diabetological contraindications to driving mechanical vehicles should be obliged to check glycemia (glucometer/CGM) each time before starting to drive. A person with diabetes should not start driving with glycemia < 100 mg/dl (5.6 mmol/l), unless the diabetologist determines a different glycemic threshold that enables driving.

16. During driving, glycemic control should occur no less frequently than every 2 hours, and in case of a drop in glycemia < 100 mg/dl, driving should be stopped, and an appropriate portion of carbohydrates consumed. Driving can be continued only after achieving normalization of glycemia and reversing the downward trend. In cases of higher risk of hypoglycemia, the necessity of using a Continuous Glucose Monitoring (CGM) system while driving should be indicated.

II. Worker examinations

1. The assessment procedure for workers and individuals starting work is regulated by the decree of the Minister of Health dated May 30, 1996, on conducting medical examinations of workers, the scope of preventive health care over workers, and medical certificates issued for purposes provided in the Labor Code (Journal of Laws of 2023, item 607).
2. The doctor conducting the preventive examination of workers may expand its scope to include a diabetological consultation and additional tests if it is deemed necessary for the correct assessment of the health status of the person being admitted to work or the employee.
3. A diabetological consultation for preventive examinations, to constitute a valuable opinion allowing for an objective decision based on an individual assessment of the patient, should contain key information for assessing health predispositions to work under specific conditions and occupational requirements. For this purpose, the use of a diabetological consultation card is recommended.
4. Based on the medical examination, the results of additional tests, and the conclusions from the consultations, the doctor authorized to conduct preventive examinations of workers issues a medical certificate about the absence or existence of medical contraindications to perform or take up work at a specific position.
5. Absolute contraindications to work in positions associated with higher health requirements include:
   - recurrent, severe hypoglycemia or even one medically unexplained incident of severe hypoglycemia in the past during waking hours (a drop in blood glucose levels leading to consciousness disturbances and the need for professional medical help),
   - unawareness of hypoglycemia during waking hours that is unlikely to improve, resulting from chronic complications of diabetes in the form of autonomic neuropathy, which impairs the ability to feel increasing hypoglycemia and, as a result, the lack of response by the person with diabetes to the drop in glycemia,
   - advanced complications from the visual organ, most often in the form of diabetic retinopathy or cataract with impaired vision,
   - other advanced chronic complications of diabetes,
   - opinion of a diabetologist or a doctor with another specialization treating diabetes in the consulted patient, stating a high risk of hypoglycemia, not feeling prodromal symptoms of hypoglycemia during waking hours.
6. Relative health contraindications to jobs requiring higher health requirements may be declared by the doctor authorized to conduct preventive examinations of workers in cases of conditions that are likely to improve:
   - lack of metabolic control of the disease (HbA_{1c} ≥ 8%),
   - lack of self-monitoring of glycemia or low ability to control it,
   - insufficient patient knowledge concerning diabetes, hypoglycemia, and ways to prevent it,
   - non-compliance with medical recommendations. In such cases, the next examination should take place within 1-3 months.

Written in collaboration with Andrzej Marcinkiewicz, MD, PhD and Prof. Jolanta Walusiak-Skorupa, MD, PhD (Prof. J. Nofer Institute of Occupational Medicine, Łódź, Poland)

Designation of the treatment entity/physician's professional practice

DIABETOLOGY CONSULTATION CARD FOR DRIVER TESTING

(Annex No. 8 to the Decree of the Minister of Health of December 5, 2022, on medical examinations of persons applying for authorization to drive and drivers (Journal of Laws of 2022, item 2503)

Personal data of the patient

Name of person tested: .....

PESEL number: | | | | | | | | | | | |

Name and number of the person's identity document, Which has not been assigned a PESEL:

Residential address: City: ..... Zip code: | | | – | | | |

Street: ..... House/apartment number: .....

Candidate ☐ Driver ☐

Diabetes

Date recognition: | Type of diabetes: | Diabetes doctor administered:

Performing entity therapeutic activity: | Clinic diabetology:

Patient's knowledge of his disease, therapeutic and complications: high sufficient inadequate ☐

Ability to control glycemia: good ☐ acceptable ☐ low ☐

Awareness of hypoglycemia, ability to prevent and counteract: good ☐ insufficient ☐

Presence of prodromal symptoms of hypoglycemia: yes ☐ no ☐

Risk of hypoglycemia: low ☐ acceptable ☐ high ☐

Presence of chronic complications of diabetes ☐ no chronic complications of diabetes ☐
On the side of the organ of vision ☐ On the side of the nervous system ☐
On the side of the cardiovascular system ☐

Notes on chronic complications of diabetes:

.....

Assessment of driving ability:

.....

Other comments

If continuous glycemic monitoring is used, 3 questions must be answered:

1. continuous use of CGM: Yes ☐ No ☐
2. good knowledge of and response to CGM: Yes ☐ No ☐
3. regular visits (not less than every 3-4 months) outpatient clinic with pump and CGM memory readings: Yes ☐ No ☐

Other comments:

.....

.....
(Date of preparation of the opinion)

.....
(Signature, name and surname, number of the doctor's license to practice specialist in the field of diabetology or other physician providing therapeutic treatment of diabetes)

Stamp of the health care facility or medical practice

DIABETOLOGY CONSULTATION CARD FOR PREVENTIVE EXAMINATIONS

Documentation of diabetes control by the attending physician for the purpose of assessing health predisposition to work

(compiled by A. Marcinkiewicz, D. Szosland)

PERSONAL DATA OF THE PATIENT

Name of person tested: .....

PESEL number: ☐☐☐☐☐☐☐☐☐☐☐

Name and number of the person's identity document,
Which has not been assigned a PESEL: ☐

Diabetes

Date of recognition: ☐ Type of diabetes: ☐

Diabetes doctor administered: ☐ primary healthcare ☐ diabetology clinic

Patient's knowledge of his disease, therapeutic and complications: high ☐ sufficient ☐ inadequate ☐

Ability to control glycemia: good ☐ acceptable ☐ low ☐

Awareness of hypoglycemia, ability to prevent and counteract: good ☐ insufficient ☐

Presence of prodromal symptoms of hypoglycemia: yes ☐ no ☐

Risk of hypoglycemia: low ☐ acceptable ☐ high ☐

Presence of chronic complications of diabetes ☐ no chronic complications of diabetes ☐
On the side of the organ of vision ☐ On the side of the nervous system ☐
On the side of the cardiovascular system ☐

Notes on chronic complications of diabetes:

.....

Other comments:

.....

If continuous glycemic monitoring is used, 3 questions must be answered:

1. continuous use of CGM: Yes ☐ No ☐
2. good knowledge of and response to CGM: Yes ☐ No ☐
3. regular visits (not less than every 3-4 months) outpatient clinic with pump and CGM memory readings: Yes ☐ No ☐

Other comments:

.....

..... (Date of opinion)

..... (signature, name, number of the license to practice as a specialist doctor in the field of diabetology or other therapeutic doctor for diabetes)

Locality ....., on .....

Name and address of the directing unit:

.....

Name, address, identification data of the person to whom the notice applies:

.....

Name of the territorially competent communications department or local government unit*:

.....

NOTICE

Pursuant to Art. 75 (1) (5) of the Act of January 5, 2011, on vehicle drivers (Journal of Laws of 2023, item 622, as amended), we notify that in Mr:

.....

there are reasonable and serious objections to the state of his/her health, which, if he/she holds a driver's license or a tramway driving permit, requires a necessary and urgent assessment of health suitability to drive the aforementioned vehicles and reviewing the medical certificate.

.....

Signature of the person making the notification

Notes:

*Territorial jurisdiction applies to the reported person.

pracuj z cukrzycą

Annex 3.

Charter of Rights and Duties of the Employer and Employee

Diabetes is a chronic metabolic disease affecting an increasing number of people. It is estimated that about 3 million people in Poland suffer from diabetes, of which diagnosed and treated cases constitute 60%. The current scale and the fact that the incidence of diabetes, both type 1 and type 2, is intensifying, translate into very tangible consequences not only medical but also socio-economic, and the problems of prevention and effective treatment of diabetes and its complications go beyond the area of responsibility of the medical community and the patients themselves.

According to World Bank estimates, diabetes is the second-largest economic burden on society after coronary heart disease. These expenditures consist not only of the costs of diagnosing and treating diabetes, including the treatment of its complications but also costs resulting from premature cessation of professional activity: incapacity to work and, consequently, pension benefits, as well as unemployment, which particularly severely affects people with diabetes.

Given that:

- the rate of unemployment among people with diabetes is more than twice as high as among healthy individuals, and their worse economic situation may hinder proper disease control,
- the workplace is an important link in the process of preventing civilization diseases,

and at the same time being convinced that:

- medications currently used in diabetes therapy, as well as the growing awareness of patients in terms of self-control, lead to an increasingly longer and more effectively maintained good health of patients and the possibility of remaining professionally active, the fact of suffering from diabetes does not automatically make a person a worse employee.

In reference to numerous initiatives undertaken on the European ground, aimed at prevention, early detection, appropriate treatment, as well as improving the quality of life of people with diabetes, including the European Parliament Resolution of March 13, 2012, on addressing the diabetes epidemic in the EU and the Copenhagen Map, adopted during the European Diabetes Forum in Copenhagen on April 25-26, 2012, on the eve of World Diabetes Day 2012, the signatories of this document, representing the medical community, the community of people with diabetes, and the employer community, advocate the drafting of rights and duties of people with diabetes and their potential employers in such a way as to strengthen the sense of responsibility of patients and their position as employees on the one hand, and on the other to counteract the exclusion of people with diabetes from the labor market.

Rights and duties of the employee with diabetes

1. Every person with diabetes should be aware that effective diabetes control takes place both at home and at work.
2. An employee with diabetes is required to follow the same rules at work as they do to control the disease at home, i.e., perform periodic glycemic measurements, take medications as prescribed by a doctor, adhere to mealtimes, and follow a diet.
3. An employee with diabetes should inform the employer about the disease and, if possible, independently adjust the mode and hours of work so that disease control is possible.
4. A person with diabetes should be aware of the contraindications to performing certain professions (e.g., pilot, public transport driver, working at heights, work requiring exceptionally intense physical effort) and if they occupy any of these positions, they should inform their employer.
5. An employee with diabetes should inform their closest co-workers about their illness so that in the event of a hyperglycemia or hypoglycemia incident, colleagues can provide proper assistance and ensure the continuity of the work performed.

Rights and duties of the employer

1. Every employer should be aware that diabetes does not disqualify individuals with the disease

from undertaking work as part of professional activity, and any discrimination against an employee due to the occurrence or presence of diabetes is unacceptable. The key to understanding the situation of a person with diabetes is for the employer to have basic knowledge about diabetes.

2. The employer, in order to fulfill the obligations resting on them, including the duty to provide safe and hygienic working conditions, has the right and should know who among their employees is a person with diabetes.
3. The employer should allow the employee with diabetes to follow the rules of controlling the disease in the workplace and motivate them to responsible behavior that guarantees work safety for the person with diabetes, as well as their co-workers.
4. The employer should, if possible, provide the employee with diabetes a position that allows optimal control of the disease (including the possibility of resigning from shift work, short breaks for additional meals).
5. The employer should, if possible, provide the employee with newly diagnosed diabetes with another/equivalent job position if the current one could pose a threat to safety at the workplace or make it difficult for the employee to control the disease.
6. The employer should, if possible, promote healthy lifestyle principles in the workplace, encouraging employees to physical activity, a balanced diet, and undergoing preventive examinations.

On behalf of the signatories Prof. Leszek Czupryniak MD, PhD
President of PTD in 2011-2015

Annex 4.

Recommendations of the Polish Endocrinological Society and the Diabetes Poland Regarding Screening Tests for Thyroid Function Disorders in Type 1 Diabetes and Type 2 Diabetes

Type 1 diabetes

1. During each individual's visit to a diabetologist, it is necessary to conduct a clinical examination for thyroid diseases – if thyroid dysfunction is suspected, the levels of thyroid-stimulating hormone (TSH) should be determined.
2. It is recommended to determine the level of TSH and the titers of autoantibodies to thyroid peroxidase (TPOAb) and to thyroglobulin (anti-thyroglobulin antibodies – TgAb) in every individua with newly diagnosed type 1 diabetes and in individuals with an existing disease, who have not yet undergone tests for the assessment of thyroid hormonal function.
3. The titers of TPOAb and TgAb should be measured once in order to diagnose autoimmune thyroid disease. They are not useful in monitoring thyroid diseases.
4. In individuals with TPOAb and/or TgAb titers above the reference values and TSH levels from 2.5 mIU/l to the upper limit of the reference range, it is recommended to measure the levels of free thyroxine (fT4) and to repeat TSH levels measurement once a year.
5. In individuals with TPOAb titers within the reference values and TSH levels from 2.5 mIU/l to the upper limit of the reference range, the TSH levels measurement should be repeated every 2 years.
6. In individuals with TPOAb titers within the reference values and TSH levels from the lower limit of the reference values to 2.49 mIU/l, the TSH levels measurement should be repeated every 5 years.
7. In individuals with a positive family history of hypothyroidism due to chronic autoimmune thyroiditis, the TSH levels should be measured once a year.
8. In individuals with diabetes and uncontrolled lipid metabolism, the TSH levels should be measured.
9. In every woman planning a pregnancy, especially in the case of an unfavorable obstetric history, it is recommended to measure the levels of TSH and the titer of TPOAb.
10. In every woman in the 4th-8th week of pregnancy (first obstetric visit), it is recommended to measure the levels of TSH and the titer of TPOAb.
11. In every pregnant woman with a history of Graves' disease, it is recommended to measure the levels of TSH and the titer of antibodies against the TSH receptor (thyrotropin receptor antibody – TRAb) in the 4th-8th week of pregnancy (first obstetric visit). Additionally, it is recommended to repeat the measurement of TRAb titers at the end of the second trimester of pregnancy (before the 22nd week of pregnancy).

Type 2 diabetes

1. During every individual visit to a diabetologist, a clinical examination for thyroid diseases is necessary, and if deviations in the physical examination are found, determining the TSH levels is required.
2. In every individual with newly diagnosed type 2 diabetes and individuals with existing disease who have not previously been tested for thyroid hormone function, it is recommended to determine the TSH levels.
3. In individuals with TSH levels from 2.5 mIU/l to the upper limit of the reference value, TPOAb titers should be determined.
4. If TPOAb titers are found to be above the reference values, the diabetes typology should be verified, primarily by determining the titers of autoantibodies against glutamic acid decarboxylase (anti-glutamic acid decarboxylase autoantibody – anti-GAD).
5. In individuals with TPOAb titers above the reference values and TSH levels from 2.5 mIU/l to the upper limit of the reference value, it is recommended to determine the levels of fT4, and additionally, the TSH levels should be repeated once a year.
6. In individuals with TPOAb titers within the reference values and TSH levels from 2.5 mIU/l to the upper limit of the reference value, it is recommended to repeat the TSH levels test every 2 years.

7. In individuals with TPOAb titers within the reference values and TSH levels from the lower limit of the reference values to 2.49 mIU/l, it is recommended to determine the TSH levels every 5 years.
8. In individuals with diabetes with unbalanced lipid metabolism, it is recommended to determine the TSH levels.
9. Every woman planning pregnancy is recommended to determine the TSH levels.
10. In every pregnant woman in the 4th-8th week of pregnancy (first obstetric visit), it is recommended to determine the TSH levels and TPOAb titers.
11. In every pregnant woman with a history of Graves' disease, it is recommended to determine the TSH levels and TRAb titers in the 4th-8th week of pregnancy (first obstetric visit). Additionally, a repeat measurement of TRAb titers is recommended towards the end of the second trimester of pregnancy (before the 22nd week).

TSH and fT4 levels in serum should be determined in all individuals with newly diagnosed diabetes induced by modern oncology therapy. In individuals with diabetes and chronic kidney disease, an assessment of TSH, fT3, and fT4 levels, as well as TPOAb at least once a year is recommended; in the case of normal levels of TSH, fT3, and fT4, but positive TPOAb antibodies, thyroid function tests should be repeated at least every 6 months.

Compiled by: Marek Ruchała, Leszek Czupryniak, Alicja Hubalewska-Dydejczyk, Andrzej Lewinski, Malgorzata Karbownik-Lewinska, Malgorzata Szelachowska, Monika Karczewska-Kupczewska, Ewa Wender-Ożegowska, Dorota Zozulińska-Ziółkiewicz, Maria Górska, Roman Junik, Katarzyna Siewko, Beata Kos-Kudła, Irina Kowalska, Nadia Sawicka-Gutaj, Paweł Gutaj, Andrzej Milewicz, Jerzy Sowiński;

Recommendations of the Polish Society of Endocrinology and the Diabetes Poland on the diagnosis and therapeutic management of thyroid dysfunction in type 1 and type 2 diabetes.

Annex 5.

Position of the Polish Association for the Study of Obesity and the Diabetes Poland on the Use of Low-Calorie Sweeteners

One of the biggest challenges of modern medicine is the increasing prevalence of overweight and obesity and their complications, mainly type 2 diabetes, and cardiovascular diseases. Obesity has been classified by WHO as the epidemic of the 21st century. The cause of the obesity epidemic is lifestyle changes, such as lack of physical activity and excessive consumption of highly processed food with high energy density, leading to a positive energy balance.

Effective prevention and treatment of overweight, obesity, and their complications require lasting lifestyle changes, which is difficult due to numerous internal and external factors that over time reduce the motivation of individuals forced to deny themselves the consumption of foods with a favored taste. **Reducing the energy density of available food, by changing the technological processes of its production and composition, is an important element of preventive actions taken at the social level.** However, the introduction of such changes requires the acceptance of consumers who must choose a product with reduced caloric content, which requires manufacturers to maintain taste attractiveness. Preferences for sweet taste are shaped in humans already in childhood, as breast milk containing lactose has a slightly sweet taste. To satisfy consumers' preferences for a sweet taste and simultaneously reduce the calorie content of food and drinks, the food industry uses low-calorie sweeteners (sweetening agents).

Low-calorie sweeteners are compounds with a sweet taste and zero or just a few kilocalories of energy. Because they are compounding whose sweet taste is very intense, they can be added to food products in very small amounts. Currently, sweeteners are used in the production of non-alcoholic beverages, confectionery, frozen desserts, yogurts, and puddings, as well as many medicines.

For baking and cooking, a low-calorie natural sweetening substance – stevia – which is resistant to high temperatures, up to 200°C, can be used. In the European Union, based on safety studies and positive opinions of the European Food Safety Authority and the Panel on Food Additives and Nutrient Sources, eleven low-calorie sweetening substances have been approved for use: acesulfame-K (E950), aspartame (E951), aspartame-acesulfame salt (E962), cyclamate (E952), neohesperidin DC (E959), saccharin (E954), sucralose (E955), thaumatin (E957), neotame (E961), erythritol (E968), and steviol glycosides (E960). According to EU Regulation No. 1333/2008 on food additives, additional labeling of food products containing these substances is required. Furthermore, Regulation No. 1333/2008 specifies the maximum content of individual low-calorie sweetening substances in a specified category of food products. In the process of registering low-calorie sweeteners, the acceptable daily intake (ADI) in mg/kg b.w./day is also determined, which is the amount that can be safely consumed daily for a lifetime without adverse effects on health. The ADI values for selected low-calorie sweeteners are presented below in Table 1.

The remaining substances are very rarely used in the food industry, which is why ADI has not been established for them. Research results conducted in Europe indicate that the consumption of all low-calorie sweetening substances is lower than their acceptable daily intake.

Referring to reports regarding the alleged increased risk of certain cancers in experimental

Table 1. Value of acceptable daily intake for selected low-calorie sweeteners

Substance	Labeling on food product	ADI [mg/kg/day]
Acetosulfam potassium salt	E950	0-15
Aspartame	E951	0-40
Cyclamate	E952	0-7
Saccharin	E954	0-5
Sucralose	E955	0-15
Neotam	E961	0-2
Steviol glycosides	E960	0-4

animals that were given saccharin, aspartame, and cyclamate, it should be emphasized that the results of the latest studies conducted in humans have not confirmed these theses. Considering the above data, the Polish Association for the Study of Obesity and the Diabetes Poland confirm the safety of using low-calorie sweetening substances in food products and recommend replacing sucrose with them by individuals diagnosed with overweight and obesity, especially in the case of carbohydrate metabolism disorders (impaired fasting glycemia, glucose intolerance, and type 2 diabetes). It should be emphasized that the beneficial effect of low-calorie sweetening substances on body weight in children and adolescents has been confirmed in randomized studies.

A separate issue is the use of low-calorie sweetening substances during pregnancy. Saccharin, due to its passage through the placenta and not fully understood impact on the fetus, should not be used in pregnancy, while the other sweeteners can be used.

The Polish Association for the Study of Obesity and the Diabetes Poland would like to draw patients' and doctors' attention to the need to analyze the caloric content of products in which sugar has been replaced with low-calorie sweetening substances and which are advertised in the trade as safe for consumption by people with diabetes, as they do not significantly affect postprandial glucose and insulin levels. Despite this modification, some of them may still be high in energy due to the content of fats and contribute to weight gain, thereby worsening glycemic control. To ensure that a product in which sugar has been replaced with low-calorie sweetening substances is indeed low energy, it is best to compare its caloric content with the same product containing sugar, and also pay attention to the fat content.

The Polish Association for the Study of Obesity and the Polish Diabetes Association emphasize that the consumption of food products whose caloric content has been reduced thanks to the use of low-calorie sweetening substances cannot be the only element of lifestyle changes. It is only a way to satisfy the need to experience a sweet taste without consuming monosaccharides and disaccharides, which can facilitate the implementation of dietary recommendations and glycemic control. In the development of overweight, obesity, and its complications, the consumption of fats, especially saturated fats, which should also be limited in the diet, also plays a significant role. It should also be emphasized that limiting the energy content of the diet causes not only a loss of fat mass but also muscle mass. To prevent the loss of skeletal muscle mass, regular physical activity is necessary (a minimum of 5 times a week for 30 minutes of aerobic exercises, e.g., walking, cycling, swimming in the pool).

Magdalena Olszanecka-Glinianowicz, President of the Polish Association for the Study of Obesity
Leszek Czupryniak, President of the Diabetes Poland in the years 2011-2015

Annex 6.

Standards of Care on Personal Insulin Pump Treatment

I. Requirements for centers initiating and/or conducting treatment of patients with diabetes using a personal insulin pump (PIP).

Place of service provision: a diabetological clinic or a department with a diabetological profile, a center equipped with computers having software or with access to cloud-based software enabling reading and analysis of data from insulin pumps, continuous glucose monitoring systems (CGM).

The medical team should comprise doctors who are specialists in endocrinology and pediatric diabetology, with a particular emphasis on those who have specialized in diabetology and are adept in the administration of Personal Insulin Pump (PIP) therapies. It is highly recommended that these doctors hold a certification from the Diabetes Poland Pump School. The nursing staff and educators are to be thoroughly trained in PIP therapy. This training ensures that they can provide comprehensive education and support to patients regarding the technical aspects of pump operation. Regular appointments should be scheduled for the meticulous reading and analysis of data from the Personal Insulin Pump, glucometers, and Continuous Glucose Monitoring (CGM) systems. This practice is crucial for ongoing assessment and adjustment of treatment plans to achieve the best possible outcomes for patients with diabetes.

II. The initiation of therapy includes: qualifying a patient for therapy with a Continuous Subcutaneous Insulin Infusion (CSII), training the patient in the use of continuous subcutaneous insulin infusion, connecting the insulin pump to the patient, and a follow-up visit to verify the patient's skills and the metabolic control achieved in diabetes management.

Patients opting for therapy with CSII should be aware of the functionality and technical parameters of individual pump models. This includes: the type of bolus calculator, options for integration with a continuous glucose monitoring system, integration with a dedicated pump application, also with a 'closed loop' function, and the choice of infusion set type – with a tube or so-called tubeless pump (patch type).

III. Indications and contraindications for therapy with a personal insulin pump covered by the National Health Fund.

A. Criteria for coverage of PIP for individuals with diabetes who require ongoing treatment with functional intensive insulin therapy using basal insulin.

Any person with diabetes who prefers and accepts this method of treatment and does not have contraindications that would prevent its safe use is eligible.

B. Contraindications for coverage of PIP by the National Health Fund for treating diabetes.

1. Certain mental illnesses that prevent the safe use of a personal insulin pump – according to physician's opinion.
2. Intellectual disabilities, including those of parents of children up to 16 years of age, that prevent understanding of the principles of intensive insulin therapy and operation of the pump.
3. Certain eating disorders preventing the safe use of a personal insulin pump – according to physician's opinion.
4. Alcohol and psychoactive substances addictions, also in parents of children up to 16 years of age.
5. Unjustified absences from medical appointment (only one visit within a year or no visit) at the diabetic clinic.
6. Non-compliance or misunderstanding of the principles of intensive functional insulin therapy (inadequate self-monitoring of glycemia, lack of ketone body control during prolonged hyperglycemia, imprecise estimation of mealtime insulin dose).
7. More than one episode of ketoacidosis within a year.
8. Severe, rapidly progressing proliferative retinopathy before or during laser therapy.
9. Non-acceptance of the disease despite full diabetic care and psychological support (written opinion from a psychologist experienced in diabetes patient care).
10. Non-adherence to personal hygiene standards.
11. Regular exposure to strong magnetic field.

In individuals with diabetes who are chronically metabolically unbalanced ($HbA_{1c} \geq 9.0\%$, average from the last year, or TIR < 30% from at least

90 days combined on two consecutive visits), the decision to initiate PIP therapy is made by the therapeutic team, assessing each case individually. For these patients, the preferred, and most often the only therapeutic option that allows for the optimization of glycemic control in a short time, is a hybrid personal insulin pump. However, it should be emphasized that in the case of a limited supply of hybrid pumps, the decision on who should receive these devices in the first instance should depend on the overall clinical picture and individually assessed possibilities and needs of the patient.

C. Contraindications to the continuation of treatment with a personal insulin pump and coverage of equipment by the National Health Fund in individuals with diabetes

1. More than one episode of diabetic ketoacidosis within a year.
2. More frequent severe hypoglycemia than during treatment with pen injectors.
3. Non-adherence to the principles of intensive functional insulin therapy, insufficient patient knowledge.
4. Severe skin reactions at the site of infusion set placement despite attempts to change the type of set.
5. Irregular replacement of infusion sets (not in accordance with the manufacturer's recommendations).
6. Unjustified absences from medical appointments (only one visit within a year or no visit).

For individuals with diabetes who are chronically poorly metabolically controlled (HbA_{1c} ≥ 9.0%, average from the last year or TIR < 30% from at least 90 days combined on two consecutive visits), the decision to continue CSII therapy is made by the therapeutic team, assessing each case individually. For these patients, a hybrid personal insulin pump is often the preferred and sometimes the only therapeutic option that allows for rapid optimization of glycemic control. However, it is important to note that if there is a limited supply of hybrid pumps, the decision on who should receive these devices first should be based on the overall clinical picture and the needs and possibilities of the patient, assessed on an individual basis.

IV. Qualification for initiation or continuation of therapy using a PIP.

Patients applying to a center that provides the service covered by government funding should submit:

- a referral with preliminary qualification from a physician working in a diabetic clinic/department,
- a glucometer report from the last 4 weeks – at least 7 measurements per day are required (data glucometer can be read at the clinic), or a CGM report from last 4 weeks,
- in some individuals with unsatisfactory metabolic control before qualifying for PIP, it is advisable to check additional information regarding the amount of carbohydrates consumed, insulin doses; sources of this information can be a self-control notebook or an appropriate application (electronic record). In the case of children with newly diagnosed diabetes, the qualification is carried out by a diabetologist or a pediatric endocrinologist and diabetologist employed in the pediatric diabetology department. The diabetologist/endocrinologist-pediatric diabetologist making decisions regarding the NHF coverage of PIP should consider the special clinical and life situations of each individual with diabetes.

V. Training individuals in the use of Personal Insulin Pump (PIP).

Educating individuals and their families to enable them to independently manage the pump and associated equipment is essential, evidenced by a medical certificate or information card (educational scope detailed in Section 9, Point III.6).

Particular emphasis should be placed on the protocols to follow in the event of a PIP failure.

Organizational requirements set a minimum of 9 hours of instructional time, divided across no fewer than three sessions. Training should be extended by an additional 2 hours for pumps integrated with Continuous Glucose Monitoring (CGM). Sessions should be small, with no more than 6-8 individuals, to ensure personalized attention. In sessions for children and adolescents, the presence of parents or legal guardians is obligatory. Practical exercises with infusion set on mannequins are crucial, and it is recommended that individuals practice inserting an infusion set into subcutaneous tissue before commencing continuous subcutaneous insulin infusion therapy.

Training must continue until the patient or caregiver is adept in the practical use of the PIP. The center initiating or referring for PIP therapy bears the responsibility for conducting proper training. The educational team must verify the

patient's knowledge, and creating a test from the center's own educational materials is suggested. It is recommended to develop a test based on one's own educational materials.

Furthermore, teaching patients to use software for downloading data from the PIP, CGM, and glucometer is beneficial, as it facilitates the effectiveness of clinical teleconsultations.

VI. Equipping an individual with PIP should consider the individual's preferences and perceptual abilities, which are important factors in the education and customization of treatment.

Recommendations regarding insulin pump requirements for centers administering therapy can be found in the table included in Annex 6. It is beneficial for centers to offer a variety of insulin pump models, allowing individuals to select the device that best suits their specific need.

VII. Connecting the insulin pump.

The initial setting of the insulin pump is done by the center initiating therapy. Settings should also include the activation of the bolus calculator function. In the case of pumps with a CGM system, it is advisable to initially set the system parameters, including alarms, considering the current metabolic level of diabetes, additional pump functions, and the individual's skills.

When connecting the PIP, the infusion set is installed by the trained individual under the supervision of an educator.

For Annex 6.

Specification of Personal Insulin Pumps – Standards of Care of the Diabetes Poland 2024. Recommended Necessary Requirements

Parameter		Description
Pump suspension of insulin delivery		Alarm indicating that the pump has been suspended
Pump lock		Electronic button lock
Bolus programming	Normal	Accuracy not less than 0.1 units/bolus
	Square Wave bolus (S)	Accuracy not less than 0.1 units/bolus Maximum bolus duration – not less than 7 hours
	Dual Wave bolus (D)	Accuracy not less than 0.1 units/bolus
Temporary change of basal delivery	Settings	Possible percentage or unit increase or decrease in insulinl delivery, every 30 min with automatic return to basal delivery at programmed time
	Information about the active basal delivery (basal imnsulin)	Accessible from the home screen position or recalled with the touch of a button
	Time	Up to 24 hours
Basal delivery programming	Entering hourly rates (number of units per hour)	Accuracy not less than 0.1, and in children < 6 years of age not less than 0.05 IU/hr. At least 2 additional basal profiles for advance preparation with the option to recall from memory and apply
"Pump memory"	History of boluses, alarms, basal dose, daily dose, temporary basal change, infusion set filling; the program to read data from the pump should have the ability to simultaneously read data from the glucometer for which strips are refunded on the date of the tender and integrate both information	A minimum of 30 days with the help of a computer program through a reader The company provides free access to the software (in the version that works locally or in the online version in the cloud) and the equipment necessary to read the data through the computer to the diabetes center providing the therapy (links) – requirements for the computer program in Attachment 1. Directly from the pump Current doses in basal delivery, a minimum of the last 20 boluses (doses and type), total daily doses for the last 30 days
Bolus calculator that is an integral part of the insulin delivery system (feature available on the insulin pump or a device that communicates wirelessly with the insulin pump or in an app on a smartphone)		**With the possibility:** - to program settings in several time intervals - user input of carbohydrate grams or carbohydrate exchanges - active insulin calculation with user-set insulin duration, which only reduces the correction dose of the insulin bolus - manual entry of glucose levels into the bolus calculator or communication with a glucometer, for which strips are refunded as of the date of the tender, or communication with the CGM system
Automatic infusion set filling		Yes – unlimited number of infusion set fillings per day directly using only the function in the pump
Infusion sets		**Insertion sets** Insertions: metal (rigid) and plastic (flexible)-all types of insertions within the reimbursement amount Length of the drain – at least 2 lengths Length of cannula – at least 2 lengths **Drainless sets for patch pumps** Cannula length – at least 2 lengths
Service		Providing telephone contact 24 hours a day with an authorized hotline (knowing exactly how the pump works, all possible alarms, errors), subject to customer review. Website with the information contained in Attachment 2. Replacement of the pump within 24 hours (working days) Shipping of the pump at the expense of the company

Parameter	Description
Batteries – powering the pump	AA, AAA batteries (commonly available in retail outlets, gas stations, home appliance and consumer electronics stores, etc.). In the case of rechargeable batteries, the possibility of powering them with a charger connected to electricity. Audible and displayed on the pump screen information on battery consumption/battery discharge greater than 70%
Additional accessories needed to use a personal insulin pump	Additional accessories for the personal insulin pump, which must be systematically replaced according to the instruction manual, are provided by the manufacturer free of charge for the life of the pump (does not apply to infusion sets, insulin reservoirs, batteries, insulin pump case)
Guarantee	At least 4 years, in case of malfunction replacement with a new pump In the case of replacement of the equipment with a new one, the total warranty period is not shorter than the one proposed in the offer; the warranty calculated from the date of implementation of the NFZ (NHF) procedure, not from the date of purchase from the manufacturer
Menu	Entirely Polish language or icons or symbols
User's Manual	Entirely Polish language, all messages displayed by the pump must be described in the instructions

Insulin pump systems functionally integrated with a continuous glucose monitoring system (CGM) and automated insulin delivery (AID) systems must meet the following requirements:

- the CGM system is part of the insulin pump or directly connects to the application managing the PIP,
- sensors and, if necessary, the transmitter for the CGM system are reimbursed on the day of the tender announcement,
- the integrated system must have a function for automatically suspending insulin in anticipation of hypoglycemia based on values indicated by the CGM system,
- the automated insulin delivery (AID) system must have functions:
  - » automatic basal delivery,
  - » automatic delivery of correction boluses,
  - » setting a temporary mode/target for hypoglycemia prevention in situations that increase its risk,
  - » automatic switch to manual mode in the event of a CGM system and/or application failure,
- in the case of application-based systems, the patient, along with the PIP, receives free access to the application for a minimum period of 4 years, and before choosing an integrated system or AID, must be informed about the necessity of having a smartphone model that allows for the use of the application,
- data from integrated systems and AID systems must be automatically transmitted to computer software, which the therapy-leading center must be equipped with, enabling the therapeutic team to have current insight into the individual's data.

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Specification of Personal Insulin Pumps – Standards of Care of the Diabetes Poland 2024. Recommended Additional Requirements

Parameter	Description
Reminder to replace the infusion set	Alarm indicating that the infusion set needs to be replaced
History of infusion set fillings	Ability to check directly in the pump's memory the history of infusion set fills
IPX 8 standard	IPX 8
Additional: a device for users to read the pump memory at home with the ability to send data to the doctor	Access to the software (either a locally running version or an online version in the cloud) and the device needed for the computer to read the data
Additional basal delivery profiles	More than 3
Bolus calculator	With user-selectable mg/dl or mmol/l (glycemic determination) settings Ability to manually enter blood glucose levels into the bolus calculator
Continuous glucose levels monitoring system	System integrated with insulin pump or additional CGM device to support therapy with personal insulin pump
Computer software to read data from the pump	Having the ability to simultaneously read data from the glucose meter for which strips are refunded on the date of the tender and integration of both information

For selected groups of individuals, it is permissible to modify the specifications of personal insulin pumps considering the patient's educational opportunities and personalization/individualization of therapeutic.

Attachment 1.

Requirements for the computer software for reading the memory of the pump:

- current basal deliveries (all possible from a single pump data retrieval, displayed in graphs or tables with exact dosages and times, precise to the pump's basal rate delivery),
- conversion values used within the bolus calculator, with set time intervals,
- bolus history (all boluses administered with a distinction between types and timing, including extended boluses),
- history of cannula fillings,
- daily charts must include:
  - basal rates for the day,
  - temporary basal modification,
  - indications of pump suspension and resumption,
  - glucose readings transmitted from the associated CGM and/or glucometer,
- alarm history,
- free provision of software to users,
- the pump data retrieval program must also be capable of reading data from the glucometer for which strips are covered under government funding as of the tender announcement date and must integrate both data sets.

Attachment 2.

Information required on the website:

- a helpline number offering 24-hour technical support for PIP users,
- contact details of local representatives, including their working hours,
- details regarding pump accessories (types of infusion sets, reservoirs, batteries, prices, etc.).

RECOMMENDED ADDITIONAL OPTIONS

1. Compatibility with at least one glucometer; wireless connectivity; option to enable or disable data transfer from the glucometer to the pump; capability to log glucose readings with the bolus calculator function active or inactive.
2. Insulin pumps, in the case of which there is a dedicated glucometer that is part of the system, should be distributed with it.
3. User-configurable reminders for boluses or glucose checks.
4. The cost of infusion sets should not exceed the monthly government funding limit for individuals < 26 years old and should be within 30% of this limit for individuals > 26 years old.

ADDITIONAL NOTE

The contracting entity may define extra parameters tailored to the needs of specific patient groups. Furthermore, the offer must include accessories essential for initiating therapy and conducting education: insertion devices, various infusion sets, insulin cartridges, batteries for powering the pump, protective cases.

In evaluating pumps during the tender process, the cost of the pump should account for 60% of the assessment, while additional features should constitute 40%.

Annex 7.

Recommendations of the Diabetes Poland and the Polish Society of Sports Medicine Concerning Obtaining Consent for Participation in Sports by Individuals with Type 1 Diabetes

Individuals with type 1 diabetes, upon receiving a positive opinion from a diabetologist, can be qualified by a sports medicine specialist to practice any sport discipline.

One of the conditions for qualification to practice sports is treatment with intensive functional insulin therapy and understanding its principles. Treatment can be administered using pen-type injectors or a personal insulin pump. The preferred method for athletes with diabetes is treatment using an insulin pump, which allows for more precise adjustment of the insulin dose to the current demand during physical exertion. It is the duty of the athlete with diabetes to systematically monitor glycemia using a glucometer, at least 6 times a day, with additional measurements during training and sporting competitions. The use of continuous glucose monitoring systems (CGM) is advisable, which additionally support treatment and increase the safety of the athlete.

Type 1 diabetes should not be a contraindication to participation in physical education classes at any educational level or in school sports (school sports associations, student sports clubs, school competitions, etc.).

Optimal glycemic levels at the start and during sports activity are within the range: for aerobic effort 126-180 mg/dl (7-10 mmol/l), for anaerobic effort 90-180 mg/dl (5-10 mmol/l).

It should be emphasized that the condition for maintaining high fitness and physical performance in individuals with type 1 diabetes who practice sports intensively over a longer period of time is > 70% of the time within the target range of 70-180 mg/dl and < 4% below 70 mg/dl, and on the day of sporting competitions < 1%.

I. Contraindications to sports participation by children and adults with type 1 diabetes requiring a sports medicine specialist's assessment

1. HbA_{1c} – average from the last 12 months > 8.5% or a current result ≥ 9%.
2. More than one episode of ketoacidosis in the last 12 months.
3. More than one episode of severe hypoglycemia in the last 12 months.
4. Self-monitoring of glycemia: number of measurements < 6 per day using a glucometer in athletes not using CGM.
5. Visits to the diabetes clinic: for children < 4/year, for adults < 2/year.
6. Hypoglycemia unawareness during wakefulness – relative contraindication, may be waived depending on the sport discipline and the use of CGM.
7. Chronic diabetes complications depending on the stage of progression and the sport discipline:

- proliferative retinopathy until the completion of laser therapy – absolute contraindication for all sports activities,
- clinically evident autonomic neuropathy – contraindication for high-intensity physical efforts,
- any microangiopathic complication or type 1 diabetes lasting more than 15 years in individuals > 35 years of age; high and very high-intensity physical activity – qualification after conducting cardiological diagnostics including resting EKG, echocardiographic examination, exercise test, 24-hour EKG recording using the Holter method,
- macrovascular complications – qualification after conducting cardiological diagnostics including resting EKG, echocardiographic examination, exercise test, 24-hour EKG recording using the Holter method,
- significant proteinuria 0.2-0.5 g/day (UACR 30-100 mg/g) – relative contraindication to competitive sports, temporary exclusion, necessary re-examination under non-exercise conditions 48 hours before and during the test, and observation – proteinuria control (UACR) every 3-6 months, systematic blood pressure monitoring, and kidney function,
- proteinuria > 0.5 g/day (UACR > 100 mg/g) – absolute (temporary or permanent) disqualification from sports participation, necessary nephrological consultation,

- eGFR 45-60 ml/min/1.73 m^2 (G3a) – creatinine and eGFR monitoring at least every 3 months,
- eGFR 30-45 ml/min/1.73 m^2 (G3b) – relative contraindication to competitive sports, temporary exclusion, creatinine and eGFR monitoring every 4-6 weeks,
- eGFR < 30 ml/min/1.73 m^2 (G4) – absolute prohibition of sports participation.

*eGFR calculation according to the Schwartz formula up to 15 years of age, according to the CKD-EPI formula from 16 years of age.

II. Examinations to be performed during the qualification of an athlete with type 1 diabetes

Preliminary qualification: current examinations consistent with the standards of the Diabetes Poland. HbA_{1c} values from the last 3 months, glucometer and/or CGM report, and insulin pump report (if used).

III. High-risk sports disciplines: motor, water, aviation, climbing

Practicing sports disciplines in which hypoglycemia constitutes a particularly high threat to the safety of the patient and the environment is not recommended for individuals with type 1 diabetes. Their practice is permitted under the following conditions:

- the athlete is very well educated and achieves treatment goals,
- glycemia measurement up to 15 minutes before the start of activity and its value ≥ 120 mg/dl (6.7 mmol/l), glycemia control using a glucometer every 30-60 minutes or less frequently in case of CGM use. For high-risk sports disciplines, the use of CGM is advisable.

IV. Contraindications to participation in training and sports competitions

1. Severe hypoglycemia in the last 24 hours.
2. Hyperglycemia above 250 mg/dl (13.9 mmol/l) with accompanying ketonemia/ketonuria resulting from insulin deficiency, not carbohydrate deficiency.
3. Ketonemia ≥ 1.5 mmol/l constitutes an absolute contraindication to start and continue physical exertion.
4. Hyperglycemia > 300 mg/dl (16.7 mmol/l) persisting for more than 2 hours.
5. Any acute event requiring medical assistance, such as visual disturbance, chest pain, fainting, acute infection, etc.

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Annex 8.

Organizational Requirements in Diabetic Care Specialized Units

1. Medical staff – two specialists in diabetology employed full-time, or, in addition to one diabetology specialist, a specialist in internal diseases with at least one year of experience working in a diabetic ward or clinic, or a doctor in the second year of diabetology specialization training.
2. Nursing staff:
- a nurse specialized in diabetic nursing or internal nursing, or who has completed a specialist course "Diabetes Educator" or a qualification course in diabetic nursing, or with at least two years of professional experience in a diabetic ward/clinic.
- one nurse per 10 diabetic beds, whose duties are limited to education and care for individuals with diabetes.
3. Dietitian – one full-time position, with duties limited to diabetic care.
4. Access to psychological consultations.
5. Access to specialist consultations.
6. Equipment:
- at least two positions designated for treating patients in acute metabolic states equipped with an EKG monitor, arterial pressure monitor, infusion pump, pulse oximeter, access to oxygen therapy,
- an educational room,
- intravenous infusion pumps,
- equipment for the diagnosis and treatment of diabetic foot syndrome,
- access to cardiological diagnostics (exercise test, EKG, echocardiography, EKG Holter, blood pressure Holter) and vascular diagnostics (Doppler artery examination).

Specialized diabetic clinics

1. The team providing care for a person with diabetes within the framework of outpatient specialist care (AOS) includes:
- A specialist in diabetology or a specialist in internal diseases with at least two years of professional experience in a ward or diabetic clinic, or a doctor in the second year of specialization in diabetology,
- In the case of a specialist clinic for children and adolescents – a specialist in diabetology or a specialist in pediatric diabetology and endocrinology, or a pediatrician with at least two years of professional experience in a pediatric diabetic clinic or ward, or a doctor in the second year of specialization in diabetology or pediatric diabetology and endocrinology,
- a nurse specialized in diabetic nursing or who has completed a course "Diabetes Educator", or a nurse specialized in internal nursing or who has completed a qualification course in diabetic nursing, or with at least two years of experience in a diabetic ward or specialized diabetic clinic,
- a full-time dietitian designated exclusively for dietary education,
- access to psychological care in justified, individual clinical cases. Children and adolescents, pregnant women (see thematic chapters).
2. Equipment of specialized clinics:
- medical offices,
- a procedure room with a designated area for sample collection and analysis,
- a nursing and educational room with a dietary section,
- the ability to read and analyze data from glucometers, insulin pumps, and continuous glucose monitoring devices using computer systems,
- a set for examination for diabetic foot syndrome (thermotip, tuning fork – 128 Hz, 10 g monofilament, neurological hammer),
- a device for the assessment of vascular flow using the Doppler method. Furthermore, access to specialist consultations should be provided to periodically monitor the state of complications.

Organization of care for patients with diabetic foot syndrome Reference diabetic foot clinics

1. Personnel requirements:
- physicians: at least two full-time equivalents – a specialist in diabetology with documented at least one year of experience in treating patients with diabetic foot syndrome,
- nurses: two full-time equivalents; with documented at least one year of experience in the

treatment and care of patients with diabetic foot syndrome or treatment and care of patients with a chronic wound.
2. Hospitalization facilities within the same unit on the ward (in the clinic) fulfilling the National Health Fund (NFZ) contract for diabetology or internal diseases.
3. Access to multi-specialty care, including consultations with a surgeon, vascular surgeon, or angiologist.
4. Provision of possibilities for intravenous antibiotic therapy.
5. Access to basic imaging diagnostics, i.e., X-ray, ultrasound (including Doppler ultrasound), as well as CT and/or MRI.
6. Access to laboratory and microbiological tests performed in a medical diagnostic laboratory registered in the register of the National Council of Laboratory Diagnosticians (KRDL).

Primary clinics

These clinics should provide diagnosis, treatment, and prevention of ulcers, infections, and Charcot neuroosteoarthropathy as part of diabetic foot syndrome management. Primary clinics collaborate with reference clinics, where more severe clinical cases are consulted and possibly referred for treatment.

Remote visits (televisits) as an element of care for people with diabetes – every diabetic clinic should be equipped with the necessary tools to conduct an effective remote visit (televisit). Clinics must have a computer with appropriate software, and the staff should be trained. People with diabetes should be encouraged to use new technologies and applications that facilitate the remote conduct of medical visits. It should be emphasized that the effectiveness of a teleconsultation is greater the more source data related to the patient's treatment (e.g., data from the memory of the glucometer, CGM system, personal insulin pump) is provided to the doctor conducting the teleconsultation.

In the case of people with diabetes, remote medical visits can be an element of both regular diabetic care and be used in situations of epidemiological threat.