2022 Guidelines on the management of patients with diabetes A position of Diabetes Poland

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Conflict of interest declaration of the Working Group members is available on the website: cukrzyca.info.pl

Contents

Contents

The 2022 Diabetes Poland guidelines – summary of the most important changes

Every year since 2005, the Diabetes Poland Association (PTD) prepares and publishes clinical recommendations for the management of people with diabetes. The originator and initiator of the set of guidelines was, in 2004, Prof. Jacek Sieradzki, who was the chairman of PTD during that time. The first chairman of the PTD Recommendations Panel was Prof. Władysław Grzeszczak, who held this position between 2005-2011. In the following term (2011-2015) these duties were taken over by the next chairman of the PTD, Prof. Leszek Czupryniak. In 2015-2019 the coordinator of the Recommendations Panel became Prof. Dorota Zozulińska-Ziółkiewicz, the representative of the PTD General Board for Clinical Recommendations. These recommendations are the result of the work of a group of around 50 experts from various fields of clinical sciences. The recommendations address many key aspects of clinical care for people with diabetes. The individual chapters are made by subteams coordinated by the leaders. The work of Experts is intended to improve prevention, diagnosis and treatment of diabetes and its complications in Poland. Advances in diabetology, results of further clinical and experimental studies, data from epidemiological observations and diabetes registries are reflected in the PTD Recommendations. This results in some modifications and new content every year. It is good practice that, from the outset conducted in accordance with EBM principles, PTD Recommendations require only a slight evolution related to new knowledge from sound, evidence-based research with important implications for clinical practice.

Summary of the most significant changes in 2022 PTD recommendations.

The recommendations concerning diagnosis of type 1 diabetes in the ADA/EASD consensus from 2021 are partially included in **CHAPTER 1**. It was highlighted that the current classification of diabetes does not distinguish LADA type, which is considered to be one of the clinical forms of type 1 diabetes. In situations where differential diagnosis of type 1 diabetes, especially diagnosed in adults, can be problematic, a standardised algorithm for differential diagnosis of type 1 diabetes was proposed. It was noted that the presence of autoantibodies and/or low levels of C-peptide are still necessary for a confident diagnosis of type 1 diabetes in an adult. Antibodies to glutamic acid decarboxylase (anti-GAD) should be determined first. If negative, antibodies to tyrosine phosphatase 2 (IA2) and/or zinc transporter 8 (ZnT8) should be measured next, if these tests are available.

CHAPTER 6 points out that in the recommendations given to patients, a wide range of possibilities for individual choice and composition of the diet should be indicated. Information concerning the need to limit or eliminate specific food products should be given to patients only in justified situations, based on scientific evidence. Dietary education should be provided at the time of diagnosis and the verification of patient›s knowledge of dietary treatment of diabetes should be checked annually, with re-education if necessary. A new element highlighted in behavioural therapy is the importance of sleep. It was pointed out that poor sleep quality and inadequate sleep duration can lead to a worsening of metabolic compensation. Attention to adequate length/quality of sleep should be an important part of diabetes treatment.

The section about physical effort of pregnant women with hyperglycaemia was added to **CHAPTER 7**. It is recommended that all women with hyperglycaemia in pregnancy and postpartum, without medical contraindication, undertake physical exercise during this time. Moderate physical activity contributes to reducing the rates of gestational diabetes mellitus (GDM), gestational hypertension, preterm births and caesarean sections. Preferred physical activities include walking, riding stationary bikes, dancing, water aerobics, stretching exercises, and lifting small weights. Lifestyle changes and physical exercise are essential elements in the management of GDM and may be sufficient therapeutic management for many women. It was pointed out that undertaking additional physical exertion beyond daily activity requires the patient to consult a gynaecologist.

In **CHAPTER 9**, the section on the use of modern techniques for education in diabetes highlight-

ed that mobile apps are of particular importance and can be used to educate on dietary adherence, self-monitoring and blood glucose goal, insulin dose adjustment, and adaptation to physical activity. The aim of the treatment team is to help the patient choose the right mobile app. Diabetes education for children and adolescents which should be tailored to age, cognitive ability, the extent of participation required in diabetes self-management was also highlighted. It was also added that the educational framework programme should include information on the importance of preventive vaccinations for a person with diabetes.

CHAPTER 10 on the management of type 1 diabetes indicates that patients treated with semi-automatic pumps (predictive insulin withholding), HCL pumps or DIY systems require appropriately modified education taking into account the characteristics of these devices. One clinically important difference is the management of hypoglycaemia, where smaller amounts of glucose (5-15 grams) are usually sufficient to normalise glycaemia. In the paragraph on special situations in people with type 1 diabetes, discussing the principles of perioperative management, it was emphasised that, in the hospital setting, a patient with type 1 diabetes who has previously benefited effectively from advanced technology, such as CGM/FGM systems or personal insulin pumps, should be able to continue self-treatment on the basis of these systems if this is done under appropriate supervision and the patient›s general condition allows it. In addition, it was pointed out that a well-educated type 1 diabetes patient who achieves satisfactory treatment effects prior to hospitalisation should be involved in therapeutic decisions regarding treatment under hospital conditions. In selected cases, patient can carry out this treatment on their own as long as they achieve their glycaemic therapeutic goals. A significant added content concerns elderly patients with type 1 diabetes. In some elderly patients with type 1 diabetes, liberalisation of therapeutic targets is suggested, with biological rather than metabolic age being the main consideration. On the other hand, in elderly patients with type 1 diabetes who are in good biological condition, the continuation of advanced technology-based treatment or the implementation of such treatment should not be abandoned *a priori*.

A section on simplifying of anti-hyperglycaemic model in type 2 diabetes was added to **CHAPTER 11**. It is recommended to simplify and decrease burdens related to treatment, particularly insulin therapy and consideration of liberalisation of glycaemic goal in many type 2 diabetes patients. This includes, for example, patients with a high risk of hypoglycaemia, cognitive impairment, not following medical advice, a short expected survival time or a negative impact of a complex treatment regimen on quality of life. A reduction in the number of insulin injections and the dose of insulin used can be achieved by a tailored combination with noninsulin antihyperglycaemic drugs.

CHAPTER 14 notes that, according to recent recommendations, lipidogram determination can be performed in non-fasting patients, while patients with hypertriglyceridaemia should be tested 8-12 hours after their last meal. In addition, in patients with significant hypercholesterolemia with suspected familial hypercholesterolemia, or patients at very high risk of cardiovascular disease, referral to specialist lipid disorder clinics should be considered for qualification for treatment with PCSK9 inhibitors.

CHAPTER 15 adds that in the event of hypoglycaemia in an unconscious person or in a person with impaired consciousness in the outpatient setting, the administration of injectable glucagon intramuscularly or subcutaneously or intranasal glucagon should be recommended to trained persons in the community.

The title of **CHAPTER 17** has been changed to ‹Principles of diagnosis and treatment of patients with chronic coronary syndrome (CCS) and coexisting diabetes›. In addition, the introduction to the chapter has been rewritten, taking into account the current nomenclature. Changes have also been made to the paragraph on antiplatelet treatment. It was emphasised that after percutaneous coronary intervention (PCI), ASA at 75-100 mg/d and clopidogrel at 75 mg/d should be used for 6 months. In cases of increased risk of haemorrhagic complications, it is advisable to shorten the treatment to 1-3 months. The use of prasugrel or ticagrelor as a second-line treatment instead of clopidogrel may be considered in situations with high risk of coronary complications such as, but not limited to: high risk of elective stent implantation (e.g. suboptimal stent implantation or other situations during the procedure associated with high risk of stent thrombosis or stent implantation with high anatomical complexity); and In the absence of clopidogrel, prasugrel or ticagrelor may be used instead of clopidogrel in situations with high risk of coronary complications such as, but not limited to: high risk elective stent implantation (e.g. suboptimal stent implantation or other situations during the procedure associated with

high risk of stent thrombosis, left coronary artery stenosis with high anatomical complexity or stent implantation in multiple vessels) or if dual antiplatelet therapy cannot be used due to ASA intolerance.

CHAPTER 23 notes that a TIR>80% should be aimed for in children and adolescents. The information that in children less than 10 years old (or earlier, had their puberty started) and having a BMI of over 95 centiles, it is recommended to perform an OGTT and/or HbA_{1c} test every 2 years. It was highlighted that during adolescence, high insulin requirements can often be associated with physical inactivity, excessive carbohydrate intake, obesity or comorbidities. In case of obesity, an addition of GLP-1 agonist may be considered. The paragraph on self-monitoring added that hybrid closed loop systems could be considered in patients with unstable diabetes. The section on outpatient counselling recommended that, despite the use of remote consultations, counselling visits must take place at least once every 6 months; it emphasised the importance of counselling visits in patients with poorly metabolically balanced diabetes or with additional health problems. It is also necessary to inform staff in the educational institution about the need for the child to have a mobile device (mobile phone, smartwatch) with applications that are receivers and transmitters of data from CGM systems, insulin pumps, integrated systems and applications that support therapy (e.g. to calculate the carbohydrate content in the food). Diabetic children and adolescents should participate in physical education lessons regularly.

In **CHAPTER 24**, a recommendation for self-monitoring blood glucose values at 2 h after a meal, which should be <120 (6,7 mmol/l), has been added. It was also pointed out that in addition to the role of good glycaemic control, attention should be paid to adequate nutrition, as well as co-morbidities and medications used. It was highlighted that continuous glycaemic monitoring through CGM systems (TIR, TAR) may allow to achieve glycaemic targets during pregnancy in patients with pre-pregnancy diabetes. In addition, it was noted that if metformin is used in women with coexisting polycystic ovary syndrome (PCOS) to treat insulin resistance or induce ovulation, it should be discontinued by the end of the first trimester of pregnancy. The paragraph on contraception highlights that pregnancy in a woman with poorly controlled diabetes outweighs the risks from any contraceptive used. A significant recommendation regards ophthalmology consultations. In women with pre-pregnancy diabetes irrespective of type, ophthalmological control should be carried out before pregnancy and at the latest in the first trimester of pregnancy and then repeated in each trimester. Eye health is not routinely checked in women with GDM.

CHAPTER 26 added information that a daily blood glucose profile before planned surgery in insulin-treated patients is not necessary for those using CGM.

The title of **ANNEX 1** has been expanded to include a change to the diabetes outpatient clinic. If the patient needs to change their diabetes clinics (paediatric or internal medicine) due to, for example, changing their place of residence, it is recommended that the patient be referred to another diabetes clinic where they can receive appropriate care. It is advisable to complete the Diabetes Care Discharge Summary during the final visit to the original clinic. Editorial changes were also made to the Diabetes Care Information Sheet.

In **ANNEX 6** in the Tables on „Specifications for personal insulin pumps - PTD recommendation 2022. the Recommended Necessary Requirements and Recommended Additional Requirements" the division into age groups was removed, leaving unified recommendations for all patients treated with personal insulin pumps.

As every year, we provide You with another edition of the Clinical Recommendations of the Diabetes Poland. Despite the still ongoing COVID-19 pandemic and the many difficulties associated with it, as well as the need to adapt to new working conditions in diabetes units and clinics, we have tried to ensure that this year's edition of the recommendations also includes guidance from the latest research. The team developing the PTD Recommendations for 2022, by applying changes already traditionally in part suggested by people using the guidelines contained therein, hopes that they will contribute to even better diabetes care for people with diabetes in our country.

Traditionally, we would like to thank everyone who has contributed to the next edition of the PTD Recommendations.

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Table 1. American Diabetes Association evidence-grading system for "Standards of Medical Care in Diabetes"

Level of evidence	Description
A	Clear evidence from well-conducted, generalizable randomized controlled trials that are adequately powered, including: • Evidence from a well-conducted multicentre trial • Evidence from a meta-analysis that incorporated quality ratings in the analysis Compelling nonexperimental evidence, i.e., "all or none" rule developed by the Centre for Evidence-Based Medicine at the University of Oxford Supportive evidence from well-conducted randomized controlled trials that are adequately powered, including: • Evidence from a well-conducted trial at one or more institutions • Evidence from a meta-analysis that incorporated quality ratings in the analysis
B	Supportive evidence from well-conducted cohort studies • Evidence from a well-conducted prospective cohort study or registry • Evidence from a meta-analysis of cohort studies Supportive evidence from well-conducted case-control study
C	Supportive evidence from poorly or incontrolled studies • Evidence from randomized clinical trials with one or more major or three or more minor methodological flaws that could invalidate the results • Evidence from observational studies with high potential for bias (such as case series with comparison with historical controls) • Evidence from case series or case reports Conflicting evidence with the weight of evidence supporting the recommendation
E	Expert consensus or clinical experience

1. Rules for diagnosing carbohydrate metabolism disorders

Key recommendations
· Blood sugar tests for early detection of prediabetes/type 2 diabetes should be performed for people over 45, as well as for younger overweight or obese people if there is at least one additional risk factor of diabetes. [**B**]
· Women not previously diagnosed with diabetes should undergo an oral glucose tolerance test between 24th and 28th week of pregnancy to diagnose gestational diabetes. [**A**]
· Diagnosing diabetes in children during the first 9 weeks after birth requires genetic tests for neonatal diabetes. [**A**]
· Patients with cystic fibrosis aged 10 and above should undergo an oral glucose tolerance test each year to diagnose diabetes. [**A**]

Diabetes is a group of metabolic diseases characterised by hyperglycaemia resulting from a defect in insulin secretion and/or activity. Chronic hyperglycaemia is associated with damage, dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels.

I. Symptoms indicative of potential diabetes with significant hyperglycaemia:

- increased diuresis (polyuria);
- increased thirst;
- loss of weight not explained by intentional dieting;
- other, less typical symptoms: weakness and increased sleepiness, purulent skin lesions and inflammation of genitourinary organs.

II. Rules for diagnosing carbohydrate metabolism disorders:

- if symptoms of diabetes occur, a random blood sugar test should be performed, with result ≥ 200 mg/dl (≥ 11.1 mmol/l) constituting grounds for diagnosing diabetes;
- if there are no symptoms or if there are symptoms, but the result of the random blood sugar test is < 200 mg/dl (< 11.1 mmol/l), diabetes can be diagnosed on the following basis:
- 2 fasting blood sugar tests (each test should be performed on a different day) performed in the morning, with two results ≥ 126 mg/dl (≥ 7.0 mmol/l) constituting grounds for diagnosing diabetes;
- one HbA_{1c} test, with level ≥ 6,5% (≥ 48 mmol/mol) constituting grounds for diagnosing diabetes;

Table 1.1. Rules for diagnosing carbohydrate metabolism disorders

Glucose concentration in venous blood plasma measured in a laboratory			HbA_{1c} level measured in a laboratory using an NGSP-certified method
Random blood sugar – measured in a blood sample collected at any time during the day, regardless of when the last meal was eaten	Fasting blood sugar – measured in a blood sample collected 8–14 hours from the last meal	Blood sugar level at minute 120 of an OGTT as per WHO	
≥ 200 mg/dl (11.1 mmol/l) → diabetes* (if there are symptoms of hyperglycaemia, such as increased thirst, polyuria, weakness)	70–99 mg/dl (3.9–5.5 mmol/l) → normal fasting glucose (NFG)	< 140 mg/dl (7.8 mmol/l) → normal glucose tolerance	
	100–125 mg/dl (5.6–6.9 mmol/l) → IFG	140–199 mg/dl (7.8–11.1 mmol/l) → IGT	
	≥ 126 mg/dl (7.0 mmol/l) → diabetes*	≥ 200 mg/dl (11.1 mmol/l) → diabetes*	≥ 6.5% (48 mmol/mol) → diabetes*

IFG – impaired fasting glucose, IGT – impaired glucose tolerance, NGSP – National Glycohemoglobin Standardization Program, OGTT – Oral Glucose Tolerance Test, WHO – World Health Organization

**Diagnosing diabetes requires that abnormalities be identified as described in the text.*

Diagnosing diabetes requires that one of the abnormalities be identified, except for fasting blood sugar test, which requires that abnormalities be confirmed 2 times; when measuring blood sugar level, it is necessary to consider the potential influence of factors unrelated to the test (time of last meal, physical exertion, time of day).

- if the result of one or two fasting blood sugar tests is between 100 and 125 mg/dl (5.6 to 6.9 mmol/l) or the result of a fasting blood sugar test is below 100 mg/dl (5.6 mmol/dl) or the result of a HbA_{1c} test is < 6.5% (< 48 mmol/mol) for a person with justifiably suspected glucose intolerance or diabetes, an Oral Glucose Tolerance Test (OGTT) should be performed, with blood sugar level ≥ 200 mg/dl (≥ 11.1 mmol/l) at minute 120 of the OGTT constituting grounds for diagnosing diabetes.

In general, it can be said that the fasting blood sugar test, blood sugar level determined at minute 120 of the OGTT and the HbA_{1c} test are equally suitable for diagnostic purposes, although they detect diabetes in different people. Compared to the fasting blood sugar test and the HbA_{1c} test, blood sugar level determined at minute 120 of the OGTT detects a higher number of people with diabetes and prediabetes (Table 1.1).

III. Rules for performance of diagnostic tests:

- Oral Glucose Tolerance Test should be performed without prior limitation of carbohydrate consumption, in the morning, for a well-rested person after overnight fasting; the person undergoing the test should spend the two-hour period between drinking the solution containing 75 g of glucose and having their blood drawn at the site where the test is being performed, resting; all glucose level tests should be performed on venous blood plasma, in a laboratory;
- if OGTT is to be performed for a person with glucose intolerance (i.e. with prediabetes) who takes metformin for this reason, metformin should be discontinued at least one week before the day on which OGTT is to be performed;
  - » blood sugar tests used for diagnostic purposes should be performed in a laboratory; using a glucose meter to determine the blood sugar level is unacceptable;
  - » a HbA_{1c} test should be performed in a laboratory using methods certified in the NGSP (*National Glycohemoglobin Standardization Program*); a HbA_{1c} test should not be performed using a POCT (*point-of-care testing*) analyzer, even if the analyzer in question is NGSP-certified;
  - » in diagnosis of diabetes, HbA_{1c} tests should not be performed for people with conditions/diseases which disrupt the relationship between the HbA_{1c} level and the average blood sugar level, such as: anaemia, pregnancy and postpartum period, haemodialysis treatment, erythropoietin therapy, HIV infection and antiretroviral therapy; for such people, diagnosis criteria based on plasma glucose concentration should be used.

IV. Nomenclature of hyperglycaemic states according to World Health Organisation:

- 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);
- impaired glucose tolerance: blood sugar level at minute 120 of an OGTT between 140 and 199 mg/dl (7.8–11 mmol/l);
- prediabetes – IFG and/or IGT;
- diabetes – one of the following criteria:
  - » symptoms of hyperglycaemia and random blood sugar ≥ 200 mg/dl (≥ 11.1 mmol/l);
  - » fasting blood sugar ≥ 126 mg/dl (≥ 7.0 mmol/l) two times;
  - » blood sugar level at minute 120 of an OGTT ≥ 200 mg/dl (≥ 11.1 mmol/l);
  - » HbA_{1c} level ≥ 6.5% (≥ 48 mmol/mol).

V. Screening for diabetes

For risk groups, it is necessary to conduct screening for diabetes, as most patients do not exhibit symptoms of hyperglycaemia. Every person over 45 should undergo testing for diabetes once every 3 years. In addition, people from the following risk groups should undergo testing every year, regardless of age:

- overweight or obese people [BMI ≥ 25 kg/m^2 and/or waist circumference ≥ 80 cm (women); ≥ 94 cm (men)];
- people with a family history of diabetes (parents or siblings);
- people who are not physically active;
- people from community or ethnic groups at increased risk of diabetes;
- people diagnosed with prediabetes during a previous test;
- women who underwent gestational diabetes;
- women who gave birth to a child with a body mass > 4 kg;
- people with arterial hypertension (≥ 140/90 mm Hg);
- people with dyslipidemia (HDL, cholesterol concentration);
- < 40 mg/dl (< 1.0 mmol/l) and/or triglyceride concentration > 150 mg/dl (> 1.7 mmol/l)];

- women with polycystic ovary syndrome;
- people with a cardiovascular disease.

VI. Aetiological classification of diabetes:

- type 1 diabetes – autoimmune destruction of beta cells of the pancreas, typically leading to absolute insulin deficiency
- type 2 diabetes – progressive loss of insulin secretion capabilities of beta cells of the pancreas, with accompanying insulin resistance
- other specific types of diabetes:
  - genetic defects of beta cell function;
  - genetic defects of insulin action;
  - diseases of the exocrine part of the pancreas;
  - endocrinopathies;
  - drugs and chemicals;
  - infections;
  - rare forms of diabetes caused by an immune process;
  - other genetically determined syndromes related to diabetes.
- hyperglycaemia diagnosed for the first time during pregnancy:
  - diabetes during pregnancy;
  - gestational diabetes.

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

As differential diagnosis of type 1 diabetes, especially when diagnosed in adults, can be problematic, a standardised algorithm for differential diagnosis of type 1 diabetes was proposed in the most recently published ADA/EASD Consensus Guidelines.

The presence of autoantibodies and/or low levels of C-peptide are still necessary for a confident diagnosis of type 1 diabetes in an adult. Antibodies to glutamic acid decarboxylase (anti-GAD) should be determined first. If negative, antibodies to tyrosine phosphatase 2 (IA2) and/or zinc transporter 8 (ZnT8) should be measured next, if these tests are available.

Monogenic diabetes

Monogenic diabetes constitutes 1–2% of all cases of diabetes. It is caused by a mutation in a single gene. Most of its forms are related to an insulin secretion defect:

- the most common forms include MODY (*Maturity-Onset Diabetes of the Young*);
- mitochondrial diabetes;
- permanent neonatal diabetes.

Taking the monogenic forms into account in differential diagnosis of diabetes may lead to optimisation of treatment and establishment of a correct prognosis for the patient and members of the patient's family. Definitive diagnosis of monogenic diabetes is based on genetic testing. Qualification for genetic testing for monogenic diabetes as well as all therapeutic decisions stemming from such diagnosis should be made in centres with considerable experience in this area.

Permanent neonatal diabetes is defined as onset within the first 9 months of life. All patients with permanent neonatal diabetes should undergo genetic testing. This testing should include a search for mutations in the *KCNJ11* gene, which encodes the Kir6.2 protein. Mutations in this gene are the most common cause of permanent neonatal diabetes. Most patients with *KCNJ11* gene mutations can, regardless of age, undergo therapy using sulphonylurea derivatives, which is an effective and safe procedure and constitutes an alternative to insulin treatment. As a next step, mutations should be looked for in insulin genes, in the *ABCC8* gene, which encodes the SUR1 protein, and in the glucokinase gene. Identifying mutations in the *ABCC8* gene makes it possible to attempt a therapy using sulphonylurea derivatives. Those with mutations in insulin genes and double mutation in the glucokinase gene have to be treated using insulin. Decisions concerning the search for mutations in other genes should be made on an individual basis by diabetologists with considerable experience in the scope of genetics of diabetes.

In families with autosomal dominant early-onset diabetes caused by impaired insulin secretion which in most cases is not accompanied by obesity, differential diagnosis should consider MODY and a search for mutations in genes responsible for this form of diabetes. The most common form of MODY is related to mutations in the *HNF1A* and glucokinase genes.

A typical clinical picture of patients with MODY caused by mutation in the *HNF1A* gene includes:

- early onset of diabetes (typically before the age of 25);
- no insulin dependency and no tendency towards ketoacidosis, low insulin requirements, quantifiable C-peptide despite the fact that the disease has continued for several years or even longer;
- family history of diabetes for at least 2 generations. Early onset of diabetes in at least 2 family members. Oral Glucose Tolerance Test performed at an early stage of diabetes development typically reveals significantly

increased blood sugar levels, frequently with normal fasting blood sugar levels;
- no autoantibodies typical for type 1 diabetes;
- glycosuria higher than would be expected based on blood sugar levels.

Chronic complications of diabetes develop in a significant percentage of patients with HNF1A MODY, which is why compensation of the disease should be strived for since the onset. Sulphonylurea derivatives are the treatment of choice (except for pregnancy or the presence of typical contraindications). If their effectiveness is exhausted, either a combination therapy using insulin, metformin or DPP-4 inbitors or an insulin monotherapy should be considered.

Testing for mutations in the glucokinase gene is indicated in the following cases:
- constantly increased fasting blood sugar levels, between 99 and 144 mg/dl (5.5–8.0 mmol/l);
- increase in blood sugar level during OGTT of less than 83 mg/dl (4.6 mmol/l);
- one parent diagnosed with diabetes, although no positive family history does not preclude this form of the disease.

Treatment of choice in case of glucokinase defect caused by a single mutation is healthy diet with exclusion of monosaccharides; pharmacotherapy tends to be ineffective. The HbA_{1c} level characteristic for a glucokinase defect does not exceed 7.5% (59 mmol/mol).

Decisions with respect to testing for mutations in other MODY genes should be made on an individual basis in centres with experience in such testing.

Mitochondrial diabetes is most commonly caused by the *A3243G* mutation of the leucine tRNA gene. Testing for this mutations should be done in case of maternal inheritance of early onset diabetes in a family where certain members are deaf. Therapeutic management of mitochondrial diabetes can include diet and administration of sulphonylurea derivatives or insulin, depending on the severity of insulin secretion defect. Metformin therapy should be avoided in mitochondrial diabetes.

Diabetes in people with cystic fibrosis

Diabetes occurs in approx. 20% of teenagers and 40–50% of adults with cystic fibrosis and is thus one of the most common comorbidities. Cystic fibrosis-related diabetes is classified under other specific types of diabetes related to diseases of the exocrine part of the pancreas, it develops slowly and typically in an asymptotic manner for many years. Diabetic ketoacidosis occurs rarely, most likely due to preservation of secretion of endogenous insulin or a simultaneous glucagon secretion impairment. Initially, hyperglycaemia is typically observed in situations which aggravate insulin resistance, such as: acute and chronic infections, glucocorticosteroid therapy or significant carbohydrate intake (orally, intravenously, through a feeding tube or via percutaneous gastrostomy). Insulin therapy is the treatment of choice.

People with cystic fibrosis aged > 10 should undergo routine, annual testing for diabetes when they are in good health.

REFERENCES

1. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes – 2020. Diabetes Care 2020; 43: S14–S31.
2. Chung WK, Erion K, Florez JC, et al. Precision medicine in diabetes: a Consensus Report from the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia 2020; 63: 1671–1693.
3. De Franco E, Flanagan SE, Houghton JAL, et al. The effect of early, comprehensive genomic testing on clinical care in neonatal diabetes: an international cohort study. Lancet 2015; 386: 957–963.
4. International Expert Committee. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. Diabetes Care 2009; 32: 1327–1334.
5. Genuth S, Alberti KG, Bennett P, et al. Expert Committee on the diagnosis and classification of diabetes mellitus. Follow-up report on the diagnosis of diabetes mellitus. Diabetes Care 2003; 26: 3160–3167.
6. Holt RIG, de Vries JH, Hess-Fischl A, et al. The management of type 1 diabetes in adults. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care Sep 2021, dci210043.
7. Little RR, Rohlfing C, Sacks DB. The NGSP: over 20 years of improving HbA_{1c} measurement. Clin Chem 2019; 65: 839–848.
8. Metzger BE, Lowe LP, Dyer AR, et al. HAPO Study Cooperative Research Group. Hyperglycemia and adverse pregnancy outcomes. N Engl J Med 2008; 358: 1991–2002.
9. Ode KL, Moran A. New insights into cystic fibrosis-related diabetes in children. Lancet Diabetes Endocrinol 2013; 1: 52–58.
10. World Health Organisation. Classification of Diabetes Mellitus 2019. https://www.who.int/health-topics/diabetes.

2. Prevention and delay of diabetes

Key recommendations
• Patients with pre-diabetes should be given recommendations on a healthy lifestyle (physical activity at least 150 min/week; in case of overweight and obese patients, weight reduction of at least 7% and weight maintenance) and information on the effectiveness of such measures in preventing the development of diabetes. [**A**]
• Apart from the modification of lifestyle, pharmacological prevention of diabetes in the form of metformin should be considered in pre-diabetic patients, especially patients with concomitant IFG and IGT and/or a body mass index (BMI) ≥ 35 kg/m^2 and/or patients under 60 years of age, as well as in women with a history of gestational diabetes mellitus. [**A**]
• Screening should be performed using fasting glucose, oral glucose. [**C**]

Type 1 diabetes

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

Type 2 diabetes

1. Screening should be performed using fasting glucose or oral glucose tolerance test.
2. Risk factors of type 2 diabetes (see chapter 1).
3. Review of recommendations for preventing or delaying the development of diabetes:

- people from high-risk groups should be adequately educated on the role of a healthy lifestyle in the prevention of type 2 diabetes;
- people with pre-diabetes should be given recommendations on a healthy lifestyle (weight reduction of at least 7% in overweight and obese people and weight maintenance through physical activity adjusted to the patient's abilities (at least 150 min/week) and an appropriate diet with information on the effectiveness of such measures in reducing the risk of diabetes;
- apart from the modification of lifestyle, pharmacological prevention of type 2 diabetes in the form of metformin should be considered in pre-diabetic people, especially people with concomitant IFG and IGT and/or a body mass index (BMI) ≥ 35 kg/m^2 and/or people under 60 years of age, as well as in women with a history of gestational diabetes mellitus (GDM);
- pharmacotherapy or bariatric treatment should be considered when non-pharmacological management of obesity does not lead to sufficient weight reduction;
- all people, irrespective of age, benefit from increasing physical activity; however, it should be noted that such intervention is most effective in those over 60 years of age;
- it is crucial for the effectiveness of the prevention of glucose metabolism disorders that lifestyle advice is repeated during each visit;
- it is recommended that people with pre-diabetes should be regularly screened for other cardiovascular risk factors (e.g. obesity, smoking, hypertension, lipid disorders) and if present, appropriate treatment should be provided. The treatment goals for concomitant diseases for people with pre-diabetes are the same as for the general population;
- prescribing diabetogenic drugs should be avoided.

REFERENCES

1. Diabetes Prevention Program Research Group. The 10-year cost-effectiveness of lifestyle intervention or metformin for diabetes prevention: an intent-to-treat analysis of the DPP/DPPOS. Diabetes Care 2012; 35: 723–730.
2. Diabetes Prevention Program Research Group Long-term Effects of Metformin on Diabetes Prevention: identification of subgroups That Benefited Most in the Diabetes Prevention Program and Diabetes Prevention Program Outcomes Study. Diabetes Care 2019; 42: 601–608.
3. Haw JS, Galaviz KI, Straus AN, et al. Long-term Sustainability of Diabetes Prevention Approaches: a systematic review and meta-analysis of randomized clinical trials. JAMA Intern Med 2017; 177: 1808–1817.
4. Knowler WC, Barrett-Connor E, Fowler SE, et al. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002; 346: 393–403.
5. Knowler WC, Fowler SE, Hamman RF, et al. Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet 2009; 374: 1677–1686.
6. Ratner RE, Christophi CA, Metzger BE, et al. Diabetes Prevention Program Research Group. Prevention of diabetes in women with a history of gestational diabetes: effects of metformin and lifestyle interventions. J Clin Endocrinol Metab 2008; 93: 4774–4779.
7. Sigal RJ, Alberga AS, Goldfield GS, et al. Effects of aerobic training, resistance training, or both on percentage body fat and cardiometabolic risk markers in obese adolescents: the healthy eating aerobic and resistance training in youth randomized clinical trial. JAMA Pediatr 2014; 168: 1006–1014.

3. Monitoring of glucose

Key recommendations
· Most people on insulin therapy using the method of multiple daily injections should self-monitor blood glucose (SMBG) both before and after meals, at bedtime, before planned physical activity, when low blood glucose is suspected, and before activities where hypoglycaemia is particularly dangerous (e.g. driving). [**B**]
· As part of a broad educational programme, the SMBG can help people on insulin therapy with less frequent injections [**B**] and people with diabetes who do not undergo insulin therapy make independent therapeutic decisions. [**E**]
· When recommending the SBMG, it is important to remember about continuous education of people with diabetes, as well as periodic assessment of the correctness of the self-monitoring technique, results and influence on therapeutic decisions. [**E**]
· Continuous glucose monitoring (CGM) in combination with intensive insulin therapy is a helpful tool to reduce HbA_{1c} levels in adults (≥ 25 years of age) with type 1 diabetes. [**A**]
· Although the evidence for lowering HbA_{1c} levels in children and young adults is weaker, CGM can also be helpful in these groups of patients. Therapeutic success depends on the regularity of measurements. [**B**]
· CGM can be a helpful tool for people with hypoglycaemia who are unaware of it and those with multiple episodes of hypoglycaemia. [**C**]

Ongoing monitoring and retrospective assessment of blood glucose are an integral part of the proper treatment of diabetes. Proper self-monitoring of blood glucose requires the systematic education of people with diabetes in this area, with particular emphasis on checking the skills in using a glucose meter and interpreting self-monitoring results, i.e. using them for the daily modification of diet, exercise and medication doses. Another crucial element of monitoring the treatment of diabetes is a regular measurement of the HbA_{1c} level.

I. Self-monitoring of blood glucose

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

People with diabetes treated with multiple insulin injections or continuous subcutaneous insulin infusion should measure a daily blood glucose profile, including fasting blood glucose in the morning, before and 60–120 minutes after each main meal, and at bedtime. The frequency and times of performing additional tests should be determined on a case-by-case basis.

The use of blood glucose monitoring systems, such as real-time continuous glucose monitoring (rtCGM) and intermittently scanned continuous glucose monitoring (flash glucose monitoring – is-CGM/FGM), as a complement to self-monitoring of blood glucose is particularly recommended in people with unstable type 1 diabetes with concomitant frequent episodes of hypoglycaemia who are unaware of it, due to the fact that it improves the safety and effectiveness of treatment.

It is also recommended to self-monitoring blood glucose in order to achieve therapeutic goals in people treated with single insulin injections, oral antidiabetics and/or GLP-1 receptor agonists (Table 3.1). Irrespective of treatment, all people with diabetes should monitor their blood glucose levels more frequently if they feel unwell or their condition suddenly deteriorates.

For the purposes of proper self-monitoring of blood glucose, people with diabetes should be instructed how to use a glucose meter and interpret results and what to do next. For self-monitoring of blood glucose, it is recommended to use glucose meters that determine glucose levels in plasma as test results, with a measurement error, declared and confirmed in publications and manufacturer's

Table 3.1. Recommended frequency of self-monitoring of blood glucose

Method of diabetes treatment	Frequency of blood glucose tests in case of self-monitoring
Multiple (i.e. at least 3 per day) insulin injections, functional intensive insulin therapy, regardless of the type of diabetes	Multiple (i.e. at least 4 × day, advise 8 × day) tests per day according to the treatment regimen and patient's needs
People taking oral antidiabetic drugs and/or GLP agonist	4-point blood glucose profile (fasting glucose and after main meals) – once a week, 1 test performed at different times of day – daily
People with type 2 diabetes treated with fixed doses of insulin	Blood glucose tests performed daily, 4-point blood glucose profile (fasting glucose and after main meals) once a week and daily blood glucose profile once a month

materials 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). In patients performing ≥ 4 measurements per day, it may be helpful to analyse the results using dedicated computer software. Glucose meters and the technique of their use by the patients should be checked in case of suspected measurement errors and at least once a year at the facility where the person with diabetes is treated on an outpatient basis. This assessment should involve measuring glucose level in the same material with a glucose meter using a comparative method [laboratory method or point of care testing (POCT) consistent with the laboratory method] — the difference in the results obtained should not exceed the above-defined margins of error.

II. Glycated haemoglobin (HbA_{1c})

HbA_{1c} level reflects average blood glucose levels in the period of approximately 3 months preceding the measurement, with about 50% of HbA_{1c} present in blood being formed during the last month before the measurement.

HbA_{1c} level measurements should be performed annually in people with stable disease who have met treatment targets. In those who have not met treatment targets or in those whose treatment regimen has been modified, HbA_{1c} level should be measured at least every 3 months.

HbA_{1c} level measurements should be performed using analytic methods certified by the National Glycohemoglobin Standardization Program (NGSP) (http:// www.ngsp.org). Point-of-care testing for HbA_{1c} is also possible provided that the method and analyser used are certified by the NGSP. It is suggested that diagnostic laboratories determine HbA_{1c} levels in SI units [mmol/mol] in addition to traditional units.

When interpreting HbA_{1c} measurement results, it is necessary to take into account interfering factors, such as changes in the erythrocyte survival time, hemoglobinopathies, and chemical haemoglobin modifications which can make it difficult or impossible to use such measurements.

REFERENCES

1. Battelino T, Phillip M, Bratina N, et al. Effect of continuous glucose monitoring on hypoglycemia in type 1 diabetes. Diabetes Care 2011; 34: 795–800.
2. Elgart JF, Gonzalez L, Prestes M, et al. Frequency of self-monitoring blood glucose and attainment of HbA_{1c} target values. Acta Diabetol 2016; 53: 57–62.
3. Farmer A, Wade A, Goyder E, et al. Impact of self monitoring of blood glucose in the management of patients with non-insulin treated diabetes: open parallel group randomised trial. BMJ 2007; 335: 132.
4. Grant RW, Huang ES, Wexler DJ, et al. Patients who self-monitor blood glucose and their unused testing results. Am J Manag Care 2015; 21: e119–e129.
5. Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, et al. The effect of continuous glucose monitoring in well-controlled type 1 diabetes. Diabetes Care 2009; 32: 1378–1383.
6. Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group. Sustained benefit of continuous glucose monitoring on A1C, glucose profiles, and hypoglycemia in adults with type 1 diabetes. Diabetes Care 2009; 32: 2047–2049.
7. Malanda UL, Welschen LM, Riphagen II, et al. Self-monitoring of blood glucose in patients with type 2 diabetes mellitus who are not using insulin. Cochrane Database Syst Rev 2012; 1: CD005060.
8. Miller KM, Beck RW, Bergenstal RM, et al. T1D Exchange Clinic Network. Evidence of a strong association between frequency of self monitoring of blood glucose and hemoglobin A1c levels in T1D Exchange clinic registry participants. Diabetes Care 2013; 36: 2009–2014.
9. Yeh HC, Brown TT, Maruthur N, et al. Comparative effectiveness and safety of methods of insulin delivery and glucose monitoring for diabetes mellitus: a systematic review and meta-analysis. Ann Intern Med 2012; 157: 336–347.

4. Setting objectives for diabetes management

Key recommendations
· In individuals with diabetes, the overall target for glycaemic control expressed by the HbA_{1c} level is no more than 7.0% (53 mmol/mol). [**A**]
· LDL fraction cholesterol less than 55 mg/dl (less than 1.4mmol/l) and a reduction of at least 50% from baseline in individuals with very high cardiovascular risk diabetes. [**B**]
· LDL-C concentration less than 70 mg/dl (1.8 mmol/l) and a reduction of at least 50% from baseline in individuals with high cardiovascular risk diabetes. [**A**]
· LDL-C levels less than 100 mg/dl (2.6 mmol/l) in individuals at moderate cardiovascular risk (young people under 35 yrs. with type 1 diabetes without chronic complications and other cardiovascular risk factors or with type 2 diabetes below 50 yrs. with a diabetes duration of less than 10 years, without other risk factors). [**A**]
· Recommended arterial blood pressure: less than 130/80 mm Hg. [**A**]

I. General remarks

1. The objectives of diabetes treatment are considered to be the achievement of target values in terms of: glycaemia, blood pressure, lipid profile, body weight.
2. In elderly patients and in the presence of co-morbidities, if the prognosis for survival does not reach 10 years, the criteria for compensation should be relaxed to a degree that does not impair the patient's quality of life.
3. Generally, in modern diabetology, the principle of far-reaching individualisation of objectives and intensification of therapy applies. In every person with diabetes, especially type 2 diabetes, when defining goals and choosing a therapeutic strategy, it is necessary to take into account the attitude of the patient and the expected involvement in treatment (also of those around them), the degree of risk of hypoglycaemia and its possible consequences (more serious in the elderly, with damage to the cardiovascular and/or nervous system), the duration of diabetes, life expectancy, the presence of serious vascular complications of diabetes and significant comorbidities, the level of education of the person with diabetes, and the relationship between the benefits and risks of achieving certain target values of therapy. In some situation (e.g. in the presence of advanced complications or in old age), the treatment goals set should be achieved gradually, over several (2–6) months.

II. Goals of metabolic control (after taking into account the above-mentioned comments)

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

1. HbA_{1c} ≤ 6.5% (≤ 48 mmol/mol):
- for type 1 diabetes, when goal striving is not associated with increased risk of hypoglycaemia and impaired quality of life [fasting and pre-meal glycaemia, also in self-monitoring: 70–110 mg/dl (3.9–6.1 mmol/l), and 2 hours after the start of a meal in self-monitoring below 140 mg/dl (7.8 mmol/l)];
- for short-term type 2 diabetes (duration of less than 5 years);
- in children and adolescents, regardless of type of disease.

When assessing the glycaemic profile, the conversion factor in Table 4.1, relating HbA_{1c} levels to the daily average and range of blood glucose concentrations, should be used in relation to target HbA_{1c} values;

2. HbA_{1c} ≤ 8.0% (≤ 64 mmol/mol) – in elderly patients with long-standing diabetes and significant macroangiopathy complications (history of myocardial infarction and/or stroke) and/or multiple comorbidities;
3. HbA_{1c} lower than 6.5% (48 mmol/mol) in women with pre-pregnancy diabetes planning pregnancy, lower than 6.0% (42 mmol/mol) in the second and third trimester of pregnancy if not associated with a higher incidence of hypoglycaemia.

If person aged over 65 years is expected to live longer than 10 years, in pursuit of overall treatment goals, progressive control of diabetes should be sought, with a HbA_{1c} levels of equal to or less than 7%.

In patients using continuous glucose monitoring (CGM) or scanning systems (isCGM/FGM), time in range (TIR) should be one of the primary parameters for assessing diabetic control. Specific recommendations regarding TIR in relation to type of diabetes were included in Table 4.2.

III. Goals of balancing lipid metabolism:

- LDL fraction cholesterol: lower than 55 mg/dl (less than 1.4 mmol/l) and a reduction of at

Table 4.1. Relationship between HbA_{1c} levels and average plasma glucose levels

HbA_{1c}	Average plasma [mg/dl]	Glucose level [mmol/l]	Average fasting glycaemia [mg/dl]	Average pre-meal glycaemia [mg/dl]	Average glycaemia after a meal [mg/dl]
6	126	7.0			
< 6.5			122	118	144
6.5–6.99			142	139	164
7	154	8.6			
7.0–7.49			152	152	176
7.5–7.99			167	155	189
8	183	10.2			
8–8.5			178	179	206
9	212	11.8			
10	240	13.4			
11	269	14.9			
12	298	16.5			

Correlation between HbA_{1c} and average glycaemic values 0.92 (according to Diabetes Care 2015; 38: 35)

Table 4.2 Target glycaemic parameters in individuals with type 1 and type 2 diabetes and in pregnant women using systematic continuous glucose monitoring or scanning systems

	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 h 48 min	70–180 mg/dl (3.9–10.0 mmol/l)	< 4%; < 1 h < 1%; < 15 min	< 70 mg/dl (< 3.9 mmol/l) < 54 mg/dl (< 3.0 mmol/l)	< 25%; < 6 h < 5%; < 1 h 12 min	> 180 mg/dl (> 10.0 mmol/l) > 250 mg/dl (> 13.9 mmol/l)
Elderly/ individual at high risk of hypoglycaemia	> 50%; > 12 h	70–180 mg/dl (3.9–10 mmol/l)	< 1%; < 15 min	< 70 mg/dl (< 3.9 mmol/l)	< 10%; < 2 h 24 min	> 250 mg/dl (> 13.9 mmol/l)
Pregnant women with type 1 diabetes	> 70%; > 16 h 48 min	63–140 mg/dl (3.5–7.8 mmol/l)	< 4% < 1h < 1 % < 15 min	< 63 mg/dl (< 3.5 mmol/l) < 54 mg/dl (< 3.0 mmol/l)	< 25% < 6 h	> 140 mg/dl (> 7.8 mmol/l)

TAR – time above range, TBR – time below range, TIR – time in range

least 50% from baseline in people with very high cardiovascular risk diabetes;
- LDL-C lower than 70 mg/dl (1.8 mmol/l) and a reduction of at least 50% from baseline in people with high cardiovascular risk diabetes;
- LDL-C lower than 100 mg/dl (2.6 mmol/l) in individuals at moderate cardiovascular risk (young people aged under 35 years with type 1 diabetes without chronic complications and other cardiovascular risk factors or individuals with type 2 diabetes aged under 50 years, with diabetes duration of less than 10 years without other risk factors).
- "non-HDL" cholesterol lower than 85 mg/dl (2.2 mmol/l) in individuals with very high cardiovascular risk diabetes;
- "non-HDL" cholesterol lower than 100 mg/dl (2.6 mmol/l) in people with high-risk diabetes;
- HDL cholesterol: higher than 40 mg/dl (higher than 1.0 mmol/l) [10 mg/dl (0.275 mmol/l) higher for women];
- triglyceride levels: lower than 150 mg/dl (less than 1.7 mmol/l).

IV. Goals of balancing blood pressure:

- systolic blood pressure < 130 mm Hg;
- diastolic pressure < 80 mm Hg.

In individuals aged under 65 years, it is recommended to maintain systolic blood pressure between 120–129 mm Hg.

In individuals aged 65 years or more, it is recommended to maintain systolic blood pressure in the range 130–140 mm Hg.

See Chapter 13. for specific criteria.

REFERENCES

1. Garber AJ. Treat-to-target trials: uses, interpretation and review of concepts. Diabetes Obes Metab 2014; 16: 193–205.
2. Inzucchi SE, Bergenstal RM, Buse JB, et al. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care 2015; 38: 140–149.
3. Lipska KJ, Ross JS, Miao Y, et al. Potential overtreatment of diabetes mellitus in older adults with tight glycemic control. JAMA Intern Med 2015; 175: 356–362.
4. Nathan DM, Kuenen J, Borg R, et al. A1c-Derived Average Glucose (ADAG) Study Group. Translating the A1C assay into estimated average glucose values. Diabetes Care 2008; 31: 1473–1478.
5. Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ 2000; 321: 405–412.
6. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993; 329: 977–986.
7. Vijan S, Sussman JB, Yudkin JS, Hayward RA. Effect of patients' risks and preferences on health gains with plasma glucose level lowering in type 2 diabetes mellitus. JAMA Intern Med 2014; 174: 1227–1234.
8. Wei N, Zheng H, Nathan DM. Empirically establishing blood glucose targets to achieve HbA1c goals. Diabetes Care 2014; 37: 1048–1051.
9. Cosentino F, Grant PJ, Aboyans V, et al. ESC Scientific Document Group. 2019 ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. Eur Heart J 2020; 7: 255–323.
10. Battelino T, Danne T, Bergenstal RM, et al. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the international consensus on time in range. Diabetes Care 2019; 42: 1593–1603.

5. Organization of medical care for patients with diabetes mellitus

Key recommendations
Contemporary diabetes care requires appropriate competency of medical staff, nurse educators or healthcare educators, and dietitians. Medical care should be focused on the patient with diabetes, taking into account his or her individual situation, needs, and preferences. Due to the multidisciplinary nature of late complications of diabetes and comorbidities, it is also necessary for health professionals from related disciplines to cooperate. [**B**]

I. Outpatient care

In particular, modern diabetes management requires competency in treatment, monitoring its effectiveness, and educating patients with diabetes mellitus in order to provide them with the necessary knowledge and motivation to follow the recommendations. It also requires collaboration between primary care and specialty care physicians.

II. Primary care tasks

Health promotion, identification of risk factors, prevention of carbohydrate metabolism disorders, education about pre-diabetes and type 2 diabetes.

1. Diagnosis of carbohydrate metabolism disorders.
2. Referral to diabetes clinic for long-term treatment for:
- type 1 diabetes;
- other specific types of diabetes;
- difficulty in determining the type of diabetes;
- any type of diabetes in children and adolescents, as well as in pregnant women and in women planning their pregnancy.
3. Treatment of pre-diabetic conditions.
4. Treatment of type 2 diabetes, including simple insulin therapy.
5. Referral for diabetes consultation (less frequently for long-term treatment) for:
- when therapeutic goals are not achieved, referral is primarily for intensification of insulin treatment;
- the presence of comorbidities that make treatment more difficult;
- occurrence of diabetes-related complications;
- occurrence of pharmacotherapy-related complications;
- other specific situations.

III. Specialty care tasks

- verification of treatment effects and goal establishment in patients with diabetes mellitus managed

by the primary care providers as part of the annual inspection;
- guiding patients with diabetes mellitus treated with injectables (insulin, GLP-1 receptor agonists);
- guiding patients with diabetes mellitus by continuous subcutaneous insulin infusion (CSII);
- conducting differential diagnosis of types of diabetes, including monogenic diabetes and diabetes associated with other diseases;
- diagnosis, prevention, and guidance of patients with diabetes mellitus regarding late complications;
- diabetes education;
- diagnosis and management of diabetes in pregnant women;
- diagnosis and treatment of comorbidities with diabetes;
- annual inspection according to the current recommendations of the Diabetes Poland (Polskie Towarzystwo Diabetologiczne) (Table 5.1).

IV. Specialist hospital care

1. Cases of newly diagnosed type 1 diabetes and type 2 diabetes with clinical symptoms of hyperglycemia; with inability to provide treatment on an outpatient basis.
2. Acute complications of diabetes (severe, recurrent hypoglycemia and hyperglycemia, diabetic ketoacidosis and diabetic comas).
3. Exacerbation of chronic complications.
4. Therapy regimen modification for patients who cannot achieve therapeutic effects on an outpatient basis.
5. Implementation of intensive insulin therapy with a personal insulin pump and/or continuous glucose monitoring system; when unable to provide treatment on an outpatient basis.
6. Implementation of insulin therapy in gestational or pregestational diabetes mellitus not previously treated with insulin; when unable to provide treatment on an outpatient basis.
7. Difficulty in achieving normoglycemia in pregnant women with pregestational diabetes mellitus; with inability to provide treatment on an outpatient basis.

V. Organizational requirements

Specialized diabetes units

1. Medical staff: two full-time diabetes specialists, or alternatively, in addition to 1 diabetes specialist, a specialist in internal medicine with a minimum of 1 year of experience working in a diabetes ward or clinic or a second year specialist registrar in diabetes.
2. Nursing staff:
- a nurse with specialization in diabetes nursing or internal medicine nursing, or after completion of specialized course „Educator in Diabetes" („Edukator w Cukrzycy"), or after qualification course in diabetes nursing or with at least 2 years of professional experience in diabetes ward/clinic;
- 1 nurse per 10 diabetes beds, whose responsibilities are limited to educating and caring for patients with diabetes mellitus.
3. Dietitian — 1 FTE, with responsibilities limited to diabetes care.
4. Access to psychological consultation.
5. Access to specialty consultations.
6. Equipment:
- at least 2 units equipped with an ECG monitor, blood pressure monitor, infusion pump, pulse oximeter, and oxygen therapy access to treat patients in acute metabolic condition;
- education room;
- intravenous infusion pumps;
- equipment for the diagnosis and treatment of diabetic foot syndrome;

Table 5.1. Recommendations for monitoring adults with diabetes mellitus

Parameter	Notes
Dietary and therapeutic education	During each appointment
HbA_{1c}	Once a year, more often if the maintenance of normoglycemia is in doubt or if verification of treatment effectiveness after its modification is needed
Total cholesterol, HDL, LDL, triglycerides in serum	Once a year, more often in presence of dyslipidemia
Albuminuria	Once a year in patients not treated with ACE inhibitors or AT1 receptor antagonists (for type 1 diabetes after 5 years of disease duration)
Urinalysis with sediment examination	Once a year
Serum creatinine and calculation of eGFR	Once a year (for type 1 diabetes after 5 years of disease duration)
Creatinine, Na^+, K^+, Ca^{2+}, PO4 in blood serum	Every six months in patients with elevated serum creatinine levels
Fundus with dilated pupils	In patients with type 1 diabetes, after 5 years; in patients with type 2 diabetes, from the time of diagnosis (see Chapter 20 for details)

- access to cardiology diagnostics (cardiac stress test, ECG, cardiac ultrasound, holter ECG monitoring, ambulatory blood pressure monitoring) and vascular diagnostics (arterial Doppler examination).

Diabetes specialist clinics

1. The team providing care to a patient with diabetes mellitus on an outpatient specialty care basis (Ambulatoryjna opieka specjalistyczna — AOS) includes:

- a specialist in diabetes or a specialist in internal medicine with at least 2 years of professional experience in a diabetes ward or clinic or a second year specialist registrar in diabetes;
- in the case of a specialist outpatient clinic for children and adolescents, a specialist in diabetes, or a specialist in paediatric diabetes and endocrinology, or a paediatrician with at least 2 years of professional experience in a paediatric diabetes clinic or ward, or a second year specialist registrar in diabetes or paediatric diabetes and endocrinology;
- a nurse with a specialization in diabetes nursing or with a completed "Diabetes Educator" ("Edukator w Cukrzycy) course, or a nurse with a specialization in internal medicine nursing, or with a completed qualification course in diabetes nursing, or with at least 2 years of experience in a diabetes ward or in a specialized diabetes clinic;
- a full-time dietitian designated solely for dietetic education;
- access to psychological care in justified, individual clinical cases.

Children and adolescents, pregnant women — see topic chapters.

2. Specialty clinic equipment:

- doctor's offices;
- treatment room with a separate area for taking samples and analysis;
- nursing-education room with dietary section;
- the possibility of reading and analyzing data from glucose meter, insulin pumps, and continuous glucose measurement devices using information systems;
- diabetic foot syndrome examination kit (tip therm, 128 Hz tuning fork, 10 g monofilament, neurological hammer);
- device for the assessment of vascular flows using the Doppler method.

In addition, access to specialist consultations for cyclical monitoring of complications should be provided.

VI. Organization of health care for patients with diabetic foot syndrome

Diabetic foot referral centres

1. Personnel requirements:

- medical staff: the equivalent of at least 2 FTEs — a specialist in diabetes with at least one year of documented experience in the treatment of patients with diabetic foot syndrome;
- nursing staff: the equivalent of 2 FTEs — with documented, at least 1-year experience in treatment and care of patients with diabetic foot syndrome or treatment and care of patients with chronic wounds.

2. Having facilities for hospitalization within the same unit in a ward (clinic) executing the National Health Fund (NFZ) contract for diabetes or internal medicine.
3. Access to multispecialty care that includes consultation with a surgeon, vascular surgeon, or angiologist.
4. Possibility of intravenous antibiotic therapy administration.
5. Access to basic diagnostic imaging, i.e. X-ray, ultrasound (including Doppler ultrasound), and CT and/or MRI.
6. Access to laboratory and microbiological tests performed in a medical diagnostic laboratory, entered into the register of the National Council of Laboratory Diagnosticians (Krajowa Rada Diagnostów Laboratoryjnych – KRDL).

Primary care offices

The role of these offices should be to diagnose, treat and prevent ulcers, infections and Charcot neuropathic osteoarthropathy in the course of diabetic foot syndrome. These offices collaborate with referral centres where more severe clinical cases are consulted and possibly referred for treatment.

Remote medical consultations as part medical care in diabetes

Every diabetes clinic should be able to conduct an effective remote medical consultation. For this purpose, the clinics must have adequate hardware facilities (computers with appropriate software) and staff with appropriate knowledge and skills. Patients with diabetes mellitus should be encouraged to use hardware technology and applications to facilitate remote medical consultations. It is important to emphasize that the effectiveness of remote medical consultations is greater when the person performing the remote medical consultation receives more source data regarding

the patient's treatment (e.g. data from the memory of blood glucose meter, continuous glucose monitoring system, or personal insulin pump)

Remote medical consultations for patients with diabetes mellitus can be both part of ongoing diabetes care and used, for example, in an epidemiological emergency.

REFERENCES

1. TRIAD Study Group. Health systems, patients factors, and quality of care for diabetes: a synthesis of findings from the TRIAD study. Diabetes Care 2010; 33: 940–947.
2. Tricco AC, Ivers NM, Grimshaw JM, et al. Effectiveness of quality improvement strategies on the management of diabetes: a systematic review and meta-analysis. Lancet 2012; 379: 2252–2261.
3. Tchero H, Kangambega P, Briatte C, et al. Clinical effectiveness of telemedicine in diabetes mellitus: a meta-analysis of 42 randomized controlled trials. Telemed J E Health 2019; 25: 569–583.

6. Behavioral therapy

Key recommendations
· All patients diagnosed with diabetes should be educated on general principles of proper nutrition in diabetes by qualified specialists (doctors, dieticians, diabetes nurses, diabetes educators) using various methods and techniques, including telemedicine. Specific dietary recommendations should be individualised according to the patient's needs and capabilities. [**A**]
· Carbohydrates are the primary dietary macronutrients that determine the insulin demand around mealtimes. The most significant element of dietary education of people with type 1 diabetes should be training in recognising and estimating the carbohydrate content of a meal to optimise insulin dosing. Patients with type 2 diabetes should be informed about portion size control, as well as the proportion of carbohydrates in individual meals and the whole diet. [**A**]
· There is no universal diet for all people with diabetes. The optimal macronutrient ratio for diabetics should be determined individually, taking into account age, the level of physical activity, presence of diabetic complications, additional conditions and preferences of the patient. [**E**]
· Due to its multidirectional benefits, physical activity is an integral part of the proper and comprehensive management of diabetes. To achieve an optimal effect, it is necessary to exercise regularly, preferably daily, or at least every 2–3 days. [**A**]
· People with diabetes should limit the time spent sitting without breaks. [**B**]

Behavioural therapy is an essential part of treatment of all patients diagnosed with diabetes (both type 1 and type 2) at any age. Proper nutrition and physical activity can significantly improve overall health, as well as prevent and treat chronic complications of diabetes. All patients diagnosed with diabetes should be educated on general principles of proper nutrition in diabetes by qualified specialists (doctors, dieticians, diabetes nurses, diabetes educators) using various methods and techniques, including interactive tools and telemedicine. Treatment of diabetics should include a therapeutic lifestyle consisting of a varied diet, regular physical activity, avoidance of stress, smoking and alcohol consumption and optimal sleep time. Education on the therapeutic lifestyle tailored to the needs and capabilities of patients with diabetes allows them to achieve their treatment goals and reduces the costs associated with the management of diabetic complications.

It is necessary to emphasise that one of the priorities of behavioural treatment of diabetes, irrespective of its type, should consist in maintaining the normal weight of the patient.

Dietary recommendations

I. General recommendations

The aim of dietary treatment of diabetics is to achieve and maintain:

- normal (close to normal) plasma glucose levels to prevent complications of diabetes;
- optimal serum lipid and lipoprotein concentrations;
- optimal blood pressure values to reduce the risk of vascular disease;
- the desired body weight.

Dietary treatment includes recommendations on:

- individually calculated diet calorie content;
- the distribution of calories between meals throughout the day;

- sources of products providing energy, vitamins, minerals and phytochemicals;
- products whose consumption should be restricted.

When planning a diet, it is necessary to take into account individual dietary and cultural preferences, age, gender, level of physical activity and economic status of the patient. An important element of dietary education should consist in the provision of information in a practical manner, which enables the direct application of acquired knowledge in everyday life. Meals constitute a significant part of a comfortable life for people with diabetes. The recommendations provided to patients should include a wide range of possibilities for individual choice and composition of the diet. Information concerning the need to limit or eliminate specific food products should be given to patients only in justified situations, based on scientific evidence. Dietary education should be provided at the time of diagnosis and the verification of patient's knowledge of dietary treatment of diabetes should be checked annually, with re-education if necessary.

The dietary treatment strategy for patients diagnosed with diabetes should include:

- assessment of the patient's regular diet;
- nutrition diagnosis;
- setting the goal and assumptions of the dietary intervention;
- dietary intervention (individual and/or group consultations);
- monitoring dietary habits and evaluating the effects of therapy;
- adjustment of the diet if the treatment goal has not been achieved.

Diabetic patients should be encouraged to follow the principles of proper nutrition for healthy people, as well as:

- control portion sizes of consumed food;
- control the amount of carbohydrates consumed in the whole diet and in individual meals;
- limit the consumption of food products containing easily digestible carbohydrates, including free sugars;
- eat meals regularly, including breakfast;
- consume food slowly.

There is no universal diet for all people with diabetes. Treatment of diabetes can be based on various dietary strategies, e.g. the Mediterranean diet, the DASH diet, the Flexitarian diet, or plant-based diets.

These models involve a significant proportion of non-starchy vegetables, a maximum reduction of added sugars and refined cereals, as well as an increase in the consumption of minimally processed foods.

Patients with type 1 diabetes should avoid eating easily digestible carbohydrates and follow the general principles of a well-balanced diet. In each case, the diet and insulin treatment regimen should be determined individually. Insulin therapy should be adapted to the dietary habits of the diabetic, the composition of meals consumed (the content of carbohydrates, protein and fat), as well as lifestyle and level of physical activity. When developing dietary guidelines, priority should be given to the identification and estimation of the digestible carbohydrate content of meals, e.g. using the carbohydrate exchange system. The glycaemic index (GI) and glycaemic load (GL) values can also help in the selection of food products. There is a very large variation in individual glycaemic response after eating the same meal or product (e.g. dairy). The order in which products from different food groups are consumed within a single meal can significantly affect the postprandial blood glucose level. It is beneficial to consume vegetables and products containing protein (meat, fish) before starchy products.

With regard to diabetics from the oldest age groups, dietary education should be individualised and provide for an adequate protein intake, but at the same time, remain simple and understandable for the patient.

Although the primary macronutrients determining the insulin demand around mealtimes are carbohydrates, people with type 1 diabetes should also be educated on the glycaemic effect of proteins and fats. Continuous glucose monitoring systems and flash systems effectively facilitate the assessment of the influence of quantity, quality and relative proportions of dietary macronutrients on blood glucose levels.

Blood glucose level checks performed before or after meals can also be easier thanks to the dedicated apps, which should be selected based primarily on the guidelines and recommendations of leading diabetes associations.

In type 2 diabetes, the main goals of treatment are to maintain the optimal metabolic control of the disease, reduce excess body weight and maintain the patient's desired body weight. Therefore, in addition to the above recommendations, the total dietary calorie content, adapted to age, current

body weight and level of physical activity, is essential. The energy deficit should be set individually in order to allow the patient to lose weight slowly but steadily (approx. 0.5–1 kg/week). A weight reduction of at least 5% facilitates the control of blood glucose levels but optimally should amount to at least 7%. A daily calorie deficit of 500–750 kcal is considered safe.

Weight reduction can be achieved through diets reducing caloric intake and those including different proportions of macronutrients (proteins, fats, carbohydrates), but long-term diets with significantly reduced carbohydrate intake and starvation are not recommended. All patients diagnosed with diabetes and those who are overweight/obese are advised to control their portion sizes.

II. Detailed recommendations

Composition of the diet

1. Carbohydrates

- there is insufficient scientific evidence that allows establishing a single optimal amount of carbohydrate suitable for the diet of diabetics;
- carbohydrates should provide around 45% of total energy; if carbohydrates come from low-GI products high in fibre, their proportion in the total caloric value of the diet can be higher (up to 60%). A high intake of calories from carbohydrates should be recommended for very active people. On the other hand, a diet in which carbohydrates provide a smaller amount of energy (25–45%) may be temporarily recommended for less active people who cannot exercise, for example, due to coexisting diseases;
- carbohydrates should be mainly derived from whole grain products, especially those with a low glycaemic index (< 55);
- the primary restriction should be placed on simple carbohydrates (mono- and disaccharides), which the person diagnosed with diabetes should consume in minimum quantities. Added (in the production and preparation of food) and free sugars, whose sources are mainly sugar and sweets, but also honey, juices and fruit drinks, should also be limited;
- sweeteners may be used in the dosage recommended by the manufacturer;
- the daily intake of fructose should not exceed 50 g; it is not recommended to use fructose as a substitute for sugar;
- the minimum daily intake of fibre should be 25 g or 15 g/1,000 kcal. It is important to increase the fibre intake by consuming at least two portions of whole-grain products and three portions of vegetables rich in fibre. If the recommended amount of fibre cannot be provided, it is necessary to consider introducing fibre supplements, particularly in the form of water-soluble fractions, into the diet. It is advisable to increase the intake of resistant starch (a fibre fraction) in the diet.

2. Fats:

- in the dietary treatment of diabetes, the proportion of fat in the diet should be the same as in the diet of individuals without diabetes and may vary from 25% to 40% of the energy value of the diet;
- the quality of fat in the diet is more important than its general amount. With high fat intake, the proportion of individual types of fatty acids is extremely important;
- saturated fats should contribute to less than 10% of energy value of the diet;
- monounsaturated fats should make up to 20% of energy value of the diet;
- polyunsaturated fats should constitute approximately 6–10% of energy values of the diet;
- cholesterol in the diet should not exceed 300 mg/day, and in patients with dyslipidaemia < 200 mg/day;
- in order to lower the LDL cholesterol fraction, the proportion of saturated fats in the diet should be reduced and/or replaced by carbohydrates with a low glycaemic index and/or monounsaturated fats;
- in case of individuals with hypercholesterolaemia, introducing foods containing the plant sterols/stanols in the diet at a rate 2–3 g per day may prove beneficial;
- the intake of trans-fatty acids, especially from processed foods, should be reduced as much as possible;
- vegetable fats are recommended, with the exception of palm and coconut.

3. Proteins:

- the amount of protein in the diet should be determined on an individual basis. There is no evidence of adverse effects of protein-rich diets in the dietary management of people with diabetes. Among most individuals with diabetes, as in general population, the proportion of energy derived from protein in the diet should be 15–20% (approx. 1–1,5 g/kg bw./day). Among individuals with type 2 diabetes and excessive weight, a reduced calorie diet containing

20–30% protein ensures increased satiety and facilitates weight reduction and maintenance. Patient with chronic kidney disease should maintain protein intake of approximately 0,8–1 g/kg bw./day;
- there is no need to restrict animal protein, although some people may find it beneficial to replace animal protein with plant protein (e.g. soy protein).

4. Vitamins and micronutrients:
- vitamin and micronutrients supplementation is not recommended for individuals without a known deficiency;
- exceptions are vitamin $_{D3}$ (supplementation as recommended for the general population), folic acid (supplementation at 400 µg in pregnant and lactating women) and vitamin B_{12} in individuals on long-term metformin treatment who have a confirmed deficiency;
- multivitamin supplementation might be necessary in elderly, vegetarian or vegan patients and in those on very low calorie diets.

5. Alcohol:
- alcohol consumption by individuals with diabetes is not recommended;
- patients with diabetes should be informed that alcohol inhibits the release of glucose from the liver, therefore its consumption (especially without a meal) can induce hypoglycaemia;
- consumptions of pure ethyl alcohol (by volume) of not more than 20 g/day per women and 30 g/day for men is allowed.

Alcohol should not be consumed by people with dyslipidaemia (hypertriglyceridaemia), neuropathy and a history of pancreatitis.

6. Table salt:
- the amount of salt from all sources (products and salting the meals) should not exceed 5 g per day (2300 mg of sodium per day);
- in justified cases, people with sodium-sensitive hypertension are advised to restrict their salt intake more, following the principles of the DASH diet; however, data on reducing sodium intake below 1500 mg/day in people with diabetes are inconclusive;
- recommendations for individuals with diabetes in special situations (e.g. pregnant, in children and adolescents, patients with advanced nephropathy etc.) were included in the relevant chapters. Specific and practical advice regarding dietary treatment of diabetes were included in Recommendations of Polish Society of Dietetics (www. ptd.org.pl).

Physical exercise

Physical exercise – due to its multidirectional benefits – is an integral part of the correct, comprehensive management of diabetes. Physical exercise has a beneficial effect on insulin sensitivity, glycaemic control, lipid profile and contributes to weight reduction; it also has a beneficial effect on mood, even in depressed individuals.

1. Principles of physical exercise:
- initial recommendations regarding physical exercises should be moderated, depended on patient's ability to exercise;
- in order to achieve optimal result, physical should be regular, made every 2–3 days, ideally every day;
- when starting intensive physical activity, it is recommended to do an introductory exercise lasting 5–10 minutes, followed by a calming exercise at the end;
- physical exercise can increase the risk of severe or delayed hypoglycaemia;
- alcohol can increase the risk of hypoglycaemia after exercise;
- attention should be paid to preventing dehydration in high ambient temperature conditions;
- it is important to remember the risk of foot damage during exercise (especially with coexisting peripheral neuropathy and lower pain threshold), and the need for foot care and comfortable footwear.

2. Intensity of physical exercises is set by a doctor on the basis of the whole clinical picture

A suitable form of exercise for people with diabetes, with coexisting overweight/obesity, at any age is *Nordic walking*.

The most appropriate form of exercise in people with type 2 diabetes aged over 65 years of age and/or overweight is brisk (up to breathless) walk 3–5 times a week (approx. 150 minutes per week).

Individuals without significant contraindications, especially from lower age groups, should be encouraged to higher physical activity, including sport. Such individuals require an additional education on glycaemic effect caused by different types of physical activity (e.g. aerobic, resistance, interval training).

Continuous glucose monitoring systems and flash systems, used both in real time and to retrospectively assess the effects of exercise and therapeutic interventions on blood glucose, are excellent tools to facilitate peri-exercise glycaemic control.

Dedicated apps can also facilitate peri-exercise glycaemic control and, as with apps used to

optimise peri-exercise glycaemic control, their selection should be based primarily on the indications and recommendations of leading diabetes associations.

A simple to implement, yet effective recommendation is that adults, especially those with type 2 diabetes, limit the time spent sitting without breaks. Glycaemic gains can be made by avoiding sitting without breaks for longer than 30 minutes.

3. Risk regarding physical activity in individuals with diabetes.

Without some preventive measures, physical activity may result in hypo, or, less likely, hyperglycaemia and metabolic decompensation. The principles of peri-exercise management to avoid extreme glycaemic values are presented in Chapter 7.

Forced exertion may have an adverse effect on the patient's general condition in the specific clinical situations listed below:

- proliferative diabetic retinopathy – risk of haemorrhage into the vitreous, retinal detachment;
- Diabetic nephropathy – increased albumin excretion and proteinuria;
- autonomic neuropathy – presence of orthostatic hypotonia;
- risk of myocardial ischaemia.

4. Physical exercise during COVID-19 pandemic

It should be emphasised that individuals with diabetes should maintain the recommended level of physical activity despite the epidemiological situation. In the case of epidemiologically imposed restrictions on mobility or the use of sports facilities, efforts should be made to replace existing forms of physical activity with those that can be carried out despite existing restrictions, for example at home. As this may involve a change in the nature of the exercise and thus its glycaemic effects, as well as the precautions to be taken, any such situation requires consultation with the treating doctor

Fight against smoking

For any current or past smoker, it is important to establish:

- age at starting smoking;
- duration of smoking;
- number of smoked cigarettes;
- possible attempts on quitting and their duration;
- time at which the individual with diabetes has quit smoking tobacco.

Consultancy:

- raising awareness of the risks of smoking and the use of e-cigarettes among people with diabetes who have not previously smoked;
- encouraging quitting smoking and using e-cigarettes completely;
- supporting the individual with diabetes in their decision to stop smoking;
- psychological and, if needed, pharmacological support;
- discussion on smoking at each medical appointment;
- a written note in the medical records if the person with diabetes refuses to stop smoking.

Sleeping

Proper sleep hygiene is an important part of healthy lifestyle. In patients with diabetes, sleep length/quality may be impaired due to the pathophysiology of the disease, behavioural factors, factors related to the treatment used. On the other hand, poor sleep quality and inadequate sleep duration can lead to a worsening of metabolic control. Sleep duration/quality should be an important part of diabetes management, e.g. guidance on timing and quality of the last meal, self-monitoring of blood glucose (with appropriate setting of alarms in patients using CGM), avoidance of factors leading to hyper/hypoglycaemia, preference for treatment that ensures stabilisation and optimisation of nighttime blood glucose.

REFERENCES

1. Bell KJ, Smart CE, Steil GM, et al. Impact of fat, protein, and glycemic index on postprandial glucose control in type 1 diabetes: implications for intensive diabetes management in the continuous glucose monitoring era. Diabetes Care 2015; 38: 1.
2. Evert AB, Dennison M, Gardner CD, et al. Nutrition therapy for adults with diabetes or prediabetes: a consensus report. Diabetes Care 2019; 42:731–754.
3. Fu S, Li L, Deng S, Zan L, Liu Z. Effectiveness of advanced carbohydrate counting in type 1 diabetes mellitus: a systematic review and meta-analysis. Sci Rep 2016; 14; 6: 37067.
4. Fleming GA, Petrie JR, Bergenstal RM, et al. Diabetes digital app technology: benefits, challenges, and recommendations. A consensus report by the European Association for the Study of Diabetes (EASD) and the American Diabetes Association (ADA) Diabetes Technology Working Group. Diabetologia 2020; 63: 229–241
5. Franz MJ, Boucher JL, Rutten-Ramos S, VanWormer JJ. Lifestyleweight-loss intervention outcomes in overweight

and obese adults with type 2 diabetes: a systematic review and meta-analysis of randomized clinical trials. J Acad Nutr Diet 2015; 115: 1447–1463.
6. Greenwood DA, Gee PM, Fatkin KJ, Peeples M. A systematic review of reviews evaluating technology-enabled diabetes self-management education and support. J Diabetes Sci Technol 2017; 11: 1015–1027.
7. Hallberg SJ, Jake ED, Kushner A, Athinarayanan SJ. Improving the scientific rigour of nutritional recommendations for adults with type 2 diabetes: a comprehensive review of the American Diabetes Association guideline-recommended eating patterns. Diabetes Obes Metab 2019; 21: 1769–1779.
8. Hamdy O, Mottalib A, Morsi A, et al. Longterm effect of intensive lifestyle intervention on cardiovascular risk factors in patients with diabetes in real-world clinical practice: a5-yearlongitudinalstudy. BMJ Open Diabetes Res Care 2017; 5: e000259.
9. Klupa T, Benbenek-Klupa T, Matejko B, Mrozinska S, Malecki MT. The impact of a pure protein load on the glucose levels in type 1 diabetes patients treated with insulin pumps. Int J Endocrinol 2015; 2015: 216918.
10. Lean ME, Leslie WS, Barnes AC, et al. Primary care-led weight management for remission of type 2 diabetes (DiRECT): an open-label, cluster-randomised trial. Lancet 2018; 391: 541–551.
11. Lewgood J, Oliveira B, Korzepa M, et al. Efficacy of dietary and supplementation interventions for individuals with type 2 diabetes. Nutrients 2021; 13: 2378.
12. Matejko B, Gawrecki A, Wróbel M, et al. Physiological characteristics of type 1 diabetes patients during high mountain trekking. J Diabetes Res 2020: 8068710.
13. Papamichoua D, Panagiotakosb DB, Itsiopoulosa C. Dietary patterns and management of type 2 diabetes: a systematic review of randomised clinical trials. Nutriton Metabol Cardiovasc Disesases 2019; 29: 531–543.
14. Pawlak R. Vegetarian diets in the prevention and management of diabetes and its complications. Diabetes Spectr 2017; 30: 82–88.
15. Riddell MC, Gallen IW, Smart CE, et al. Exercise management in type 1 diabetes: a consensus statement. Exercise management in type 1 diabetes: a consensus statement. Lancet Diabetes Endocrinol 2017; 5: 377–390.
16. Schwingshackl L, Chaimani A,Hoffmann G, et al. A network meta-analysis on the comparative efficacy of different dietary approaches on glycaemic control in patients with type 2 diabetes mellitus. Eur J Epidemiol 2018; 33: 157–170.
17. Scientific Advisory Committee on Nutrition (SACN). Lower carbohydrate diets for adults with type 2 diabetes. May 2021. Available: www.gov.uk/government/groups/scientific-advisory-committee-on-nutrition.
18. Shapira N. The metabolic concept of meal sequence vs. satiety: glycemic and oxidative responses with reference to inflammation risk, protective principles and mediterranean diet. Nutrients 2019; 11: 2373.
19. Shukla AP, Andono J, Touhamy SH, et al. Carbohydrate-last meal pattern lowers postprandial glucose and insulin excursions in type 2 diabetes. BMJ Open Diab Res Care 2017: 5:e000440.
20. Thorsen IK, Johansen MY, Pilmark NS, et al. The effect of frequency of activity interruptions in prolonged sitting on postprandial glucose metabolism: a randomized crossover trial. Metabolism 2019; 96: 1–7.
21. The Members of The Joslin Clinical Oversight Committee. evidence-based diabetes management. Am J Manag Care 2018; 4: SP204-SP262.
22. Williams PG. The benefits of breakfast cereal consumption: a systematic review of the evidence base. Adv Nutr 2014; 5: 636S–673S.

7. Principles of undertaking physical exertion and sports activity by diabetics

Key recommendations
· Patients with type 1 diabetes without established clinically significant chronic complications of diabetes can undertake any type of exercise, including maximum intensity exercise.[**E**]
· Aerobic exercise performed until breathlessness occurs is safe and can be recommended to all people with diabetes without contraindications. [**B**]
· Patients with type 2 diabetes are advised to include elements of resistance exercise alongside aerobic exercise. [**B**]
· Severe hypoglycaemia is a contraindication to exercise – patients should avoid it for 24 hours. [**E**]
· Late hypoglycaemia can occur up to 24 hours after exercise. [**C**]
· Proliferative retinopathy is a contraindication to exercise until retinal image stabilisation is achieved. [**E**]
· Hyperglycaemia > 250 mg/dl without established ketosis and/or ketonuria is not a contraindication to exercise, provided the patient feels well and the cause of the hyperglycaemia is known. [**E**]
· The rules for exertion in competitive sports and during competitions are very different from amateur sports and require individual solutions for each patient. [**E**]

I. Recommended duration and intensity of exercise

The diabetologist should determine whether a diabetic can undertake physical activity based on the following: an assessment of the degree of physical activity of the diabetic patient (type, time, intensity of exercise), possible contraindications, the expectations of the diabetic patient, the patient's knowledge and skills in the prevention of hypoglycaemia, previous training. For people with type 2 diabetes aged > 65 years and/or overweight, as well as for patients after a cardiovascular incident and with cardiovascular disease, heart rate monitoring and assessment of exercise intensity using the Borg scale is recommended. Heart rate and exercise intensity ranges can be determined during an electrocardiographic exercise test. In this patient group, aerobic exercise (up to the onset of breathlessness) is safe and should be recommended for at least 150 min. a week. Obese people are advised to do 200–300 min of exercise per week, leading to an energy deficit of 500–750 kcal per day. Younger diabetic patients without significant contraindications are recommended to undertake daily intensive physical exercise, including actively doing sports.

II. Contraindications to physical exercise

Contraindications to recreational sporting activities are defined in Chapter 6 of the Recommendations of the Diabetes Poland. Decisions by the diabetologist may require consultation with other specialists, including an ophthalmologist, cardiologist, nephrologist and neurologist.

Contraindications to participation in training and sports competitions are outlined in Appendix No. 7 to the Recommendations of the Diabetes Poland.

III. Self-monitoring of blood glucose during exercise

Self-monitoring of blood glucose is recommended in patients whose treatment model is associated with a risk of hypoglycaemia. Blood glucose level should be measured with a glucometer up to 15 min before exercise and every 60 min throughout its course, or less frequently if CGM or isCGM/FGM is used. Optimal use of CGM requires individual programming of higher hypoglycaemia alert thresholds and consideration of glycaemic trends. Informing other participants of exercise sessions about one's diabetes is a vital aid to self-monitoring of blood glucose.

IV. Hypoglycaemia and hyperglycaemia in relation to exercise

Figure 7.1. shows glycaemic changes during exercise

Severe hypoglycaemia is a contraindication to exercise – patients should avoid it for 24 hours.

In the event of an alert indicating hypoglycaemia of ≤ 70mg/dl, simple carbohydrates should be consumed, preferably in the form of liquid, and exercise can be continued once symptoms of hypoglycaemia have subsided.

In the event of severe hypoglycaemia in patients with type 1 diabetes, the effect of glucagon after intense exercise may be weaker, however, it should always be administered nonetheless.

Late hypoglycaemia can occur up to 24 hours after exercise and is more likely to occur in untrained individuals and those who exercise in an unsystematic manner. It is this patient group in particular that ought to use nocturnal hypoglycaemia prevention measures.

Anaerobic exercise can cause hyperglycaemia, the correction of which with rapid-acting insulin should be undertaken with care due to the risk of hypoglycaemia several hours after exercise.

If there occurs hyperglycaemia of > 250 mg/dl, and in addition, ketonuria and/or ketosis of ≥1.5 mmol/l, exercise is contraindicated.

If hyperglycaemia > 250 mg/dl is not accompanied by ketonuria and/or ketosis and/or the cause of the hyperglycaemia is known, patients may undertake light to moderate exercise.

V. Principles of physical exercise for type 2 diabetes patients not requiring insulin treatment

People with diabetes who do not use insulin or sulphonylurea derivatives have a very low risk of hypoglycaemia. Glycemia of < 100 mg/dl does not require additional carbohydrate intake. Self-monitoring of blood glucose in relation to exercise should only be carried out periodically.

Systematic physical activity improves insulin sensitivity and thus increases the chances of delaying the commencement of insulin therapy. A vital addition to aerobic training is also the inclusion of resistance exercises. It is recommended to put a load on large muscle groups 2–3 times a week, with 8–12 repetitions.

VI. Principles of physical exercise for people undergoing insulin treatment

Physical activity undertaken up to 2 hours after the administration of a rapid-acting insulin analogue requires a reduction in insulin dose in cases where the physical activity lasts at least 30 min.

A reduction in the bolus can range from 25 to 75% and depends on the time and intensity of exercise.

Physical exertion requires the consumption of an additional portion of carbohydrates in the following quantities:

- 1.0–1.5 g/kg b.w./hour of vigorous exercise during the maximum activity of an unreduced insulin bolus,
- 0.2–0.5 g/kg b.w./hour of vigorous exercise during the maximum activity of a reduced insulin bolus or one administered more than 2 hours after the start of exercise.

It is recommended that insulin pumps never be disconnected during exercise for more than 3 hours. The condition for disconnecting the insulin pump is active insulin, the amount of which should be monitored using a bolus calculator.

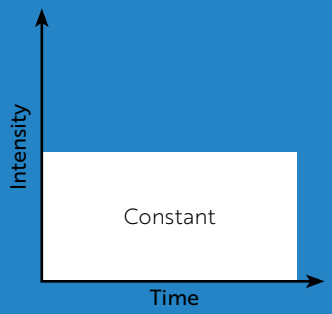
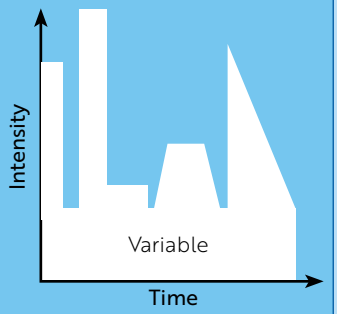
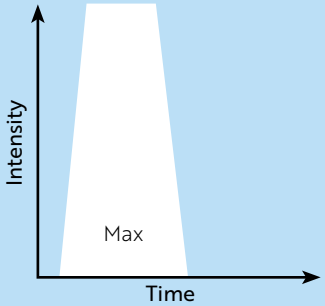
Type of exercise	**Aerobic** Examples: walking, nordic walking, slow cycling, jogging	**Mixed (aerobic-anaerobic)** Examples: team games, more rapid running, swimming, interval cycling	**Anaerobic** Examples: sprint, strength training with maximum load
Intensity			
Heart rate range	< 55 (60)% HR_{max}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

Figure 7.1. Types of exercise and their effect on glycaemic change

A reduction in basal insulin is particularly necessary for prolonged endurance exercise. The factors that must be taken into account include not only the type of exercise but also, in the case of treatment with injectors, the type of basal insulin preparation used, i.e. NPH/long-acting insulin analogue/ultra-long-acting insulin analogue.

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

VII. Principles of physical exercise for pregnant women with hyperglycaemia

It is recommended that all women with hyperglycaemia in pregnancy and postpartum, without medical contraindication, undertake physical exercise during this time. Moderate physical activity contributes to reducing the rates of gestational diabetes mellitus, gestational hypertension, preterm births and caesarean sections.

Aerobic exercise of moderate intensity should be performed for at least 150 minutes a week (3–4 times a week – exercise time 30–60 minutes) at an intensity of less than 60–80% of the maximum heart rate for the mother's age, usually not exceeding 140 beats/minute. Static aerobic and muscle strengthening exercises may also be undertaken. Adding stretching exercises can also be beneficial.

Preferred exercise types include walking, riding stationary bikes, dancing, water aerobics, stretching exercises, and lifting small weights. Lifestyle changes and physical exercise are essential elements in the management of gestational diabetes mellitus (GDM) and may be sufficient therapeutic management for many women.

In insulin-treated patients with pre-pregnancy diabetes mellitus (PGDM), exercise requires a reduction in basal insulin infusion and/or insulin boluses, taking into account the pre-pregnancy principles.

Undertaking additional physical exertion beyond daily activity requires the patient to consult a gynaecologist.

REFERENCES:

1. Berghella V, Saccone G. Exercise in pregnancy! Am J Obstet Gynecol 2017; 216: 335–337.
2. Jelleyman C, Yates T, O'Donovan G, et al. The effects of high-intensity interval training on glucose regulation and insulin resistance: a metaanalysis. Obes Rev 2015; 16: 942–961.
3. Moser O, Riddell MC, Eckstein ML, et al. Glucose management for exercise using continuous glucose monitoring (CGM) and intermittently scanned CGM (isCGM) systems in type 1 diabetes: position statement of the European Association for the Study of Diabetes (EASD) and of the International Society for Pediatric and Adolescent Diabetes (ISPAD) endorsed by JDRF and supported by the American Diabetes Association (ADA). Diabetol 2020; 63: 2501–2520.
4. Ostman C, Jewiss D, King N, Smart NA. Clinical outcomes to exercise training in type 1 diabetes: a systematic review and meta-analysis. Diabetes Res Clin Pract 2018; 139: 380–391.
5. Riddell MC, Gallen IW, Smart CE, et al. Exercise management in type 1 diabetes: a consensus statement. Lancet Diabetes Endocrinol 2017; 5: 377–396.
6. Riddell MC, Scott SN, Fournier PA, et al. The competitive athlete with type 1 diabetes. Diabetol 2020; 63: 1475–1490.
7. Sluik D, Buijsse B, Muckelbauer R, et al. Physical activity and mortality in individuals with diabetes mellitus: a prospective study and meta-analysis. Arch Intern Med 2012; 172: 1285–1295.
8. Tikkanen-Dolenc H, Wad´en J, Forsblom C, et al.; Finn-Diane Study Group. Physical activity reduces risk of premature mortality in patients with type 1 diabetes with and without kidney disease. Diabetes Care 2017; 40: 1727–1732.
9. Stanford KI, Goodyear LJ. Exercise and type 2 diabetes: molecular mechanisms regulating glucose uptake in skeletal muscle. Adv Physiol Educ 2014; 38: 308–314.
10. WHO guidelines on physical activity and sedentary behaviour. Available: https://apps.who.int/iris/bitstream/handle/10665/336656/9789240015128-eng.pdf.

8. Psychological management of diabetes

Key recommendations
· The mental state of a person diagnosed with diabetes should be assessed at the beginning of diabetes treatment and during each doctor's appointment afterwards. [**B**]
· Depression often occurs alongside diabetes and significantly increases the risk of developing complications. [**A**]
· People diagnosed with diabetes should be assessed for anxiety symptoms, addiction, eating disorders and cognitive impairment. Such conditions can significantly impair adaptation to this disease. [**B**]
· Psychological and social care should be combined with an approach focused on cooperation with the patient and accessible to all diabetics in order to optimise treatment outcomes and the quality of life. [**A**]

The mental state (mood) of a person with diabetes affects almost all aspects of their treatment. Poor adherence to medical recommendations is frequently associated with psychological issues that require diagnosis and appropriate psychotherapeutic intervention. For this reason, education consisting in simply providing information on the prescribed treatment and the recommended course of action is not very effective. The mental state of a person diagnosed with diabetes should be assessed at the beginning of diabetes treatment and during each doctor's appointment afterwards. It is advisable to use properly prepared questionnaires and tests for this purpose.

I. Psychological support for people diagnosed with diabetes should include:

- an appropriate method of communicating with the patient;
- regular checks (monitoring) of the patient's mental state and their way of complying with medical recommendations, as well as psychological interventions.

II. The individualised approach to patients with diabetes aims to:

- take into account the psychosocial situation of the diabetic person and establish the course of treatment that, in the patient's opinion, is feasible in terms of their current life situation (which is important in terms of establishing an optimal and feasible treatment strategy):
- develop motivation for optimal behaviour;
- avoid scaring the diabetic about the consequences of a failure to follow medical advice correctly, which, in most cases, is ineffective and harmful;
- use an optimal method of education based on the psychological diagnosis.

III. In medical practice, the mental state assessment (psychological diagnosis) in a person diagnosed with diabetes includes:

1. Social and psychological (life) situation.
2. Quality of life of a person with diabetes.
3. Attitudes, beliefs, worries and responsibilities associated with diabetes (unfounded fears and worries can impair the ability to cope with the disease). Ask the following questions:

To what extent are you worried about the future and the possibility of developing serious complications: (0) it is not a problem; (1) it is a slight problem; (2) it is a moderate problem; (3) it is a fairly serious problem; (4) it is a serious problem. Three points or more indicate a significant risk of developing psychosocial problems.

4. The sense of having an influence over the course of the disease (the lack of an adequate sense of having an influence over the course of diabetes results in the use of coping methods characterised by the avoidance of thinking about the disease and/or suppression of emotions triggered by its existence).
5. The assessment of the coping method (there is a decrease in the tendency to search for an optimal coping strategy and a solution-oriented method caused by the disease).
6. The assessment of symptoms of depression (depression often occurs together with diabetes and significantly increases the risk of developing diabetic complications).

A. Use freely available online depression screening tools: the WHO-5 well-being index (www.who-5.org) – a score < 13 is an indication for screening for depression and a score ≤ 7 indicates a high risk of depression) or the Patient Health Questionnaire 9 (PHQ-9, www.phqscreeners.com/overview.aspx) – a score < 5 indicates a normal

state, 5–9 indicates mild depression, 10–14 indicates moderate depression, 15–19 indicates moderately severe depression and 20–27 indicates severe depression. In the Polish translation, a score > 12 indicates a high risk of a depressive episode (sensitivity 82%, specificity 89%).

or

B. Ask two questions:

Have you often felt depressed or hopeless in the past month?

Have you often lost interest in doing certain things or lost enjoyment in doing them in the past month?

A positive answer to one of these questions indicates a 97% sensitivity and a 67% specificity in diagnosing depression. In such a case, the diabetic person should be referred for a psychiatric consultation.

7. The assessment of symptoms of anxiety, addiction, eating disorders, cognitive impairment (they can significantly hinder the adaptation to diabetes).

IV. Psychological interventions in a person with diabetes include:

1. Developing a sense of having an influence over the course of the disease by:
- providing information concerning the disease and its treatment that is understandable to the diabetic patient,
- jointly formulating goals and treatment plans that are feasible in the patient's opinion,
- gradually shifting to an optimal level of adherence (small steps strategy),
- offering the possibility of assistance in the event of a failure to carry out predetermined plans (it aims to convince the patient that the doctor will help them identify the cause of the failure and will not have a negative attitude towards them);
2. Developing and maintaining a solution-oriented method of coping with the problems associated with the disease.

V. Psychiatric consultation

The presence of clinical depression (depressive episode, dysthymia) and other mental disorders requires **psychiatric consultation**. In the case of adaptation disorders related to the inability to adjust to the disease, psychotherapeutic interventions can be undertaken by the GP or specialist. In more difficult cases, it is necessary to reach for the help of a clinical psychologist.

VI. Teamwork

An important condition of successful therapy is a coherent attitude of the entire treatment team. It is essential that team members communicate effectively. In diabetes clinics, psychologists are essential members of the specialist treatment teams.

REFERENCES

1. Anderson RJ, Freedland KE, Clouse RE, Lustman PJ. The prevalence of comorbid depression in adults with diabetes: a meta-analysis. Diabetes Care 2001; 24: 1069–1078.
2. Anderson RJ, Grigsby AB, Freedland KE,, et al. Anxiety and poor glycemic control: a meta-analytic review of the literature. Int J Psych Med 2002; 32: 235–247.
3. Aquino JA, Baldoni NR, Flôr CR, et al. Effectiveness of individual strategies for the empowerment of patients with diabetes mellitus: a systematic review with meta-analysis. Prim Care Diabetes 2018; 12: 97–110.
4. Baldoni NR, Aquino JA, Sanches-Giraud C, et al. Collective empowerment strategies for patients with Diabetes Mellitus: a systematic review and meta-analysis. Prim Care Diabetes 2017; 11: 201–211.
5. Kokoszka A, Jastrzębski A, Obrębski M. Ocena psychometrycznych właściwości polskiej wersji Kwestionariusza Zdrowia Pacjenta-9 dla osób dorosłych. Psychiatria 2016; 13: 187–193.
6. Kovacs Burns K, Nicolucci A, Holt RIG, et al. Diabetes Attitudes, Wishes and Needs second study (DAWN2): cross-national benchmarking indicators for family members living with people with diabetes. Diabet Med 2013; 30: 778–788.
7. Lloyd CE, Nouwen A, Sartorius N, et al. Prevalence and correlates of depressive disorders in people with type 2 diabetes: results from the International Prevalence and Treatment of Diabetes and Depression (INTERPRET-DD) study, a collaborative study carried out in 14 countries. Diabet Med 2018; 35: 760–769.
8. Nouwen A, Adriaanse M, van Dam K, et al. Longitudinal associations between depression and diabetes complications: a systematic review and meta-analysis. Diabet Med 2019; 36: 1562–1572.
9. Young-Hyman D, de Groot M, Hill-Briggs F, et al. Psychosocial care for people with diabetes: a position statement of the American Diabetes Association. Diabetes Care 2016; 39: 2126–2140.

9. Therapeutic education

Prepared in collaboration with mgr Alicja Szewczyk, the national consultant in diabetes nursing

Key recommendations
· Education is the basis of effective care for patients with diabetes and successful prevention of this disease. [**A**]
· Every person diagnosed with diabetes and their carers should participate in diabetes education to acquire knowledge and skills related to diabetes self-care, as well as support the implementation and maintenance of regular self-monitoring. [**B**]
· The main tasks of diabetes education include effective self-care, improvement of metabolic control and quality of life, and support for the diabetic person/their carers. The effectiveness of individual and group education as well as its programmes should be systematically tracked, evaluated and methodically improved. [**B**]
· Diabetes education should focus on the person diagnosed with diabetes and their individual needs. [**B**]
· A joint and uniform view of the diabetes multi-speciality team positively influences metabolic control and the psychological aspect of treatment. [**B**]
· All patients with diabetes and their carers should have access to institutionalised education. [**B**]

I. General recommendations

1. Education should be provided to people at higher risk of diabetes, with pre-diabetes and those being treated for diabetes, as well as their carers and family members. Education is a constant, integral and essential component of the therapeutic management of diabetes provided during each doctor's appointment and nursing consultation. It should be delivered in a structured manner, including education at the beginning of the treatment and followed by re-education based on a systematic assessment of the training needs of the diabetic person or, at their request, taking into account advances in diabetology as well as organisational and social improvements.
2. The education programme for people diagnosed with diabetes should be developed with the participation of the patient and the treatment team (a doctor – team leader, nurse, diabetes educator, dietician, psychologist), as well as be closely related to and coordinated with the prescribed diabetes treatment. A person with diabetes who exercises self-care is an active member of the treatment team.
3. Education of a diabetic person should aim to support them in self-management of their disease (*self-management training*) and lifestyle modification resulting from the recommended diet and physical activity. In type 2 diabetes, education focused on combating obesity is particularly important. The primary goal is to avoid severe complications of diabetes: hypoglycaemia and hyperglycaemia.
4. The effectiveness of self-management programmes has been documented. They actively engage individuals participating in the learning process, adapting the content and form to their individual situation and personal experiences, as well as motivate them to set personal behavioural treatment goals in consultation with their doctor.
5. Nursing, dietetic and psychological management including the establishment of basic standards, guidelines, organisational and technical conditions for the provision of diabetes therapeutic education (e.g. to a nurse/midwife working as a diabetes educator) should be provided by the employer.

II. Detailed recommendations

1. Strategies for integrating therapeutic and self-care management of diabetes into a health-promoting daily lifestyle are recommended. They focus on *empowering* people diagnosed with diabetes and consist in helping them discover and apply innate and acquired abilities to be responsible for their own lives.
2. It is recommended that individualised education and group education programmes (groups of 6–10 persons) be conducted concurrently. Education should be provided by appropriately trained professionals (doctors, diabetes educators, nurses, dieticians). It should also involve members of the treatment team representing different health professions. There is a need for education programmes intended for people diagnosed with diabetes and re-education programmes for those who have been

suffering from this disease for a long time. It is necessary to offer education to families and carers, especially of children and elderly people with diabetes, as well as their guardians.

3. Education should include modern methods of special pedagogy for youth and elderly people. The use of electronic communication, text messages, remote education, webinars as well as individual and group teleconferences using reliable websites and mobile applications is recommended. Mobile apps used to educate on diet, self-monitoring, the meaning of blood glucose levels, correction of insulin doses and adaptation to physical activity are of particular importance. The aim of the treatment team is to help the patient choose the right mobile app. Advantages of online therapeutic education on diabetes include high accessibility, practical and individual interactivity, flexible schedule and the possibility to repeat/replay certain information by patients with diabetes. However, the online method also has disadvantages, such as the lack of personal contact with the educator and other people with diabetes included in the group. This approach may only be regarded as a supplementary method. The knowledge of a diabetic patient should be checked in person. Topics, methods and nature of the recipients of educational information require particular clarity of teaching.
4. The education programme should be based on the establishment of individual treatment goals, taking into account the difficulties and problems specific to a given individual or group of patients. It should increase the motivation of the diabetic patient to follow treatment recommendations, as knowledge alone is not sufficient to optimally manage diabetes.
5. Diabetes education for children and adolescents should be tailored to age, cognitive abilities and the extent of participation required in diabetes self-management.
6. Therapeutic education should also be offered to elderly people. Objectives and training methods should be adapted to the intellectual and physical abilities of older individuals (independent people, patients functionally dependent on their carers, people at the end of life). Carers of diabetic patients should be educated as well. The blood glucose monitoring plan should be set at a minimum level. The fundamental goals of education of elderly patients and their families should include the reduction of the risk of severe complications of diabetes: hypoglycaemia, acute hyperglycaemia and the risk of nonketotic diabetic coma in daily geriatric care.

III. The framework education programme must cover

1. Support in terms of accepting the illness, strengthening of adequate motivation for treatment and self-determination skills (*empowerment*).
2. Establishment and assessment of individual therapeutic goals, taking into account the course of the disease, prognosis, recommended treatment as well as the personal and social living situation of the diabetic patient.
3. Basic information about the disease and its treatment (causes, clinical characteristics, course and prognosis, effects of antihyperglycaemic drugs, insulin activity profiles, adjustment of insulin doses), acquisition of observation skills (self-monitoring) during treatment with oral antihyperglycaemic drugs.
4. Training in techniques for systematic *self-monitoring* of blood glucose levels using a blood glucose meter and/or continuous glucose monitoring (CGM) systems, maintenance of a traditional or virtual/electronic self-monitoring journal, determination of the level of ketones in blood and urine, measurement of blood pressure, etc., as well as the management of emergencies.
5. Lessons on methods of subcutaneous administration of insulin and other drugs: sites of administration, needle sizes, factors affecting drug absorption, prevention of post-injection complications).
6. For individuals whose treatment is based on the use of a personal insulin pump: advantages, disadvantages, indications and contraindications to this therapy, types and selection of devices, principles of programming and modifying the basal infusion rate, temporal change of the basal infusion rate, use of simple, prolonged and compound boluses, use of bolus and active insulin calculator functions, infusion set insertion schemes (principles of selection of sets and insertion sites), management of a failure of the personal insulin pump – principles of re-adjustment to therapy with pen injectors and management in case of initial symptoms of ketoacidosis or disconnection of the insulin pump in certain situations (e.g. sport), technical operation of the insulin pump,

self-reading of the pump memory and its interpretation, calculation of carbohydrates and the content of protein and fat in the diet with provision of an appropriate dosage of insulin during meals, maintenance of an electronic self-monitoring journal (a programme, cloud, smartphone application).

7. Information on the correct application of independent and pump-integrated continuous glucose monitoring (CGM) systems, use of their functions, setting of alarms for values indicating hypo- and hyperglycaemia, the dynamics of trend changes as well as the self-reading and interpretation of CGM results for ongoing therapy.
8. Information concerning the diagnosis and treatment of acute and chronic complications as well as their risk factors and methods of prevention of diabetes-related complications and diseases.
9. Principles of healthy eating and its role in treatment (practical information on the macronutrient content of foods, their effect on the blood glucose level, as well as the energy value and content of meals, development of a nutritional plan that takes into account individual habits, needs and treatment strategies, etc.).
10. Information on the effects of physical activity on blood glucose levels (hypo-, hyperglycaemia, etc.) and mobilisation of people diagnosed with diabetes to start/maintain regular physical activity.
11. Instruction on how to deal with certain situations (travel, pregnancy planning and contraception, pregnancy, illness, risky behaviour).
12. Social rights of people diagnosed with diabetes (work, driving licence, social assistance, insurance, benefits related to rehabilitation, stay in health resorts, drug coverage, allowances).
13. Principles of the use of health care services (frequency of doctor's appointments, check-ups, transition from paediatric diabetes care to adult diabetes care), optimal adherence to medical recommendations.
14. Discussion on the importance of psychological problems (independent of diabetes, as well as, for example, burnout associated with diabetes, referred to as "diabetes distress", related to diabetes treatment and the possibility of using specialist care (psychologist/therapist/psychiatrist).
15. Discussion on the importance of preventive vaccination of a diabetic patient.

IV. Organisational recommendations

1. Initial education provided upon the diagnosis to a person with diabetes treated on the basis of a diet or a diet combined with oral antihyperglycaemic drugs should last at least 5 hours. Education of a patient receiving insulin should be at least 9-hour long, while that of a person treated with a personal insulin pump and glucose monitoring systems should last at least 15 hours and take place in an outpatient or inpatient setting, depending on the situation of the diabetic person and the capacity of the facility providing the care. Every person diagnosed with diabetes should undergo diabetes education immediately upon receiving the diagnosis and continue educating themselves in this regard afterwards. In subsequent years, the time spent on re-education must depend on the amount of knowledge the patient has acquired, the number of errors they have made, and the type of complications or associated diseases that may occur. Periodical (annual) checks of the patient's knowledge, which can be done in person or online, using electronic means of communication, are also recommended. Further checks and re-education should be carried out when new risk factors/complications arise.
2. For practical purposes, it may be advisable to organise a "school for diabetes education".
3. Education provided by doctors, nurses, diabetes educators and dieticians should be conducted concurrently with pharmacological treatment and take into account the aforementioned timeframes, which requires dedicated funding under a separately defined and contracted service.
4. Each education programme should take into account the principle of professional communication between the diabetologist and the patient. Its purpose is to gain trust, show empathy and motivate the patient to strictly adhere to medical recommendations.
5. A description of diabetes treatment, particularly therapeutic education procedures, should be enforced and available at the site where education is provided.

V. Standards of the facility providing education

1. Provision of education premises and equipment of the workstation with resources neces-

sary to carry out education at a level that enables diabetes education goals to be achieved.
2. Maintenance of records of the education process concerning the framework education programme and individual education plan, the person coordinating education in the facility and responsibilities of individual employees involved, as well as individual patient education sheets. **Periodic, preferably annual, checks of the patient's knowledge (*feedback*).**
3. Improvement of skills by means of regular updates of knowledge of individuals involved in education (participation in training, conferences).
4. Inclusion of assessment of the quality of education by patients and their carers, also in evaluation programmes (at least once a year).
5. Establishment of the manner in which educational decisions are consulted within the treatment team and ensuring of a constant flow of information about treatment goals and educational progress.
6. The employer must facilitate and create the conditions the conditions for induction, raising professional qualifications and self-training for members of the diabetes treatment team, including those employed as diabetes educators.

REFERENCES

1. Bansal V, Mottalib A, Pawar TK, et al. Inpatient diabetes management by specialized diabetes team versus primary service team in non-critical care units: impact on 30-day readmission rate and hospital cost. BMJ Open Diab Res Care 2018; 6: e000460.
2. Buysse H, Coremans P, Pouwer F, Ruige J. Sustainable improvement of HbA 1c and satisfaction with diabetes care after adding telemedicine in patients on adaptable insulin regimens: Results of the TeleDiabetes randomized controlled trial. Health Informatics J 2020; 26: 628–641.
3. Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: a systematic review of the effect on glycemic control. Patient Educ Couns 2016; 99: 926–943.
4. Cooke D, Bond R, Lawton J, et al. Structured type 1 diabetes education delivered within routine care: impact on glycemic control and diabetes-specific quality of life. Diabetes Care 2013; 36: 270–272.
5. Dickinson JK, Maryniuk MD. Building therapeutic relationships: choosing words that put people first. Clin Diabetes 2017; 35: 51–54.
6. Duncan I, Birkmeyer C, Coughlin S, et al. Assessing the value of diabetes education. Diabetes Educ 2009; 35: 752–760.
7. Dunning T. Diabetes Education, Wiley-Blachwell Ltd., Oxford 2013.
8. Greenwood DA, Gee PM, Fatkin KJ, Peeples M. A systematic review of reviews evaluating technology-enabled diabetes self-management education and support. J Diabetes Sci Technol 2017; 11: 1015–1027.
9. He X, Li J, Wang B, et al. Diabetes self-management education reduces risk of all-cause mortality in type 2 diabetes patients: a systematic review and meta-analysis. Endocrine 2017; 55: 712–773.
10. Heller SR, Gianfrancesco C, Taylor C, et al. What are the characteristics of the best type 1 diabetes patient education programmes (from diagnosis to long-term care), do they improve outcomes and what is required to make them more effective? Diabet Med 2020; 37: 4.
11. Improving Care and Promoting Health in Populations: Standards of Medical Care in Diabetes – 2021. Diabetes Care 2021; 44 (Supplement 1): S7–S14.
12. Phillip M, Bergenstal RM, Close KL, et al. The digital/virtual diabetes clinic: the future is now – recommendations from an international panel on diabetes digital technologies introduction. Diabetes Technol Ther 2021; 23: 146–154.
13. Pereira K, Phillips B, Johnson C, Vorderstrasse A. Internet delivered diabetes self-management education: a review. Diabetes Technol Ther 2015; 17: 55–63.
14. Rathbone AL, Prescott J. The use of mobile apps and sms messaging as physical and mental health interventions: systematic review. J Med Internet Res 2017; 19: e295.
15. American Association of Diabetes Educators. Role of the diabetes educator in inpatient diabetes management inpatient diabetes management. Diabetes Educ 2018; 44: 57–62.
16. Steinsbekk A, Rygg LŘ, Lisulo M, et al. Group based diabetes self-management education compared to routine treatment for people with type 2 diabetes mellitus. A systematic review with meta-analysis. BMC Health Serv Res 2012; 12: 213.
17. Szewczyk A, Tobiasz-Kałkun N, Stefanowicz-Bielska A, et al. Practical guidelines for nursing and midwifery diabetes care – 2020. A position of the Polish Federation for Education in Diabetology. Nurs 21st Century 2020; 19: 3.
18. Tatoń J. Kultura zawodu lekarza w XXI wieku. Wydawnictwo Tinta, Działdowo 2018.
19. Van Eikenhorst L, Taxis K, van Dijk L, de Gier H. Pharmacist-led self-management interventions to improve diabetes outcomes. A systematic literature review and meta-analysis. Front Pharmacol 2017; 8: 891.

10. General rules for managing patients with type 1 diabetes

Key recommendations
· Intensive functional insulin therapy using multiple subcutaneous insulin doses or continuous subcutaneous insulin infusion (CSII) via a personal insulin pump is the recommended treatment model. [**A**]
· A key element in treatment of type 1 diabetes is for the patient to acquire the ability to modify insulin doses depending on carbohydrate content in meals, initial blood sugar level and planned physical activity. Understanding the effect of protein and lipids on blood sugar level is also important for optimisation of insulin dosing. [**E**]
· In people with type 1 diabetes, insulin analogues are preferred due to lower risk of hypoglycaemia and increased quality of life. [**A**]
· For people who use continuous glucose monitoring (CGM) systems or scanning systems (isCGM/FGM), time in range should be a key parameter for assessment of compensation of diabetes; optimally, it should exceed 70%. [**E**]
· All therapeutic decisions concerning treatment of type 1 diabetes should be consulted with the patient and made only with the patient's approval**. [E]**

Treatment of type 1 diabetes

1. People with type 1 diabetes must be treated with insulin. Insulin therapy should be continued even during remission of the disease.
2. Intensive functional insulin therapy using multiple subcutaneous insulin doses or continuous subcutaneous insulin infusion (CSII) via a personal insulin pump is the recommended treatment model. A prerequisite for effective treatment is proper education (in accordance with the rules specified in chapter 8) to enable people with diabetes to modify insulin doses on their own based on systematic self-monitoring of blood sugar level using a glucose meter or other device registered for this purpose (in accordance with the rules specified in chapter 3). In people with type 1 diabetes, insulin analogues are preferred due to lower risk of hypoglycaemia and increased quality of life.
3. Optimisation of insulin doses is crucial in insulin therapy of type 1 diabetes. Prolonged administration of overphysiological quantities of insulin without diagnosing the cause of increased insulin requirements and making an attempt to act on that cause – except for justified cases (comorbidity, drugs which increase insulin requirements, stress) – may lead to adverse metabolic consequences and an excessive increase in body mass.
4. A key element in treatment of type 1 diabetes is for the patient to acquire the ability to modify insulin doses depending on carbohydrate content in meals, initial blood sugar level and planned physical activity. Understanding the effect of protein and lipids on blood sugar level is also important for optimisation of insulin dosing.
5. The use of continuous glucose monitoring (CGM) systems may facilitate optimisation of metabolic compensation, especially in patients with frequent episodes of hypoglycaemia, nocturnal hypoglycaemia, severe hypoglycaemia or significant variations in blood sugar level during the day. Combining CSII and CGM in devices which automatically stop insulin administration during hypoglycaemia or when the patient is in danger of hypoglycaemia (predictive insulin withholding) and in hybrid closed loop personal insulin pumps (which also normalise hyperglycaemia in an autonomous manner) is particularly effective.
6. Pumps based on open APS (Artificial Pancreas System) applications, known as DIY ("do-it-yourself") pumps, are devices whose principle of operation is similar to HCL pumps. Although such systems can help many people to significantly improve metabolic control, it should be noted that these are not certified systems and so the patient is responsible for their use and related risks.
7. Patients treated with semi-automatic pumps (predictive insulin withholding), HCL pumps or DIY systems require appropriately modified education taking into account the characteristics of these devices. One clinically important difference is the management of hypoglycaemia, where smaller amounts of glucose (5–15 g) are usually sufficient to normalise glycaemia.
8. The use of scanning systems (isCGM/FGM) can also reduce the risk of hypoglycaemia and increase the quality of life of a person with diabetes.

- Telemedicine is an important tool in optimisation of diabetes management. For all people with type 1 diabetes, the therapeutic team should, in consultation and cooperation with the patient, strive to develop a system which makes it possible to conduct effective remote medical consultations. Development of such a system should be based on patient education and encouragement to use appropriate technological solutions. Remote medical consultations for patients with type 1 diabetes can both constitute an element of constant diabetic care and be used e.g. during a state of epidemic.
- SGLT-2 inhibitors are drugs which, when combined with insulin therapy, can lead to improved blood sugar control and body mass reduction in type 1 diabetes. It should be noted, however, that only some drugs classified under this group have so far been registered for support treatment of type 1 diabetes. Their use may entail the risk of normoglycaemic ketoacidosis, especially when the daily insulin dose is significantly reduced.

Organisation of care for a patient with type 1 diabetes

1. From the moment type 1 diabetes is diagnosed and during subsequent course of the disease, a person with type 1 diabetes should be under the care of a specialist diabetologist. This ensures constant cooperation with the educational team (in accordance with the rules specified in chapter 5) and access to necessary consultations.
2. New cases of type 1 diabetes as well as acute complications of diabetes which are difficult to manage require hospitalisation in a reference unit.

Goals of type 1 diabetes treatment

1. The goal of type 1 diabetes treatment is good metabolic control, with maintaining of blood sugar level as close to normal as possible. The basic therapeutic goal is to achieve an HbA1c level < 7%. Striving for lower HbA1c levels (≤ 6.5%) is justified as long as it does not entail increased risk of hypoglycaemia or reduced quality of life for the person with diabetes.
2. Fulfilling treatment goals right from the onset may prevent acute and chronic complications and make it possible for the person to have a normal and active family, professional and social life.
3. For people who systematically use CGM and isCGM/FGM, the basic therapeutic goal is to achieve a high percentage (over 70%) of time spent in therapeutic goal range, understood as blood sugar level between 70 and 180 mg/dl. It should be noted that avoiding hypoglycaemia should be one of treatment priorities (maximum permissible time spent in values lower than 70 and 54 mg/dl is, respectively, 4% and 1%). Target parameters for people who use CGM and isCGM/FGM are summarised in Table 4.2.

Early diagnosis of chronic complications of diabetes

1. early diagnosis of complications of diabetes is possible via screening for nephropathy, retinopathy and diabetic neuropathy. The rules for performing such screening for people with type 1 diabetes are discussed in chapters 19, 20 and 21.
2. People with prolonged type 1 diabetes, especially if onset occurred at a young age, may experience, earlier compared to healthy population, macrovascular disease (diabetic macroangiopathy), manifesting itself as ischemic heart disease, cerebrovascular disease or lower extremity arterial disease. The rules for diagnosis and treatment of ischemic heart disease are discussed in chapter 17, while management of stroke and acute coronary syndrome is consistent with the rules presented in chapters 18 and 17.1.

Diagnosis and treatment of acute complications

A duly educated person with type 1 diabetes needs to know the rules for managing acute, moderate and mild hyper- and hypoglycaemia and should be able to handle such situations on his/her own. More severe conditions require medical attention, in accordance with the rules presented in chapters 15 and 16.

Specific situations in patients with type 1 diabetes

1. A person with type 1 diabetes, with proper metabolic compensation, treated using intensive insulin therapy, may undergo surgery under a "single day" system (small surgeries);
2. In a hospital setting, a patient with type 1 diabetes who has previously benefited effectively from advanced technology, such as CGM/FGM systems or personal insulin pumps, should be able to continue self-treatment based on

these systems if this is done under appropriate supervision and the patient's general condition allows it;

3. A well-educated type 1 diabetes patient who achieves satisfactory treatment effects prior to hospitalisation should be involved in therapeutic decisions regarding treatment in a hospital setting. In selected cases, patient can carry out this treatment on their own as long as they achieve their glycaemic therapeutic goals. Other rules for perioperative management of patients with type 1 diabetes are presented in chapter 26.
4. Type 1 diabetes is, more frequently compared to general population, accompanied by endocrinopathies, especially autoimmune diseases of the thyroid (Hashimoto's disease, Graves' disease) and adrenal cortex (Addison's disease) as well as coeliac disease, vitamin B_{12} deficiency anemia and collagenoses. These comorbidities can significantly worsen the course of type 1 diabetes.
5. The occurrence of diseases which complicate the course of diabetes may require hospitalisation in a specialised ward.
6. A person with type 1 diabetes may exhibit obesity with accompanying markers of insulin resistance. This increases the daily insulin requirements and impairs metabolic control. Diagnosis and management of such situation requires specialised diagnostics and treatment.
7. An increasingly frequent problem in young people with type 1 diabetes is eating disorders in the form of bulimia or anorexia as well as fear of hypoglycaemia. Diagnosis and treatment of these conditions require specialised psychiatric treatment with close cooperation of a diabetologist.
8. Some elderly patients with type 1 diabetes may require liberalisation of therapeutic targets; in this regard, biological rather than chronological age should be the main consideration. In elderly patients with type 1 diabetes who are in good biological condition, the use of treatment based on advanced technologies or the commencement of such treatment should not be forgone *a priori*.

A well-educated person with type 1 diabetes who is treated using intensive insulin therapy and exhibits correct metabolic compensation is capable of undertaking the same physical activity and achieve the same professional goals as people of similar age who do not have diabetes.

REFERENCES

1. Anderson SM, Buckingham BA, Breton MD, et al. Hybrid closed-loop control is safe and effective for people with type 1 diabetes who are at moderate to high risk for hypoglycemia. Diabetes Technol Ther 2019; 21: 356-363.
2. Battelino T, Danne T, Bergenstal RM, et al. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the international consensus on time in range. Diabetes Care 2019; 42: 1593–1603.
3. Bell KJ, Barclay AW, Petocz P, et al. Efficacy of carbohydrate counting in type 1 diabetes: a systematic review and meta-analysis. Lancet Diabetes Endocrinol 2014; 2: 133–140.
4. Bergenstal RM, Klonoff DC, Garg SK, et al. Threshold-based insulin-pump interruption for reduction of hypoglycemia. N Engl J Med 2013; 369: 224–232.
5. Bolinder J, Antuna R, Geelhoed-Duijvestijn P, et al. Novel glucose-sensing technology and hypoglycaemia in type 1 diabetes: a multicentre, non-masked, randomised controlled trial. Lancet 2016; 388: 2254–2263.
6. Breton MD, Patek SD, Lv D, et al. Continuous glucose monitoring and insulin informed advisory system with automated titration and dosing of insulin reduces glucose variability in type 1 diabetes mellitus. Diabetes Technol Ther 2018; 20: 531–540.
7. Cnop M, Klupa T, Tentolouris N, et al. Europe has to step up its efforts to produce innovative and safe diabetes technology. Diabetologia 2017; 60: 2532–2533.
8. Danne T, Cariou B, Banks P, et al. HbA1c and hypoglycemia reductions at 24 and 52 weeks with sotagliflozin in combination with insulin in adults with type 1 diabetes: the European inTandem2 study. Diabetes Care 2018; 41: 1981–1990.
9. Gawrecki A, Klupa T, Araszkiewicz A, et al. Utilization of do-it-yourself artificial pancreas systems in the management of patients with type 1 diabetes: a position statement of the Pump School Education Initiative by Diabetes Poland. Pol Arch Intern Med 2019; 129: 141–142.
10. Knox ECL, Quirk H, Glazebrook C, et al. Impact of technology-based interventions for children and young people with type 1 diabetes on key diabetes self-management behaviours and prerequisites: a systematic review. BMC Endocr Disord 2019; 19: 7.
11. Miller KM, Beck RW, Bergenstal RM, et al. Evidence of a strong association between frequency of self-monitoring of blood glucose and hemoglobin A1c levels in T1D Exchange clinic registry participants. Diabetes Care 2013; 36: 2009–2014.
12. Pinsker JE, Bartee A, Katz M, et al. Predictive low-glucose suspend necessitates less carbohydrate supplementation to rescue hypoglycemia: need to revisit current hypoglycemia treatment guidelines. Diabetes Technol Ther 2021; 23: 512–516.

13. Pratley RE, Kanapka LG, Rickels MR, et al. Effect of continuous glucose monitoring on hypoglycemia in older adults with type 1 diabetes: a randomized clinical trial. JAMA 2020; 323: 2397–2406.
14. Rawshani A, Sattar N, Franzén S, et al. Excess mortality and cardiovascular disease in young adults with type 1 diabetes in relation to age at onset: a nationwide, register-based cohort study. Lancet 2018; 392: 477–486.
15. Riddell MC, Gallen IW, Smart CE, et al. Exercise management in type 1 diabetes: a consensus statement. Lancet Diabetes Endocrinol 2017; 5: 377–390.
16. The diabetes control and complications trial/epidemiology of diabetes interventions and complications research group. Retinopathy and nephropathy in patients with type 1 diabetes four years after a trial of intensive therapy. N Engl J Med 2000; 342: 381–388.
17. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993; 329: 977–986.
18. Tauschmann M, Hovorka R. Technology in the management of type 1 diabetes mellitus – current status and future prospects. Nat Rev Endocrinol 2018; 14: 464–475.
19. Triolo TM, Armstrong TK, McFann K, et al. Additional autoimmune disease found in 33% of patients at type 1 diabetes onset. Diabetes Care 2011; 34: 1211–1121.

11. Oral antidiabetic drugs and GLP-1 receptor agonists in treatment of type 2 diabetes

Key recommendations
· Metformin should be the drug of first choice when commencing pharmacotherapy in type 2 diabetes, unless it is contraindicated or poorly tolerated. [**A**]
· The choice of further drugs should be individualised and consider their effect on the cardiovascular system, their effect on kidneys, their efficacy, adverse effects, effect on body mass, risk of hypoglycaemia, price and patient preferences. [**E**]
· If monotherapy in maximum recommended or tolerated doses becomes insufficient to achieve or maintain the target HbA_{1c} level, a second oral drug should be included, either a GLP-1 receptor agonist or basal insulin. This decision should not be postponed for more than 3–6 months. [**A**]
· In justified cases, such as documented atherosclerotic cardiovascular disease, systolic heart failure, chronic kidney disease or coexistence of multiple cardiovascular risk factors, decision to initiate combination therapy in freshly diagnosed diabetes should be considered. In such cases, drugs which reduce the risk of progression of these conditions (flozins or GLP-1 receptor agonists) should be used in addition to metformin. [**A**] Combination therapy in freshly diagnosed type 2 diabetes should be considered also in case of increased hyperglycaemia.
· When intensifying treatment for patients with atherosclerotic cardiovascular disease, systolic heart failure, chronic kidney disease or multiple cardiovascular risk factors, drugs with proven beneficial effects on the risk of progression of these conditions as well as total and cardiovascular mortality rate should be used first. In addition to metformin, this effect has been proven for some SGLT2 inhibitors and certain drugs classified as GLP-1 receptor agonists. [**A**]
· For patients with chronic kidney disease and systolic heart failure, flozins should be preferred, and if they are contraindicated, GLP-1 receptor agonists should be used. [**A**]
· For patients with atherosclerotic cardiovascular disease, both drug groups should be considered, and if multiple risk factors are present, GLP-1 receptor agonists should be considered first. In the aforementioned cases, early combination therapy using metformin and flozins and/or GLP-1 receptor agonists should be considered for every patient regardless of achievement of therapeutic goal. [**A**]
· The progressive nature of type 2 diabetes means that insulin therapy in individually selected models is indicated for many people with type 2 diabetes. [**B**]
· All therapeutic decisions concerning treatment of type 2 diabetes should be consulted with the patient and made only with the patient's approval. [**E**]

Pharmacological reduction in hyperglycaemia in multifactorial treatment of type 2 diabetes (in addition to treatment of hypertension, dyslipidemia, change of lifestyle, antiplatelet therapy, etc.) is crucial in prevention and inhibition of progress of chronic complications of diabetes (macro- and microvascular).

I. Hyperglycaemia reduced

Hyperglycaemia is reduced by correcting pathogenetic mechanisms of type 2 diabetes – insulin resistance and impaired insulin secretion. A separate therapeutic mechanism of antihyperglycaemic drugs is glycosuric action. Treatment of type 2 diabetes must be progressive, with each stage adapted to the progressive nature of the disease and taking into account any comorbidities. If therapy administered at the given stage ceases to be effective, i.e. the target HbA1c level for the given patient is not being reached, next stage should be commenced within 3–6 months.

II. Stages of type 2 diabetes treatment

1. Commencement of therapy:

- lifestyle modifications (body mass reduction, increase in physical activity to 30–45 minutes/day), reduction in energy value of meals combined with metformin monotherapy;
- to minimise the risk of adverse effects of metformin, which primarily entail gastrointestinal symptoms, its administration should begin with small doses, gradually increased until maximum tolerated dose;
- if metformin is not tolerated or contraindicated, sodium-glucose cotransporter-2 inhibitors (SGLT-2 inhibitors, flozins) or sulphonylurea derivatives or an incretin drug (a DPP-4 inhibitor or a GLP-1 receptor agonist) or a PPAR-γ agonist (pioglitazone) can be used; in this case, incretin drugs and SGLT-2 inhibitors should be preferred for patients with cardiovascular diseases, multiple risk factors of such diseases or chronic kidney disease, increased obesity or high risk related to occurrence of hypoglycaemic states, while PPAR-γ agonists should not be used in patients with heart failure;
- therapeutic efficacy of commenced oral treatment can be assessed only after several weeks of administration;
- in justified cases, such as documented atherosclerotic cardiovascular disease, systolic heart failure, chronic kidney disease or coexistence of multiple cardiovascular risk factors, decision to initiate combination therapy in freshly diagnosed diabetes should be considered. In such cases, drugs which reduce the risk of progression of these conditions (flozins or GLP-1 receptor agonists) should be used in addition to metformin. Combination therapy in freshly diagnosed type 2 diabetes should be considered also in case of increased hyperglycaemia.

2. Intensification of therapy using oral drugs or GLP-1 receptor agonists:

- lifestyle modifications and addition of an SGLT-2 inhibitor or an incretin drug (a DPP-4 inhibitor or a GLP-1 receptor agonist) or a sulphonylurea derivative or a PPAR-γ agonist to metformin. The choice of drug at an early stage should take into account comorbidities, especially diagnosed cardiovascular disease and chronic kidney disease, as well as coexisting obesity, risk of hyperglycaemia and the patient's financial resources. For patients with atherosclerotic cardiovascular disease, systolic heart failure, chronic kidney disease or multiple cardiovascular risk factors, drugs with proven beneficial effects on the risk of progression of these conditions as well as total and cardiovascular mortality rate should be used first. This effect has been proven for some SGLT2 inhibitors and certain drugs classified as GLP-1 receptor agonists. For patients with chronic kidney disease and systolic heart failure, flozins should be preferred, and if they are contraindicated, GLP-1 receptor agonists should be used. For patients with atherosclerotic cardiovascular disease, both drug groups should be considered, and if multiple risk factors are present, GLP-1 receptor agonists should be considered first. In the aforementioned cases, early combination therapy using metformin and certain flozins and/or GLP-1 receptor agonists should be considered for every patient regardless of achievement of therapeutic goal. Drugs classified as GLP-1 receptor agonists or SGLT-2 inhubitors should be preferred also in case of coexisting obesity. In case of high risk of hypoglycaemia, the same drug groups as well as a DPP-4 inhibitor or a PPAR-γ agonist should be considered. Given that reimbursement for new antihyperglycaemic drugs in Poland is limited, the most economically available drug groups are sulphonylurea derivatives and PPAR-gamma agonist;
- lifestyle modifications and three-drug therapy using metformin (always) and two other drugs with varied mechanisms of action from the following groups: SGLT2 inhibitors, GLP-1 receptor agonists, sulphonylurea derivatives, DPP-4 inhibitor, PPAR-γ agonist. The choice of drugs at this stage is based on the same grounds as for the previous stage and on general rules for combination of antihyperglycaemic drugs.
Basal insulin can also be added to metformin,

which means a direct transition from monotherapy to insulin therapy, bypassing intermediate stages.

3. Intensification of insulin therapy:

- lifestyle modifications and simple insulin therapy [primarily using basal insulin (NPH insulin, long-acting analogue, ultra long-acting analogue)]; various models – see chapter 12), with continued administration of metformin and other oral drugs or a GLP-1 receptor agonist, especially in case of persistent overweight or obesity. For patients undergoing their first injection therapy, e.g. using basal insulin or a GLP-1 receptor agonist, intensification can be achieved using combination drugs with a constant proportion of basal insulin and a GLP-1 agonist;
- lifestyle modifications and combination insulin therapy with recommended continued administration of metformin and other oral drugs (incretin, pioglitazone, flozin) or a GLP-1 receptor agonist, especially in case of persistent excessive body mass (see chapter 12).

4. Simplification of the antihyperglycaemic treatment model:

- for many patients with type 2 diabetes, it is necessary to reduce the complexity of and burdens related to treatment, especially with respect to insulin therapy, and consider liberalisation of the target blood sugar level; this applies to, for instance, patients at high risk of hypoglycaemia, patients with cognitive symptoms, patients who do not follow doctor's instructions, patients with a short life expectancy and patients who experience negative effects of a complex treatment regimen on their quality of life;
- reduction in the number of insulin injections and in insulin doses via individually matched combination with non-insulin antihyperglycaemic drugs is one of the tools enabling such simplification.

III. A list of drugs

A list of drugs used in treatment of type 2 diabetes is shown in Table 11.1.

When selecting the therapy and combining drugs, their effect on parameters other than blood sugar level (risk of death, cardiovascular risk, renal risk, body mass, risk of hypoglycaemia, lipid metabolism, etc.) should also be taken into account, in compliance with the principle of individualisation of treatment (see chapter 4.1.3). Data from large-scale randomised clinical trials indicates beneficial effects in terms of reduction in total and cardiovascular mortality rates as well as cardiovascular and renal outcomes as a result of administration of certain drugs classified as GLP-1 receptor agonists and SGLT-2 inhibitors.

IV. A practical algorithm for pharmacotherapy

A practical algorithm for pharmacotherapy of type 2 diabetes is shown in Figures 11.1 and 11.2.

REFERENCES

1. Marso SP, Daniels GH, Brown-Frandsen K, et. al. Liraglutide and cardiovascular outcomes in type 2 diabetes. N Engl J Med 2016; 375: 311–322.
2. Gaede P, Lund-Andersen H, Parving HH, Pedersen O. Effect of a multifactorial intervention on mortality in type 2 diabetes. N Engl J Med 2008; 358: 580–591.
3. Gerstein HC, Colhoun HM, Dagenais GR, et al. Dulaglutide and cardiovascular outcomes in type 2 diabetes (REWIND): a double-blind, randomised placebo-controlled trial. Lancet 2019; 394: 121–130.
4. Holman RR, Bethel MA, Mentz RJ, et al. effects of once-weekly exenatide on cardiovascular outcomes in type 2 diabetes. N Engl J Med 2017; 377: 1228–1239.
5. Holman RR, Farmer AJ, Davies MJ, et al. Three-year efficacy of complex insulin regimens in type 2 diabetes. N Engl J Med 2009; 361: 1736–1747.
6. Holman RR, Thorne KI, Farmer AJ, et al. Addition of biphasic, prandial, or basal insulin to oral therapy in type 2 diabetes. N Engl J Med 2007; 357: 1716–1730.
7. Kahn SE, Haffner SM, Heise MA, et al. Glycemic durability of rosiglitazone, metfor min, or glyburide monotherapy. N Engl J Med 2006; 355: 2427–2443.
8. Matthews DR, Paldanius PM, Proot P, et al. Glycaemic durability of an early combination therapy with vildagliptin and metformin versus sequential metformin monotherapy in newly diagnosed type 2 diabetes (VERIFY): a 5-year, multicentre, randomised, double-blind trial. Lancet 2019; 394: 1519–1529.
9. McMurray JJV, Solomon SD, Inzucchi SE, et al. dapagliflozin in patients with heart failure and reduced ejection fraction. N Engl J Med 2019; 381: 1995–2008.
10. Marso SP, Bain SC, Consoli A, et al. Semaglutide and cardiovascular outcomes in patients with type 2 diabetes. N Engl J Med 2016; 375: 1834–1844.
11. Neal B, Perkovic V, Mahaffey KW, et al. Canagliflozin and cardiovascular and renal events in type 2 diabetes. N Engl J Med 2017; 377: 644–657.
12. Gerstein HC, Bosch J, Dagenais GR, et al. Basal insulin and cardiovascular and other outcomes in dysglycemia. N Engl J Med 2012; 367: 319–328.
13. Packer M, Anker SD, Butler J, et al. Cardiovascular and re-

Table 11.1. List of drugs used in treatment of type 2 diabetes (insulin – see chapter 12)

	Metformin	Sulphonylurea derivatives	GLP-1 receptor agonists	DPP-4 inhibitors	PPAR-γ agonist	SGLT-2 inhibitors
Effect/ mechanism	Decreased hepatic glucose production, increased insulin sensitivity	Increased insulin secretion regardless of the severity of hyperglycemia	Increased hyperglycemia-mediated insulin secretion, decreased appetite	Increased hyperglycemia-mediated insulin secretion	Increased insulin sensitivity	Induction of glucosuria
Hypoglycemic effect	High	High	High	Medium	High	High
Plasma insulin	↓	↑↑	↑↑	↑	↓	↓
LDL cholesterol	↓	↔	↓	↓ or ↔	↔	↔ or ↑
HDL cholesterol	↑	↔	↑	↑	↑	↑
Triglycerides	↓	↔	↓	↔	↓	↔
Body weight	↓ or ↔	↑	↓↓	↔	↑	↓
Risk of hypoglycemia	↔	↑	↔	↔	↔	↔
Adverse effects	Gastrointestinal upset	Hypoglycemia, increase in body weight	Gastrointestinal upset (nausea, vomiting)	No significant	Fluid retention (edema), increase in body weight, increased risk of long bone fractures	Genital fungal infections, increased thirst
Beneficial cardiovascular effect			Yes[#]			Yes[#A]
Contraindications	Organ failure (heart, brain, liver, kidneys*, respiratory), alcohol abuse	Heart, liver, kidney failure	Gastrointestinal neuropathy	Liver failure	Heart or liver failure, bladder cancer	Significant reduction of glomerular filtration rate[B]

DPP-4 – dipeptidyl peptidase-4; GLP-1 – glucagon-like peptide 1; HbA_{1c} – hemoglobin A_{1c}; HDL – high-density lipoprotein; LDL – low-density lipoprotein; PPAR-γ – peroxisome proliferator activated receptor gamma; SGLT-2 – sodium-glucose transport protein 2.

**See Table 19.3. **Proven for some drugs of this class, according to the recent results from randomized clinical trials.*

[A]For empagliflozin and canagliflozin, there were no differences in cardiovascular outcome trials between higher and lower doses: 10 mg vs. 25 mg and 100 mg vs 300 mg, respectively.

[B]Use of specific medications according to the current summary of product characteristics wording as related to the estimated glomerular filtration rate.

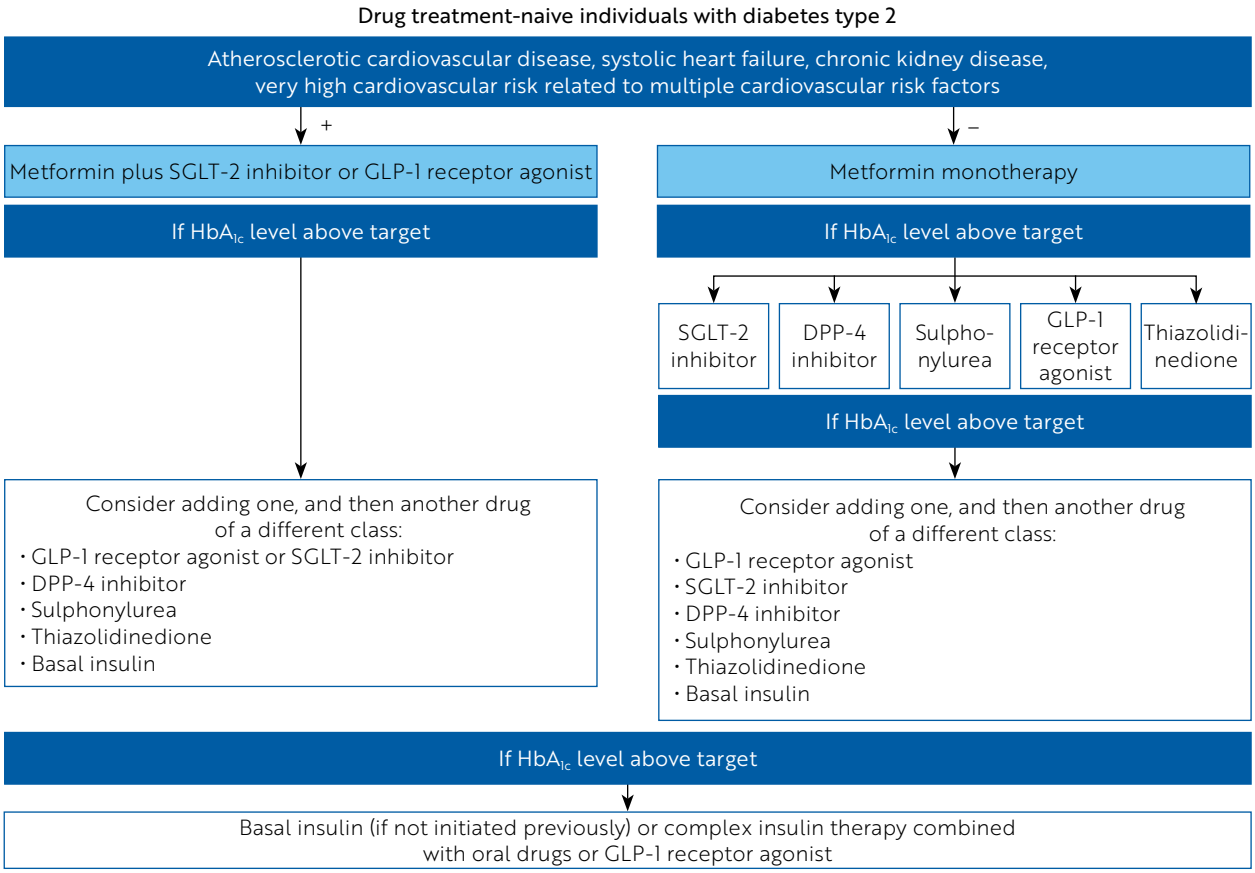


Figure 11.1. Drug treatment algorithm for drug treatment-naive individuals with diabetes type 2

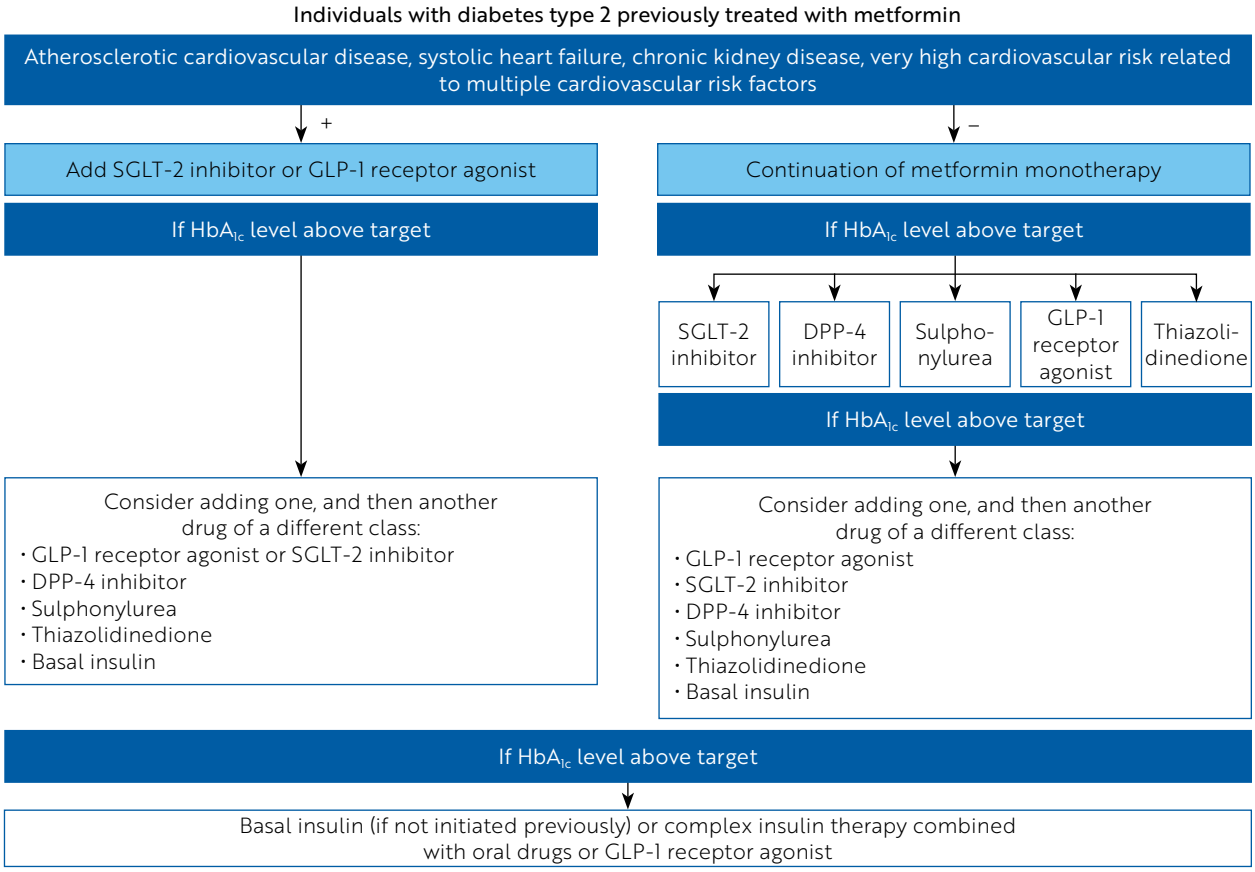


Figure 11.2. Drug treatment algorithm for individuals with diabetes type 2 previously treated with metformin

nal outcomes with empagliflozin in heart failure. N Engl J Med 2020; 383: 1413–1424.
14. Perkovic V, Jardine MJ, Neal B, et al.; Canagliflozin and renal outcomes in type 2 diabetes and nephropathy. N Engl J Med 2019; 380: 2295–2306.
15. UK Prospective Diabetes Study (UKPDS) Group. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). Lancet 1998; 352: 854–865.
16. Wiviott SD, Raz I, Bonaca MP, et al. Dapagliflozin and cardiovascular outcomes in type 2 diabetes. N Engl J Med 2019; 380: 347-357.
17. Zinman B, Wanner C, Lachin JM, et al. Empagliflozin, cardiovascular outcomes, and mortality in type 2 diabetes. N Engl J Med 2015; 373: 2117–2128.

12. Insulin therapy

Key recommendations
· In people with type 1 diabetes, insulin therapy is the only available treatment. The recommended model is intensive insulin therapy implemented using injector pens or a personal insulin pump. [**A**]
· In people with type 1 diabetes, insulin analogues are preferred because of the lower risk of hypoglycaemia. [**A**]
· Type 2 diabetes is progressive in nature. The increasing pathophysiologic abnormalities underlying it, particularly the beta cell defect, necessitate gradual intensification of treatment, including initiation of insulin therapy. [**B**]

I. Indications for initiating insulin therapy of type 2 diabetes:

- newly diagnosed diabetes (with the possibility of returning to the standard algorithm and discontinuing insulin); glycaemia ≥ 300 mg/dl (16.7 mmol/l) with intercurrent clinical symptoms of hyperglycaemia;
- treatment without insulin ineffective (HbA_{1c} exceeding target values despite the intensification of behavioural therapy).

II. Indications for changing the current antihyperglycaemic treatment

Indications for changing the current antihyperglycaemic treatment (from therapy with oral antihyperglycaemic drugs, in some cases used in combination with a GLP-1 receptor agonist) to combination therapy with insulin if glycaemic control is not achieved:

- repeated confirmation of persistent hyperglycaemic state;
  and
- unsuccessful attempts to correct potentially removable causes of hyperglycaemia, such as:
  - » dietary errors;
  - » insufficient physical activity;
  - » irregular intake of oral antihyperglycaemic drugs (lack of cooperation);
  - » infections;
  - » inadequate dosage of oral drugs.

III. Indications for initiating insulin therapy, regardless of the value of glycaemia:

- pregnancy;
- latent autoimmune diabetes in adults (LADA, type 1);
- cystic fibrosis related diabetes;
- justified request of the patient.

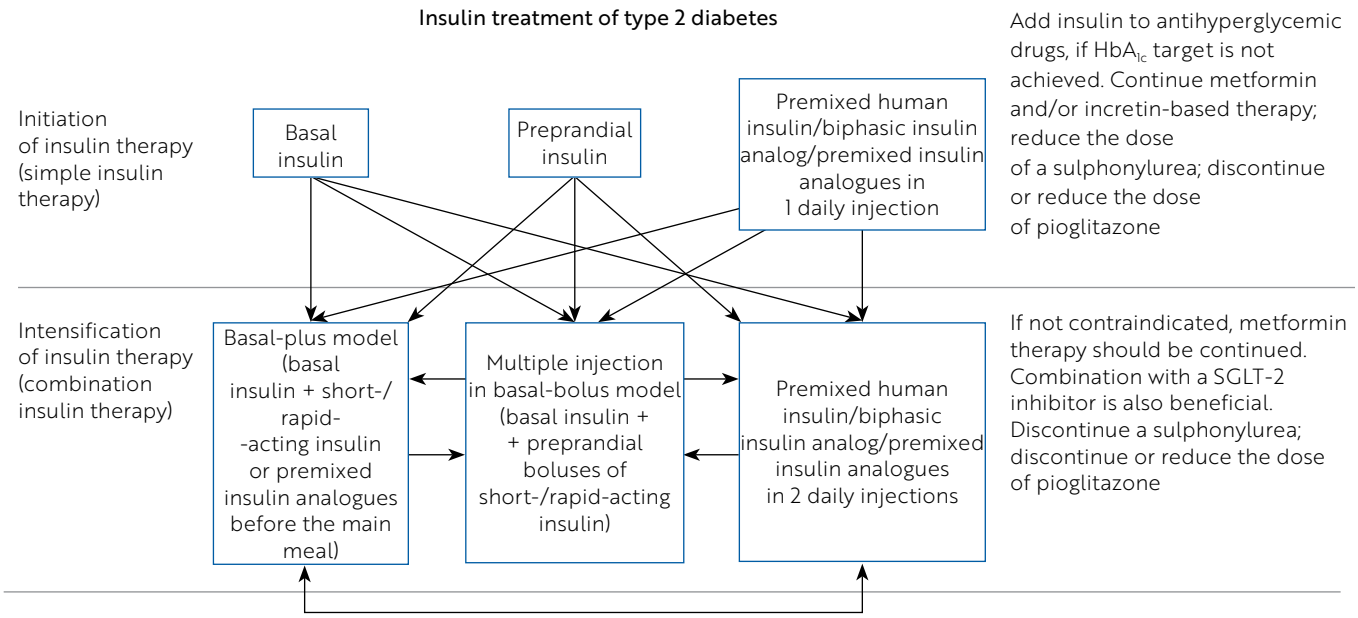
In patients with type 1 diabetes and overweight or obesity, it is preferable to use the model of combination therapy with metformin and insulin.

IV. Indications for temporary insulin therapy:

- diabetes decompensation due to transient causes (infection, injury, corticotherapy);
- surgery (see chap. 27);
- stroke (see chap. 19);
- percutaneous transluminal coronary angioplasty (PTCA);
- acute coronary syndrome;
- other acute conditions requiring hospitalisation in an intensive care unit.

V. Algorithm for insulin therapy in type 2 diabetes

1. Long-acting insulin (isophane insulin — NPH analogue, ultra long-acting analogue) in one injection:
- for morning hyperglycaemia — in the evening; the use of long-acting analogues reduces the risk of night and severe hyperglycaemia;
- for normoglycaemia while fasting and hyperglycaemia during the day — in the morning (consider multiple injections of a short-acting/fast-acting insulin preparation for postprandial hyperglycaemia).



Each model of insulin therapy requires education. In justified cases, insulin treatment may be initiated while omitting the stage of simple insulin therapy. In active patients with type 2 diabetes who have the motivation and potential to acquire the ability to adapt insulin doses, it is possible to recommend intensive functional insulin therapy.

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

In certain cases when the introduction of insulin has been delayed too long, resulting in the patient experiencing exacerbation of hyperglycaemia and the level of HbA_{1c} far exceeding the therapeutic target, it is possible to consider introducing more intensive models of insulin therapy (see point 5), which should be considered especially in the treatment of relatively young patients with a long expected survival period. There is currently no convincing evidence of greater therapeutic effectiveness or safety of human insulin or analogue blends. The final choice of preparation should be individualised, taking into account the patient's preferences regarding the number of meals and the cost of therapy.

2. Initial dose is 0.1–0.2 j./kg bw or 10 j.
3. Oral antihyperglycaemic drugs and injection incretin drugs can be used, as registered, in people treated with insulin:
   - in all patients, efforts should be made to maintain metformin therapy as long as it is tolerated and there are no contraindications to its continuation;
   - in the case of coexistent overweight and obesity, preference should be given to combination therapy of metformin with an SGLT-2 inhibitor or incretin drug (DPP-4 inhibitor or GLP-1 receptor agonist).
4. Verification of glycaemic control over 4–5 days with gradual dose increase by 2–4 j. based on the results of self-monitoring, until complete glycaemic control is achieved.
5. If the demand for basal insulin is > 0,3–0,5 j./kg per day and glycaemic control is not achieved, it is possible to consider intensification of treatment by:
   - gradually adding to the basal insulin (administered 1 or 2 times per day) injections of short-acting insulin or fast-acting analogue, at first to the main meal or the meal which is followed by the largest increase in glucose concentration and then to next meals (basal-plus model, intensive insulin therapy) The recommended initial doses of prandial insulin are 4 j. or 10% of the daily dose of basal insulin;
   - using combination insulin preparations: insulin blends including analogue;
   - adding GLP-1 receptor agonist injections, if it has not already been used.

   It is advisable to consider discontinuing drugs that stimulate insulin secretion.
6. When using high doses of insulin, over 100 j. per day (which indicate insulin resistance), it is necessary to consider the causes of this phenomenon and the possibility of adverse reactions occurring. It is recommended to attempt to reduce the degree of insulin resistance by using 72–96-hour continuous subcutaneous or intravenous insulin infusion.

Intensive insulin therapy

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

I. Principles of insulin therapy:

- daily self-monitoring of glycaemia;
- patient independently making decisions on the modification of the insulin dose and any additional doses, on the basis of the determined glycaemic value, energy requirements and physical activity;
- precise definition of the target glycaemic value;
- proper therapeutic and nutritional education and motivation of the patient;
- possibility for the patient to quickly contact the treatment team;
- in type 2 diabetes, subcutaneous infusion using a personal insulin pump is not a routine procedure.

II. Algorithms for multiple injections:

- short-acting insulin or fast-acting analogue before meals;
- long-acting isophane insulin (NPH) or long-acting insulin analogue or ultra long-acting
- insulin analogue to provide consistent basal insulin concentrations at bedtime and/or in the morning.

In some cases of type 2 diabetes, if the fasting glycaemic values are normal it is sufficient to use only short-acting insulin or fast-acting analogue before or after a meal.

III. Algorithm for personal insulin pump treatment

Therapy with personal insulin pumps should be provided in centres with experience in this kind of treatment. This method is used in type 1 diabetes and some forms of other specific types of diabetes (e.g. in the course of cystic fibrosis)

1. Indications:
- necessity to use small insulin doses (e.g. in children);
- recurrring, unpredictable hypoglycaemic episodes;
- unawareness of hypoglycaemia;
- irregular lifestyle and irregular meals;
- dawn hyperglicaemia;
- pregestational diabetes, difficult to control with the multiple injections method;
- patient's preferences, assuming they accept the cost of pump therapy.

2. Contraindications:
- low level of inteligence or education of the patient;
- lack of cooperation from the patient;
- no contact with the outpatient clinic.

REFERENCES

1. Bergenstal RM, Klonoff DC, Garg SK, et al. Threshold-based insulin-pump interruption for reduction of hypoglycemia. N Engl J Med 2013; 369: 224–232.
2. Diabetes Control and Complications Trial (DCCT)/Epidemiology of Diabetes Interventions and Complications (EDIC) Study Research Group. Mortality in type 1 diabetes in the DCCT/EDIC ver- sus the general population. Diabetes Care 2016; 39: 1378–1383.
3. The Diabetes Control and Complications Trial Research Group. The effect of intensive reatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993; 329: 977–986.
4. Yeh HC, Brown TT, Maruthur N, et al. Comparative effective- ness and safety of methods of insulin delivery and glucosemonitoring for diabetes mellitus: a systematic review and meta-analysis. Ann Inter. Me. 2012; 157: 336–347.

13. Rules of treatment of hypertension in patients with diabetes mellitus

Key recommendations
• The overall target for blood pressure control in people with diabetes mellitus is < 130/80 mm Hg (in patients > 65 years of age it is <140/80 mm Hg). [**A**]
• Hypertension therapy should be started with a two-drug combination: 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 for hypertension should be continuous, as only then a reduction in cardiovascular risk is achieved. [**A**]
• Hypertension therapy in patients with diabetes mellitus should aim not only to achieve BP targets but also to maintain or restore normal diurnal BP variability assessed by 24-hour monitoring, especially in pregnant women with diabetes mellitus. [**B**]

In patients with diabetes mellitus, pharmacotherapy is recommended when blood pressure is above 140/90 mm Hg. The treatment goal is to optimally reduce the global risk of cardiovascular complications by lowering systolic blood pressure below 140 mm Hg, aiming for 130 mm Hg in patients younger than 65 years of age (and below 130 mm Hg if well tolerated due to the benefit of stroke risk reduction). For diastolic pressure, a value below 80 mm Hg is optimal. Hypertension can be diagnosed based on the results of a 24-hour blood pressure monitoring using automated blood pressure monitoring (ABPM).

I. Rules of blood pressure measurement

Blood pressure should be measured at each appointment, also in the standing position, in order to assess for orthostatic hypotension. Self-management at home is recommended in all patients diagnosed with hypertension. In patients 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 a different day and blood pressure monitoring should be recommended outside the doctor's office. Repeated blood pressure values of not less than 140 mm Hg or diastolic blood pressure values of not less than 90 mm Hg confirm the diagnosis of hypertension. Nocturnal hypertension, as well as masked hypertension (when blood pressure values in the doctor's office are lower than those measured at home) is often found in patients with diabetes mellitus, therefore 24-hour ambulatory blood pressure monitoring is recommended. Also, patients with diabetes mellitus should be advised to measure their blood pressure at home (SBPM, self-blood pressure monitoring).

II. Rules for treatment of hypertension

- taking into account the above-mentioned aims of hypertension treatment in patients with diabetes mellitus, simultaneously a decrease in systolic blood pressure below 120 mm Hg should be avoided. In patients with chronic kidney disease, the decrease below 130 mm Hg should be avoided;
- diastolic blood pressure should not be decreased below 70 mm Hg;
- in every case of diagnosed hypertension, pharmacological management should be combined with lifestyle changes;
- as a general rule, therapy should be started with the two-drug combination: angiotensin-converting enzyme inhibitor (ACEI) or angiotensin AT1 receptor antagonist with a calcium antagonist or thiazide or thiazide-like diuretic, however, in case of certain comorbidities (e.g. ischemic heart disease, chronic kidney disease, etc.) the combination of the two drugs may be different;
- in view of the above recommendation, it is advisable to use combination drugs in order to improve *compliance*;
- the presence of proteinuria does not change the target BP;
- in the treatment of patients with hypertension and cardiac complications (ischemic heart disease, heart failure), a combination of an ACEI and a β-blocker is commonly used;
- combinations of drugs with a similar mechanism of action or similar side effects are not valuable because the hypotensive effect is less than additive or there is an increased risk of undesirable side effects;
- if the target blood pressure value is not reached with two-drug treatment, another

drug from a different group should be added (one of the drugs should be a diuretic);
- in patients with a lack of nocturnal BP decrease (*non-dipping*) or an excessive morning BP increase (*morning surge*), modifying the time of administration of hypotensive medications should be considered;
- when administered once a day, long-acting hypotensive drugs that provide 24-hour efficacy should be preferred;
- when administering an ACEI, ARB, renin inhibitor, or diuretic, the creatinine concentration, GFR and serum potassium level should be monitored;
- in patients > 65 years of age, blood pressure should be decreased gradually in order to avoid complications resulting from therapy;
- in patients with very advanced age (> 80 years of age) or *frailty syndrome*, it is reasonable to start hypotensive treatment with monotherapy.

III. The choice of hypotensive drug

Effective treatment that achieves normal blood pressure values is more important for preventing vascular complications than the type of drug used:
- hypotensive treatment may begin with administration of an ACEI, ARB, diuretic, β-blocker (vasodilating β-blockers preferred in case of no specific indication) or calcium channel antagonist;
- if albuminuria/proteinuria is present, drugs that inhibit the renin-angiotensin-aldosterone system (RAA) should be preferred;
- the combination of an ACEI with an ARB is contraindicated;
- drugs used in combination therapy may be selected from those listed above or from other groups, taking into account the rules of drug combination;
- treatment of patients with hypertension and coexisting abnormal renal function or structure - see Chapter 19;
- in patients > 55 years of age with other cardiovascular disease risk factors, regardless of blood pressure values, the use of ACEIs should be considered in order to reduce the risk of cardiovascular incidents;
- ACEIs or ARBs are not recommended in normotensive patients with normoalbuminuria for primary prevention of diabetic kidney disease;
- ACEIs or ARBs are recommended in normotensive patients with albuminuria ≥ 30 mg/g in order to prevent the onset and progression of diabetic kidney disease;
- in patients with ischemic heart disease, after myocardial infarction, and in case of heart failure, a β-blocker and an ACEI are indicated as first-line drugs in order to reduce the risk of death;
- if peripheral artery disease coexists, a non-selective b-adrenergic receptor blocking drug should be avoided;
- thiazide/thiazide-like diuretics should be used when GFR ≥ 30 ml/min/1.73 m^2; a loop diuretic should be used when GFR < 30 ml/min/1.73 m^2.

Clinical studies indicate that in order to achieve therapeutic goals, a majority of patients require 3 different hypotensive drugs. This often requires the use of drugs from groups other than those previously mentioned (e.g. α-blockers, centrally acting drugs, vasodilators).

Presence of diabetes mellitus often results in development of resistant hypertension. This requires concomitant use of multiple medications. In this situation, the use of spironolactone should be considered. In patients with diabetes mellitus with resistant hypertension, examination for obstructive sleep apnea should be considered.

Among the antidiabetic drugs, SGLT-2 inhibitors and GLP-1 receptor agonists exert hypotensive effects and for this reason may also be recommended for the diabetes mellitus treatment.

For rules for the treatment of diabetes mellitus in children and adolescents, in pregnant women and in women planning their pregnancy, and in people > 65 years of age, see the topic chapters.

IV. Distinctions in the management of hypertension in pregnant women

The blood pressure targets for pregnant women with diabetes mellitus are: systolic 110-139 mmHg and diastolic 81-85 mmHg. In pregnant diabetic women with vascular complications, target BP < 130/80 mm Hg.

In pregnant women with hypertension that is not severe, the oral drugs of choice are (in order): methyldopa, labetalol, and calcium antagonists. In life-threatening situations, labetalol or nitroglycerin (parenteral) are the preferred agents. Parenteral hydralazine can be used when they are not available; however, there are reports of an increased incidence of undesirable side effects in the perinatal period.

REFERENCES

1. Cushman WC, Evans GW, Byington RP, et al. Effects of intensive blood-pressure control in type 2 diabetes mellitus. N Engl J Med 2010; 362: 1575–1585.
2. Arguedas JA, Leiva V, Wright JM. Blood pressure targets for hyper- tension in people with diabetes mellitus. Cochrane Database Syst Rev 2013; 10: CD008277.
3. Brunstrom M, Carlberg B Effect of antihypertensive treatment at different blood pressure levels in patients with diabetes melli- tus: systematic review and meta-analyses. BMJ 2016; 352: i717.
4. Emdin CA, Rahimi K, Neal B, et al. Blood pressure lowering in type 2 diabetes: a systematic review and metaanalysis. JAMA 2015; 313: 603–615.
5. Mann JF, Schmieder RE, McQueen M, et al. Renal outcomes with telmisartan, ramipril, or both, in people at high vascular risk (the ONTARGET study): a multicentre, randomised, double-blind, controlled trial. Lancet 2008; 372: 547–553.
6. Palmer SC, Mavridis D, Navarese E. Comparative efficacy and safety of blood pressurelowering agents in adults with diabetes and kidney disease: a network meta-analysis. Lancet 2015; 385: 2047–2056.
7. Thomopoulos C, Parati G Zanchetti A. Effects of blood-pressure-lowering treatment on outcome incidence in hypertension: 10 – should blood pressure management differ in hypertensive patients with and without diabetes mellitus? Overview and meta-analyses of randomized trials. J Hypertens 2017; 35: 922–944.
8. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension 2018; 71: 1269–1324.
9. Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. Eur Heart J 2018; 39: 3021–3104.
10. Wright JT Jr, Williamson JD, Whelton PK, et al. A randomized trial of intensive versus standard blood-pressure control. N Engl J Med 2015; 373: 2103–2116.
11. Zoungas S, Chalmers J, Neal B, et al. Follow-up of blood-pressure lowering and glucose control in type 2 diabetes. N Engl J Med 2014; 371:1392–1406.
12. Postępowanie w nadciśnieniu tętniczym u kobiet w ciąży. Zapobieganie, diagnostyka, leczenie i odległe rokowanie. Stanowisko Polskiego Towarzystwa Nadciśnienia Tętniczego, Polskiego Towarzystwa Kardiologicznego oraz Polskiego Towarzystwa Ginekologów i Położników. Ginekol Perinatol Prakt 2019; 4: 43–111.

14. Principles of treating dyslipidemia

Key recommendations
• LDL fraction cholesterol < 55 mg/dl (< 1.4 mmol/l) and a reduction of at least 50% from baseline in people with very high cardiovascular risk diabetes. [B]
• LDL-C concentration < 70 mg/dl (< 1.8 mmol/l) and a reduction of at least 50% from baseline in people with high cardiovascular risk diabetes. [A]
• LDL-C levels < 100 mg/dl (< 2.6 mmol/l) in people with moderate cardiovascular risk diabetes (young people below 35 years of age with type 1 diabetes without chronic complications or other cardiovascular risk factors or patients with type 2 diabetes below 50 years of age, with diabetes duration below 10 years and no other risk factors). [A]

The primary aim of the treatment is to lower LDL fraction cholesterol. Changing the „non-HDL" concentration is a secondary treatment target. The normalisation of the entire atherogenic lipid profile once a target LDL fraction concentration is achieved – i.e. an increase in HDL fraction cholesterol and a decrease in triglycerides – may be associated with beneficial effects.

Diabetic patients with existing vascular complications (history of myocardial infarction, acute coronary incident, coronary and other revascularisation procedures, stroke, transient ischaemic attack and peripheral vascular disease) or other organ damage (proteinuria or microalbuminuria, impaired renal function – GFR < 30 ml/min/1.73 m^2, left ventricular hypertrophy, retinopathy, neuropathy) or with at least three major risk factors (age, hypertension, dyslipidaemia, smoking, obesity), or early-onset and long-lasting type 1 diabetes (above the age of 20) are patients at a very high cardiovascular risk. In the absence of chronic complications of diabetes and the presence of additional cardiovascular risk factors, this risk is defined as high. The risk is moderate in young type 1 diabetes patients below the age of 35 and type 2 diabetes patients below the age of 50 and diabetes duration below

10 years, as well as no other cardiovascular risk factors. Resting ECG, as well as carotid/femoral artery ultrasound to detect the presence of atherosclerotic plaques and the measurement of ABI (*ankle-brachial index*) are helpful in cardiovascular risk assessment. The presence of atherosclerotic plaques in the carotid and/or femoral arteries on arterial ultrasound can be considered a risk-modifying factor.

I. Diagnosis of lipid disorders

The diagnosis includes:

- dietary assessment, information on alcohol consumption;
- physical activity assessment – type and duration of exercise;
- presence of cardiovascular diseases: ischaemic heart disease, cerebrovascular and peripheral vascular diseases;
- testing for the presence of thyroid, liver and kidney diseases to exclude secondary forms of hyperlipidemia;
- occurrence of lipid disorders, cardiovascular disease, hypertension and diabetes in first-degree relatives;
- use of medications that can increase lipid levels.

Table 14.1 contains the recommended lipid parameter values.

In people with diabetes and existing cardiovascular disease, further lowering of LDL-C levels is associated with a greater reduction in the risk of cardiovascular events.

The LDL-C concentration can be calculated using the Friedewald formula if the serum triglyceride concentration is < 400 mg/dl (< 4.5 mmol/l) and no direct determination of LDL fraction cholesterol is possible:

LDL-C [mmol/l] = total cholesterol [mmol/l] – – HDL-C [mmol/l] – Tg/2.2 [mmol/l].

HDL-C:

- no target value, but > 1.0 mmol/l (> 40 mg/dl) in men and > 1.2 mol/l (> 45 mg/dl) in women indicates a lower cardiovascular risk.

Triglycerides:

- no target value, but < 1.7 mmol/l (< 150 mg/dl) indicates a lower cardiovascular risk.

Apart from non-HDL-C levels, apolipoprotein B levels can be determined in people with high triglyceride levels, diabetes, obesity or very low LDL-C levels.

The target apoB concentrations (as an additional therapeutic target) are as follows:

- 65 mg/dl in the very-high-risk group;
- 80 mg/dl in the high-risk group;
- 100 mg/dl in the moderate risk group.

While lipidogram determination can be performed in non-fasting patients, in patients with hypertriglyceridaemia, tests should be performed 8–12 hours after their last meal.

II. Lipid control and monitoring

1. Type 1 diabetes

When lipid levels indicate a moderate risk, lipid control is recommended every 2–5 years, depending on the presence of other cardiovascular disease risk factors.

2. Type 2 diabetes:

- lipids should be measured at the time of diagnosis of diabetes, and then monitored once a year or more often, depending on their level;
- if lipid concentrations are above normal, it is recommended to check them every 8–12 weeks from the start of therapy until the recommended concentrations are reached;
- if lipid concentrations are within the desired threshold, check-ups should be performed once a year.

III. Treatment of dyslipidaemia in diabetics

1. Lifestyle changes:

- increasing physical activity;
- weight reduction in overweight or obese individuals;
- quitting smoking;
- a diet with a limited saturated fat intake amounting to less than 10% of total energy intake; cholesterol intake below 300 mg per day or below 200 mg per day if the LDL cholesterol is elevated; limiting trans unsaturated fat intake as much as possible; intake of n-6 polyunsaturated fatty acids should be 4–8% and of n-3 polyunsaturated should be 2 g of linolenic acid and 200 mg of very-long-chain fatty acids per day;
- in hypertriglyceridaemia, it is crucial to reduce overweight, alcohol intake, intake of mono- and disaccharides (reducing fructose intake), reduce carbohydrate intake, reduce saturated fat intake, as well as to include monounsaturated fats in the diet.

2. Proper blood glucose level control

Proper blood glucose level control is critical for the compensation of lipid disorders, especially hypertriglyceridaemia.

3. Pharmacological treatment

Statins are first-line drugs for the treatment of diabetic dyslipidaemia.

Table 14.1. Cardiovascular risk categories and target concentrations of LDL-C and non-HDL-C

Cardiovascular risk categories	Criteria	LDL-C and non-HDL-C target concentrations
Very high	Patients with diabetes and cardiovascular disease **or** damage to other target organs* **or** 3 or more major cardiovascular risk factors** **or** type 1 early-onset and long-term diabetes (> 20 years)	LDL-C < 1.4 mmol/l (55 mg/dl) and LDL-C reduction of 50% (IB) Non-HDL-C < 2.2 mmol/l (85 mg/dl) (IB)
High	Patients with diabetes duration of 10 or more years, without target organ damage* plus additional risk factors	LDL-C < 1.8 mmol/l (70 mg/dl) and reduction of LDL-C by 50% (IA) Non-HDL-C < 2.6 mmol/l (100 mg/dl) (IB)
Moderate	Young patients below the age of 35 with type 1 diabetes or patients below the age of 50 with type 2 diabetes, diabetes duration below 10 years and no other risk factors	LDL-C < 2.6 mmol/l (100mg/dl) (IA) Non-HDL < 3.4 mmol/l (130 mg/dl)

**Organ damage includes proteinuria or microalbuminuria, impaired renal function (GFR < 30 ml/min/1.73 m²), left ventricular hypertrophy, retinopathy, neuropathy.*

***Major cardiovascular risk factors include age, hypertension, dyslipidaemia, smoking, obesity.*

Statin-based pharmacological treatment is primarily used in the following cases:

- in diabetic patients with coexisting cardiovascular conditions;
- in diabetic patients with chronic kidney disease; or organ damage; or presence of 3 or more major risk factors;
- in diabetic patients without cardiovascular comorbidities but with 1 or more cardiovascular risk factors present.

The use of statins in type 1 diabetes is recommended in the case of patients subject to high and very high cardiovascular risk.

Women with diabetes can use statins as long as they are not planning a pregnancy.

The use of statins is contraindicated during pregnancy and breastfeeding. The use of statins should not be recommended in women of childbearing age unless they use effective contraception. Moreover, taking statins is contraindicated in patients whose transaminase values exceed the normal limit threefold, as well as in patients whose keratin kinase levels exceed the upper normal value fourfold;

- in diabetic patients with coexisting hypertriglyceridaemia above 200 mg/dl (> 2.3 mmol/l), which persists after the LDL fraction cholesterol target has been achieved by using statins; an increase in statin dosage should be considered to lower "non-HDL" cholesterol, which is a secondary treatment target. Combination treatment with fenofibrate should be considered when appropriate.

4. Combination therapy. Intensification of statin treatment should be considered before introducing combination therapy:

- in the subgroup of type 2 diabetic patients characterised by Tg levels above 200 mg/dl (> 2.3 mmol/l) and HDL-C levels below 35 mg/dl (< 0.9 mmol/l) who are undergoing statin-based treatment, the addition of fenofibrate is associated with a further reduction in cardiovascular events;
- combination therapy with statin and ezetimibe is associated with a further reduction in LDL-C and a further reduction in cardiovascular events compared to statin monotherapy. As such, ezetimibe may prove useful in patients who have not achieved the recommended LDL-C reduction with the maximum tolerated dose of a statin as well as in statin-intolerant individuals. PCSK9 inhibitors that significantly lower LDL-C may be useful in diabetic patients with very high cardiovascular risk and persistently elevated LDL-C levels despite the administration of a second hypolipemic drug apart from the maximum tolerated dose of statins or in the case of statin intolerance (IA). Combination therapy with statins and other lipid-lowering drugs (ezetimibe, PCSK9 inhibitors, fenofibrate) may be applicable in achieving lipid profile targets in diabetic patients. Combination therapy (primarily statin + fenofibrate) is associated with an increased risk of abnormal liver function tests, myositis and rhabdomyolysis, particularly in cases where there is coexisting chronic kidney disease and high drug doses are used.

5. Management of severe hypertriglyceridaemia.

The risk of acute pancreatitis is clinically significant at Tg levels above 880 mg/dl (> 10 mmol/l). Hypertriglyceridaemia accounts for about 10% of cases of acute pancreatitis; however, acute pancreatitis can already occur with hypertriglyceridaemia of more than 440 mg/dl (5 mmol/l).

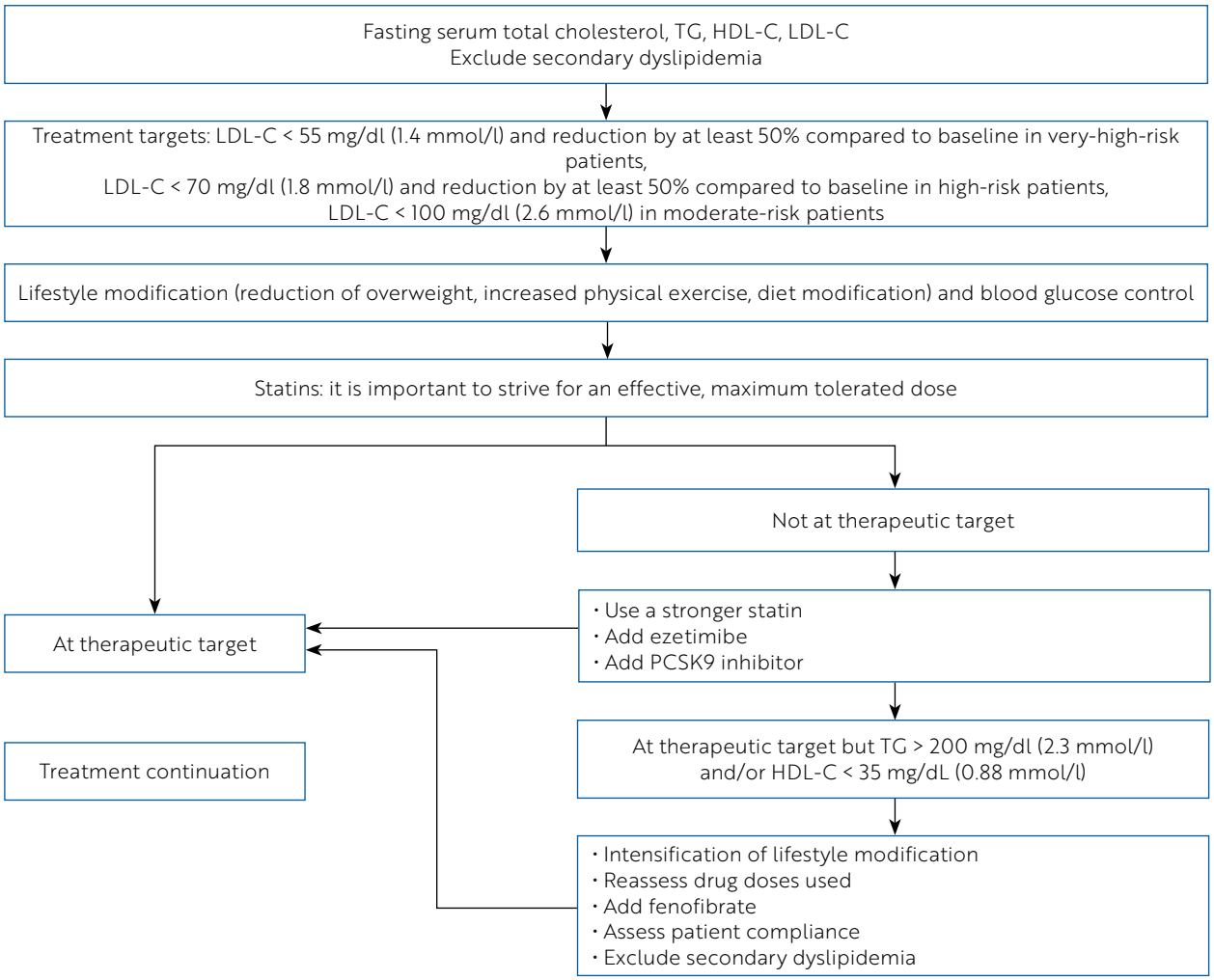


Figure 14.1. An algorithm for managing dyslipidemia in diabetes

Recommended treatment:

- hospitalisation in the case of acute pancreatitis;
- strict control of triglyceridaemia:
  - » limiting calorie intake and the fat content of the diet (10–15%);
  - » no alcohol;
  - » introducing fenofibrate therapy.

In acute conditions, a rapid reduction in TG levels can be achieved by plasmapheresis

In diabetics who are not treated with insulin, insulin therapy must be commenced – usually by means of an intravenous infusion using an infusion pump – to achieve optimal blood glucose level control. Such management can reduce triglyceridaemia within 2–5 days.

For patients with significant hypercholesterolemia with suspected familial hypercholesterolemia, or patients at very high risk of cardiovascular disease, referral to specialist lipid disorder clinics should be considered for qualification for treatment with PCSK9 inhibitors.

Two new cholesterol-lowering drugs have recently been introduced. Bempedoic acid, an oral cholesterol synthesis inhibitor, is mainly used in combination with ezetimibe in statin-intolerant patients. Inclisiran, a small interfering RNA (siRNA), inhibits PCSK9 synthesis and reduces LDL-C by 50–55%; it is administered subcutaneously twice per year.

REFERENCES

1. Boekholdt SM, Hovingh GK, Mora S, et al. Very low levels of atherogenic lipoproteins and the risk for cardiovascular events: A meta-analysis of statin trials. J Am Coll Cardiol 2014; 64: 485–494.
2. Cosentino F, Grant PJ, Aboyans V, et al. ESC Scientific Document Group . 2019 ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. Eur Heart J 2020; 41: 255-323.
3. De Ferranti SD, de Boer IH, Fonseca V, et al. Type 1 diabetes mellitus and cardiovascular disease: a scientific statement from the American Heart Association and Ameri-

can Diabetes Association. Circulation 2014; 130: 1110–1130.
4. Ginsberg HN, Elam MB, Lovato LC, et al. Effects of combination lipid therapy in type 2 diabetes mellitus. N Engl J Med 2010; 362: 1563–1574.
5. Mach F, Baigent C, Catapano AL, et al. 2019 ESC/EAS guidelines for the managementof dyslipidaemias: lipid modification to reduce cardiovascular risk. The Task Force for the management of dyslipidaemias of the European Society of Cardiology (ESC) and European Atherosclerosis Society (EAS). Eur Heart J 2020; 41: 111–188.
6. Mihaylova B, Emberson J, Blackwell L, et al. Cholesterol treatment trialists' (CTT) collaborators. The effects of lowering LDL cholesterol with statin therapy in people at low risk of vascular disease: meta-analysis of individual data from 27 randomised trials. Lancet 2012; 380: 581–590.
7. Ray KK, Colhoun HM, Szarek M, et al. Effects of alirocumab on cardiovascular and metabolic outcomes after acute coronary syndrome in patients with or without diabetes: a prespecified analysis of the ODYSSEY OUTCOMES randomised controlled trial. Lancet Diabetes Endocrinol 2019; 7: 618-628.
8. Sabatine MS, Giugliano RP, Keech AC, et al. FOURIER Steering Committee and Investigators. Evolocumab and clinical outcomes in patients with cardiovascular disease. N Engl J Med 2017; 376: 1713–1722.
9. Taskinen MR, del Prato S, Bujas-Bobanovic M, et al. Efficacy and safety of alirocumab in individuals with type 2 diabetes mellitus with or without mixed dyslipidaemia: analysis of the ODYSSEY LONG TERM trial. Atherosclerosis 2018; 276: 124–130.
10. Visseren FLJ, Mach F, Smulders YM, et al. 2021 ESC guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J 2021; 42 : 3227–3337.
11. Zhang XL, Zhu QQ, Zhu L, et al. Safety and efficacy of anti- PCSK9 antibodies: a meta-analysis of 25 randomized, controlled trials. BMC Med 2015; 13: 123.

15. Hypoglycaemia

Key recommendations
• Every diabetic should be asked about the symptoms and frequency of hypoglycaemia at every medical appointment. [**C**]
• Anyone at high risk of clinically significant hypoglycaemia (< 54 mg/dl, < 3.0 mmol/l) should be prescribed glucagon. Family members, guardians, teachers of children and young people with diabetes should be familiar with the administration of glucagon. [**E**]
• Consideration should be given to a change in the management of diabetes with episodes of severe hypoglycaemia and unawareness of hypoglycaemia. [**E**]
• For the treatment of hypoglycaemia in conscious patients (with a glucose level ≤ 70 mg/dl, 3.9 mmol/l), it is necessary to administer 15 g of glucose or other simple carbohydrates orally. If glucose determination continues to indicate hypoglycaemia after 15 minutes, glucose / carbohydrate administration should be repeated. Once hypoglycaemia has subsided, the diabetic should have a snack / meal if there is a possibility of recurrence. [**E**]
• In insulin-treated diabetic patients with unawareness of hypoglycaemia or an episode of severe hypoglycaemia, the therapeutic goal should be slightly higher glucose levels for at least a few weeks to at least partially restore the perception of hypoglycaemic symptoms and to prevent their occurrence in the future. [**A**]

I. Definition

Hypoglycaemia is diagnosed when blood glucose levels drop below 70 mg/dl (3.9 mmol/l), regardless of the presence of clinical symptoms, which in some people – especially those with long-standing type 1 diabetes – may only appear at lower glycaemic values. A value of 70 mg/dl (3.9 mmol/l) should be considered a warning concentration that needs the ingestion of carbohydrates or dose adjustment of medications with glycaemic lowering properties, irrespective of the presence or absence of symptoms, in order to prevent a further drop in blood glucose. This justifies setting the cut-off value for life-threatening hypoglycaemia at 70 mg/dl (3.9 mmol/l). A value less than 54 mg/dl (3.0 mmol/l) should be considered clinically significant hypoglycaemia. Symptoms of hypoglycaemia may also occur at higher blood glucose values, even > 100 mg/dl (5.6 mmol/l), when the blood glucose level drops rapidly. Hypoglycaemia unawareness, defined as not experiencing pathologically low (≤ 70 mg/dl, i.e. ≤ 3.9 mmol/l) blood glucose values, is a serious complication of frequent hypoglycaemic episodes.

The classification of hypoglycaemia according to the International Hypoglycaemia Study Group 2017 is shown in Table 15.1. Severe hypoglycaemia is an episode that requires the assistance of another person to administer carbohydrates, glucagon or take other action. Information on blood glucose

levels may not be available during an episode; however, the cessation of symptoms after the administration of glucose and/or glucagon is considered sufficient evidence that the episode occurred due to low blood glucose levels.

Recurrent severe hypoglycaemia: 2 or more episodes of severe hypoglycaemia in the last 12 months.

II. General remarks

1. Diabetic patients must not automatically be considered at risk of hypoglycaemia and be burdened with the resulting employment and social consequences.
2. The risk of hypoglycaemia increases in the following situations:

- the use of insulin as part of monotherapy or in combination with other antihyperglycaemic drugs;
- the use of sulphonylurea derivatives as part of monotherapy or in combination with other antihyperglycaemic drugs;
- inappropriate dosage of the above drugs in cases of increased physical exertion, reduced caloric intake or alcohol consumption;
- attempting to rapidly normalise HbA_{1c} levels;
- existence of comorbidities conducive to hypoglycaemia (e.g. renal failure, hypothyroidism, adrenal insufficiency, nutritional disorders, diseases accompanied by impaired intestinal absorption):
- hypoglycaemia unawareness;
- episode of severe hypoglycaemia in recent weeks.

3. In some patients (the elderly, people suffering from ischaemic heart disease), hypoglycaemia can be life-threatening.

III. The management of recurrent hypoglycaemia consists in:

- conducting a thorough analysis of both the diabetic's habits and the treatment used for diabetes and other diseases;
- raising awareness of the need to prevent hypoglycaemia among diabetics (e.g. recommending the reduction of insulin dose before exercise);
- modifying diabetes therapy to reduce the risk of hypoglycaemia (e.g. replacing sulphonylurea derivatives with drugs characterised by a lower risk of hypoglycaemia, changing the insulin therapy model, using insulin medications subject to a lower risk of hypoglycaemia, using insulin pumps, preferably models that automatically stop the insulin supply in the case of hypoglycaemia or a risk thereof, etc.);
- self-monitoring and use of continuous glycemic monitoring (CGM) or scanning (isCGM/FGM) systems if available to the patient.

IV. Management of hypoglycaemia unawareness

Implement management as in the case of recurrent hypoglycaemia and:

- educate diabetics and their relatives in recognising subtle and atypical signs of imminent hypoglycaemia (hypoglycaemia detection training);
- take hypoglycaemia into account in the patient's professional activity and driving;
- modify therapy to significantly reduce the frequency of hypoglycaemia as the only method to improve the detection of hypoglycaemia.

V. Emergency management of hypoglycaemia

1. In conscious persons:

- consumption of 15 g of glucose or other simple carbohydrates and checking the blood glucose level after 15 minutes is advisable. Should hypoglycaemia persist, it is recommended that 15 g of glucose/simple carbohydrates be consumed again and that blood glucose level be re-checked after 15 minutes;
- in the event of a possible re-occurrence of a hypoglycaemic incident – e.g. following an

Table 15.1. The classification of hypoglycaemia according to the *International Hypoglycaemia Study Group*, 2017

Level	Criterion of plasma	Remark
Alarming glucose level (level 1)	≤ 70 mg/dl ≤ 3,9 mmol/l	Glucose levels requiring treatment with simple carbohydrates; Adjusting glucose-lowering drug dosage is recommended
Clinically significant hypoglycaemia (level 2)	< 54 mg/dl < 3,0 mmol/l	Sufficiently low glucose levels indicative of clinically relevant hypoglycaemia
Severe hypoglycaemia (level 3)	No specific glucose threshold	Hypoglycaemia accompanied by severe cognitive impairment requiring the assistance of others to remedy an episode of hypoglycaemia

accidental insulin overdose, alcohol consumption or prolonged exercise – the consumption of complex carbohydrates and blood glucose level monitoring are recommended in addition to the above intervention.

2. In unconscious persons or ones with impaired consciousness and unable to swallow:
   - administer intravenously a 10% or 20% glucose solution (0.2–0.5 g glucose/kg of body weight); if there is a risk of another drop in blood glucose level, the infusion of a 10% glucose solution should be maintained along with blood glucose level control;
   - in case of difficulties with venous access, administer 1 mg of glucagon intramuscularly or subcutaneously (0.5 mg in children weighing below 25 kg and 1 mg in children weighing above 25 kg); a 3 mg dose of glucagon may also be administered intranasally in diabetics over the age of 4, regardless of body weight;
   - after regaining consciousness, if there is a risk of recurrent hypoglycaemia incident, oral administration of 10–20 g of carbohydrates along with blood glucose level monitoring is recommended;
   - diabetics treated with insulin or sulphonylurea derivatives may experience prolonged episodes of hypoglycaemia, sometimes requiring hours of glucose solution infusion;
   - hospitalisation of the patient should be considered in cases of severe hypoglycaemia incidents due to the life-threatening possibility of irreversible changes in the central nervous system; this particularly applies to patients who may suffer the re-occurrence of severe hypoglycaemia;
   - in the outpatient setting, intramuscular or subcutaneous injection of glucagon or intranasal glucagon administration by trained community members is recommended.
3. In patients undergoing intensive insulin therapy with the use of insulin analogues or treatment with a personal insulin pump, managing hypoglycaemia typically involves only the oral administration of 15 g of glucose and checking blood glucose after 15 minutes. If the low blood glucose level persists, glucose should be administered once again, with the blood glucose level re-checked after another 15 minutes (15/15 rule). With personal insulin pump therapy, if hypoglycaemia does occur or there is a risk that it may do so, it is advisable to stop the basal insulin infusion and re-check the blood glucose level.
4. In patients treated with long-acting insulins (human insulin and analogues), yet another factor to be considered is the possibility of a delayed relapse of hypoglycaemia once the diabetic patient has first been brought out of the hyperglycaemic state.

REFERENCES

1. Heinemann L, Freckmann G, Ehrmann D, et al. Real-time continuous glucose monitoring in adults with type 1 diabetes and impaired hypoglycaemia awareness or severe hypoglycaemia treated with multiple daily insulin injections (HypoDE): a multicentre, randomised controlled trial. Lancet 2018; 391: 1367–1377.
2. Hermanns N, Heinemann L, Freckmann G, et al. Impact of CGM on the management of hypoglycemia problems: overview and secondary analysis of the HypoDE study. J Diabetes Sci Technol 2019; 13: 636–644.
3. International Hypoglycemia Study Group. Glucose concentrations of less than 3 mmol/l (54 mg/dl) should be reported in clinical trials: a joint position statement of the American Diabetes Association and European Association for the Study of Diabetes. Diabetes Care 2017; 40: 155–157.
4. Seaquist ER, Anderson J, Childs B, et al. Hypoglycemia and diabetes: a report of a work group of the American Diabetes Association and the Endocrine Society. Diabetes Care 2013; 36: 1384–1395.

16. Management of acute diabetic complications in the course of hyperglycaemia

Key recommendations
· There are no large randomised clinical trials to substantiate the therapeutic management of acute hyperglycaemic conditions recommended in various guidelines. Nonetheless, following the guidelines for the management of diabetic ketoacidosis shortens the treatment time. [**C**]
· In diabetic ketoacidosis, crystalloids are preferred over colloid fluids in replenishing the body's water deficit. [**C**]
· In acute hyperglycaemic conditions, continuous intravenous insulin infusion is preferred, with the initial dose (bolus) calculated based on current body weight rather than blood glucose level values. [**C**]
· In acute hyperglycaemic states, particularly diabetic ketoacidosis, potassium should be supplemented by monitoring serum potassium levels. [**B**]
· Bicarbonate administration is not recommended in diabetic ketoacidosis at pH values exceeding 6.9. [**B**]

I. Classification

1. Diabetic ketoacidosis (mortality: 0.2–2%; risk of death is increased in patients with recurrent episodes of DKA).
2. Hyperosmolar Hyperglycaemic State (mortality – ca. 15%).
3. Lactic acidosis (mortality – ca. 50% based on historical data but nowadays largely depends on the experience of the centre providing treatment, as well as the severity of the underlying disease and co-morbidities).

II. Diabetic ketoacidosis

1. Causes:
- interruption of or errors in insulin therapy;
- late diagnosis of type 1 diabetes;
- smoking, alcohol abuse;
- acute inflammations (e.g. bacterial, viral, fungal infections);
- pregnancy;
- diabetic renal disease;
- other.

2. Diagnosing: see table 16.1.
3. Differentiation:
- starvation ketosis;
- alcoholic ketoacidosis [blood glucose level rarely above 250 mg/dl (13.9 mmol/l); bicarbonate concentration usually at 18 mmol/l or higher];
- metabolic acidosis with an anion gap above 20 mEq/l (intoxication with ethyl glycol, methanol, paraldehyde and salicylates);
- lactic acidosis (note that an increase in blood lactate levels may occur in ketoacidosis);
- other comatose states that lead to hyperglycaemia and ketosis or are accompanied by such things as stroke or uremic coma.

4. Monitoring ketoacidosis:
- assessing blood pressure, pulse rate, respiratory rate and degree of consciousness every 1–2 hours;
- measuring fluid balance every 1–2 hours;
- measuring body temperature every 8 hours;
- measuring blood glucose levels every 1 hour;
- determining serum or plasma sodium and potassium concentrations every 4 hours [corrected

Table 16.1. Ketoacidosis diagnosis criteria along with severity assessment

	Diabetic ketoacidosis		
	Mild	Moderate	Severe
Plasma glucose [mg/dl]*	> 250	> 250	> 250
blood pH	7.25–7.30	7.00–7.24	< 7.00
Blood $NaHCO_3$ concentration [mEq/l]	15–18	10–15	< 10
Ketones in urine**	Present	Present	Present
Ketones in serum**	Present	Present	Present
Serum osmolality [mOsm/kg]	Variable	Variable	Variable
Anion gap***	> 10	> 12	> 12
Impaired consciousness	Conscious	Conscious/disoriented	Stupor/coma

** Not applicable to patients treated with SGLT2 inhibitors (Flozin) who may have lower blood glucose values (euglycaemic diabetic ketoacidosis); **Nitroprusside method; *** as per the following formula: Na^+ (mEq/l) – [Cl – (mEq/l) + HCO_3– (mEq/l)]*

serum sodium concentration should be calculated as follows: for every 100 mg/dl (5.6 mmol/l) of blood glucose level value above 100 mg/dl (5.6 mmol/l), add 2 mmol/l to the current serum Na+ result];
- for hyperkalaemia > 5.5 mmol/l when potassium is not being administered – check after 2 hours; for kalemia < 5.5 mmol/l with potassium supplementation – check every 4 hours;
- arterial blood gas test – every 4 hours;
- determination of baseline ketone level in blood and/or urine.

5. Treatment:

A. Hydration of the patient:

The water deficit (on average 100 ml/kg body weight) should be made up intravenously within 24–48 hours along with monitoring the state of the circulatory system:
- 1,000 ml of 0.9% NaCl solution within the first hour, then;
- 500 ml/h of 0.9% NaCl solution for 4 hours, then;
- 250 ml/h of 0.9% NaCl solution until the acid-base balance is restored;
- once the blood glucose level falls below 250 mg/dl (13.9 mmol/l), a 5% glucose infusion should be added, administered at a rate of 100 ml/h; if glucose is added after 24 hours of fluid therapy, the volume of the administered 0.9% NaCl solution should be reduced to 150 ml/hour;
- in states of increased energy demand (e.g. infection concomitant with ketoacidosis, hyperthyroidism, pregnancy) it is recommended to administer a 10% glucose solution and not a 5% one, at an infusion rate of 70 ml/hour;
- In patients with low body weight – below 50 kg – hydration should be carried out according to paediatric recommendations (Figure 23.1).

B. Reducing hyperglycaemia:

Intravenous insulin therapy:
- the starting bolus dose of insulin is 0.1 units/kg of body weight;
- this is followed by continued intravenous insulin infusion at a rate of 0.1 units/kg bw/h along with blood glucose level control; in patients who have subcutaneous insulin deposition after previous injections, intravenous insulin therapy should be started with an infusion of 0.1 units/kg bw/h without a starting bolus dose;
- the infusion rate should be adjusted according to the current blood glucose level, which must be monitored every 1 hour;
- the reduction in blood glucose values per hour should not exceed 100 mg/dl (5.6 mmol/l);
- if plasma glucose does not fall by 50–70 mg/dl (2.8–3.9 mmol/l) from the baseline value within the first hour, the rate of intravenous insulin infusion should be increased (usually doubled) every hour until a continuous blood glucose level decrease of 50–70 mg/dl/hour (2.8–3.9 mmol/l/hour) is achieved.

C. Rectifying electrolyte abnormalities:
- the potassium deficit in persons with ketoacidosis is 3–5 mmol/kg bw;
- potassium supplementation should be carried out according to the principles outlined below.
- Serum potassium concentration:
- K+ > 5.5 mmol/l → do not administer KCl;
- K+ 5-5.5 mmol/l → 5–10 mmol of KCl per hour;
- K+ 4-5 mmol/l → 10–15 mmol of KCl per hour;
- K+ 3-4 mmol/l → 15–20 mmol of KCl per hour;
- K+ < 3 mmol/l → stop insulin administration; use an intravenous infusion of 25 mmol of KCl per hour.

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

D. The use of bicarbonate should be considered only when pH below 6.9 is found in arterial blood (in small doses not exceeding 1 mmol/kg bw); elevated lactate concentration in the course of ketoacidosis is not an indication for the administration of bicarbonate (a small increase in lactate due to tissue hypoxia often occurs in ketoacidosis).

E. Low Molecular Weight Heparin – consider administering a preventive dose in patients with severe DKA.

6. Adverse effects of the treatment used:
- hypokalaemia associated with insulin administration and compensation of acidosis using bicarbonates;
- hypernatraemia, mainly associated with unwarranted administration of $NaHCO_3$ (e.g. pulmonary oedema, cerebral oedema; should cerebral oedema occur, the following treatment is recommended: intravenous infusion of mannitol at a dose of 1–2 g/kg of body weight over 20 minutes);
- hyperglycaemia caused by discontinuation of intravenous insulin after improvement, without timely administration of insulin by the subcutaneous route;
- hypoglycaemia caused by too intensive insulin treatment;
- hyperchloremia due to the use of too much saline.

7. Complications of ketoacidosis:
- hypovolaemic shock;
- acute renal failure;
- cerebral oedema – more common in children.

8. Figure 23.1 shows the unique aspects of managing acute ketoacidosis in children.

III. Hyperosmolar Hyperglycaemic State

1. Causes:
- it typically develops following delayed diagnosis or inadequate treatment of type 2 diabetes;
- in the course of a stroke or myocardial infarction;
- after heavy alcohol consumption;
- following the use of certain diuretics;
- as well as in patients with chronic renal failure;
- with mental illness and with symptoms of infection.

2. Diagnosis

Laboratory diagnostic criteria for Hyperosmolar Hyperglycemic State:
- blood glucose level > 600 mg/dl (> 33.3 mmol/l);
- pH > 7.30;
- serum bicarbonate concentration > 15.0 mmol/l;
- corrected hypernatraemia (calculated according to the formula) ≥ 150 mmol/l;
- serum ketones: none/trace amounts;
- effective osmolality > 320 mOsm/kg H_2O.

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

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

3. Differentiation:
- ketosis coma;
- coma states in the course of central nervous system diseases;
- uremic coma;
- coma in the course of poisoning.

4. Treatment

The principles of treatment are similar to those for ketoacidosis:
- lowering blood glucose level (similar insulin doses as in the treatment of ketoacidosis);
- normalising plasma molality – gradual reduction in osmolality (not more than 3 mOsm/kg H_2O/hour);
- subcutaneous administration of Low Molecular Weight Heparin;
- compensating for water and electrolyte deficiencies: significantly higher water loss than in patients with ketoacidosis;
- using a hypotonic solution (0.45% NaCl or emergency rehydration fluid), and once the appropriate plasma molality has been achieved, 0.9% NaCl by intravenous infusion under cardiovascular control: the NaCl solution infusion rate is set according to the serum sodium concentration and plasma molality;
- the blood glucose level must be checked every hour and the electrolyte level every 4–6 hours.

IV. Lactic acidosis

1. Causes:
- type A lactic acidosis develops following cardiogenic shock, severe bleeding, septic shock or acute and chronic respiratory failure (not characteristic of diabetes), with 3/4 of diabetics dying from cardiovascular causes; this syndrome can occur in diabetic patients;
- type B lactic acidosis occurs for reasons other than hypoxia. It occurs in patients with diabetes mellitus, liver disease and proliferative diseases, as well as after taking ethanol, biguanides, salicylates and methyl alcohol.

2. Laboratory diagnostic criteria:
- moderately elevated blood glucose level; however, it may also be normal;
- reduced blood pH (< 7.30), bicarbonate concentration < 10 mmol/l, anion gap > 16 mmol/l;
- lactate concentration > 5 mmol/l;
- no change in serum sodium concentration (may be reduced in alcoholics);
- there is usually an increase in serum potassium levels.

3. Treatment includes the following actions:
- counteracting shock (compensating for dehydration and hypovolaemia, moderate administration of peripheral vasoconstrictors);
- prevention of hypoxaemia and hypoxia;
- preventing excessive lactic acid formation (infusion of glucose and insulin while monitoring blood glucose level);
- alkalinisation by administering sodium bicarbonate (the requirement is as follows: BE × 0.3 × body weight [in kg]);
- in justified cases (biochemical and/or clinical indications), renal replacement therapy is required.

REFERENCES

1. Chua HR, Schneider A, Bellomo R. Bicarbonate in diabetic ketoacidosis — a systematic review. Ann Intensive Care 2011; 6: 23.
2. Cieluch A, Uruska A, Falkowski B, et al. Nonadherence to potassium replacement protocol leads to prolonged management of diabetic ketoacidosis. Pol Arch Intern Med 2018; 128: 416–420.
3. Dhatariya KK, Nunney I, Higgins K, et al. A national survey of the management of diabetic ketoacidosis in the UK in 2014. Diabetic Med 2016; 33: 252–260.
4. Dhatariya KK, Vellanki P. Treatment of diabetic ketoacidosis (DKA)/hyperglycemic hyperosmolar state (HHS): Novel advances in the management of hyperglycemic crises (UK Versus USA). Curr Diab Rep 2017; 17: 33.
5. Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic crises in adult patients with diabetes. Diabetes Care 2009; 32: 1335–1343.
6. Perel P, Roberts I, Ker K. Colloids versus crystalloids for fluid resuscitation in critically ill patients. Cochrane Database Syst Rev 2013; 2. CD000567.
7. Umpierrez GE, Jones S, Smiley D, et al. Insulin analogs versus human insulin in the treatment of patients with diabetic keto- acidosis: a randomized controlled trial. Diabetes Care 2009; 32: 1164–1169.
8. Thomas M, Harjutsalo V, Feodoroff M, et al. The Long-term incidence of hospitalization for ketoacidosis in adults with established T1D-A prospective cohort study. J Clin Endocrinol Metab 2020; 105: 231–241.

17. Principles of diagnosis and treatment of patients with chronic coronary syndrome and coexisting diabetes

Key recommendations
• In diabetic patients with chronic coronary syndrome (CCS) in the absence of contraindications, acetylsalicylic acid and statins should be used [A] and ACE inhibitor treatment should be considered. [**C**]
• After a heart attack, the administration of a β-blocker should be continued indefinitely. [**B**]
• After myocardial infarction, drugs with documented cardioprotective effects (SGLT2 inhibitors, GLP1 agonists) should be included. [**A**]

Coronary artery disease (CAD) is a condition caused by the presence of atherosclerotic plaques in the epicardial coronary arteries. The clinical course of the disease can be variable, changing over time. The course of CAD can involve long periods of stability. This disease, as a chronic, progressive condition, can worsen at any time, resulting in an acute coronary syndrome (ACS) conditioned by an acute thrombotic event caused by rupture or erosion of atherosclerotic plaque. CAD is therefore clinically diverse and in its clinical course, acute coronary syndromes (ACS) and chronic coronary syndromes (CCS) can be distinguished.

The following clinical situations are most commonly encountered when CCS is suspected or diagnosed:

- patients with suspected CCS and 'stable' angina and/or dyspnoea;
- patients with newly diagnosed heart failure or left ventricular dysfunction and suspected CCS;
- patients who are asymptomatic or have stable symptoms one year after the diagnosis of disease or revascularisation;
- patients with symptoms of angina and suspected vasospastic or microvascular disease;
- asymptomatic patients diagnosed with CCS at screening. All of the above situations are classified as CCS, but each is associated with a different risk of future cardiovascular events, which may vary over time.

I. The differences in the clinical course of CCS as above in people with diabetes indicate the need to perform at least annual check-ups to assess the presence of risk factors for this disease.

II. Indications for tests for coronary artery disease diagnosis

Indications for diagnostic, functional and anatomical tests for CCS diagnosis and risk stratification in diabetic patients (cardiology consultation) (Fig. 17.1)

1. Presence of typical or atypical cardiovascular symptoms.
2. Abnormal resting ECG.

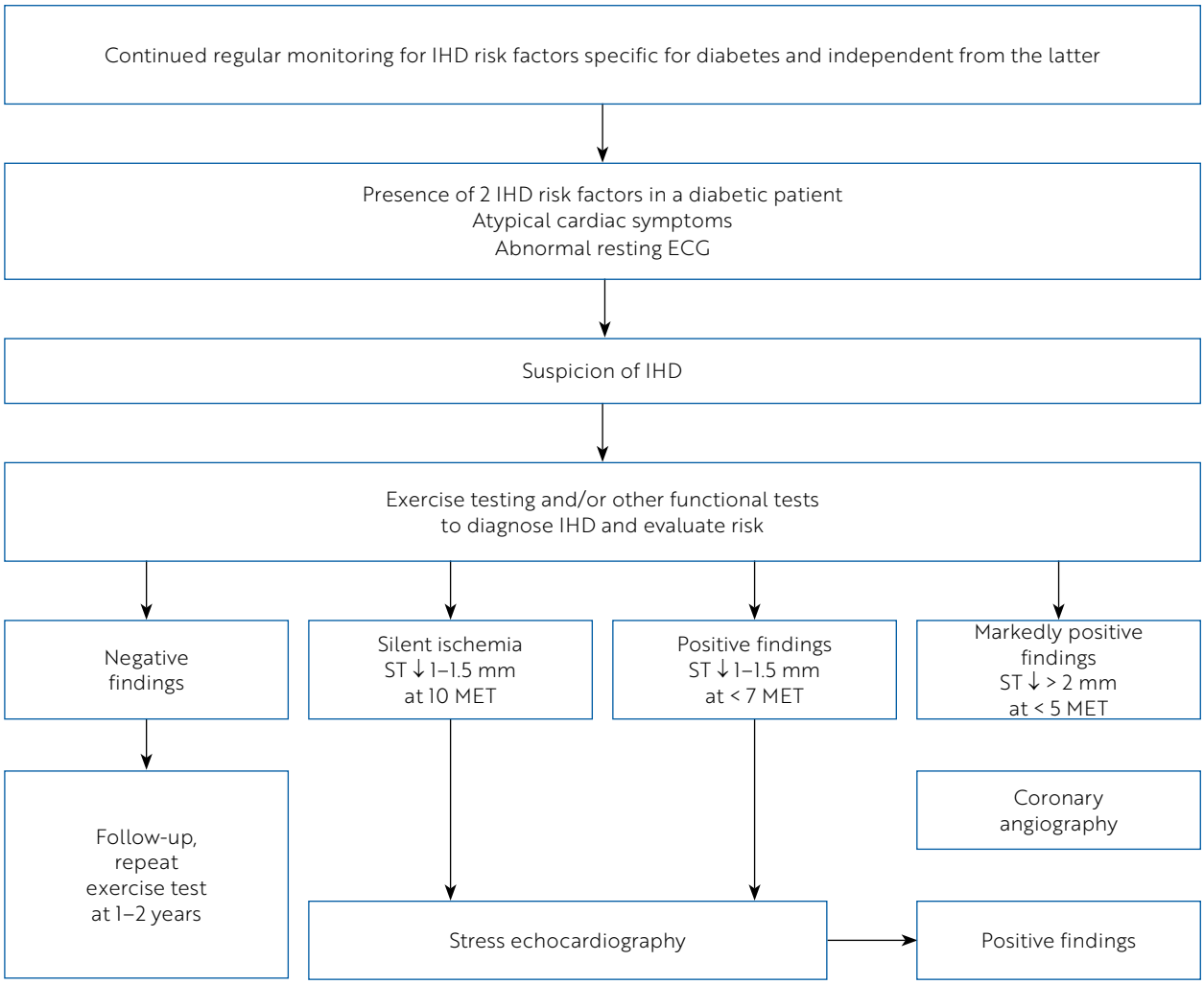


Figure 17.1. An algorithm for the diagnosis of and risk stratification in ischemic heart disease (IHD) in diabetic patients.

3. Coexistence of atherosclerotic lesions in peripheral arteries, including carotid arteries.
4. Planned initiation of intensive exercise in people > 35 years old with a history of an inactive lifestyle.
5. Type 1 diabetes, lasting > 15 years.
6. Presence, in addition to diabetes, of two or more CCS risk factors:

- abnormal lipid metabolism parameters (see Chapter 4);
- hypertension;
- smoking;
- family history of premature atherosclerosis;
- presence of albuminuria;
- the presence of autonomic neuropathy.

III. Treatment of diabetic patients with chronic coronary syndrome – according to the new terminology of the European Society of Cardiology

1. Implementing a healthy lifestyle (see Chapter 6).
2. Hypoglycaemic treatment aimed at achieving therapeutic goals (see Chapter 4).
3. Reduction or normalisation of risk factors for coronary artery disease:

- normalisation of blood pressure (see Chapter 13);
- treatment of lipid disorders (see Chapter 14).

4. Specificity of pharmacotherapy of CCS in diabetes

- antiplatelet treatment – acetylsalicylic acid. Should also be used in patients with type 2 diabetes and type 1 diabetes > 40 years of age, at increased risk of cardiovascular events (> 5% risk of developing ischaemic heart disease within 10 years). The efficacy of acetylsalicylic acid for primary prevention in diabetic patients with low cardiovascular risk has not been confirmed:
  - » the recommended dose of acetylsalicylic acid is 75 –100 mg/day;
  - » in case of contraindications to acetylsalicylic acid it may be appropriate and advis-

able to administer clopidogrel at a dose of 75 mg/day;

» after percutaneous coronary intervention (PCI), ASA at 75–100 mg/day and clopidogrel at 75 mg/day for 6 months is recommended. In cases of increased risk of haemorrhagic complications, it is advisable to shorten the treatment to 1–3 months. Prasugrel or ticagrelor may be considered as second-line treatment in place of clopidogrel in situations of high risk of coronary complications such as, but not limited to: high risk of elective stent implantation (e.g. suboptimal stent implantation or other situations during the procedure associated with a high risk of stent thrombosis, left coronary artery trunk stenosis with high anatomical complexity or stent implantation in multiple vessels) or if DAPT cannot be used due to ASA intolerance;

- use of cardioselective β-blockers or multifunctional β-blockers blocking α1 and β1 receptors;
- drugs that block the RAA system (ACE inhibitors).

If pharmacotherapy fails, it is advisable to consider revascularisation.

Exercise testing and other functional methods are used to: confirm the diagnosis, document ischaemia, stratify risk, and facilitate the selection of methods of treatment and the evaluation of their effectiveness. Exercise test is the most frequently performed test as it still continues to be the most easily accessible method, but its sensitivity and specificity in detecting ischaemia are limited, especially in women. Other functional methods include stress echocardiography, perfusion scintigraphy, magnetic resonance imaging (MRI), and positron emission tomography (PET). Among anatomical methods, invasive coronary angiography is still the "gold standard", and multidetector computed tomography (MDCT) may also be useful. It should be pointed out that patients with diabetes are usually at high and very high risk of coronary heart disease. In the high-risk group, functional tests are recommended as a first step, while in very high-risk patients, coronary angiography is the first step in the diagnostic process. The role of multislice CT is a high negative predictive value, so it is rather useful to exclude significant coronary artery stenosis. It is not recommended for high-risk patients as it represents an unnecessary burden of contrast and radiological exposure for them.

REFERENCES

1. Baigent C, Blackwell L, Collins R,. et al. Aspirin in the primary and secondary prevention of vascular disease: collaborative meta-analysis of individual participant data from randomised trials. Lancet 2009; 373: 1849–1860.
2. Kearney PM, Blackwell L, Collins R, et al. Efficacy of cholesterol-lowering therapy in 18,686 people with diabetes in 14 randomised trials of statins: a meta-analysis. Lancet 2008; 371: 117–125.
3. Gaede P, Lund-Andersen H, Parving HH, Pedersen O. Effect of a multifactorial intervention on mortality in type 2 diabetes. N Engl J Med 2008; 358: 580–591.
4. Knuuti J, Wijns W, Saraste A, et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. Eur Heart J 2020; 41: 407–477.
5. Neumann FJ, Sousa-Uva M, Ahlsson A, et al. 2018 ESC/EACTS guidelines on myocardial revascularization. Eur Heart J 2019; 40: 87–165.
6. Shepherd J, Barter P, Carmena R, et al. Effect of lowering LDL cholesterol substantially below currently recommended levels in patients with coronary heart disease and diabetes: the Treating to New Targets (TNT) study. Diabetes Care 2006; 29: 1220–1226.

17.1. Management of acute coronary syndromes in patients with diabetes – antihyperglycemic therapy

Key recommendations
· When a patient with acute coronary syndrome is admitted to hospital, blood glucose should be measured, in diabetic patients if no current result is available, HbA_{1c} should also be assessed. [**A**]
· On the first day of acute coronary syndrome, intravenous insulin infusion is recommended under glycaemic control, with target values of 100–180 mg/dl. [**C**]

In acute coronary syndrome, normalisation of glycaemia with intravenous insulin infusion is recommended in states of unspecified ‚relative hyperglycaemia'. Relative hyperglycaemia is defined as a blood glucose of more than 140 mg/dl (7.8 mmol/l) in patients with previously diagnosed diabetes or more than 180 mg/dl (10.0 mmol/l) in patients without previously diagnosed diabetes. Intravenous insulin is the only way to rapidly normalise blood glucose and improve prognosis after acute coronary syndrome. Treatment of ischaemic heart disease in people with carbohydrate metabolism disorders should involve a diabetes specialist wherever possible.

I. First day of acute coronary syndrome

1. Oral antidiabetic drugs should be discontinued.
2. In all cases of acute coronary syndrome, blood glucose should be measured on admission.
3. When blood glucose exceeds 140 mg/dl (7.8 mmol/l) in people with previously diagnosed diabetes or 180 mg/dl (10.0 mmol/l) in people without previously diagnosed diabetes, an intravenous insulin infusion should be given at the rate shown in Table 17.1.1. Recommended frequency of blood glucose control during the day: every 1 hour, and after blood glucose stabilisation: every 2 hours. Glucose levels should be maintained in the range of 100–180 mg/dl (5.6–10 mmol/l), adjusting insulin infusion accordingly.
4. Potassium levels should be monitored during the insulin infusion.

If blood glucose is above 180 mg/dl (10.0 mmol/l), the intravenous glucose infusion should be temporarily interrupted and restarted once blood glucose has fallen to 180 mg/dl (10.0 mmol/l), with a concomitant increase in the rate of intravenous insulin infusion.

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

II. From the second day of acute coronary syndrome until the end of hospitalisation

1. Hypoglycaemic treatment must provide 24-hour blood glucose values between 100 and 180 mg/dl (5.6–10.0 mmol/l). It must therefore be individualised, preferably carried out in collaboration with a diabetologist.
2. In patients without evidence of acidosis, with carbohydrate metabolism disorders diagnosed on the first day of acute coronary syndrome or previously successfully treated with metformin, good metabolic control of diabetes in this period may be ensured by an appropriate diet (Chapter 6). In all other cases, insulin therapy should be provided in a multiple-injection model according to the previously described principles (Chapter 12).
3. In type 2 diabetic patients with overweight or obesity immediately before the end of hospitalisation, even as early as the third day after the intervention, metformin can be administered in addition, in the absence of contraindications to its administration. After 2–3 days of treatment with metformin, it may be possible to reduce the dose of insulin.

III. At the end of hospitalisation

Metformin should be started in any patient with type 2 diabetes after an acute coronary syndrome, unless there are contraindications or intolerance to the drug.

Patients with type 2 diabetes who have achieved good metabolic control (II. 1) on the day

Table 17.1.1. Approximate insulin infusion rate as a function of glucose concentration

Blood glucose	10% glucose solution [ml/hour]	Insulin [units/hour]
< 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 blood glucose is reduced to < 180 mg/dl (10.0 mmol/l)/hour, and then 50	2,0–4,0
250–300 mg/dl 13,9–17,4 mmol/l	Stop the infusion, until blood glucose is reduced to < 180 mg/dl (10.0 mmol/l)/hour, and then 50	4,0–6,0

of hospital discharge, with a daily insulin requirement not exceeding 30 units, may be returned to the hypoglycaemic therapy used before the acute coronary syndrome. Patients who were diagnosed with diabetes during hospitalisation and achieved good metabolic control (II. 1) on the day of hospital discharge, with a daily insulin requirement not exceeding 30 units, who are obese or overweight, can be managed with oral metformin, possibly in combination with other drugs. If good metabolic control of diabetes is not achieved or the daily insulin requirement exceeds 30 units, insulin therapy should be continued. Any patient with carbohydrate metabolism disorders after an acute coronary syndrome should be urgently referred to a diabetes specialist.

Note 1: In every patient with acute coronary syndrome, except those with previously diagnosed diabetes, an oral glucose tolerance test should be performed before leaving hospital (see section 1, point III, Table 17.1.1). If glucose intolerance or diabetes is diagnosed, a diabetes consultation is indicated.

Note 2: Before elective coronary angiography performed for diagnostic or therapeutic purposes, metformin should be discontinued at least 48 hours before the procedure. It can be resumed 24 hours after coronary angiography.

Note 3: Results from randomised trials indicate additional cardioprotective effects of SGLT2 inhibitors and GLP1 agonists. Their addition to therapy should be considered in patients at high or very high cardiovascular risk.

REFERENCES

1. Kristensen SL. Cardiovascular, mortality, and kidney outcomes with GLP-1 receptor agonists in patients with type 2 diabetes: a systematic review and meta-analysis of cardiovascular outcome trials. Lancet Diabetes Endocrinol 2019; 7: 776–785.
2. McGuire DK, Shih WJ, Cosentino F, et al. Association of SGLT2 inhibitors with cardiovascular and kidney outcomes in patients with type 2 diabetes a meta-analysis. JAMA Cardiol 2021; 6: 148–158.
3. Finfer S, Chittock DR, Yu-Shuo Su S, et al. Intensive versus conventional glucose control in critically ill patients. N Engl J Med 2009; 360: 1283–1297.
4. Ritsinger V, Malmberg K, Mårtensson A, et al. Intensified insulin-based glycaemic control after myocardial infarction: mortality during 20 year follow-up of the randomised Diabetes Mellitus Insulin Glucose Infusion in Acute Myocardial Infarction (DIGAMI 1) trial. Lancet Diabetes Endocrinol 2014; 2: 627–633.
5. Umpierrez GE, Reyes D, Smiley D, et al. Hospital discharge algorithm based on admission HbA1c for the management of patients with type 2 diabetes. Diabetes Care 2014; 37: 2934–2939.

18. Stroke in diabetic patients

Key recommendations
· Hyperglycaemia detected on admission to hospital in the acute phase of stroke is associated with higher mortality, more severe stroke and greater neurological deficit in both diabetic and non-diabetic patients. [**A**]
· The intervention studies conducted to date provide no evidence that maintenance of normoglycaemia, achieved with intravenous insulin therapy, in the acute phase of stroke improves patient prognosis. However, such therapy is associated with a higher risk of hypoglycaemia. [**A**]
· Current guidelines for correcting hyperglycaemia in stroke are based only on expert recommendations/opinions. [**E**]

Diabetes is a strong risk factor for both ischaemic and haemorrhagic stroke. Elevated glucose levels are found in more than 60% of patients hospitalised for acute stroke. Approximately 20% of cases of hyperglycaemia are found in individuals with previously diagnosed diabetes, 16–24% of cases include patients with previously undiagnosed diabetes, while the remaining cases represent patients with transient (stress) hyperglycaemia.

Hyperglycaemia found in the acute stage of stroke stroke is an unfavourable prognostic factor in both diabetic and non-diabetic patients. Its presence is associated with a risk of a larger ischaemic focus and its haemorrhagic conversion, a more severe course of the disease and a worse prognosis (lower independence of patients and higher early and late mortality). Hyperglycaemia found on admission to hospital usually tends to gradually and spontaneously decrease after the first several hours/days of the condition.

The few randomised intervention studies conducted in the acute stage of stroke (up to 72 hour) do not provide evidence that maintenance of normoglycaemia, achieved with intravenous insulin therapy, reduces mortality or improves neurological deficit. The recommended glycaemic targets for people diagnosed with acute stroke are similar to those recommended for other severe acute conditions. Insulin therapy should be initiated with glycaemic values ≥ 180 mg/dl (10 mmol/l) and glycaemic levels should be maintained in the range of 140–180 mg/dl (7.8–10 mmol/l), avoiding the risk of hypoglycaemia.

Insulin should be administered intravenously in 0.9% NaCl solution using a syringe pump, under strict glycaemic control. The rate of insulin infusion should be modified according to point-of-care blood glucose values measured every 1 hour, and every 2 hours once stable values are obtained. A general scheme for modifying the rate of intravenous insulin infusion according to the found glycaemia is shown in Table 26.1. Potassium levels should be monitored during insulin infusion 2–3 times a day.

The administration of insulin by intravenous infusion of GIP (glucose, insulin, potassium) is not recommended. In the first few days after a stroke and in patients who remain unconscious for longer, insulin should not be administered subcutaneously.

A medical unit providing stroke treatment should have a specific dosing algorithm for intravenous insulin infusion, which takes into account changes in the infusion rate according to the glycaemic values. The team of doctors and nurses should be trained in hyperglycaemic therapy.

As soon as the patient's condition improves and they start eating meals, the intravenous insulin infusion should be discontinued and subcutaneous insulin administration sholud be initiated. Discontinuation of intravenous insulin infusion should be preceded by subcutaneous administration of short-acting insulin or a rapid-acting insulin analog approximately 1 hour before stopping the intravenous infusion. The recommended treatment regimen for subcutaneously administered insulin is a short-acting insulin or its rapid-acting analog administered before meals and a long-acting insulin administered 1 or 2 times a day. In some cases it is sufficient to administer only a short-acting or rapid-acting insulin before meals. The insulin should be administered before meals, based on blood glucose measurements taken immediately before meals.

Due to the high likelihood of diabetes in patients with recent ischaemic stroke, in whom diabetes has not been previously diagnosed, it is necessary to carry out an evaluation in this direction once the patient's condition has been stable.

Recommendations regarding blood pressure and other aspects of the management of patients with ischaemic stroke are the same as for non-diabetic patients, as there are no data that would suggest the benefit of different or specific management in diabetic patients.

Secondary prevention after stroke follows generally applicable principles.

REFERENCES

1. Bellolio MF, Gilmore RM, Ganti L. Insulin for glycaemic control in acute ischaemic stroke. Cochrane Database Syst Rev 2014; 1: CD005346.
2. Capes SE, Hunt D, Malmberg K, et al. Stress hyperglycemia and prognosis of stroke in nondiabetic and diabetic patients: a systematic overview. Stroke 2001; 32: 2426–2432.
3. Jauch EC, Saver JL, Adams HP, et al. Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2013; 44: 870–947.
4. Johnston KC, Bruno A, Pauls Q, et al. Intensive vs. standard treatment of hyperglycemia and functional outcome in patients with acute ischemic stroke: the SHINE randomized clinical trial. JAMA 2019; 322: 326–333.
5. Powers WJ, Rabinstein AA, Ackerson T, et al. American Heart Association Stroke Council. 2018 guidelines for the early management of patientswith acute ischemic stroke: a guideline forhealthcare professionals from the American HeartAssociation/American Stroke Association. Stroke 2018; 49: e46-e110.
6. Fuentes B, Ntaios G, Putaala J, et al. European Stroke Organisation (ESO) guidelines on glycaemia management in acute stroke. Eur Stroke J 2018; 3: 5–21.

19. Prevention, diagnosis and treatment of diabetic kidney disease

Key recommendations
• Screening for increased urinary albumin excretion should be performed once a year in patients with type 1 diabetes (T1D) from the 5th year of disease duration; in patients with type 2 diabetes (T2D) from the time of diagnosis and in all diabetic patients with coexisting hypertension. [**B**]
• To reduce the risk of diabetic kidney disease and/or to slow its progression, glycaemic control, blood pressure control and control of lipaemia should be optimised. [**A**]
• If increased urinary albumin excretion is found, therapy with ACE inhibitors or angiotensin AT1 receptor antagonists should be used as they reduce the risk of progression of diabetic kidney disease (considering contraindications for their use). [**A**]
• Serum creatinine and potassium levels should be monitored when using an ACE inhibitor, angiotensin AT1 receptor antagonist and/or a diuretic. [**E**]

In diabetic patients, urinary albumin excretion, serum creatinine levels and estimated glomerular filtration rate (eGFR) should be determined to detect or assess the severity of diabetic kidney disease. Albuminuria and eGFR are independent predictors of cardiovascular and renal risk in diabetic patients.

I. Screening for albuminuria

Screening for albuminuria should be performed as follows once a year;

- in T1D patients from the 5th year of disease duration;
- in T2D patients from the time of diagnosis.

To assess urinary albumin excretion: the *albumin/creatinine ratio* (ACR) should be determined from the results of quantitative determinations in a single urine sample (preferably morning urine) — interpretation of results is shown in Table 19.1. The diagnosis of increased urinary albumin excretion is mandated by two positive ACR results.

II. Blood creatinine levels

Blood creatinine levels should be determined in diabetic patients at least once a year, and this should be done regardless of the amount of urinary albumin excretion. The creatinine levels should be used to determine the eGFR value.

III. Epidemiology Collaboration formula should be used for determining GFR

CKD-EPI

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

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 = minimum of Scr/k or 1
max = maximum of Scr/k or 1

IV. Chronic kidney damage

The stages of chronic kidney damage are defined in Table 19.2.

Table 19.1. Definition of abnormal urinary albumin excretion*

Category	AER [mg/day]	ACR (spot urine sample) [mg/d. or mg/g of creatinine]*	Albumin excretion [µg/min] — urine collection
A1 – normal albuminuria or slightly increased albuminuria	< 30	< 30	< 20
A2 – moderately increased albuminuria	30–300	30–300	20–200
A3 – overt proteinuria	> 300	> 300	≥ 200

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

Table 19.2. Stages of chronic kidney damage

Category	Description	eGFR [ml/min/1.73 m^2]
G1	Kidney damage* with normal or increased eGFR	≥ 90
G2	Kidney damage* with mildly decreased eGFR	60–89
G3a	Moderately decreased eGFR	45–59
G3b	Moderately to severely decreased eGFR	30–44
G4	Significantly decreased eGFR	15–29
G5	End-stage renal failure	< 15

**Kidney damage is defined when there are a) abnormalities in biochemical composition and/or urine sediment; b) abnormal renal injury markers in blood and/or in imaging examinations of the kidneys or urinary tracts, which persist for more than 3 months*

V. Nephrology consultation

A referral of the patient for nephrology consultation should be considered if:

- in the event that eGFR decreases to < 60 ml/min/1.73 m^2 and non-diabetic kidney disease is suspected;
- in the event that eGFR decreases to < 30 ml/min/1.73 m^2, the patient should be referred for nephrology consultation.

VI. Preventive recommendations

1. To reduce the risk of diabetic kidney disease and/or to slow its progression, glycaemic control, blood pressure control and control of lipaemia should be optimised.
2. 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, the therapeutic targets for glycaemia, lipidaemia and blood pressure outlined in Chapter 4 should be pursued.
2. If albuminuria is found, therapy with ACE inhibitors or angiotensin AT1 receptor antagonists should be used as they reduce the risk of progression of nephropathy (considering contraindications for their use).
3. Serum creatinine and potassium levels should be monitored when using an ACE inhibitor, angiotensin AT1 receptor antagonist and/or a diuretic.
4. The combined use of ACE inhibitors with angiotensin AT1 receptor antagonists is not recommended.
5. The use of thiazide/thiazide-like diuretics should be used when GFR ≥ 30 ml/min/1.73 m^2; a loop diuretic should be used when GFR < 30 ml/min/1.73 m^2.
6. Metformin should not be used in patients with eGFR < 30 ml/min/1.73 m^2. In patients with eGFR 30–59 ml/min/1.73 m^2, metformin doses should be adjusted according to renal excretory function.
7. In T2D patients with chronic kidney disease, consideration should be given to the use of a sodium-glucose cotransporter 2 inhibitor or glucagon-like peptide receptor agonist for which a nephroprotective effect was proved. These drugs reduce the risk of progression of chronic kidney disease (Table 19.3).

Table 19.3. Dosage recommendations for oral antidiabetic drugs and GLP-1 receptor agonists according to the severity of renal failure

Categories (stages) of chronic kidney disease (CKD) according to KDIGO (Kidney Disease: Improving Global Outcomes) (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			More frequent control of eGFR if eGFR is 30–44. Reduced dose to 500 mg 2 x daily		
Sulphonylurea derivatives		Increased risk of hypoglycaemia if eGFR is < 60. Considered dose reduction. Glycoside is the preferred drug because it is metabolised by the liver			
Pioglitazone	Dialysis patients should not use pioglitazone.				
Alogliptin		Dose reduction to 12.5mg/day if eGFR is < 50		Dose reduction to 6.25mg/day	
Linagliptin					
Saxagliptin		Dose reduction to 2.5 mg/day. Dialysis patients should not use saxagliptin.			
Sitagliptin			Dose reduction to 50 mg/day.	Dose reduction to 25 mg/day.	
Vildagliptin		Dose reduction to 50 mg/day if eGFR is < 50			
Canagliflozin (if albuminuria is < 30 mg/mmol before treatment)	Initial dose is 100 mg; a gradual escalation of the dose to 300 mg if necessary	Initiation or continuation of 100 mg/day dose and discontinuation if eGFR is < 45			
Canagliflozin (if albuminuria is ≥ 30 mg/mmol before treatment)		Initiation or continuation of 100 mg/day dose		Continuation of 100 mg/day dose Treatment should not be initiated. Discontinuation in dialysis patients	
Dapagliflozin	Initial dose is 10 mg; discontinuation when eGFR is < 45. Dapagliflozin should not be used if GFR is < 60.				
Empagliflozin	Initial dose is 10 mg/day; a gradual escalation of the dose to 25 mg/day if necessary. Treatment should not be initiated if GFR is < 60.	If eGFR falls below <60, the dose should be reduced to 10 mg/day. Discontinuation if eGFR is < 45.			
Dulaglutide					
Exenatide (administered 2x daily)		Cautious escalation of the dose with creatinine clearance of 30–50 ml/min			
Exenatide (administered 1x daily)					
Liraglutide					
Lixisenatide					
Semaglutide	There is limited experience in patients with severe renal damage – eGFR < 30				

No need for dose adjustment according to eGFR *Recommended dose adjustment according to eGFR* *Not recommended for a given eGFR*

REFERENCES

1. Patel A, MacMahon S, Chalmers J, et al. Intensive blood glucose control and vascular outcomes in patients with type 2 diabetes. N Engl J Med 2008; 358: 2560–2572.
2. De Boer IH, Sun W, Cleasry PA, et al. Intensive diabetes therapy and glomerular filtration rate in type 1 diabetes. N Engl J Med 2011, 365, 2366–2376.
3. DCCT/EDIC Research Group: Effect of intensive diabetes treatment on albuminuria in type 1 diabetes: long-term follow-up of the Diabetes Control and Complications Trial and Epidemiology of Diabetes Interwentions and Complications Study. Lancet Diabetes Endocrinol 2014; 2: 793–800.
4. Delanaye P, Glassock RJ, Pottel H, et al. An age-calibrated definition of chronic kidney disease: rationale and benefits, Clin Biochem Rev 2016; 37: 17–26.
5. Ismail-Beigi F, Craven T, Banerji MA, et al. Effect of intensive treatment of hyperglycemia on microvascular outcomes in type 2 diabetes: an analysis of the ACCORD randomized trial. Lancet 2010; 376: 419–430.
6. Molitch ME, Steffes M, Sun W, et al. Development and progression of renal insufficiency with and without albuminuria in adults with type 1 diabetes in the Diabetes Control Complications Trial and the Emidemiology of Diabetes Interventions and Complications Study. Diabetes Care 2010; 33: 1536–1543.
7. National Kidney Foundation, KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl 2013; 3: 1–150.
8. Percovic V, Heerspink HL, Chalmers J, et al. Intensive glucose control improves kidney outcomes in patients with type 2 diabetes. Kidney Int 2013; 83: 517–523.
9. Tuttle KR, Bakirs GL, Bilous RW, et al. Diabetic kidney disease: a raport from an ADA Consensus Conference. Diabetes Care 2014; 37: 2864–2883.
10. UK Prospective Diabetes Study (UKPDS) Group. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). Lancet 1998; 352: 854–865.
11. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet 1998; 352: 837–853.
12. Wong MG, Percovic V, Chalmers J, et al. Long-term benefits of intensive glucose control for preventing end-stage kidney disease: ADVANCE-ON. Diabetes Care 2016; 39: 694–700.
13. Zoungas S, Chalmers J, Neal B, et al. Follow-up of blood pressure lowering and glucose control in type 2 diabetes. N Engl J Med 2014; 371: 1392–1406.

20. Diabetic retinopathy

Key recommendations
· Optimising glycaemic control, blood pressure and lipaemia reduces the risk of the development and progression of diabetic retinopathy. [**A**]
· Dilated-pupil fundus examination should be performed no later than 5 years in adults with type 1 diabetes and immediately after diagnosis of type 2 diabetes. [**B**]
· Laser photocoagulation reduces the risk of vision loss in patients with proliferative retinopathy. [**A**]
· Intravitreal injections of anti-VEGF in patients with macular oedema can improve vision. [**A**]
· Acetylsalicylic acid treatment aimed at cardioprotection is not contraindicated in patients with retinopathy and does not increase the risk of retinal haemorrhage. [**A**]

Complications related to diabetes affect almost all anatomical structures in the visual system. The most common and the most severe, because it threatens vision loss, is diabetic retinopathy and the associated diabetic macular oedema. Retinopathy is a highly specific neurovascular complication of both type 1 and type 2 diabetes. Of the extraretinal complications of diabetes, cataract and secondary glaucoma have the most clinical significance. The following recommendations take into account 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 retinopathy — more lesions than in the mild form and less than in the severe form.
4. Severe non-proliferative diabetic retinopathy:

- haemorrhages (> 20) in the 4 retinal quadrants;
- and/or venous streptococcosis in at least 2 quadrants;

- and/or intraretinal microvascular abnormalities in at least 1 quadrant.

5. Proliferative diabetic retinopathy (PDR) (vascular and connective tissue proliferation in the retina) leading to vision loss due to the following mechanisms:
- recurrent haemorrhages into the vitreous humour from the newly formed vessels;
- retinal detachment resulting from the retina being pulled by proliferative membranes;
- the development of glaucoma.

II. Natural history and classification of diabetic macular oedema

1. Absence of diabetic macular oedema.
2. Mild diabetic macular oedema —abnormalities outside of the centre of the macula.
3. Moderate diabetic macular oedema —abnormalities near the centre of the macula.
4. Severe diabetic macular oedema —abnormalities involving the centre of the macula.

III. Risk factors for the development and progression of diabetic retinopathy

1. Duration of diabetes — the strongest predictor of the development and progression of diabetic retinopathy .
2. Poor metabolic control of diabetes:
- intensive treatment reduces the risk of development and progression of retinopathy in patients with type 1 diabetes;
- intensive treatment of type 2 diabetes reduces the frequency of microangiopathic complications, and a 1% decrease in the percentage of HbA_{1c} results in a significant reduction in the risk of microangiopathy development.

3. Hypertension.
4. Lipid metabolism disorders.
5. Diabetic renal disease.
6. Pregnancy in women with diabetes.
7. Puberty.
8. Cataract surgery.
9. Status post kidney-pancreas or kidney-only transplants.

IV. Diagnosis of diabetic retinopathy

1. Visual acuity test.
2. Colour recognition test.
3. Funduscopic examination (ophthalmoscopy, always after dilating the pupil).
4. Colour digital fundus images used mainly for screening purposes (they dare not a substitute for a full eye examination).
5. Fundus fluorescein angiography – indications:
- detecting lesions in the course of moderate to severe non-proliferative retinopathy;
- detecting initial foci of vascular proliferation in proliferative retinopathy;
- assessing the effectiveness of laser photocoagulation;
- explaining the cause of unjustified deterioration of visual acuity.

6. Wide-field scanning laser ophthalmoscopy.
7. Optical coherence tomography — the primary method for detecting and monitoring macular oedema.
8. Ultrasound — especially in patients with vitreous haemorrhage.
9. Confocal microscopy (evaluation of the cornea as an early indicator of neuropathy).

V. Indications for eye examinations in patients with diabetes

1. First examination:
- in type 1 diabetes — to be carried out within the first 5 years of onset;
- in type 2 diabetes — must be done at the time of diagnosis or shortly after diagnosis.

2. Follow-up examinations and possible treatment:
- advisable due to the initially asymptomatic nature of retinopathy;
- frequency depends on the stage of diabetic retinopathy:
  - » no retinopathy — every 1—2 years;
  - » mild to 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 surgery or other eye surgery (e.g. vitrectomy);
  - » diabetic macular oedema — in the extrafoveal form laser surgery, in the form with foveal involvement it is advisable to use intravitreal injections of anti-VEGF antibodies, which may be complemented with laser surgery;
  - » post retinal laser surgery — one month after surgery;
  - » post vitrectomy — the examination date is set individually, depending on the condition of the eye fundus;
  - » in pregnant diabetic women;
- every 1—3 months throughout the pregnancy depending on the condition of the eye;

in women planning a pregnancy — before pregnancy and during, if necessary, retinal laser surgery is performed.

3. Urgent indications for eye examination:

- risk of vision loss:
  - » the presence of proliferative retinopathy;
  - » presence of advanced ocular complications (vascular proliferation in the iris, vitreous haemorrhage, fresh retinal detachment);
- presence of lesions potentially threatening vision loss:
  - » severe non-proliferative retinopathy;
  - » non-proliferative retinopathy with diabetic macular oedema;
  - » other abnormalities present in the eye fundus, difficult to interpret or unexplained deterioration of visual acuity;
  - » pregnancy.

The recommended frequencies of eye examinations in each patient group are shown in Table 20.1.

VI. Screening examinations

Screening for diabetic retinopathy is performed by an ophthalmologist or a trained person on a dilated pupil using an ophthalmoscope or a fundus camera based on a colour photograph of the fundus. Screening can also be carried out using telemedicine with the use of a fundus camera and evaluation of the images by qualified staff or using appropriate image analysis software. Colour eye photography has great potential to provide monitoring services in areas where access to qualified specialists is difficult. Retinal photography can therefore serve as a screening tool for retinopathy but does not replace a comprehensive eye examination, which should be performed no later than after 5 years in adults with type 1 diabetes and at the time of diagnosis of type 2 diabetes. Further examinations are performed at the intervals recommended by the ophthalmologist.

In patients with type 1 diabetes, if no retinal abnormalities are found in the first 2 consecutive years, fundus examination can be evaluated every 2 years. In patients with type 2 diabetes with good metabolic control, in the absence of abnormalities on the fundus — every 2—3 years.

In women with type 1 and type 2 diabetes, eye examinations should be performed before pregnancy or in the first trimester of pregnancy and then repeated in each trimester of pregnancy and for one year after delivery, to evaluate the stage of retinopathy.

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

The screening strategies developed can significantly reduce the risk of blindness even by a few times and reduce the costs of treatment for patients with diabetic eye complications.

Table 20.1. Recommended frequency of ophthalmologic examinations in various patient groups

Initial examination	
Diabetes type 1	**Diabetes type 2**
Initial 5 years after the diagnosis (when diagnosed during puberty — shortly after the diagnosis)	At the time of the diagnosis
Follow-up examinations and treatment	
Severity of retinopathy	Frequency of examinations and treatment
No retinopathy	Every 1–2 years
Non-proliferative mild or moderate	Every 6–12 months
Non-proliferative severe	At least every 3–6 months
Proliferative	Urgent laser therapy
Diabetic macular edema: • extrafoveal • intrafoveal	 Urgent laser therapy Intravitreal anti-VEGF injections + optionally laser therapy
Follow-up after ophthalmologic procedures in special situations	
After laser treatment	Depending on fundoscopy findings
After vitrectomy	Depending on fundoscopy findings
Pregnant women	Every 1–3 months depending on fundoscopy findings
Women planning pregnancy	Before conception; laser therapy at that time
Uncontrolled diabetes, hypertension or proteinuria	Every 1–6 months depending on fundoscopy findings

VII. Treatment of diabetic retinopathy

1. Intensification of treatment in patients with poor metabolic control of diabetes, intensive treatment of hypertension, primarily with ACE inhibitors and AT1 receptor inhibitors, and disorders in lipid metabolism (fenofibrate, statins). Acetylsalicylic acid — administered for cardioprotective purposes — is not contraindicated in patients with retinopathy and does not pose a risk of retinal haemorrhages.
2. In diabetic macular oedema involving the fovea and visual impairment, the recommended first-line treatment is intravitreal injections of anti-VEGF drugs: aflibercept, ranibizumab and bevacizumab, optionally supplemented with laser treatment. Bevacizumab is used off-label and has lower efficacy in patients with more significant visual impairment.
3. Retinal laser treatment (possible if the optical structures of the eye are clear):

- retinal laser treatment performed early enough inhibits the progression of advanced diabetic retinopathy;
- types of retinal laser treatment:
  - » subthreshold (mainly micropulse) laser treatment - without tissue coagulation, used in macular oedema without significant thickening of the macula and without deterioration of visual acuity;
  - » focal laser treatment — recommended in the presence of initial abnormalities in diabetic macular oedema without foveal involvement;
  - » grid laser treatment — in diffuse macular oedema when first-line treatment has not been successful;
  - » panretinal photocoagulation — recommended in severe nonproliferative and proliferative retinopathy.

4. Intravitreal or periocular injections of steroids that have anti-angiogenic and anti-oedematous effects, for example triamcinolone, dexamethasone or fluocinolone acetate in an extended-release form, can be considered as first-line drugs when contraindications to VEGF inhibitors are identified or if monthly visits cannot be continued at the same frequency.
5. Vitrectomy indications:

- haemorrhages into the vitreous body that are not absorbed despite other methods of treatment;
- vitreoretinal tractions running vertically towards the macula;
- advanced proliferative retinopathy with complications.

6. In cases of irreversible visual impairment, consultation/rehabilitation is required for persons who are visually impaired or blind.
7. Sulodexide at a dose of 250 LSU twice daily may be used in mild to moderate retinopathy with hard exudates.

REFERENCES

1. Ahmed J, Ward TP, Bursell SE, et al. The sensitivity andspecificity of nonmydriatic digital stereoscopicretinal imaging in detecting diabetic retinopathy. Diabetes Care 2006; 29: 2205–2209.
2. Bragge P, Gruen RL, Chau M, et al. Screening for presence or absence of diabetic retinopathy: a meta-analysis. Arch Ophthalmol 2011; 129: 435–444.
3. Chew EY, Davis MD, Danis RP, et al. The effects of medical management on the progression of diabetic retinopathy in persons with type 2 diabetes: the action to Control Cardiovascular Risk in Diabetes (ACCORD) Eye Study. Ophthalmology 2014; 121: 2443–2451.
4. Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of longerm complications in insulin-dependent diabetes mellitus. N Engl J Med 1993; 329: 977–986.
5. Wells JA, Glassman AR, Ayala AR, et al. Aflibercept, bevacizumab, or ranibizumab for diabetic macular edema. N Engl J Med 2015; 372: 1193–1203.
6. Daskivich LP, Vasquez C, Martinez C Jr, Tseng CH, Mangione CM. Implementation and evaluation ot a large -scale teleretinal dlabetic retinopathy screening program in the Los Angeles County Department ot Health Services. JAMA Intern Med 2017;177: 642-649
7. Do DV, Wang X, Vedula SS, et al. Blood pressurecontrol for diabetic retinopathy. Cochrane Database Syst Rev 2015; 1: CD006127.
8. Ferris FL 3rd. How effective are treatments for diabetic retinopathy? JAMA 1993; 269: 1290–1291.
9. Gunderson EP, Lewis CE, Tsai AL, et al. A 20-year prospective study of childbearing andincidence of diabetes in young women, controlling for glycemia before conception: the Coronary Artery Risk Development in Young Adults (CARDIA) Study. Diabetes 2007; 56: 2990–2996.
10. Shih CJ, Chen HT, Kuo SC, et al. Comparative effectiveness of angiotensin-converting-enzyme inhibitors and angiotensin II receptor blockers in patients with type 2 diabetes and retinopathy. CMAJ 2016; 188: E148-E157.
11. Shi R, Zhao L, Wang F, et al. Effects of lipid- lowering agents on diabetic retinopathy: a meta-analysis and systematic review. Int J Ophthalmol 2018; 11: 287–295

12. The Diabetic Retinopathy Study Research Group. Preliminary report on effects of photocoagulation therapy. Am J Ophthalmol 1976; 81: 383–396.
13. Gross JG, Glassman AR, Jampol LM, et al. Panretinal photocoagulation vs. intravitreous ranibizumab for proliferative diabetic retinopathy: a randomized clinical trial. JAMA 2015; 314: 2137–2146.
14. Gubitosi-Klug RA, Sun W, Cleary PA, et al. Effects of prior intensive insulin therapy and risk factors on patient-reported visual function outcomes in the Diabetes Control and Complications Trial/ Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) cohort. JAMA Ophthalmol 2016; 134: 137–145.

21. Prevention, diagnosis and treatment of diabetic neuropathy

Key recommendations
· In individuals with type 1 diabetes, maintaining optimal glycemic control from the time of diagnosis is critical for the primary and secondary prevention of diabetic peripheral and cardiovascular autonomic polyneuropathies. [**A**]
· The diagnosis of diabetic neuropathy should include assessment of the functioning of both small fibres (pain and/or temperature sensation) and large fibres (vibration sensation), in addition to a detailed history. Each patient should undergo a screening for loss of sensation with a 10 g monofilament once a year to assess the risk of diabetic foot ulceration. The screening should be performed 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 treatment for neuropathic pain in people with diabetes. [**A**]

Distal symmetric polyneuropathy causes severe discomfort, significantly impairs the patients' quality of life, and is a recognised risk factor for the development of diabetic foot ulcers and Charcot neuroarthropathy. Neuropathy heightens the risk of amputations, fractures, and falls, increases medical costs, and is a predictor variable of increased risk of death. Cardiovascular autonomic neuropathy is an independent risk factor for increased mortality in diabetic patients. Neuropathy may develop already in the pre-diabetes stage. For this reason, its diagnosis should be also considered in prediabetic patients with symptoms of peripheral neuropathy.

I. Clinical classification of neuropathies:

- generalised symmetric polyneuropathies:
  - » chronic peripheral sensorimotor;
  - » autonomic;
  - » acute sensory;
- focal and multifocal neuropathies:
  - » cranial nerve;
  - » spinal nerve (thoracic and lumbar);
  - » focal neuropathies of the extremities, including compression syndromes;
  - » proximal motor (amyotrophy).

II. Principles of testing for neuropathy:

- frequency of testing, diabetic neuropathy symptoms should be tested for at least annually, for the first time:
  - » in the case of type 1 diabetes — 5 years after the onset of the disease, unless symptoms suggesting neuropathy are present earlier;
  - » in the case of type 2 diabetes — at the time of diagnosis;
- other, non-diabetic causes of peripheral nervous system damage should be considered and possibly ruled out;
- in ambiguous cases, neurological consultation is recommended.

III. Diagnostic criteria for diabetic neuropathy

Distal symmetric polyneuropathy

A. Diagnostic methods:

- sensory testing with a 10 g compression monofilament (Semmes-Weinstein 5.07);
- vibration perception threshold testing — using a neurothesiometer or a calibrated 128 Hz tuning fork;
- pain sensation testing (sterile needle);
- temperature sensation testing (testing gauge with 2 ends — metal and plastic);

- tendon reflexes testing;
- muscle strength testing;
- electro-neurophysiological testing.

B. Principles of diagnosis:

- — symptoms: sensory disturbances, numbness, stinging, prickling, burning and twitching sensations, spontaneous pains, muscle spasms, mainly in the area of feet and lower legs, persisting for several months (they intensify or occur mainly at night; physical exertion does not cause or intensify the symptoms);
- — signs: muscle weakness, weakness or loss of tendon reflexes (knee, ankle), weakness or loss of sensation of touch, vibration, pain and temperature;
- diabetic peripheral neuropathy is considered probable based on the presence of 2 of the following 3 clinical examination items: symptoms, weakness or loss of sensation (touch, vibration, pain, and/or temperature), and/or weakness or loss of tendon reflexes;
- in the painful form, these items of the physical examination may be normal, in the case of typical complaints, neuropathy can be diagnosed even in the absence of abnormalities in the physical examination;
- in some patients, it may be necessary to perform an electro-neurophysiological examination for a definite diagnosis of neuropathy and for possible differential diagnosis of the causes; it is especially recommended in the case of rapid progression of symptoms, asymmetry, motor-predominant neuropathy or a suspected non-diabetic cause;
- in the diagnosis of small fibre neuropathy, in the case of uncertainty regarding the clinical picture, an additional assessment of the nerve fibre density in the cornea by confocal microscopy or skin biopsy can be done.

Autonomic neuropathy

The activity of the autonomic nervous system is indirectly assessed based on the analysis of changes in the activity of the effector organs under the influence of certain stimuli. Due to the non-specificity of the clinical symptoms, the diagnosis should be supported by specific tests. It is necessary to rule out another disease of the effector organ or the influence of the applied treatment, and consider organic and functional disorders of a different nature.

Autonomic neuropathy is most often clinically manifested by hypoglycemia unawareness, tachycardia, orthostatic hypotension, gastroparesis, constipation or diarrhea, potency disorders, neurogenic bladder or sweating disorders.

1. Cardiovascular system

Cardiovascular autonomic neuropathy is diagnosed by tests that assess heart rate variability.

Autonomic neuropathy is considered probable or early-onset if one of the heart rate variability tests is abnormal, and confirmed if two of the heart rate variability tests listed below are abnormal. Acute (advanced) cardiovascular neuropathy is diagnosed when there are abnormal heart rate variability tests and abnormal blood pressure response to standing upright:

- tests assessing the condition of the parasympathetic nervous system:
  - » change in heart rate in response to deep breathing;
  - » change in heart rate in response to standing upright;
  - » change in heart rate in response to the Valsalva Manoeuvre;
- tests assessing the condition of the sympathetic nervous system: change in blood pressure in response to standing upright.

2. Gastrointestinal tract:

- gastric dysfunction – X-ray, radioisotope scintigraphy, breath tests, electrogastrography (EGG), manometry, ultrasonography;
- small intestine dysfunction – no specific diagnostic tests, ruling out other causes, manometry, wireless diagnostic capsule – small intestine motility disorders;
- large intestine dysfunction – ruling out other causes (endoscopy), contrast study upon oral administration of contrast agent, manometry, wireless diagnostic capsule;
- gallbladder dysfunction — functional ultrasound imaging.

3. Genitourinary system:

- bladder dysfunction — cystometry (assessment of bladder filling before and after micturition), urethral sphincter electromyography, uroflowmetry and urethral pressure profile;
- erectile impotence — questionnaires (IIEF — *International Index of Erectile Function* and its shortened 5-question version — IIEF-5), vascular tests (Doppler ultrasound), caverosonography, hormonal tests, psychological tests, vibration perception threshold assessment in given body regions, functional tests — monitoring of nocturnal penile tumescence.

4. Sweating disorders — simple sweat markers, tests requiring sophisticated equipment (as-

sessment of sweat secretory function using the Sudoscan device).
5. Pupillary dysfunction — pupillometry.

IV. Treatment

Approximately 50% of diabetic neuropathies are asymptomatic. Causal treatment involves glycemic control. Optimisation of glycemic control should be implemented as soon as possible in patients with type 1 and type 2 diabetes to prevent and/or delay the development of neuropathy. In patients with neuropathic pain, treatment is absolutely necessary as the pain worsens the quality of life and functioning of patients and may lead to depression. There are various therapeutic options for pain management. Treatment of autonomic neuropathy alleviates symptoms, improves quality of life and prognosis, but is often demanding, and its effectiveness varies on an individual basis.

1. . Treatment targeting the pathomechanisms of diabetic neuropathy:
- optimal glycemic control as well as avoiding hypoglycaemia and large diurnal glucose fluctuations is essential in the treatment of diabetic neuropathy;
- control of blood pressure and lipid metabolism, smoking and alcohol consumption cessation;
- supportive pharmacotherapy: α-lipoic acid, benfotiamine, angiotensin-converting enzyme inhibitors.

2. Symptomatic treatment of neuropathic pain in diabetic somatic neuropathy (the analgesic effect of treatment is patient specific) (Table 21.1).
3. Symptomatic treatment of diabetic autonomic neuropathy:
- cardiovascular system:
  - » cardiac rhythm control disorders — controlled, gradual exercise, ACE inhibitors, β-blockers without intrinsic sympathomimetic activity;
  - » orthostatic hypotension — compression clothing for lower limbs and abdomen, adding salt to food, isometric exercises, mineralocorticoids (fludrocortisone), α1-adrenergic agonists (midodrine);
- gastrointestinal tract:
  - » gastroparesis – diet modification (frequent, small meals, in acute forms semi-liquid or liquid diet), prokinetic agents (cisapride, itopride, erythromycin, trimebutine), drugs inhibiting gastric acid secretion (H2 blockers, proton pump inhibitors), antiemetics, surgical treatment, stimulation of gastric bioelectrical activity;
  - » intestinal dysfunction – diet modification (consider a gluten-free diet, lactose restriction), cholestyramine, clonidine, octreotide, constipation inducers (loperamide), pancreatic enzymes, antibiotics;
- genitourinary system:
  - » bladder dysfunction – avoiding urinary retention, regular, systematic urination, cholinergic agonists (bethanechol), external bladder massage before micturition, bladder catheterisation (temporary, permanent);
  - » male sexual dysfunction — psychotherapy, cGMP phosphodiesterase inhibitors (silde-

Table 21.1. The algorithm for drug treatment of symptomatic neuropathic pain in somatic diabetic neuropathy

First line treatment – one of the following drugs	Effective doses
Anticonvulsants	
Pregabalin	300–600 mg/day
Gabapentin	900–3,600 mg/day
Selective serotonin and norepinephrine reuptake inhibitors	
Duloxetine	60–120 mg/day
Venlafaxine	75–225 mg/day
Second line treatment	**Effective doses**
Tricyclic antidepressants	
Amitriptyline	25–100 mg/day
Opioids	
Tramadol	200 mg/day
Tapentadol	Starting at 50 mg twice daily, maximum dose 500 mg/day
Topical medications	
Capsaicin, lidocaine	

Effective drug doses are given. Gradual dose increase is necessary. If one on first-line drugs is not effective, an alternative drug or combined therapy is indicated. Chronic use opioids is not recommended. At each stage, non-pharmacological methods (physical therapy, acupuncture) may be used

nafil, vardenafil, tadalafil), vacuum suction devices, injections into the corpora cavernosa (prostaglandin E1), penile prostheses;
  - » female sexual dysfunction — psychotherapy, mechanical genital stimulators, topical lubricants; flibanserin;
- sweating disorders — botulinum toxin, vasodilators, moisturising creams.

REFERENCES

1. Diabetes Control and Complications Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993; 329: 977–986.
2. Finnerup NB, Attal N, Haroutounian S, et al. Pharmacotherapy for neuropathic pain in adults: a systematic review and metaanalysis. Lancet Neurol 2015; 14: 162–173.
3. Martin CL, Albers JW, Pop-Busui R. Neuropathy and related findings in the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications study. Diabetes Care 2014; 37: 31–38.
4. Perkins BA, Olaleye D, Zinman B, Bril V. Simple screening tests for peripheral neuropathy in the diabetes clinic. Diabetes Care 2001; 24: 250–256.
5. Ziegler D, Rathmann W, Dickhaus T, et al. Prevalence of polyneuropathy in pre-diabetes and diabetes is associated with abdominal obesity and macroangiopathy: the MONICA/KORA Augsburg Surveys S2 and S3. Diabetes Care 2008; 31: 464–469.

22. Diagnosis and treatment of diabetic foot syndrome

Key recommendations
• Maintaining optimal control of blood sugar level, blood lipid level and arterial pressure reduces the risk of diabetic foot syndrome. **[A]**
• Effective treatment of diabetic foot syndrome is possible only in multidisciplinary clinics. **[B]**
• The golden standard for relieving the uninfected, neuropathic foot is a total contact cast covering the foot and the lower leg. **[A]**
• Wound debridement, systemic antibiotic therapy in case of infection and vascular interventions in the ischaemic foot play a crucial role in the treatment of DFS. **[A]**

Multispecialist diabetic foot units (reference units) should be created in regional (provincial, university) centres for diabetes care, while primary diabetic foot units which continue the therapy prescribed by a multispecialist clinic should be established in diabetes care clinics.

Structure and tasks as per the Programme for Support of Outpatient Treatment of Diabetic Foot Syndrome (DFS) of the Ministry of Health (http://www.mz.gov.pl/zdrowie-i-profilaktyka/programy-zdrowotne/wykaz-programow/program-wsparcia-ambulatoryjnego-leczenia-zespolu-stopy-cukrzycowej/).

I. Definition

Diabetic foot is an infection and/or ulceration and/or destruction of deep tissues of the foot (e.g. bones) caused by damage to peripheral nerves and/or vessels of the foot of varied degree of advancement. This definition leads to the division into neuropathic diabetic foot, vascular diabetic foot and mixed diabetic foot.

Diagnosis of diabetic foot syndrome includes evaluation of the presence of peripheral polyneuropathy, disorders of blood supply to lower extremities, deformative lesions and other risk factors of foot damage. If loss of protective nociception is established, it is recommended that a doctor examine the patient's feet during every visit.

II. Risk factors of Diabetic Foot Syndrome:

- peripheral neuropathy and/or signs of ischaemia of lower extremities;
- lack of knowledge on the part of the patient;
- prolonged, poorly managed diabetes;
- improper foot hygiene;
- improper footwear;
- presence of calluses;
- foot deformation;

- reduced pressure on the plantar side of the foot;
- smoking.

Factors which promote recurrence of the disease:

- previous amputations;
- history of ulceration;
- Charcot foot.

III. Prevention:

- systematic foot examination; once per year, testing for sensory disorders (physical examination) and ischaemia (evaluation of pulse on the dorsal artery of foot and the posterior tibial artery; evaluation of the ankle-brachial index should be considered) for all patients; frequency of foot examination depending on assessment of the risk of wound formation is shown in Table 22.3;
- regular podiatric procedures (removal of calluses and hyperkeratosis);
- systematic education in the scope of principles of prevention of ulceration, with a particular emphasis on selection of appropriate footwear;
- education and systematic treatment with respect to other risk factors, such as smoking, overweight, arterial hypertension, lipid disorders, metabolic compensation of diabetes;
- early detection and treatment of ischaemia in extremities;
- walking exercises for a patient with ischaemia may be recommended only to patients without ulceration on the plantar side of the foot.

IV. Clinical classification of diabetic foot syndrome

Recommended classifications are PEDIS (*Perfusion, Extent, Depth, Infection, Sensation*), which takes into account both infections and the ischaemic factor (Table 22.1), and SINBAD (Table 22.2).

V. Infections in the course of diabetic foot

1. Diagnosis of an infection is based primarily on the clinical picture (presence of at least 2 of the classic signs and symptoms of infection), and not only on results of microbiological and laboratory tests.
2. Assessment of the severity of infection (see: PEDIS classification).
3. Microbiological test (including an antibiogram) and its interpretation (colonisation, contamination, infection):

- recommended collection of tissue fragment, aspirate, scrapings for culture after the wound has been cleaned;
- necessary if a clinically infected wound is present;
- interpretation of culture when assessing infection is difficult; it is recommended to take into account primarily the clinical picture;
- blood culture is recommended only if there are general symptoms of infection;
- if there are clinically uninfected wounds, performing a microbiological test is not indicated; if there are wounds with a low-severity infection and antibiotics have not been previously used, it is permissible to not perform culture and apply an empirical antibiotic therapy.

4. Testing for bone inflammation (should be performed in every case of infected ulceration, especially when prolonged):

- probe-to-bone test;
- X-ray image of foot bones (every 3–6 weeks);
- magnetic resonance imaging (indicated);
- bone biopsy or culture from a bone fragment and histopathological examination (indicated); bone biopsy is necessary if diagnosis of bone inflammation is uncertain or if it is necessary to determine the pathogen;

Table 22.1. Foot screening frequency according to the risk of ulcer (International Working Group on the Diabetic Foot risk stratification system)

Category	Ulcer risk	Characteristics	Frequency
0	Very low	No loss of protective sensation, no ischemia	Once a year
1	Low	Loss of protective sensation or ischemia	Once every 6–12 months
2	Moderate	Loss of protective sensation and ischemia or loss of protective sensation + foot deformity or ischemia + foot deformity	Once every 3–6 months
3	High	Loss of protective sensation or ischemia and one or more of the following: · history of foot ulcer · a lower extremity amputation · end-stage renal disease	Once every 1–3 months

Table 22.2. The PEDIS classification

	Degree of severity			
	1	2	3	4
Blood supply	Characteristics of correct blood supply: pulse palpable on the arteries of the feet or ABI > 0.9	Clinical signs of circulatory impairment: presence of intermittent claudication, ABI < 0.9, $TcpO_2$ 30–60 mm Hg	Critical ischaemia: rest pain, ABI < 0.4, $TcpO_2$ < 30 mm Hg	
Size	The size of the wound is expressed in square centimetres			
Hollowing	Superficial ulceration, not exceeding the dermis	The wound may involve all soft tissues	Penetration of infection into bone: visible on X-ray, features of osteolysis or bone palpable with probe	
Intensification of infection	No signs of clinical symptoms of infection	Infection involving the skin and subcutaneous tissue, inflammation within 2 cm from the margin of the ulceration	Locally severe inflammation, beyond 2 cm from the margin of the ulceration, but no evidence of a systemic infection	Signs of widespread infection: fever > 38°C, pulse > 90/min, respiratory rate > 20/min, leukocytosis > 12,000 or < 4,000
Sensory neuropathy	No evidence of sensory neuropathy in basic tests (using a monofilament and tuning forks or Neurotip)	Presence of sensory neuropathy		

- laboratory tests – ESR > 70 mm/hour increases probability of bone inflammation; lower levels mean lower risk. CRP and leukocytosis tests can also help. Normal results of laboratory tests do not fully preclude the existence of bone inflammation.

5. The primary criterion for selection of dressing is the nature of the wound (dry or exudating).

A. Rules for antibiotic therapy:

- use only in case of confirmed infection (do not use in a preventive manner);
- do not delay the commencement of therapy;
- initially use an antibiotic which takes into account the presence of the most common flora (staphylococcaceae and streptococcaceae);
- grade 4 infection according to PEDIS – take into account the presence of Gram-negative and anaerobic bacteria;
- duration of antibiotic therapy – until clinical symptoms of infection subside (not until the wound heals):
  - » grade 2 infection according to PEDIS – typically 1–2 weeks, sometimes longer (especially for patients with immunosuppression and patients with limb ischaemia);
  - » grade 3–4 infection according to PEDIS – 2–4 weeks;

Table 22.3. The SINBAD classification

Category	Definition	Score
Location	Forefoot Midfoot/back of foot (heel area)	0 1
Ischaemia	Blood supply to the foot is normal – pulse palpable in at least one artery Clinical signs of ischaemia	0 1
Neuropathy	Preserved sensation Lack of sensation	0 1
Infection	Not present Present	0 1
Area	< 1 cm^2 ≥ 1 cm^2	0 1
Depth	Skin and subcutaneous tissue ulceration The ulceration involves muscles, tendons or deeper structures	0 1
Total		6

- route of administration:
  - » intravenous – grade 4 infections according to PEDIS and, in justified cases, grade 3 infections according to PEDIS (MRSA infection, *P. aeruginosa* infection) or if oral antibiotics are not tolerated;

- » oral – grade 2 and grade 3 infections according to PEDIS and once improvement is achieved in a grade 4 according to PEDIS;
- » topical – the use of a collagen sponge moistened with gentamicin (garamycin sponge) as support treatment for a systemic antibiotic therapy can be considered;
- » intraarterial – not recommended.

B. Choice of antibiotics

- severe infections:
  - » intravenous treatment – ciprofloxacin + clindamycin, amoxicillin with clavulanic acid or piperacillin with tazobactam or carbapenem + vancomycin until the MRSA pathogen is excluded;
  - » continuation using oral treatment – amoxicillin with clavulanic acid + trimethoprim with sulfamethoxazole (double dose) or ciprofloxacin 2 × 750 mg or moxifloxacin + linezolid;
  - » MRSA infection: linezolid, vancomycin;
- less severe infections:
  - » usually oral treatment using similar antibiotics as for a severe infection, e.g.;
  - » a Gram-positive pathogen: semi-synthetic penicillins/1st generation cephalosporins;
  - » an infection recently treated with an antibiotic, Gram-positive and Gram-negative pathogens: fluoroquinolones, β-lactam antibiotics, in case of allergy for these antibiotics: clindamycin, fluoroquinolone, sulfamethoxazole + trimethoprim;
- treatment of bone inflammation (no uniform treatment model has been established):
  - » surgical treatment with removal of the abnormal bone (small amputation);
  - » antibiotic therapy in case of severe infections;
  - » monitoring of effectiveness of treatment of bone inflammation: laboratory tests (ESR, CRP), X-ray image of foot bones.

VI. Multidisciplinary treatment of diabetic foot syndrome

Effective treatment of diabetic foot syndrome is possible only in multidisciplinary clinics. This concept encompasses an organisational structure which enables the patient to consult with the necessary specialists who possess knowledge and experience in treatment of diabetic foot and form a team which remains in constant communication.

Treatment of diabetic foot syndrome includes:

- metabolic compensation of diabetes: insulin therapy (with intensive insulin therapy being the preferred treatment model); it is permissible to use oral antihyperglycaemic drugs if such treatment leads to correct metabolic compensation of diabetes and there are no indications for insulin treatment;
- relief – temporary shoe for relieving the forefoot or the heel, compensation shoe for the healthy limb, therapeutic inserts, crutches, wheelchair, weight-relieving cast in case of ulceration of the forefoot and the metatarsus (so-called *total contact cast*) – a classic plaster cast, but also a plastic cast, preferably up to the knee, but if impossible of if the patient does not consent, up to the ankle is also acceptable, specialist footwear, limited walking, including at home. In other locations (e.g. heel), with the presence of infection and/or ischaemia of the limb the first and next choice are removable relievers. The decision regarding the choice of limb relief should take into account the patient's condition and performance, comorbidities, patient preference and team training. In many patients (especially in the case of atrophy of protective pain sensation, ischaemia and existing deformities), in order to correct excessive pressure forces acting on the sole surface of the foot, it is advisable to use appropriate footwear inserts to prevent ulceration or to prevent its recurrence.

  In many patients, in order to correct excessive pressure forces acting on the sole surface of the foot, it is advisable to use appropriate footwear inserts to prevent ulceration or to prevent its recurrence:
- antibiotic therapy (oral or intravenous), see above;
- surgical procedures – removal of necrotic tissue, drainage, incision;
- endovascular and vascular surgery, hybrid procedures [diabetic foot characterised by a predominantly ischaemic factor – patients with a low (< 0.5) *ankle brachial index* (ABI), a $TcPO_2$ value < 25 mm Hg and/or a diagnosis of intermittent claudication should be referred for further urgent vascular diagnosis and then to a vascular surgeon or angiologist. Diagnostic imaging and revascularization should also be considered – even if the results of the tests listed above are normal – if, despite standard management, there is no progression of wound healing within 4 weeks. It should be emphasized that many diabetic patients with lower limb ischemia may progress without typical pain symptoms]; the goal of revascularization

should be to restore blood flow to at least one artery, preferably the one supplying the anatomic area of the ulceration;
- podiatric procedures (regular wound debridement at a frequency depending on the local condition;
- traditional dressings and therapy to provide a moist wound environment. Application of TLC-NOSF dressings should be considered in non-infected wounds with neuropathic-ischemic etiology (but without features of critical/significant ischemia), if they do not heal despite optimal standard treatment;
- other — hyperbaric chamber (ischaemic wounds that do not heal despite standard treatment), negative pressure wound therapy (should be considered especially for post-operative wounds in parallel to standard treatment), drugs improving blood flow (ischaemic foot or with predominant vascular factor): low molecular weight heparin preparations (acute ischaemic conditions, critical ischaemia), acetylsalicylic acid, walking training. Treatment with sulodexide can be considered.

"Artificial skin" transplantation, growth factors, ozone therapy, and autologous platelet gel are not recommended.

In justified cases, the use of Lucilia sericata larvae cultured under sterile conditions in specialised laboratories may be considered for wound bed preparation.

Every patient with diabetic foot syndrome should be educated on ulcer prevention.

Charcot neuroarthropathy (Charcot foot)
Diagnosis:
- the diagnosis is made on the basis of the patient's history and clinical picture (unilateral swelling, reddening, increase in foot temperature, especially if there is no ulceration, in a patient with features of diabetic polyneuropathy), after ruling out other causes, especially deep vein thrombophlebitis and gout.

Treatment:
- acute condition – off-loading for 24 hours/days. (total contact cast, other forms of off-loading), bisphosphonates, including vitamin D and calcium preparations may be considered, but currently there are no studies whose results would indicate the long-term effectiveness of pharmacological treatment. The off-loading should be maintained until the process is stabilised – transition to the inactive phase. Return to full load on the limb should be very slow.
- chronic condition — education, foot hygiene, specialised orthopaedic footwear with therapeutic insoles to correct deformities, orthopaedic surgery to correct deformities (exostectomy, arthrodesis).

The therapy should be conducted by a multidisciplinary team of specialists.

VII. Hospitalisation — indications

In emergency mode:
- grade 4 infection according to PEDIS;
- grade 3 infection according to PEDIS, if there is a need for intravenous antibiotic therapy;
- every case of critical ischaemia.

Admission according to schedule:
- no improvement after 2 months of outpatient treatment;
- preparation for the planned surgical procedures (small amputation, skin graft, revascularisation procedures).

VIII. Amputation

Before any amputation, it is necessary to assess the blood supply to the limb.

1. "Major" amputation (above the ankle) – should be considered when this occurs:
- life-threatening inflammation, extensive necrosis (absolute indication);
- debilitating, treatment-resistant pain, especially as a result of ischaemia (relative indication);
- utrata funkcji podporowych stopy (wskazanie względne);

2. "Minor" amputation (below the ankle) – should be considered when this occurs:
- colliquative necrosis;
- inflammation of the bones of the distal phalanges of the toes (avoidance of chronic antibiotic therapy - accelerates healing);
- in case of mummification necrosis, it is recommended to wait for self-amputation.

The choice of amputation level depends on blood supply status, reconstructive and rehabilitative possibilities.

It is recommended that amputation be carried out as sparingly as possible.

REFERENCES

1. Blume PA, Walters J, Payne W, et al. Comparison of negative pressure wound therapy using vacuum-assisted closure with advanced moist wound therapy in the treatment of diabetic foot ulcers: a multicenter randomized controlled trial. Diabetes Care 2008; 31: 631–636.
2. Bus SA, Waaijman R, Arts M, et al. Effect of custom-made footwear on foot ulcer recurrence in diabetes: a multi-

center randomized controlled trial. Diabetes Care 2013; 36: 4109– 4116.
3. Cohen M, Cerniglia B, Gorbachova T, Horrow J. Added value of MRI to X-ray in guiding the extent of surgical resection in diabetic forefoot osteomyelitis: a review of pathologically proven, surgically treated cases. Skeletal Radiol 2019; 48: 405–411.
4. Edmonds M, Lazaro-Martinez JL, Alfayate-Garcia JM, et al. Sucrose octasulfate dressing versus control dressing in patients with neuroischaemic diabetic foot ulcers (Explorer): an international, multicentre, double-blind, randomised, controlled trial. Lancet Diabet Endocrynol 2018; 6: 186–196.
5. Gariani K, Lebowitz D, von Dach E, et al. Remission in diabetic foot infections: duration of antibiotic therapy and other possible associated factors. Diabetes Obes Metab 2019; 21: 244–251.
6. Ince P, Abbas ZG, Lutale JK, et al. Use of the SINBAD classification system and score in comparing outcome of foot ulcer management on three continents. Diabetes Care 2008; 31: 964–967.
7. Jeon BJ, Choi HJ, Kang JS, et al. Comparison of five systems of classification of diabetic foot ulcers and predictive factors for amputation. International Wound 2017; 14: 537–545.
8. Lauri C, Tamminga M, Glaudemans AWJM, et al. Detection of osteomyelitis in the diabetic foot by imaging techniques: a systematic review and meta-analysis comparing mri, white blood cell scintigraphy, and FDG-PET. Diabetes Care 2017; 40: 1111–1120.
9. Lo ZJ, Lin Z, Pua U, et al. Diabetic foot limb salvage – a series of 809 attempts and predictors for endovascular limb salvage failure. Ann Vasc Surg 2018; 49: 9.
10. Löndal M. Hyperbaric oxygen therapy as adjunctive treatment of diabetic foot ulcers. Med Clin North Am 2013; 97: 957.
11. Prutsky G, Domecq JP, Tsapas A, et al. A systematic review and meta-analysis of off-loading methods for diabetic foot ulcers. FJ Vasc Surg 2016; 63: 59S–68S.
12. Rizzo L, Tedeschi A, Fallani E, et al. Custom-made orthesis and shoes in a structured follow-up program reduces the incidence of neuropathic ulcers in high-risk diabetic foot patients. Int J Low Extrem Wounds 2012; 11: 59–64.
13. Sheehan P, Jones P, Caselli A, et al. Percent change in wound area of diabetic foot ulcers over a 4-week period is a robust predictor of complete healing in a 12-week prospective trial. Diabetes Care 2003; 26: 1879–1882.
14. Ulbrecht JS, Hurley T, Mauger DT, Cavanagh PR. Prevention of recurrent foot ulcers with plantar pressure-based inshoe orthoses: the CareFUL prevention multicenter randomized controlled trial. Diabetes Care 2014; 37: 1982–1989.

23. Diabetes in children and adolescents

Key recommendations
· Children and adolescents with type 1 diabetes should begin treatment with intensive insulin therapy and continuous glucose monitoring systems immediately after diagnosis. **[A]**
· The blood glucose level should be assessed on an empty stomach, before meals and sleep, as well as before, during and after physical activity, when the patient is feeling unwell, 1–2 hours after a meal and at night. **[B]**
· The use of continuous glucose monitoring systems with intensive insulin therapy in children and adolescents improves metabolic control of diabetes (lowering HbA_{1c} and increasing TIR levels), reduces the risk of acute and chronic complications of the disease and increases the lifespan. **[B]**
· Personal insulin pumps with an automatic insulin suspension function are particularly beneficial in the prevention of hypoglycaemia. **[B]**
· In children and adolescents, the recommended target HbA_{1c} level is ≤ 6.5% with a stable blood glucose level, minimised hypoglycaemic episodes and maintenance of good quality of life. **[E]** See Chapter 4 for guidelines on the assessment of CGM parameters. In children and adolescents, TIR should be higher than 80%.

The following chapter outlines the differences in general recommendations related to the specifics of developmental age.

I. Forms of diabetes in developmental age

1. The most common type of diabetes is type 1 with autoimmune pathogenesis.
2. Obese people may experience abnormal fasting blood glucose levels and/or abnormal glucose tolerance, followed by type 2 diabetes. Children aged 10 and more (or younger, if their puberty has begun) whose BMI amounts to more than 95 centiles should be subjected to an OGTT and/or HbA_{1c} test every two years.

3. It should be noted that monogenic diabetes is the second most commonly occurring form of diabetes in the paediatric population in Poland. The indications for testing for monogenic diabetes have been outlined in Chapter 1.
4. The number of children diagnosed with impaired glucose tolerance or cystic fibrosis-related diabetes is increasing. Diabetes is usually asymptomatic. Children aged 10 and more who have been diagnosed with cystic fibrosis should be annually subjected to OGTT with fasting blood glucose level measurement at 30, 60, 90 and 120 minutes.
5. Initial diagnosis of hyperglycaemia or revision of diagnosis includes determination of *glutamic acid decarboxylase* (anti-GAD) antibodies and 1–2 of the following elements: undefined *islet cell antibodies* (ICA), *insulin autoantibodies* (IAA), *insulinoma-associated autoantigen 2* (IA-2) and *zinc transporter family member 8 autoantibodies* (ZnT8) (tests should be performed in a reference laboratory). Such tests can also be conducted in people at high risk of developing type 1 diabetes. The presence of a high titer value of one antibody or elevated titre values of two antibodies indicates an active autoimmune process of pancreatic β-cell apoptosis and allows diagnosing stage I (pre-clinical) diabetes. If IFG and/or IGT are included, stage 2 preclinical diabetes can be diagnosed. Due to the significant risk of developing overt type 1 diabetes (stage 3), patients must be educated on periodic assessment of blood glucose values to prevent the development of ketoacidosis.
6. It should be remembered that a patient may suffer from diabetes due to mixed causes.

II. Goals of diabetes treatment

1. Prevention of acute and chronic complications of diabetes.
2. Acquisition and maintenance of normal, harmonious physical development: growth, body weight and its composition (value in centiles), as well as the course of puberty appropriate to age and sex, while ensuring the well-being of the child and the child's family.
3. Parameter target values reducing the risk of vascular complications:

- HbA_{1c} ≤ 6.5% while maintaining stable blood glucose level, minimising hypoglycaemic episodes and maintaining a good quality of life, TIR > 70%, however, TIR > 80% is preferable (each 5% increase in TIR reduces the risk of cardiovascular complications in adults);
- concentration of total cholesterol < 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 < 90 centiles depending on age, sex and height (from the age of 16 < 130/85 mm Hg);
- BMI < 85 centiles depending on age and sex;
- physical activity of at least moderate intensity > 1 hour per day;
- resting daily activity < 2 hours per day;
- no smoking.

III. Treatment of diabetes

1. Pharmacotherapy

Type 1 diabetes – insulin therapy:

- the insulin therapy method should be adapted to the individual needs of the patient, as well as accepted by the patient and their carers;
- the method of choice is *intensive functional insulin therapy* (IIT) consisting in constant adaptation of insulin doses to the current blood glucose level and the trend of its change, the amount of consumed carbohydrates, fats and proteins in meals, physical activity and emotions, performed as:
  - » *continuous subcutaneous insulin infusion* using a personal insulin pump (CSII);
  - » *multiple daily injections* (MDI) of insulin using injection needles measuring ≤ 6 mm;
- for indications and contraindications to CSII, see the relevant topic section;
- it is advisable to use CSII from the onset of diabetes, as long as no contraindications occur and the method of therapy is accepted by the patient and/or their parents;
- the use of the bolus calculator function is recommended from the beginning of therapy, as it increases blood glucose stability and reduces the risk of hypo- and hyperglycaemia; it is necessary to review and modify the bolus calculator settings regularly;
- the choice of rapid- or ultra rapid-acting and long- or ultra long-acting insulin analogues should be tailored to the individual needs of the patient and take into account the pharmacological differences between the medicines, as well as registered indications;
- the daily insulin demand is highly variable; its highest values are recorded during puberty but should not exceed 1.5 units/kg/day. High

insulin demand can often be linked to physical inactivity, excessive carbohydrate intake, obesity or co-morbidities. In cases of obesity, the addition of the GLP-1 receptor agonist may be a good option to consider;
- in the functional IIT method: the size of the basal dose (20–50% of the daily dose) and its profile depend on the age of the child and the type of the personal insulin pump used;
- rapid-acting/short-acting insulin is usually better administered before a meal, 15–20 minutes and 30 minutes respectively, while the ultra rapid-acting analogue 2–10 minutes before a meal; in the youngest children, due to the lack of the possibility to plan the timing and sizes of meals, it is advisable to consider dividing the dosage, administering half of the regular dose before a meal and half during or after a meal, in exceptional cases administering the whole dose after a meal.

Type 2 diabetes – insulin, SGLT-2 inhibitors, metformin and GLP-1 receptor agonists may be used in this age group (age restrictions as indicated in the Summary of Product Characteristics).

In the case of newly diagnosed diabetes and:
- the lack of symptoms, HbA_{1c} < 9% and the absence of acidosis, pharmacotherapy in children may begin with metformin;
- the presence of symptoms and/or HbA_{1c} ≥ 9% and the absence of acidosis, treatment begins with the metformin and basal insulin;
- the presence of ketoacidosis – the initial treatment is identical as in the case of type 1 diabetes.

In the case of patients with inadequate blood glucose level control and the lack of normalised weight despite undergoing treatment based on metformin and/or insulin for a considerable amount of time, it is necessary to consider expanding the treatment with GLP-1 receptor agonists and/or SGLT-2 inhibitors.

Monogenic diabetes or diabetes due to genetic syndromes associated with diabetes – the treatment method depends on the type of disease (use of sulphonylurea derivatives is "off label").

Diabetes due to cystic fibrosis – Chapter 1.

2. Nutrition of children and adolescents diagnosed with diabetes

The basic principles of healthy nutrition for children with diabetes are the same as for healthy children. It is advisable to maintain a balanced calorie intake and reduce the consumption of digestible carbohydrates to a maximum of 45–50% of daily calorie requirements. The consumption of simple sugars should be limited to 10% of daily caloric intake and a portion of vegetables should be a part of every meal.

3. Self-monitoring:
- blood glucose monitoring should be carried out by self-measuring glucose levels using continuous glucose monitoring systems, by regular scanning (FGM/isCGM) or real-time scanning (generating notifications and audible alarms without user intervention (rtCGM, real-time continuous glucose monitoring), or a glucometer;
- CGM is recommended for all children and adolescents from the onset of the disease;
- the required frequency of blood glucose measurements using a glucometer is individualised;
- in the case of functional IIT, the measurements should not be carried out less than eight times a day. The blood glucose level should be measured on an empty stomach and before meals, 1–2 hours after a meal, before sleep, as well as before, during and after physical activity. It is also necessary to check the nocturnal glucose profile. If the patient is feeling unwell, they should immediately measure their blood glucose level.

The use of CGM systems requires structured diabetes education on the correct interpretation of current results, modification of therapy according to the dynamics of changes in glucose concentration (trend arrows), retrospective analysis of results according to the recommendations on TIR (Chapter 4). If rtCGM is used, the education should also include the principles of correct sensor calibration, as well as proper selection and programming of alarm and notification.

The use of CGM systems allows adjusting insulin doses to glucose trends more effectively and thus increase the stability of glucose concentration, reduce the number of hypoglycaemic events, improve metabolic control and the quality of life of patients and their carers, as well as decrease the risk of cardiovascular complications.

The use of rtCGM, optimally insulin pumps integrated with rtCGM with automatic insulin suppression function in the event of a low glucose level or with automatic insulin suppression in cases where there is a risk of hypoglycaemia is recommended in patients unaware of hypoglycaemia or suffering from frequent hypoglycaemic events. Only continuous use of CGM has been proven to be therapeutically effective (min. 70% of the time). The use of hybrid closed-loop systems can be taken into account in the treatment of patients with unstable diabetes.

The measurement of β-hydroxybutyrate concentration in blood using strip tests is a more sensitive indicator of ketonaemia than the measurement of the level of ketones in urine.

4. Therapeutic education:
- is the key element of diabetes management and should always include the child and their guardians;
- the patient and/or their parents/guardians should undergo initial education and regular re-education at least once every 1–2 years;
- educational methods and programmes should be varied and adapted to the child's age and intellectual abilities, as well as to the parents' educational tasks;
- in cases involving adolescents and young adults, particular attention should be paid to the prevention of chronic complications of diabetes, contraception, pregnancy and addiction;
- the process of acquiring self-management skills should be gradual; the shift of responsibility to diabetic children and adolescents too early or too late may result in treatment failure;
- workshops and camps for children, adolescents and young adults diagnosed with diabetes constitute beneficial and effective educational tools;
- members of the diabetes team providing care for patients under 18 staying at camps without their parents should provide intensive medical care that includes night duty. Legal and organisational support from administrative units providing care for children with diabetes is expected;
- provision of education on diabetes and its follow-up is the responsibility of the entire diabetes team, especially the diabetes educator.

5. Psychological care:
- children, adolescents and young adults with diabetes and their families must be under constant psychological care from the onset of the disease;
- subclinical and clinical depressive syndromes, *anorexia nervosa* (especially in adolescent girls) and other eating disorders not otherwise specified (ED-NOS) are frequently observed;
- care should be provided by an experienced psychologist, a specialist in the field of diabetes occurring in developmental age;
- screening for depressive disorders should be performed in all patients every 1–2 years and in any patient with unsatisfactory metabolic control of the disease.

6. Additional notes:
- it is necessary to involve the whole family in the management of diabetes in children and adolescents; it is advisable to discuss treatment goals together;
- patients should be encouraged to be independent and take responsibility for their own treatment to an extent appropriate to their age, taking into account their intellectual development and emotional maturity;
- children aged 10 or more should independently measure their blood glucose level using a glucometer and/or CGM system, as well as interpret the results, administer insulin with a pen injector, change insulin pump infusion sets and CGM sensors.

IV. Comorbidities of type 1 diabetes

The most common comorbidities include:
- autoimmune thyroiditis and coeliac disease; they usually give a small number of symptoms or are asymptomatic (e.g. fluctuations of blood glucose levels, improper dynamics of growth and pubescence);
- IgA deficiency;
- certain additional chronic diseases (e.g. epilepsy, Asperger's disease, mental and intellectual disorders) may place additional conditions on diabetes therapy.

V. Acute and chronic complications of diabetes (see respective chapters):

1. Acute complications:
- in the case of blood glucose levels below and equal to 70 mg/dl (3.9 mmol/l) or clinical symptoms of hypoglycaemia, glucose should be administered in the dose of approx. 0.3 g/kg bw, the dose depends on blood glucose and active insulin values, (the maximum dose usually does not exceed 15 g of glucose for a child ≥ 50 kg bw), the blood glucose level should be measured again after 15 minutes;
- the blood glucose level < 54 mg/dl (3.0 mmol/l) indicates clinically significant hypoglycaemia;
- in the case of CGM, hypoglycaemia is diagnosed if the blood glucose level is < 54 mg/dl for more than 15 minutes;
- severe hypoglycaemia in children is diagnosed in the case of disorders of consciousness and/or convulsions;
- the management of severe hypoglycaemia is described in Chapter 14;

- biochemical criteria for the diagnosis of acute hyperglycaemic conditions in children and adolescents are shown in Table 23.1;
- the management of ketoacidosis in children is presented in Figure 22.1. It is emphasised that hydration can be carried out using 0.45% or 0.9% NaCl;
- management of hyperglycaemic hyperosmolar state:
  - » fluid therapy – rapid initial infusion of 0.9% NaCl in the dose of ≥ 20 ml/ /kg, the next doses should be administered until the restoration of peripheral perfusion, then fluids should be replaced within 24–48 hours using 0.45% NaCl. The optimal rate of reduction of sodium level is 0.5 mmol/l per hour, blood glucose level is 50–70 mg/dl per hour and no more than 90 mg/dl per hour. If the blood glucose level decreases by more than 90 mg/dl, the addition of 2.5–5% glucose solution should be considered after the firt few hours of hydration;
  - » insulin therapy – insulin should be included in the treatment if despite the appropriate fluid therapy, the blood glucose level does not decrease by more than 50 mg/dl per hour as a result of the administration of fluids only, the initial does of insulin: 0.025–0.05 unit/kg/hour, then modified dose to achieve the blood glucose level reducation of 50–70 mg/dl per hour;
  - » electrolytes – sodium, potassium, phosphorus, and magnesium deficits are higher than in diabetic ketoacidosis, the supplementation of potassium should be started as soon as renal function and diuresis is stabilised; the intravenous administration of potassium phosphate and potassium chloride 1:1 ensures adequate phosphate supplementation, the administration of phosphates may result in hypocalcemia, the supplementation of magnesium should be considered in hypomagnesemia;
- each centre treating children with diabetes should develop a protocol for the management of diabetic ketoacidosis specifying local indications for hospitalisation in intensive care units, taking into account human resources of of the diabetes unit, experience of the team, and access to intensive care units;
- indications for treatment in an intensive observation room within diabetes units or in intensive care units:
  - » severe diabetic ketoacidosis (pH < 7.1) with a long duration of symptoms, circulatory disorders, decreased level of consciousness;
  - » increased risk of cerebral oedema (age < 5 years, rapidly developing acidosis, low pCO2 level, high urea nitrogen level);
  - » hyperosmolar diabetic ketoacidosis.

2. Chronic complications:

- to prevent complications, regular health examinations are necessary (tab. 23.2);
- if any chronic complication is diagnosed, screening for other disorders must be performed (e.g. diabetic kidney disease, retinopathy, neuropathy and macroangiopathy);
- in case of persistent albuminuria exceeding normal values, the use of an ACE inhibitor or AT1 receptor antagonist is recommended to inhibit its progression. For the treatment to be effective, albuminuria must be managed appropriately;

Table 23. 1. Biochemical criteria for the diagnosis of acute hyperglycaemic conditions in children and adolescents with diabetes

	DKA			Hyperglycaemic-hyperosmolar state	Hyperosmolar DKA
Parameter	Mild	Moderate	Severe		
Plasma glucose [mg/dl]	> 200	> 200	> 200	> 600	> 600
venous blood pH	< 7.3	< 7.2	< 7.1	> 7.3	< 7.3
Bicarbonate [mmol/l]	< 15	< 10	< 5	> 15	< 15
Ketotic hypoglycemia a (β-hydroxybutyrate [mmol/l]	> 3	> 3	> 3		> 3
Ketonuria	Moderate or high	Moderate or high	Moderate or high	Absent or mild	Moderate or high
Effective plasma osmolality [mOsm/kg]	< 320	< 320	< 320	> 320	> 320

DKA – diabetic ketoacidosis

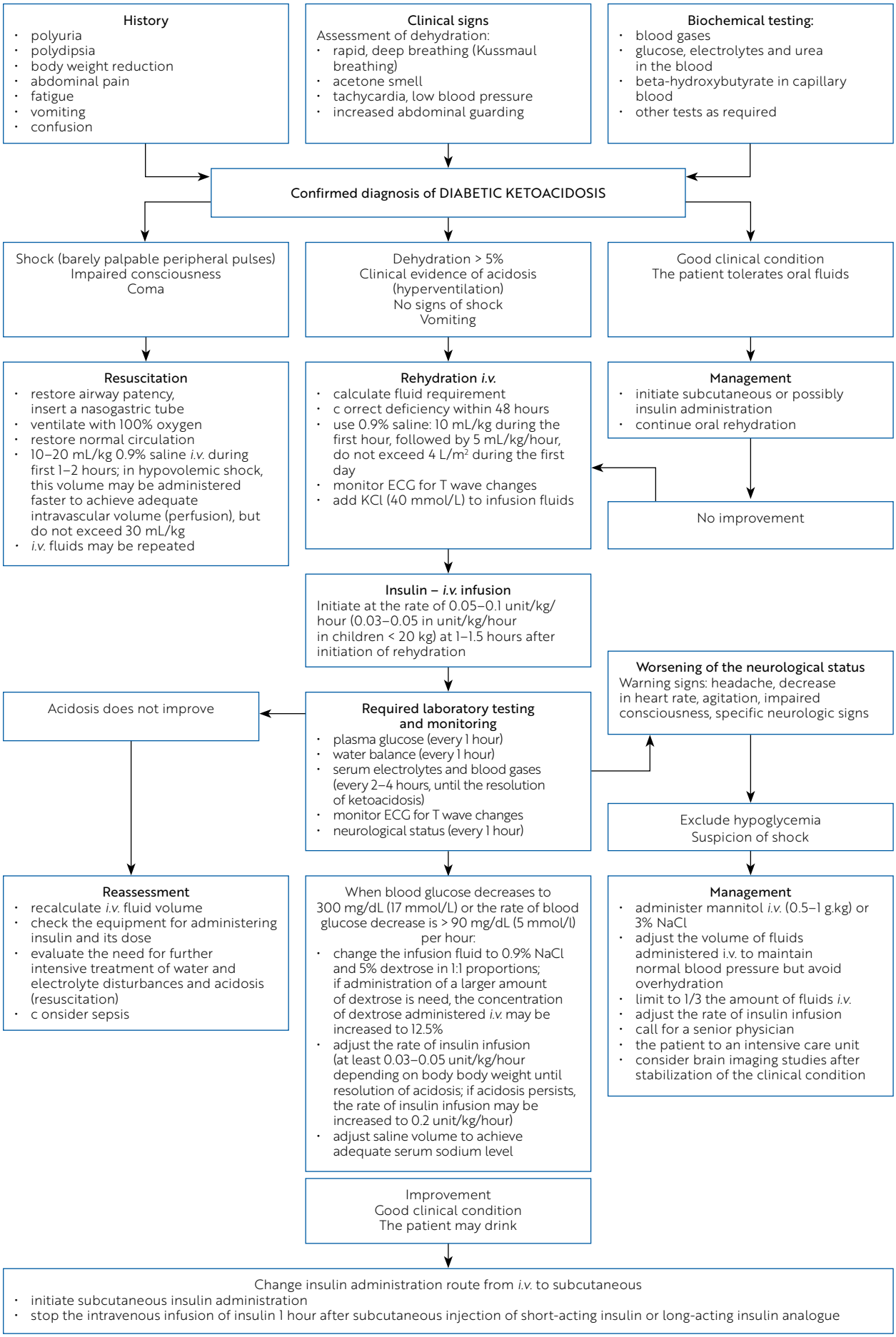


Figure 23.1. Management of diabetic ketoacidosis in children

ECG – electrocardiogram; i.v. – intravenous

- ACE inhibitors or AT1 receptor antagonists are recommended for use in normalising blood pressure; the therapy effectiveness should be continuously monitored, and it is also advisable to achieve a reduction in nocturnal blood pressure, as recorded during continuous ambulatory blood pressure monitoring (ABPM);
- for lipid disorders: when LDL-C > 100 mg/dl (2.6 mmol/l), improved blood glucose control and lifestyle changes are required;
- in children above the age of 8, unless previous attempts at lifestyle changes have not had a beneficial effect on the plasma lipid profile or if other atherosclerotic risk factors coexist with LDL levels above 159 mg/dl (4.1 mmol/l), it is recommended to consider genetic testing for LDL cholesterol receptor mutations and possible use of statins.

VI. Surgery-related treatment

See the section on the relevant topic.

VII. Recommendations regarding diabetes care in children and adolescents with diabetes

1. General recommendations:
- for each new onset of diabetes, the child should be hospitalised in a specialised paediatric diabetes unit, and thereafter, should only receive regular specialised care in paediatric and adolescent diabetes clinics until he or she is transferred to an adult diabetes clinic (for transfer rules, see Appendix 1);
  - » it is necessary to provide 24-hour access to diabetes information for patients and their caretakers;
  - » hospitalisation in a diabetes unit should always be considered in case of disease decompensation (persistent hyperglycaemia, blood glucose fluctuations, recurrent hypoglycaemia);
  - » in diabetes care, it is necessary to read data from the memory of insulin delivery devices and blood glucose monitors and interpret them during each hospitalisation and diabetes consultation.
2. Therapy team:
- hospital care – per 10 paediatric-diabetes beds: 2 full-time physicians (paediatric diabetology specialist, paediatric endocrinology and diabetology specialist, and if they are unavailable, paediatrics/diabetology/endocrinology specialist experienced in paediatric diabetology, as confirmed by the provincial diabetology consultant or provincial paediatric endocrinology and diabetology consultant); 2 full-time nurses dedicated exclusively to diabetes education or 2 full-time diabetes educators, full-time dietician and psychologist and a 1/4 FTE social worker. A nurse dedicated to diabetes care must be available at diabetes units providing intensive care;
- outpatient care – a therapy team rendering services for 300 patients: 1 full-time paediatric diabetologist, endocrinology and paediatric diabetology specialist (and if no such specialist is available, paediatrics specialist, diabetologist or endocrinologist experienced in paediatric diabetology, as confirmed by a provincial consultant); 1–2 nurses whose scope of duties is limited to only to diabetological care or 1–2 diabetological educators; a half-time dietician and a half-time psychologist.

3. Outpatient consultations:
- unlimited frequency of diabetes visits; the recommended frequency is one visit every 6–8 weeks, with no less than 4 visits a year;
- some outpatient appointments can be replaced by video or phone consultations provided that the relevant data can be read and sent to the clinic remotely:
  - » data from blood glucose monitoring devices;
  - » data from insulin delivery devices or apps used as electronic self-management journals;
- irrespective of the use of remote consultations, patients must visit the clinic at least once every 6 months;
- in patients with poorly metabolically balanced diabetes or additional health problems, in-person clinic visits should be recommended;
- the recommended average visit time is 20–30 minutes for specialist advice and 30–40 minutes for treatment and diagnostic advice (personal insulin pump therapy);
- educational visits are not always part of medical advice and can also be conducted electronically;
- additionally, the tasks of the therapy team include holding classes on diabetes care at educational institutions, as well organising educational workshops and preparing awareness-raising materials.

4. Clinic and ward equipment:
- equipment – automatic syringes, personal insulin pumps, glucometers, continuous glucose monitoring devices, blood pressure Holter

Table 23.2. Recommendations regarding diabetes care in children and adolescents with diabetes

Therapeutic education provided to the patient and his/her caregivers	At the diagnosis and afterwards, at the discretion of the doctor or education nurse
Nutritional education provided to the patient and his/her caregivers	At the diagnosis and afterwards, at the discretion of the doctor or education nurse/dietician
Psychological care of the patient and his/her caregivers	At the diagnosis and afterwards, at the discretion of the doctor or education nurse or psychologist
Evaluation of the type of diabetes	At the diagnosis and revision of the diagnosis: clinical picture; family history; assessment of insulin secretion, pancreatic antibody test[#], insulin sensitivity test*; genetic tests*
HbA_{1c}	3–4 times a years, may be measured less frequently in patients who regularly use FGM/CGM
Total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides in serum	After the stabilisation of blood glucose level, and then, if in normal range, every 2 years in patients over the age of 10
Abdominal ultrasound	At the diagnosis of diabetes
Body weight and growth monitoring	During each visit using percentile charts for age and gender
Monitoring of physical development according to the Tanner scale	At the discretion of the doctor, at least once a year, assessment of the regularity of the menstrual cycle
Blood pressure	During 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 two years or in the case of elevated blood pressure values in random measurements
Testing for celiac disease	According to the ESPGHAN guidelines regarding the diagnosis of celiac disease, if no clinical symptoms – screening every 2 years
Evaluation of thyroid function/evaluation for disorders	At the onset of the disease: TSH, fT4, anti-TPO and anti-TG (USG in case of positive antibodies and/or thyroid dysfunction), then TSH, anti-TPO and anti-TG every 2 years (at the discretion of the doctor)
Screening for chronic complications: creatinine, albuminuria, general urianalysis, ophthalmological consultation	After the stabilisation of blood glucose level, and then every 2 years in patients over the age of 10 or with the duration of diabetes of more than 5 years. In the case of abnormal results, the frequency of subsequent tests should be determined on a case-by-case basis according to the patient's need
Specialist consultations	According to the general paediatric indications and at the revision of the diagnosis

1 only at the diagnosis of the disease, within the first 5 days from the start of insulin therapy

**As required.*

[#]Only at the diagnosis of the disease, within the first 5 days from the start of insulin therapy.

(ABPM), ophthalmoscope, monofilament device, food scales, a computer set for reading and printing data from the memory of therapeutic systems;
- facilities and the necessary teaching aids for education;
- additional ward equipment: 1 or more intensive metabolic monitoring stations equipped with pulse oximeters per 10 diabetic patient beds, ECG monitor, oxygen access, ultrasound machine with vascular flow assessment capability (Table 23.2).

VIII. Children with diabetes at educational institutions

1. The diabetes treatment team must work with the teaching staff, the school nurse and the family to ensure the child's safety at school and prevent the stigmatisation of diabetics:
   - once a child has been diagnosed with diabetes, the teaching staff should be provided with written information about diabetes and about providing assistance in emergency life-threatening conditions, as well as phone numbers of the child's parents and doctor and of the nurse at the given educational institution;
   - the staff at the educational institution must also be informed about the need for the child to have a mobile device (mobile phone, smartwatch) with applications used to receive and transmit CGM system, insulin pump, integrated system and therapy support application data (e.g. to calculate the carbohydrate content in the food);
   - the teaching staff must receive the appropriate training in diabetes self-care;
   - training the nurse/staff responsible for supervising the diabetic child at school in the use

of glucometers, CGM systems, injectors or personal insulin pumps;
- caretakers must provide the institution with a continuous supply of glucose and glucagon;
- diabetes is not an indication for the student to be granted an individual teaching programme or be exempt from any classes (e.g. physical education, school trips).

2. The tasks of the teaching staff include:
- immediately providing diabetes first aid in life-threatening situations;
- providing comprehensive assistance aimed at enabling the patients to quickly and safely return to their educational institution and fully integrate with their peers;
- knowing the basic scope of diabetes self-care;
- enabling self-monitoring in educational and childcare settings for all age groups, with younger children being supervised by school staff;
- working closely with the diabetes treatment team and the patients' caretakers.

IX. Travel:
- it is the responsibility of the patient and his/her caregivers to inform the organiser about the disease, its treatment, nutrition and help and to provide telephone numbers to the therapeutic diabetes team;
- in the case of international travels, an appropriate certificate in English informing about the disease should be prepared;
- insulin, glucagon, glucose, glucose meter with test strips, insulin pens, and equipment for insulin pumps and CGM systems should be secured for the duration of the travel and stored in a hand luggage.

X. Physical activity, practising sports
1. Children and adolescents with diabetes:
- should be encouraged to engage in daily moderate or intensive physical activity;
- should regularly participate in physical education classes;
- may practise sports similarly to children without diabetes.

2. Recommendations regarding physical activity and practising sports are presented in Chapter 7 and Annex 7.

XI. Choice of profession:
- particular attention should be paid to the education of diabetic adolescents – they should be provided with the best education possible;
- it is the task of the diabetes team to help the patient choose a profession by evaluating his/her health, presence of complications, and intellectual and mental capabilities.

REFERENCES
1. Alotaibi A, Al Khalifah R, McAssey K. The efficacy and safety of insulin pump therapy with predictive low glucose suspend feature in decreasing hypoglycemia in children with type 1 diabetes mellitus: a systematic review and meta-analysis. Pediatr Diabetes 2020; 21: 1256–1267.
2. Bell KJ, Barclay AW, Petocz P, et al. Efficacy of carbohydrate counting in type 1 diabetes: a systematic review and meta-analysis. Lancet Diabetes Endocrinol 2014; 2: 133–140.
3. Carlsson A, Shepherd M, Ellard S, et al. Absence of islet autoantibodies and modestly raised glucose values at diabetes diagnosis should lead to testing for MODY: lessons from a 5-year pediatric swedish national cohort study. Diabetes Care 2020; 43: 82–89.
4. Fullerton B, Jeitler K, Seitz M, et al. Intensive glucose control versus conventional glucose control for type 1 diabetes mellitus. Cochrane Database Syst Rev 2014; 14: CD009122.
5. ISPAD Clinical Practice Consensus Guidelines 2018. Available: https://www.ispad.org/general/custom.asp?page=ISPADGuidelines2018.
6. Karges B, Schwandt A, Heidtmann B, et al. Association of insulin pump therapy vs insulin injection therapy with severe hypoglycemia, ketoacidosis, and glycemic control among children, adolescents, and young adults with type 1 diabetes. JAMA 2017; 318: 1358–1366.
7. Kmietowicz Z. Insulin pumps improve control and reduce complications in children with type 1 diabetes. BMJ 2013; 347: f5154.
8. Slover RH, Welsh JB, Criego A, et al. Effectiveness of sensor-augmented pump therapy in children and adolescents with type 1 diabetes in the STAR 3 study. Pediatr Diabetes 2012; 13: 6–11.
9. Nevo-Shenker M, Phillip M, Nimri R, et al. Type 1 diabetes mellitus management in young children: implementation of current technologies. Pediatr Res 2019; 87: 624–629.
10. Pastore I, Bolla AM, Montefusco L, et al. The Impact of Diabetes Mellitus on Cardiovascular Risk Onset in Children and Adolescents Int J Mol Sci 2020; 21: 4928.

24. Diabetes and pregnancy

Key recommendations
• Pregnancy planning in women with diabetes reduces the incidence of adverse events in mothers and children and should be part of standard diabetes care for diabetic women of child-bearing age. [**A**]
• Contraception using barrier methods or oral hormonal contraceptives should be used for planning pregnancy in women with diabetes. [**B**]
• In Poland, it is obligatory to carry out screening tests for hyperglycaemia in pregnant women. The classification and diagnostic criteria of hyperglycaemia during pregnancy are in accordance with the WHO guidelines. [**A**] Screening is recommended at the first visit during pregnancy and between 24th and 28th week of pregnancy.
• In many women with gestational diabetes, behavioural modifications make it possible to ensure adequate blood glucose control, and pharmacotherapy in the form of insulin should be initiated if therapeutic targets are not met. [**A**]
• General principles of the treatment of diabetes during pregnancy: 1. Hyperglycaemia during pregnancy increases the risk of maternal and fetal complications, and thus, blood glucose control should be optimised both in pre-pregnancy diabetes and hyperglycaemia first diagnosed during pregnancy. [**A**] 2. Self-monitoring of blood glucose is recommended as the basic metabolic control assessment method in all types of diabetes complicating pregnancy. Currently, the following target blood glucose values in self-monitoring are recommended – fasting blood glucose level and blood glucose level before meals: 70–90 mg/dl (3.9–5.0 mmol/l); maximum blood glucose level within the first hour after the commencement of the meal: < 140 mg/dl (< 7.8 mmol/l); within the second hour after the commencement of the meal < 120 mg/dl (6.7 mmol/l), between the second and the fourth hour: 70–90 mg/dl (3.9–5.0 mmol/l). [**A**] 3. The measurement of HbA_{1c} levels is a tool to assess blood glucose control in women with pre-pregnancy diabetes. The recommended levels are < 6.5% (48 mmol/mol) during pregnancy planning and in the first trimester and < 6.0% (42 mmol/mol) in the second and third trimester. [**B**] 4. In addition to the role of good blood glucose control, attention should be paid to adequate nutrition, as well as co-morbidities and medications used. [**B**] 5. Continuous blood glucose monitoring and achieved target blood glucose levels using CGM (TIR, TAR) systems can help to achieve target blood glucose levels in pregnancy in women with pre-pregnancy diabetes. [**B**] 6. Insulin is the only antihyperglycaemic drug recommended in pregnancy. Based on the current knowledge, the use of other antidiabetic drugs, either oral agents or injections, is not recommended. [**A**] 7. Metformin used in women with polycystic ovary syndrome (PCOS) to treat insulin resistance or induce ovulation should be discontinued by the end of the first trimester of pregnancy. [**A**]
• Patients with a history of (GDM) should be tested for diabetes before the next pregnancy and if it is diagnosed, they should be treated to reduce the risk of developmental anomalies in children. [**E**]

Pregnancy planning in all women with diabetes has a major impact on the course of pregnancy, reducing the incidence of maternal and fetal/neonatal adverse events.

Diabetes in pregnancy includes:

- pregestational diabetes mellitus (PGDM) — when a woman with diabetes becomes pregnant (regardless of the type of diabetes);
- hyperglycaemia first diagnosed during pregnancy.

I. Contraception

Patients should be informed that diabetes itself is not a contraindication for hormonal contraception. Patients should be evaluated for conventional contraindications against hormonal contraception and be offered an opportunity to choose an individually preferred, effective contraception method, taking into account the risk associated with unplanned pregnancy. Intrauterine devices or progestogen-only contraceptive pills are recommended for patients with diabetes if the duration of diabetes is > 20 years or with neurovascular complications (nephropathy/retinopathy/neuropathy). Patients who plan pregnancy should be informed that the risk of pregnancy complications increases with the duration of diabetes, presence of organ complications of diabetes, and lack of metabolic control.

Combined oral contraceptives containing less than 35 µg, preferably 15 and 20 µg, of ethinylestradiol are recommended due to their minimal impact on carbohydrate and lipid metabolism. Preferred progestins include levonorgestrel and norethisterone.

A progestin-releasing IUD is recommended as a contraceptive method in obese women who are > 35 years of age, in women with type 2 diabetes, and in those with concomitant vascular complications.

Pregnancy in a woman with poorly controlled diabetes outweighs the risks of any contraceptive used.

II. Model of care for pregnant women with diabetes

1. During pregnancy planning, pregnancy, and the postpartum period, all women with diabetes should remain under the care of an experienced team of diabetologists and obstetricians (maternal and fetal medicine specialists). Women with type 2 diabetes treated with oral drugs require insulin therapy at the stage of pregnancy planning to achieve proper blood glucose levels. In women with type 2 diabetes metformin can only be used in the preconception period if this treatment ensures optimal metabolic control. Once pregnant, a woman should stop taking metformin and use only insulin to ensure blood glucose control. SGLT-2 inhibitors and GLP-1 receptor agonists are currently not approved for use during pregnancy and should not be used during pregnancy planning.

Each doctor who has a woman with type 2 diabetes under his/her care should regularly discuss her pregnancy plans with her and inform her about the need for pregnancy planning due to the existence of complex risk factors for obstetric failure in this population of women and frequent use of antihypertensive drugs and statins.

2. The aim of such a management is:

- to optimise the treatment of diabetes;
- to evaluate and treat complications of diabetes;
- to provide diabetes education, including nutritional education;
- to advise women to stop smoking;
- to evaluate thyroid function (to exclude hypothyroidism); the upper limit of the reference range for TSH should be: 2.5 μIU/ml in the first trimester and up to 3 μIU/ml in the second and third trimester;
- during pregnancy, a consultation with a diabetologist should occur at least once a month, and in justified cases every 2–3 weeks. This is due to changing insulin demand and the need to monitor the body weight, renal function, eyesight, and blood pressure etc.;
- in women with pre-pregnancy diabetes irrespective of type, ophthalmological control should be carried out before pregnancy and at the latest in the first trimester of pregnancy and then repeated in each trimester. Eye health is not routinely checked in women with GDM;
- if gestational hypertension develops, treatment should be provided when blood pressure values are above 140/90 mm Hg;
- in women with diabetes and chronic hypertension before pregnancy or with renal complications, target systolic blood pressure is < 135 mm Hg and target diastolic blood pressure is < 85 mm Hg (methyldopa is the first-line drug during pregnancy);
- in women with pre-pregnancy diabetes, the use of acetylsalicylic acid in the dose of 1 mg/kg bw (100–150 mg/day) is recommended from the 12th to the 36th week of pregnancy (prevention of preeclampsia) depending on the obstetrician's decision.

3. Pregnancy is discouraged in diabetic women in the following clinical settings:

- nephropathy manifested by a creatinine clearance below 40 ml/min;
- untreatable proliferative retinopathy;
- advanced untreatable ischaemic heart disease:
  - » hypertrophic cardiomyopathy or severe left ventricular dysfunction (LVEF < 30%, NYHA III/IV);
  - » a history of peripartum cardiomyopathy with any residual left ventricular dysfunction;
- autonomic neuropathy affecting the cardiac or gastrointestinal conduction systems.

While the final decision on procreation rests with the patient, she must be informed by specialists in the relevant field of the risks to her life and health that pregnancy poses in such circumstances.

Pregnancy does not appear to be associated with post-partum worsening of chronic diabetic complications. Diabetic women are free to have as many offspring as they want, provided that none of the above contraindications exists.

III. Criteria for the diagnosis and classification of hyperglycaemia first diagnosed in pregnancy

All pregnant women should be tested for impaired glucose tolerance as soon as possible once pregnancy has been determined. Pregnant women at risk should undergo a 75g OGTT (described in Chapter 1) at their first visit while all others should have a fasting blood glucose test done. If no abnormal blood glucose values are found (see Fig. 23.1), the diagnostic test should be repeated at 24–28 weeks of gestation or when the first symptoms suggestive of diabetes occur. Diagnosis in the group of patients with no risk factors and normal blood glucose level at the first examination during their pregnancy should be carried out at 24–28 weeks of pregnancy and is a single-step process consisting in performing a 75 g OGTT.

Hyperglycaemia first diagnosed during pregnancy should be diagnosed and classified according to WHO recommendations (2013):

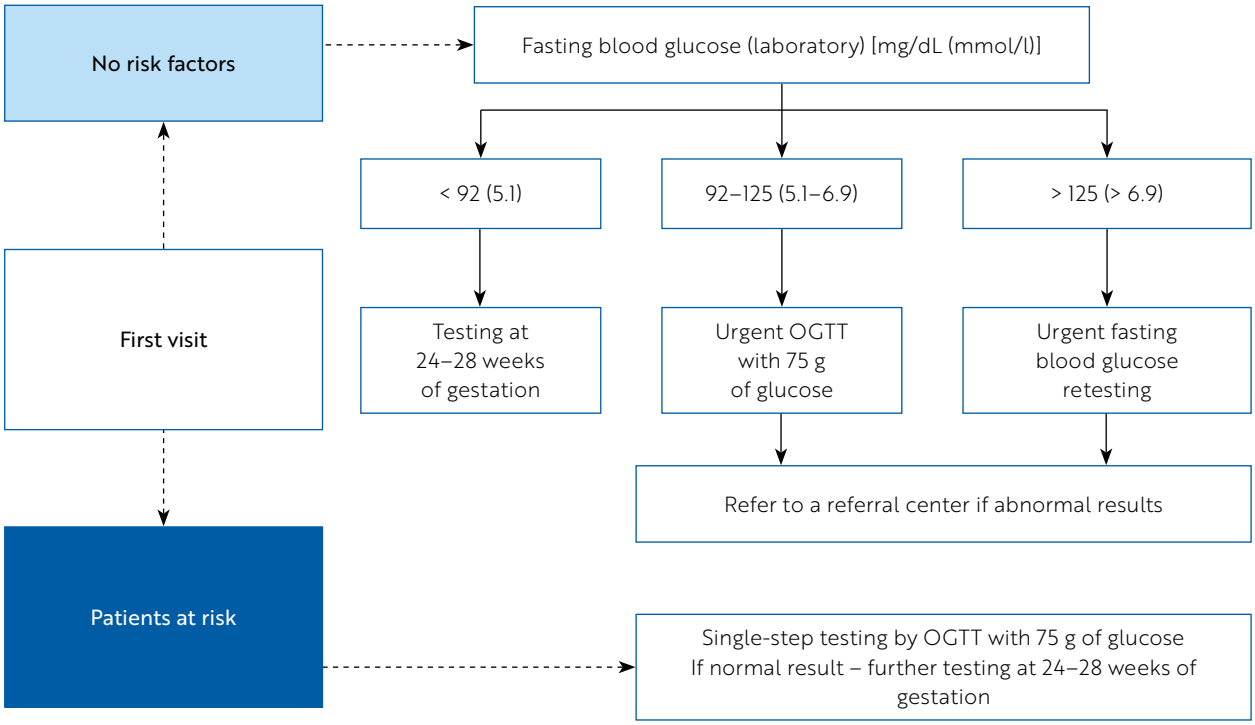


Figure 24.1. Diagnostic scheme for carbohydrate metabolism disorders in pregnancy

Note: Fasting blood glucose above 92 mg/dl but below 125 mg/dl on one occasion during the first trimester cannot be a basis for the diagnosis of hyperglycaemia in pregnancy.

- diabetes in pregnancy – when the general conditions for the diagnosis of diabetes are met, i.e.:
  - » fasting blood glucose ≥ 126 mg/dl (≥7.0 mmol/l);
  - » or blood glucose during the 2nd hour of the 75 g OGTT ≥ 200 mg/dl (11.1 mmol/l);
  - » or causal blood glucose ≥ 200 mg/dl (11.1 mmol/l), accompanied by clinical signs of hyperglycaemia;
- *gestational diabetes mellitus* (GDM) – when at least one of the criteria listed in Table 24.1 is met.

After delivery, most women's glucose levels normalise, but since diabetes in pregnancy is a risk factor for overt diabetes in later life, all women should be screened for impaired glucose tolerance. It is recommended that a 75 g OGTT be performed 6–12 weeks postpartum, followed by fasting blood glucose measurement once a year. A glucose tolerance test (75 g OGTT) should be performed before the next pregnancy. Women with a history of gestational diabetes should be treated as a group at high risk for diabetes and cardiovascular disease (see Chapter 2 for details on management).

Table 24.2. Diagnostic criteria of gestational diabetes based on the result of 75 g in the OGTT according to IADPSG 2010 and WHO 2013

Plasma glucose		
	[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 of pre-pregnancy diabetes and hyperglycaemia in pregnancy

Hyperglycaemia in pregnancy increases the risk of obstetric complications in the pregnant woman and the developing foetus and affects the child's subsequent development. Therefore, irrespective of the type of diabetes (pre-pregnancy diabetes or hyperglycaemia diagnosed during pregnancy), it is necessary to strive to achieve blood glucose values recorded in healthy pregnant women. Based on the current stage of knowledge, the following self-monitoring blood glucose values are deemed the proper target values:

- fasting and pre-meal blood glucose: 70–90 mg/dl (3.9–5.0 mmol/l);
- maximum blood glucose at 1 hour after the start of a meal: < 140 mg/dl (< 7.8 mmol/l) or at 2 hours < 120 mg/dl (6.7 mmol/l);
- between 2:00 a.m. and 4:00 a.m.: 70–90 mg/dl (3.9–5.0 mmol/l).

Pregnant women should perform blood glucose measurements themselves, after appropriate training by a nurse experienced in diabetes care. The number and timing of glucose level determinations should

depend on the severity of the carbohydrate disturbance and the treatment being administered. Continuous subcutaneous glucose monitoring (*CGM*) is recommended for women treated with CSII. In the case of CGM, it is recommended that blood glucose values above 140 mg/dl (7.8 mmol/l represent less than 25% of 24-hour measurements, values at 63–140 mg/dl (3.5–7.8 mmol/l) more than 70% of measurements, values below 63 mg/dl (3.5 mmol/l) less than 4%, and values below 54 mg/dl (3.0 mmlo/l) less than 1% of them. In pregnant women with type 2 diabetes and gestational diabetes in the target range of 63–140 mg/dl (3.5–7.8 mmol/l), patients should achieve more than 90% of this value.

The HbA_{1c} value in women with pre-pregnancy diabetes should be determined every 6 weeks and the aim should be to achieve a level below < 6.5% (< 48 mmol/mol) in the first trimester and below 6.0% (< 42 mmol/mol) in subsequent trimesters. There is no evidence for the utility of HbA_{1c} as a tool for monitoring metabolic control in GDM.

1. Dietary treatment:
- 40–50% carbohydrates (about 180 g carbohydrate/d.), preferring low glycaemic index carbohydrates in the diet;
- 30% protein (1.3 g/kg bw/day);
- 20–30% fats (including < 10% saturated fats);
- the number of calories depends on body weight, height, physical activity and age – the average daily calorie requirement is about 30 kcal per kg of body weight, i.e. 1500–2400 kcal;
- in overweight patients, a diet of 25–30 kcal per kg of body weight is recommended;
- considering the very restrictive blood glucose targets, pregnant women should consume a fixed amount of carbohydrates at relatively fixed times to be able to adjust insulin doses and avoid both hyper- and hypoglycaemia;
- it is necessary to control weight gain during pregnancy, as excessive weight gain in pregnant diabetics is associated with excessive foetal growth (Tables 24.2, 24.3);
- the use of artificial sweeteners is permitted, except for saccharin, which passes across the placenta and its effects on the foetus are not fully known (see Appendix 5);
- when planning pregnancy, it is recommended to implement folic acid supplementation (min. 0.4 mg/day) for at least 6 weeks before pregnancy, which should continue through the 12th week of pregnancy.

2. Physical exercise: unless contraindications exist, aerobic physical activity of moderate intensity is recommended.
3. Insulin therapy in PGDM:
- human insulin has long been used in pregnant patients with diabetes-related complications and has been proven to be safe. The safety of using lispro and glargine insulin analogues in pregnancy has been demonstrated in numerous observational studies while the safety of aspart and detemir insulins has been confirmed in randomised trials as well. None of the studies to date has shown the passage of insulin analogues across the placenta;
- intensive insulin therapy by multiple daily injections (see section 11, p. 3);
- a slight increase in insulin sensitivity occurs during early pregnancy, and as such, pregnant women may experience incidents of hypoglycaemia with the insulin dose used to date;
- insulin resistance begins to increase starting from the 16th week of pregnancy, requiring the insulin dose to be regularly increased based on the patient's needs;
- insulin therapy by *continuous subcutaneous insulin infusion* (CSII) – short-acting insulins or rapid-acting insulin analogues are recommended. The qualification and management of personal insulin pump users with pre-pregnancy diabetes should be carried out at diabetes centres experienced in

Table 24.2. Recommendations regarding body weight gain during pregnancy

Pre-pregnancy body mass index BMI [kg/m²]	Recommended body weight gain [kg]	Recommended body weight gain in the 2nd and 3rd 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	5–9	0.22 (0.17–0.27)
Assuming that body weight gain in the 1st trimester of pregnancy is 0.5-2.0 kg		

Table 24.3. Risk factors for hyperglycaemia during pregnancy

Pregnancy over 35 years of age
History of delivery of a newborn with an excessive body weight (> 4000 g)
Delivery of a newborn with a developmental anomaly
History of fetal death
Hypertension
Overweight or obesity
Family history of type 2 diabetes
Gestational diabetes during previous pregnancies
Multiparity
Polycystic ovary syndrome

CSII therapy. Insulin pump therapy should be commenced at the pregnancy planning or early pregnancy stage (up to the 12th week). In exceptional cases, it may be commenced later in patients in whom achieving satisfactory metabolic control by multiple insulin injections is impossible.

4. Insulin therapy in hyperglycaemia diagnosed during pregnancy:
- the recommended methods include intensive insulin therapy with multiple injections or using a personal insulin pump;
- the need for insulin decreases rapidly after delivery, and as such, it is possible to discontinue insulin administration in most women who had hyperglycaemia during pregnancy, provided that blood glucose control is maintained.

5. Oral antidiabetic drugs are not currently recommended for the treatment of diabetes in pregnancy since they pass across the placenta and because some randomised trials indicate that they negatively affect the long-term development of the offspring. It is recommended that women taking oral antidiabetic drugs commence insulin therapy during the planning of pregnancy or as soon as possible after pregnancy is determined.

6. Education system:
- clinical issues – classes are to be taught by a doctor, nurse or dietician with expertise in personal insulin pump therapy;
- technical aspects of personal insulin pump operation – classes are to be taught by a nurse or doctor certified as a technical training specialist or an employee of a personal insulin pump manufacturer;
- the education programme is to be implemented according to a training sheet documenting the course of treatment;
- the education programme may be implemented in an outpatient or inpatient setting;
- therapy may be implemented as soon as the patient has basic clinical and technical knowledge of CSII (understanding of the principles of therapy and ability to use the pump's main functionalities).

7. Breastfeeding should be widely promoted and recommended in women with pre-pregnancy diabetes and hyperglycaemia in pregnancy unless there are other contraindications.

8. Oral medication and lactation: The available literature and clinical data show that metformin passes into breast milk in very small amounts and does not exceed 1% of the maternal concentration. As such, type 2 diabetes patients can safely use metformin during lactation.

REFERENCES

9. Bateman BT, Hernandez-Diaz S, Fischer MA, et al. Statins and congenital malformations: cohort study. BMJ 2015; 350: h1035.
10. Brown J, Grzeskowiak L, Williamson K, Downie MR, Crowther CA. Insulin for the treatment of women with gestational diabetes. Cochrane Database Syst Rev 2017; 11: CD012037.
11. Bullo M, Tschumi S, Bucher BS, et al. Pregnancy outcome following exposure to angiotensin-converting enzyme inhibitors or angiotensin receptor antagonists: a systematic review. Hypertension 2012; 60: 444–450.
12. Farrar D, Tuffnell DJ, West J, West HM. Continuous subcutaneous insulin infusion versus multiple daily injections of insulin for pregnant women with diabetes. Cochrane Database Syst Rev 2016; 6: CD005542.
13. Feig DS, Donovan LE, Corcoy R, et al. Continuous glucose monitoring in pregnant women with type 1 diabetes (CONCEPTT): a multicentre international randomised controlled trial. Lancet 2017; 390: P2347-P2359.
14. Metzger BE, Lowe LP, Dyer AR, et al.. Hyperglycemia and adverse pregnancy outcomes. N Engl J Med 2008; 358: 1991–2002.
15. Hartling L, Dryden DM, Guthrie A, et al. Benefits and harms of treating gestational diabetes mellitus: a systematic review and meta-analysis for the U.S. Preventive Services Task Force and the National Institutes of Health Office of Medical Applications of Research. Ann Intern Med 2013; 159: 123–129.
16. Jensen DM, Korsholm L, Ovesen P, et al. Periconceptional A1C and risk of serious adverse pregnancy outcome in 933 women with type 1 diabetes. Diabetes Care 2009; 32: 1046–1048.
17. Landon MB, Spong CY, Thom E, et al. A multicenter, randomized trial of treatment for mild gestational diabetes. N Engl J Med 2009; 361: 1339–1348.
18. Middleton P, Crowther CA, Simmonds L. Different intensities of glycaemic control for pregnant women with pre-existing diabetes. Cochrane Database Syst Rev 2016; 5: CD008540.
19. Poolsup N, Suksomboon N, Amin M. Efficacy and safety of oral antidiabetic drugs in comparison to insulin in treating gestational diabetes mellitus: a meta-analysis. PLoS One 2014; 9: e109985.
20. Tolcher MC, Chu DM, Hollier LM, et al. Impact of USPSTF recommendations for aspirin for prevention of recurrent pre- eclampsia. Am J Obstet Gynecol 2017; 217: 365.e1–365.e8.
21. De Veciana M, Major CA, Morgan MA, et al. Postprandial versus preprandial blood glucose monitoring in women with gestational diabetes mellitus requiring insulin therapy. N Engl J Med 1995; 333: 1237–1241.
22. Wotherspoon AC, Young IS, Patterson CC, et al. Effect of pregnancy planning on maternal and neonatal outcomes

in women with Type 1 diabetes. Diabet Med 2017; 34: 1303–1308.
23. Ratner RE,Christophi CA, Metzger BE, et al. Prevention of diabetes in women with a history of gestational diabetes: effects of metformin and lifestyle interventions. J Clin Endocrinol Metab 2008; 93: 4774–4779108.
24. ArodaVR,Christophi CA, Edelstein SL, et al. The effect of lifestyle intervention and metformin on preventing or delaying diabetes among women with and without gestational diabetes: the Diabetes Prevention Program outcomesstudy 10-year follow-up. J Clin Endocrinol Metab 2015; 100: 1646–1653.
25. Glatstein MM, Djokanovic N, Garcia-Bournissen F, et al. Use of hypoglycemic drugs during lactation. Can Fam Physician 2009; 55: 371–373.
26. Priya G, Kalra S. Metformin in the management of diabetes during pregnancy and lactation. Drugs Context 2018; 7: 212523.
27. Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines. Weight Gain During Pregnancy: Reexamining the Guidelines. Rasmussen KM, Yaktine AL (eds.). Washington (DC): National Academies Press (US); 2009. PMID: 20669500.

25. Diabetes in persons over the age of 65

Key recommendations
· When starting diabetes treatment in people over the age of 65, therapeutic goals should be individually determined depending on the patient's health state, cognitive abilities, and social and living conditions. [**C**]
· One of the main goals in the treatment of diabetes in people over the age of 65 is to prevent hypoglycaemia by individualising therapeutic goals and avoiding medications that are associated with a high risk of hypoglycaemia. [**B**]
· In individuals over the age of 65, who do not have significant complications, the therapeutic goal may be similar to that in the younger adult population. [**C**]
· During the intensification of treatment, target values for glycaemia, blood pressure, and lipids should be considered, taking into account the specificity of the age group and comorbidities. [**B**]

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

Hyperglycaemia symptoms in patients over the age of 65 may be less severe than in younger individuals, which may result in delayed diagnosis of the disease.

Survival time is much shorter in patients with diabetes at an advanced age, therefore, when choosing a method of treatment, it should be remembered that prevention of complications developing after several or more years in the course of the disease is less important than in younger people.

I. Goals of the treatment of diabetes in persons under the age of 65:

- the primary goal of the treatment of elderly diabetic patients is to strive to improve or at least maintain their current quality of life. It is crucial to avoid hypoglycaemia while reducing symptoms of hyperglycaemia;
- if a diabetic patient over the age of 65 does not have significant complications or comorbidities, gradual control of diabetes should be achieved while realising the general goals of treatment, assuming HbA_{1c} ≤ 7% as the target value;
- in patients at an advanced age and with long history of diabetes and significant macrovascular complications (past myocardial infarction or stroke), the target HbA_{1c} value is ≤ 8.0%;
- conducting diagnostic tests for diabetes complications, preventing their progression and recommending appropriate treatment;
- treatment of comorbidities in order to reduce functional impairment and improve the quality of life.

II. Physical efficiency

After an initial determination of the patient's individual risk and physical efficiency, outdoor exercise involving a slow onset and slow end should be recommended. The patient should avoid straining and breath-holding exercises and pay attention to the risk of injury and especially the risk of developing diabetic foot syndrome.

III. Dietary recommendations

General recommendations; no specific age-related recommendations, diet modification is ineffective due to established eating habits.

IV. Oral antihyperglycaemic drugs:

- metformin — rules described in Chapter 11, section II (description of stage 1 treatment of type 2 diabetes) should be followed, and co-morbidities that increase the risk of metabolic acidosis should be taken into account; special care should be taken in patients with eGFR < 60 ml/min/1.73 m^2;
- sulfonylurea derivatives — treatment should be started with low doses because of the risk of hypoglycaemia;
- DPP-4 inhibitors, GLP-1 agonists, α-glucosidase inhibitor, PPAR-γ agonist, SGLT-2 inhibitors;
- there are no specific contraindications for the use of these drugs for people > 65 years of age; these drugs may be particularly beneficial in this age group due to the negligible risk of hypoglycaemia. PPAR-γ agonist should not be administered to patients with heart failure and high fracture risk.

V. Insulin therapy:

- there are no specific indications or contraindications for insulin therapy for the elderly;
- starting insulin therapy, if indicated, should not be delayed;
- when starting or modifying insulin therapy, preparations that have the lowest risk of hypoglycaemia should be chosen;
- age > 65 years is not a contraindication to intensive insulin therapy;
- in some elderly patients (> 80 years), low-dose short-acting insulin preparations or rapid-acting insulin analogues before main meals, without concomitant use of long-acting (basal) insulin, may be effective;
- in situations where meal size is unpredictable (e.g. in the case of patients with poor appetite, advanced dementia), it may be advisable to administer an appropppriate dose of rapid-acting insulin analogue immediately after the meal.

VI. Diabetes education

Should include both patients and their caregivers.

VII. Antihypertensive therapy:

- age is not a criterion for selecting a particular class of antihypertensive drugs;
- the benefits of antihypertensive therapy in people aged > 65 are comparable to those obtained in younger people.

VIII. Hypolipidemic therapy:

Despite the lack of objective data, it should be concluded that the benefits of hypolipidemic therapy in both primary and secondary prevention, observed in younger people, also apply to patients aged > 65.

REFERENCES

1. Barnett AH, Huisman H, Jones R, et al. Linagliptin for patients aged 70 years or older with type 2 diabetes inadequately controlled with common antidiabetes treatment: a randomized, double-blind, placebo-controlled trial. Lancet 2013; 382: 1412–1424.
2. Kirkman MS, Briscoe VJ, Clark N, et al. Diabetes in older adults: a consensus report. Diabetes Care 2012; 35: 2650–2664.
3. Lipska K, Ross JS, Miao Y, et al. Potential overtreatment of diabetes mellitus in older adults with tight glycemic control. JAMA 2015; 175: 356–362.
4. Matter JB, Musi N, McFarland Horne F, et al. Diabetes and cardiovascular diseases in older adults. Current status and future directions. Diabetes 2014; 63: 2578–2589.

26. Principles of preparing a person with diabetes for operation

Prepared in cooperation with prof. Prof. dr. n. med. Wojciech Szczeklik

Key recommendations
· Planned surgery in an individual with diabetes should be postponed when HbA_{1c} value exceeds 8.5%. [**B**]
· Insulin therapy should not be discontinued in people treated with insulin before surgery, and periodic insulin treatment should be used in most people with type 2 diabetes previously treated with oral antihyperglycaemic drugs. [**B**]
· In critically ill diabetic patients on parenteral nutrition, treatment with intravenous insulin in glycaemia-dependent dose is recommended. [**C**]
· Perioperative glycaemic monitoring in patients with diabetes reduces the risk of complications and death. [**B**]
· The recommended target perioperative glycaemic values are 100–280 mg/dl. [**C**]

I. Examinations that should be carried out before planned surgery:

- daily glycaemic profile (7 measurements during a day and at approx. 3 a.m. in case of insulin treatment); daily glycaemic profile is not necessary if patient uses continuous glycaemic measurement system;
- HbA_{1c};
- morphotic blood composition;
- serum concentration: creatinine, electrolytes (Na+, K+), aminotransferase activity (AST, ALT);
- INR indicator, bleeding time; APTT;
- acid-base balance (blood gasometry) (if abnormalities are suspected);
- general urinalysis;
- fundus evaluation (current result);
- resting ECG (see note 1);
- chest X-ray.

Note 1: In patients at high and very high cardiac risk and when planning extensive procedures (e.g. abdominal or hip vessel surgery, cardiac surgery), extended non-invasive diagnostics should be performed (stress test, echocardiography, Holter ECG).

Note 2: Same-day surgery can be performed in patients with diabetes with good metabolic control, treated with intensive insulin therapy and in patients with type 2 diabetes who do not need periodic insulin treatment in the perioperative period. Withholding antihyperglycaemic medication for the day of surgery will not result in glycaemia > 180 mg/dl (10 mmol/l).

II. Management before elective surgery

1. A patient with diabetes mellitus requiring periodic insulin treatment should be admitted to the hospital 2 days before the scheduled surgery.
2. Elective surgery should be deferred in a patient with inadequate metabolic control (i.e. persistent glycemic values in the daily profile > 250 mg/dl (13.9 mmol/l), HbA_{1c} > 8.5%, and/or the presence of glycosuria with acetonuria).
3. If a patient with type 2 diabetes treated with two or three antihyperglycemic drugs will not be eating on the day of surgery, or will be undergoing a large surgery with an increased risk of hemodynamic instability, it is recommended to withhold current therapy and use periodic insulin therapy.
4. A multiple insulin injections (base-bolus) model is recommended for periodic insulin treatment.
5. Daily insulin dose – 0.3–0.7 units/kg body weight; 50–60% of the daily dose – short-acting (rapid-acting) insulin given 15–30 min before main meals according to the schedule: 50–20–30% of the daily dose of short-acting (rapid-acting) insulin; 40–50% of the daily dose – long-acting insulin (NPH) given in two injections – 7:00–8:00 AM (40%) and 10:00–11:00 PM (60%) or long-acting analogue given in 1 injection, usually during the evening hours.
6. A well-trained and metabolically balanced patient with diabetes mellitus treated with intensive insulin therapy independently adjusts insulin doses to current needs, therefore the patient should not be deprived of this opportunity in the hospital and treatment should not be started with rigid, non-modifiable doses of the product.

7. Patients treated with a personal insulin pump should maintain their current treatment until the day of surgery.
8. If preparation for surgery requires a strict diet on the day(s) prior to surgery, an intravenous infusion of 10% glucose solution with 12 units of short-acting (rapid-acting) insulin and 10 mmol KCl is recommended instead of a meal.
9. Achieving glycaemic control: in the perioperative period, blood glucose levels should be maintained within safe limits of 100–180 mg/dl (5.6–10.0 mmol/l).
10. Notifying the surgical and anaesthetic team of complications that increase surgical risk (heart or kidney disease, neuropathy, proliferative retinopathy).

Note 3: Periodic insulin therapy is not required for patients undergoing so-called minor surgery (tooth extraction, abscess incision, small amputation performed on an outpatient basis, cataract surgery), but only if preparation for the surgery does not require a change in the current diet. When a patient is unable to eat for more than 12 hours due to surgery, an intravenous infusion of glucose solution with insulin and potassium (500 ml of 10% glucose solution with 12 units of short-acting (rapid-acting) insulin and 10 mmol KCl is recommended at a rate of 100–150 ml/hour. Depending on blood glucose and potassium levels, the dose of insulin and potassium should be modified.

III. Proceedings on the day of surgery

Apply

1. Intravenous infusion of glucose, insulin and potassium under glycaemic control:
   - algorithm 1 – in patients with absolute insulin deficiency, a separate continuous intravenous insulin infusion (solution concentration: 1 unit of a short-acting human insulin preparation in 1 ml of 0.9% NaCl) and glucose solution (5–10%) using infusion pumps. In order to balance 1 g of exogenous glucose, 0.2–0.3 units of insulin are needed (Table 26.1). If glycaemia rises 30–50 mg/dl above 180 mg/dl during the procedure, the insulin infusion rate should be increased by 1–2 units/hour. If blood glucose levels exceed 250 mg/dl (13.9 mmol/l), the glucose intravenous infusions should be discontinued and not resumed until blood glucose levels decrease to 180 mg/dl (10 mmol/l). It is recommended that the intravenous insulin infusion rate be increased at the same time. This method of treatment should be continued until oral nutrition is started. During intravenous insulin infusion, it is recommended to monitor the blood glucose levels every 1 hour and after stabilisation of the blood glucose levels in the following 3 measurements, every 2 hours;
   - algorithm 2: in type 2 diabetic patients with preserved insulin secretion, an optional glucose-insulin-potassium solution (500 ml of 10% glucose containing 12–16 units of short-acting insulin and 10–20 mmol of potassium chloride) can be administered:
     - a higher dose of insulin (≥ 16 units) should be considered in obese patients, when there is a severe infection, during cardiothoracic surgery, in patients with perioperative hypothermia or when the baseline glucose levels are > 180 mg/dl (10.0 mmol/l);
     - a lower dose of insulin (< 12 units) should be considered in slim patients as well as in those taking low doses of insulin or oral hypoglycaemic drugs before surgery.
2. Intravenous infusion of glucose, insulin and potassium should be started at 8.00 am and continued at a rate of 80 ml/hour until normal nutrition is started.
3. During the administration of intravenous infusions of glucose, insulin and potassium, plasma glucose levels should be maintained at 100–180 mg/dl (5.6–10.0 mmol/l):

Table 26.1. Dosing of 10% and 5% dextrose and insulin infusion in relation to blood glucose levels

Blood glucose	10% dextrose [ml\hour]	5% dextrose* [ml\hour]	Insulin [units\hour]
< 90 mg/dl (< 5.0 mmol/l)	50	100	Stop infusion for 15–30 minutes
90–120 mg/dl (5.0–6.7 mmol/l)	50	100	0,5–2
120–180 mg/dl (6.7–10 mmol/l)	50	100	2–3

**5% dextrose is preferred with greater volume deficit and/or higher plasma osmolality*

- if plasma glucose levels decrease or remain within the lower limits of the recommended values, the dose of insulin should be reduced by 2–4 units;
- it is recommended to increase the dose of insulin by 2 units for every 30 mg/dl (1.6 mmol/l) of plasma glucose levels > 180 mg/dl (> 10 mmol/l).

4. If continuous monitoring of the operated diabetic patient is possible, algorithm 1 should be preferred.

IV. Postoperative management

1. Insulin treatment in a multiple insulin injection model or with a personal insulin pump should be initiated when the patient starts oral feeding and continued (in the case of intermittent insulin therapy) until the end of hospitalisation. Insulin should be administered subcutaneously 1–3 hours before the end of the intravenous infusion depending on the blood glucose levels.
2. In patients with type 2 diabetes taking non-insulin medications with good glycaemic effect prior to surgery, their use can be resumed with the start of normal feeding, provided there are no clinical contraindications.

Note 4: in previously insulin-treated diabetic patients undergoing surgery for acute or chronic inflammation, the possibility of reducing daily insulin requirements should be taken into account.

Note 5: In glycaemic control, perioperative use of continuous glucose monitoring systems reduces the risk of hypoglycaemia.

V. Procedure related to surgery – peculiarities in children

Insulin administration algorithm in case of major surgery or those requiring intravenous in-

Table 26.2. Perioperative management in children. An algorithm for intravenous insulin dosing in relation to blood glucose levels

Infusion of a 1 unit of insulin/1 mL solution (add 50 units of insulin to 50 mL 0.9% saline) using a syringe pump		
Blood glucose [mg/dl]/[mmol/l]	**Insulin infusion rate**	**Hydration**
< 90/5.0	Stop infusion for 10–15 minutes	Type of fluid:
90–109/5–6.1	0.02 ml/kg/hour	· Blood glucose > 250 mg/dl: 0.9% saline
110–126/6.1–7.0	0.025 ml/kg/hour (basal infusion rate)	· Blood glucose < 250 mg/dl: 10% dextrose
127–143/7.0–8.0	0.035 ml/kg/hour	Rate:
144–216/8.0–12.1	0.05 ml/kg/hour	· 4 ml/kg/hour (for body weight up to 10 kg)
217–271/12.1–15.1	0.075 ml/kg/hour	· Add 2 ml/hour per each kg of body weight between 11–20 kg
> 271/> 15.1	0.1 ml/kg/hour	· Add 1 ml/hour per each kg of body weight > 20 kg Maximum rate 2000–2500 ml/day

Table 26.3. Subcutaneous insulin therapy in case of non-major procedures under general anesthesia or conscious sedation

Basal–bolus therapy	Basal insulin: NPH insulin — 50% of the morning dose, long-acting insulin analog — 100% of the morning dose
	Initiate intravenous fluids; in patients with normal blood glucose levels, non-glucose-containing fluids may be used initially, followed by 5% or 10% dextrose in amounts appropriate to prevent hypoglycemia.
	Morning procedure: · Bolus — only as a correction dose · Initiate intravenous fluids
	Afternoon procedure: · Bolus — if the child is allowed to have a breakfast — the usual dose of a rapid-acting insulin analog or 50% of the usual dose of a short-acting insulin; a correction dose may be added · Initiate intravenous fluids 2 hours before the procedure or no later than at noon
Therapy using personal insulin pump	It may be continued only if the anesthesiologist accepts this form of therapy and is able to manage it
	Continue insulin therapy using a previously programmed basal dose for a given period during the day (modification of the basal dose is usually not required)
	Hypoglycemia: withhold basal dose administration (for up to 30 minutes)
	Hyperglycemia: a correction bolus
	Initiate intravenous fluids 2 hours before the procedure

sulin therapy (Table 26.2). For "minor" procedures (< 2 hours) under general anaesthesia or sedation, a metabolically well-balanced patient should be admitted to hospital in the morning of the day of the procedure or in the afternoon of the day before the procedure. Subcutaneous insulin therapy may be maintained, or the algorithm as for "major" procedures may be used (Table 26.3).

VI. Emergency operation

Sometimes urgent surgery is necessary in diabetic patients.

In these cases, the possibility of peritoneal symptoms due to ketoacidosis accompanying diabetic metabolic disorders should be excluded in advance. Therefore, in the presence of symptoms of "acute abdomen" accompanied by diabetic acidosis (acetone in the urine and exponents of metabolic acidosis in the gasometric examination), immediate action should be taken to balance the acid-base imbalance.

In the case of ketoacidosis (BE < –12; pH < 7.3) or hyperglycaemic-hyperosmolar state, prior metabolic control is required according to generally accepted principles. If an operation cannot be postponed, metabolic disorders should be treated along with surgical procedures.

If there are no signs of severe diabetic complications and the patient has taken the morning dose of insulin, intravenous insulin infusion should be used during the procedure according to the schedule given above.

REFERENCES

1. Aldam P, Levy N, Hall GM. Perioperative management of diabetic patients: new controversies. Br J Anaesth 2014; 113: 906–909.
2. Boreland L, Scott-Hudson M, Hetherington K, et al. The effectiveness of tight glycemic control on decreasing surgical site infections and readmission rates in adult patients with diabetes undergoing cardiac surgery: a systematic review. Heart Lung 2015; 44: 430e–440e.
3. Ehrenfeld JM, Wanderer JP, Terekhov M, et al. A perioperative systems design to improve intraoperative glucose monitoring is associated with a reduction in surgical site infections in a diabetic patient population. Anesthesiol 2017; 126: 431–440.
4. Galindo R, Migdal A, Davis G, et al. Comparison of the freestyle libre pro flash continuous glucose monitoring (CGM). System and Point-of-Care Capillary Glucose Testing in hospitalized patients with type 2 diabetes treated with basal-bolus insulin regimen. Diabetes Care 2020; 43: 2730–2735.
5. Simha V, Shah P. Perioperative glucose control in patients with diabetes undergoing elective surgery. JAMA 2019; 321: 399.
6. Studzińska D, Szczeklik W. Praktyka kliniczna – opieka okołooperacyjna: opieka okołooperacyjna nad pacjentem z cukrzycą. Med Prakt 2019; 9: 110–119.

27. Preventive vaccination in diabetic patients

Key recommendations
Every diabetic child should be vaccinated according to the current vaccination programme (CVP). [**C**]
Annual influenza vaccination of children aged > 6 months and adults is recommended. [**C**]
All diabetics are advised to be vaccinated against hepatitis B. [**C**]

Every diabetic child should be vaccinated according to the current vaccination programme (CVP). All children in Poland born after 1 January 2017 should be routinely vaccinated against pneumococcus. Vaccination status should be checked and missing vaccination doses should be administered if necessary. Diabetic children born before 1 February 2017 should have mandatory vaccination against Streptococcus pneumoniae. As individuals at risk, they should be vaccinated by the age of 5 years (10- or 13-valent vaccine for children up to 5 years of age and only 13-valent vaccine for older children). Annual influenza vaccination of children aged > 6 months and adults is recommended. It is allowed to use quadrivalent vaccines that are available on the Polish market for both intramuscular (a killed vaccine) and intranasal (a live vaccine) application. Non-immunised individuals should be vaccinated against varicella (2 doses at 6-week intervals), rubella, parotitis and measles, since contracting these diseases may cause serious decompensation of diabetes.

Since 1996, all born children are vaccinated against hepatitis B. Since 2000, adolescents aged 14 are also vaccinated against this disease . Vaccination is recommended for all patients. It is man-

datory to actively identify unvaccinated individuals of all ages and vaccinate them according to the 0-, 1- and 6-month schedule. When anti-HBs antibody titres are found <10 IU/l in previously vaccinated persons, revaccination with 1–3 doses of the vaccine is recommended. If protective antibody levels are not obtained after 3 doses of the vaccine (4–12 weeks after the last vaccination), further vaccination is not recommended. Routine, mandatory and recommended vaccinations before travelling to endemic areas in accordance with the recommendations of the Ministry of Health of 16 September 2010 (Dz. U./Journal of Laws/of 2010, no. 180, item 1215), as well as CDC (Centres for Disease Control) and WHO. A medical examination is mandatory before each vaccination.

Due to the ongoing COVID-19 pandemic, with the availability of vaccines against this disease, vaccination of all diabetics is recommended.

REFERENCES:

1. Tomczyk S, Lynfield R, Schaffner W, et al. Prevention of antibiotic-nonsusceptible invasive pneumococcal disease with the 13-valent pneumococcal conjugate vaccine. Clin Infect Dis 2016; 62: 1119–1125.
2. Goeijenbier M, van Sloten TT, Slobbe L, et al. Benefits of flu vaccination for persons with diabetes mellitus: a review. Vaccine 2017; 35: 5095–5101.
3. Vaccination in Poland in 2012. Ann Rep Nat Inst Public Health; 2013: 83–85.
4. Górska-Ciebiada M, Saryusz-Wolska M, Ciebiada M, et al. Pneumococcal and seasonal influenza vaccination amongelderly patients with diabetes. Post Hig Doswiad 2015; 69: 1182–1189.
5. Phadke VK, Bednarczyk RA, Salmon DA, et al. Association between vaccine refusal and vaccine-preventable diseases in the United States review of measles and pertussis. JAMA 2016; 315: 1149–1158.
6. Szczepienia w podróżach międzynarodowych. [W:] Mrożek-Bucyn D. Wakcynologia Praktyczna, wyd. III. Alfa Medica Press, Bielsko-Biała 2012, 97–103.
7. Polack FP, Thomas SJ, Kitchin N, et al. Safety and efficacy of the BNT162b2 mRNA COVID-19 vaccine. N Engl J Med 2020; 383: 2603–2615.

28. Professional activity recommendations for people with diabetes

Prepared in cooperation with dr n. med. Andrzej Marcinkiewicz and Prof. dr. n. med. Jolanta Walusiak-Skorupa Prof. J. Nofer Institute of Occupational Medicine in Łódź)

1. Diabetes cannot be a reason for discrimination or unequal treatment. Professional restrictions should be imposed after careful consideration of a person's situation and medical condition.
2. The role of a diabetologist in terms of keeping a person with diabetes active is, apart from providing effective therapy:
- health education aimed at creating health awareness and understanding of the limitations resulting from potential complications of diabetes;
- providing an objective opinion on health conditions for professional purposes to a physician qualified to make adjudicative decisions.
3. The opinion of the person with diabetes himself or herself should be the basis of the physician's decision in terms of assessing his or her health status for professional purposes. All people with diabetes, regardless of type or therapy, must actively participate in the treatment of their disease.
4. A doctor authorised to conduct preventive medical examinations or examinations of drivers decides on a person's health status for professional purposes. Due to the incidental nature of patient contact (sometimes in a one-time visit), a person with diabetes is advised to provide the opinion of the treating physician in order to make a decision based on an individual health assessment.
5. During the consultation for adjudicative purposes, the diabetologist should:
- assess the knowledge of a person with diabetes regarding the disease, treatment and possible complications on a scale of: high, sufficient or insufficient;
- assess glycemic control skills on a scale of good, acceptable, or poor;
- assess the awareness of hypoglycaemia of a person with diabetes, the ability to prevent it and to prevent its development on a scale of: good or inadequate;

- confirm the presence or indicate the absence of the prodromes of hypoglycaemia;
- determine the risk of hypoglycaemia on a scale of low, acceptable, or high;
- indicate the possiblity of chronic complications of diabetes in the vision, nervous system, and the cardiovascular system;
- enter additional comments regarding the chronic complications of diabetes and the established health status of a person with diabetes relevant to assessing the risk of threats to public safety.

6. The justification for professional restrictions for a person with diabetes is twofold and is due to:
- the possibility of a hypoglycaemia and disturbance of consciousness;
- the possibility of developing late complications of diabetes that impair the ability to work.

Contraindications to driving by category and contraindications to working in specific positions are shown in Appendix 2.

7. People with advanced chronic complications of diabetes must not perform activities in which damage of a given organ, which is involved in the complications of diabetes, could affect job safety. However, this should not prevent a person from having a job in which a given complication is not relevant. At the same time, the type of work, as well as its seriousness, should not impede the metabolic control of diabetes, and thus not protect the person with diabetes from the development and acceleration of chronic complications of the disease.
8. The diabetes consultation for the examination of drivers or employees should result in a clear opinion in the form of structured consultation sheets, specimens of which are provided in Annex 2.
9. The health requirements for a person with diabetes should be divided into two categories depending on the professional activity or a position held.
10. The first category (higher) consists of activities and occupations requiring full psychomotor skills and involving the exposure to adverse psychosocial factors, the performance of which is related to the safety of the emplyee himself and his environment (co-workers and other persons not directly involved in the work, but who are in his vicinity or affected by his activities, such as road users, shoppers, etc.). More restrictive health requirements should be discussed in the context of the possibility of impaired consciousness, which in case of people with diabetes can result from severe hypoglycaemia.
11. Occupations requiring a higher category of health requirements, for which special consideration must be given to the fact that an employee has diabetes, include those related to public security, i.e:
- professional driving (passenger transport, heavy goods vehicles, overground and underground train drivers, taxi drivers);
- uniformed and emergency services: armed forces (land forces, navy, air force), police, fire brigade, municipal police, rescue service, maritime navigation, prison service, licensed security personnel;
- representatives of civil aviation: pilots and flight engineers, cabin crew, air traffic controller;
- particularly hazardous occupations (working at heights, working with moving machinery and with furnaces, working high temperatures, in incinerators, steelworks, mining, in places with heavy traffic and others associated with a high risk of accidents).

12. The second (lower) category of health requirements are activities and occupations and the harmful and arduous factors that may adversely affect the course of diabetes. In the case of a lower category of health requirements, we should speak more about non-recommended occupations or jobs rather than absolute contraindications. Therefore, a decision on whether people with diabetes can take up or continue working in the following occupations requires additional attention and individual assessment of health condition:
- occupations requiring increased physical effort, especially static ones (e.g. miner, steelworker);
- occupations with shift and night work;
- occupations with exposure to carbon disulphide and the pesticide dichlorophenoxyacetic acid compounds (e.g. dichlorprop, mekoprop).

13. A diabetologist should provide consultations for young people, whose choice of an occupation requires particular care. In this case, it is necessary to take into account not only the current state of health, but above all the nature of diabetes, which, at various times, due to health restrictions, may prevent not only prac-

tical vocational training, but above all working in the long term.

14. Annex 3 contains the *Rights and Obligations of the Employer and Employee*, which aims on the one hand to strengthen the sense of responsibility of people with diabetes and their position as employees and on the other hand to prevent the exclusion of people with diabetes from the labour market.

29. Diabetes management in correctional institutions

People with diabetes mellitus in correctional facilities (prison, custody, juvenile detention centre) should have access to the same level of medical care, including diabetes care, that is offered to all patients.

Institution staff should be informed that the inmate is diabetic. Moreover, the staff should be trained to recognize and manage hyperglycemic and hypoglycemic conditions or other emergencies.

30. Metabolic surgery

Key recommendations
• Surgical treatment of obesity should be recommended in patients with type 2 diabetes with a BMI > 35 kg/m^2, especially in the presence of comorbidities and unsatisfactory glycaemic control with behavioral therapy and the use of antihyperglycaemic drugs. [**A**]
• Any patient after surgical treatment of diabetes should permanently remain under the care of a diabetologist and general surgeon and receive continuous vitamin and micronutrient supplementation to prevent deficiencies. [**C**]

Metabolic surgery is an effective method for the treatment of obesity and comorbidities, in particular type 2 diabetes. A multidisciplinary approach allows to properly qualify patients for metabolic surgery and choose the correct surgical technique.

I. Eligibility guidelines for metabolic surgery

1. Metabolic surgery should be considered in any patient with type 2 diabetes with a *body mass index* (BMI) > 35 kg/m^2, especially in the presence of comorbidities, such as hypertension and lipid disorders. In particular, qualification for metabolic surgery should be considered when type 2 diabetes and obesity respond poorly to pharmacological and behavioural therapy.
2. Qualification for metabolic surgery is recommended in any patient with a BMI > 40 kg/m^2 and type 2 diabetes.
3. Patients with type 2 diabetes between the ages of 18 and 65 are eligible for metabolic surgery. The upper age limit may be extended to the age of 70 in justified cases, provided that the individually considered risks of the surgery are less than the potentially achievable benefits of the surgery.
4. The qualification for bariatric surgery should be done by a team of doctors including at least a diabetologist and a general surgeon with extensive experience in metabolic surgery. It is recommended that the multidisciplinary team of specialists involved in the qualification procedure also include a cardiologist, a pulmonologist, a psychologist or psychiatrist, an anaesthesiologist and a dietician.

II. Types of surgical procedures performed

1. It is recommended that patients be qualified for surgical procedures that involve minimally invasive techniques (laparoscopy).
2. In the light of the available study results, in patients with type 2 diabetes, the first recommendation is to qualify them for *laparoscopic Rouex-en-Y gastric bypass*, *laparoscopic mini gastric bypass*, *laparoscopic sleeve gastrectomy*, *laparoscopic biliopancreatic diversion* and *single anastomosis duodeno-ileal bypass* (SADI).

3. The choice of the type of surgery to be performed should be made after surgical consultation and individual consideration of the advantages and disadvantages of each of the above-mentioned metabolic surgery methods.
4. It is recommended that patients read the informed consent forms prepared by The Metabolic and Bariatric Surgery Chapter of the Association of Polish Surgeons before making a decision about undergoing metabolic surgery.

III. Complications associated with surgical treatment of type 2 diabetes

Within 30 days of surgery, mortality related to metabolic surgery is associated with a calculated mortality risk of 0.1–0.3%, which is identical to the mortality risk for laparoscopic cholecystectomy and should be described as low. The most common complications after metabolic surgery include suture line leak (3.1%), surgical site infection (2.3%), respiratory complications (2.3%), and gastrointestinal bleeding (1.7%).

IV. Evaluation of the results of surgical treatment of type 2 diabetes

Type 2 diabetes resolves in 40–95% of patients depending on the disease duration, the degree of initial obesity and the type of surgery performed.

The following method of assessing the outcome of the surgical treatment of type 2 diabetes is recommended:

1. The resolution of the disease and comorbidities

The disease can be considered resolved after discontinuation of pharmacotherapy if:

- the HbA_{1c} level is < 6.5%;
- the patient does not experience hypoglycaemic episodes;
- total cholesterol level is < 155 mg/dl (< 4 mmol/l), LDL cholesterol level is < 77 mg/dl (< 2 mmol/l);
- triglyceride levels are < 195 mg/dl (< 2.2 mmol/l);
- blood pressure is < 140/90 mm Hg;
- weight loss is > 15% compared to the state at the time of the qualification for surgery.

2. Improvement in the course of the disease

An improvement in the course of the disease after metabolic surgery can be said to occur if after reducing the doses of medication taken before the surgery:

- HbA_{1c} levels decrease by > 20%;
- LDL-cholesterol level is < 100 mg/dl (2.6 mmol/l);
- blood pressure is < 140/90 mm Hg.

V. Recommendations after surgical treatment of type 2 diabetes

1. Every patient after the surgical treatment of diabetes should remain under the care of a diabetologist and general surgeon.
2. Continuous vitamin and micronutrient supplementation is necessary to prevent deficiencies.

VI. Pregnancy and metabolic surgery

1. No contraindications to pregnancy for women 24 months after metabolic surgery.
2. Continuous contact with the patient's diabetologist is recommended before and during pregnancy.

VII. Contraindications to qualifying patients with type 2 diabetes for metabolic surgery

Absolute contraindications:

1. Lack of consent to surgical treatment of type 2 diabetes from the patient.
2. Alcohol or drug addiction (qualification for surgical treatment of obesity may be considered in the case of at least one year of documented abstinence).
3. Mental illnesses that cannot be controlled despite treatment and pharmacotherapy.
4. High cardiovascular risk associated with the procedure.
5. Underlying endocrine diseases associated with obesity (e.g. Cushing's syndrome).
6. Inability to participate in continuous long-term follow-up after surgical treatment.
7. 12-month period preceding planned pregnancy, pregnancy and breastfeeding.

Relative contraindications:

1. Weight gain in the period immediately preceding surgery indicative of the lack of patient co-operation.
2. Active peptic ulcer disease — it requires treatment prior to surgery; for patients with asymptomatic H. pylori infection, eradication prior to surgery is recommended but not absolutely necessary.
3. For patients with a history of oncological treatment, an oncological consultation documenting cancer recovery is required.

REFERENCES

1. Adams TD, Gress RE, Smith SC, et al. Longterm mortality after gastric bypass surgery. N Engl J Med 2007; 357: 753–761.
2. Arterburn DE, Olsen MK, Smith VA, et al. Association between bariatric surgery and long-term survival. JAMA 2015; 313: 62–70.
3. Mingrone G, Panunzi S, De Gaetano A, et al. Bariatric-metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single-centre, randomised controlled trial. Lancet 2015; 386: 964–973.
4. Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes – 3-year outcomes. N Engl J Med 2014; 370: 2002–2013.
5. Sjostrom L, Lindroos AK, Peltonen M, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. N Engl J Med 2004; 351: 2683–2693.
6. Sjostrom L, Narbro K, Sjostrom CD, et al.. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med 2007; 357: 741–752.

31. Certain specific situations and diseases in diabetics

Prepared in cooperation with Prof. Renata Górska

I. Shift work

Shift work may be associated with both an increased risk of diabetes and poorer diabetes control. It results in the need to periodically change the hours of administration of oral antihyperglycaemic drugs or insulin.

1. Shift-workers suffering from diabetes must conduct intense self-control, particularly during periods of changing working hours.
2. Solutions preferred in the case of diabetic shift-workers include drugs (oral and injectable antihyperglycaemic drugs and insulin preparations), the use of which is associated with a low risk of hypoglycaemia and whose administration enables greater flexibility.
3. Patients with diabetes – particularly type 1 diabetes – who are undergoing insulin treatment should be able to modify their insulin doses (intensive functional insulin therapy).

II. Changing time zones

Travel is not contraindicated for diabetic patients. Diabetics treated with insulin, particularly ones suffering from type 1 and type 2 diabetes, should prepare for travel by taking into account such things as the journey's duration, the mode of transport, time zone changes (in this regard, the direction of travel must be considered – east or west) and the climate of the destination country. Changing time zones quickly (air travel) may prove particularly difficult for diabetics.

1. Diabetic patients treated with insulin – especially ones with type 1 diabetes – should take special care when adjusting to a new time zone (this period is assumed to last as many days as there are hours of time difference). The blood glucose level must be monitored frequently throughout this period.
2. Patients undergoing basal-bolus insulin treatment and opting for westbound air travel (day lengthening) should administer their current dose of long-acting insulin in the evening according to their new time zone. Possible hyperglycaemia resulting from such things as eating aboard the aircraft can be corrected with additional doses of short-acting insulin/rapid-acting analogue. When travelling east (day shortening) it may be necessary to reduce the dose of long-acting insulin administered in the evening.
3. Patients using a personal insulin pump do not need to adjust the pump clock or modify insulin doses if the time change is less than 2 hours. However, if the time change exceeds 2 hours and the planned stay in another time zone is long, it is advisable to gradually shift the time frame of the basic infusion by 2 hours a day.

III. Glucocorticosteroid therapy

Many drugs have diabetogenic effects. The diabetogenic effect of glucocorticosteroids appears to be particularly important because of its

strength, as well as the frequency at which glucocorticosteroids are used. Glucocorticosteroids primarily cause an increase in postprandial blood glucose levels.

1. Glucocorticosteroid substitution doses (hydrocortisone up to 20 mg/d) and inhaled glucocorticosteroids have no significant effect on carbohydrate metabolism.
2. The following factors contribute to an increased risk of steroid-induced diabetes: older age, obesity, impaired glucose tolerance, high-dose glucocorticosteroid use and concomitant use of other diabetogenic drugs.
3. The preferred treatment method of glucocorticosteroid-induced diabetes is intensive insulin therapy (in cases where fasting and premeal blood glucose levels are acceptable, it is also possible to only administer short-acting/fast-acting insulin preparations before meals). In the case of steroid-induced diabetes, the superiority of using one insulin preparation or analogue over the others has never been proven.
4. In type 2 diabetic patients treated with oral antihyperglycaemic drugs who require temporary use of glucocorticosteroids, especially at high doses, intermittent intensive insulin therapy is recommended.
5. In type 2 diabetic patients, combination therapy with basal insulin (NPH insulin, long-acting insulin analogue) usually requires the addition of short-acting insulin before meals.
6. The use of glucocorticosteroids in insulin-treated diabetic patients is associated with increased insulin requirements, primarily during the day.

IV. Periodontal diseases

Periodontal and other oral diseases are more common in people with diabetes. Periodontal disease negatively affects the metabolic control of diabetes and increases the risk of its complications. Treatment of periodontal disease improves the diabetic metabolic compensation.

1. In the case of all diabetics, a history of oral diseases should be taken and physical examination focused on such diseases should be performed.
2. All diabetics should undergo a dental examination once a year.

REFERENCES

1. Benbenek-Klupa T. Chory na cukrzycę w podróży. [W:] Franek E., Walicka W. Leczenie cukrzycy w praktyce klinicznej. Tom 1. Wydawnictwo PZWL, Warszawa 2018.
2. Knutsson A, Kempe A. Shift work and diabetes – a systematic review. Chronobiol Int.2014; 31: 1146–51.
3. Wallace MD, Metzger NL. Optimizing the Treatment of Steroid-Induced Hyperglycemia. Ann Pharmacother 2018; 52: 86–90.

Appendix 1

Recommendations for transferring a patient with type 1 diabetes from paediatric care to internal medicine care or to a different diabetes outpatient clinic

A. The period of transition from being under the care of a paediatric diabetes specialist to the care of an internal medicine diabetes specialist is an important moment in the life of a young patient with type 1 diabetes. The guiding principle in transferring a patient to an adult diabetes clinic should be the continuity of medical care to prevent a significant interruption between leaving a paediatric clinic and beginning treatment in an internal medicine clinic. It is advisable to comply with the following recommendations to ensure that the process is uninterrupted:

1. The timing of the transfer of a diabetic patient from the paediatric clinic to the adult diabetes clinic should be determined individually for each patient so that the process does not interfere with the course of therapy. Depending on the patient's emotional development, family and educational situation, and other considerations, the optimal time for the transfer of care falls between the ages of 16 and 21.
2. The paediatrician should be preparing the patient for the transfer to internal medicine care for at least one year. During this time, it is advisable to perform follow-up examinations for chronic complications of the disease and comorbidities.
3. During the last visit to a paediatric diabetes outpatient clinic, that should take place no later than 6 months prior to the transfer of care, the patient should be referred to the diabetes outpatient clinic in a coordinated manner, which in particular means:

- providing the patient with a Diabetes Care Discharge Summary prepared in accordance with the template (see page 109);
- issuing a referral to a diabetes outpatient clinic

4. The patient should receive internal medicine care no later than 6 months after the termination of paediatric care.
5. It is advisable to create regional networks of cooperating paediatric and internal medicine clinics between which would establish common rules for regular contact and referral of patients.
6. If a lot of patients are transferred, it is advisable to appoint, in both the paediatric and internal medicine clinics, a care transfer coordinator whose job would be to regulate the process of referring and admitting patients, schedule appointments, ensure an efficient flow of information, etc.
7. Creating separate admission days for patients transferring to adult outpatient care is not necessary but may be helpful, e.g. for organisational reasons. When planning the operation of an internal medicine outpatient clinic, it is important to take into account the fact that the visits of patients transferring from paediatric care are significantly more time-consuming, especially if they are treated with a personal insulin pump (PIP).

B. If the patient needs to change their diabetes clinics (paediatric or internal medicine) due to, for example, changing their place of residence, it is recommended that the patient be referred to another diabetes clinic where they can receive appropriate care. It is advisable to complete the Diabetes Care Discharge Summary during the final visit to the original clinic.

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DIABETES CARE DISCHARGE SUMMARY

PATIENT'S PERSONAL DATA

Name and surname:..... PESEL | | | | | | | | | | | |

[Personal identification number]

Diagnosis: Type ..... diabetes Date of diagnosis (MM/YYYY): .....

CURRENT THERAPY:

Multiple daily insulin injections ☐ Types of insulin:..... Daily dose:..... Basal dose: ..... Prandial dose:..... Correctional dose:.....	Continuous subcutaneous insulin infusion ☐ Types of insulin:..... Pump report attached ☐* or: Daily dose:..... Basal dose: ..... Prandial conversion factors.....
Antihyperglycaemic drugs:	Date of PIP reimbursement: .....

Glycaemic control: ☐ glucosemeter ☐ CGM (name) .....

HbA_{1c} in the last two years:.....

last result: (date-result):.....

Number of visits to the clinic in the last 12 months .....

PAST HOSPITALISATIONS DUE TO ACUTE COMPLICATIONS IN THE LAST 5 YEARS:

Cause	Number
Ketoacidosis	
Severe hypoglycaemia	

Severe hypoglycaemia in the last 12 months (dates: .....)

Chronic complications of diabetes:		GRADE/REMARKS
Retinopathy	YES/NO	
Diabetic renal disease	YES/NO	
Somatic neuropathy	YES/NO	
Autonomic neuropathy	YES/NO	

Comorbidities

Diagnosis		Date of diagnosis	Current treatment
Autoimmune thyroiditis:	YES/NO		
Coeliac disease	YES/NO		
Hypertension	YES/NO		
Hyperlipidaemia	YES/NO		

Education level: needs improvement ☐ satisfactory ☐ very good ☐

Enclosed:

Hospital Discharge Summary Report YES/NO

Follow-up examination results from the last 12 months YES/NO

Date of completion..... Signature of the physician.....

PATIENT STATEMENT

I, the undersigned, declare that I have received the discharge summary of treatment in the diabetes care outpatient clinic:

Date of collection: .....

Patient's signature: .....

Signature of the parent: .....

VOLUNTARY INFORMATION PROVIDED BY THE PATIENT FOR THE DIABETES SPECIALIST PRIOR TO THE FIRST VISIT:

I think that I would like to improve the treatment of diabetes in the following areas:

☐ Frequency of glycaemia measurements
☐ Regular administration of insulin before meals and to correct hyperglycaemia
☐ Healthier diet, e.g. eating less sugar
☐ Counting carbohydrate exchanges
☐ Knowledge of the glycaemic index and load
☐ Knowledge of the effects of protein and fat on glycaemia
☐ Knowledge of the energy requirements
☐ Regular physical activity

Patients using insulin pumps

☐ Regular replacement of infusion sets
☐ Use of Bolus calculator
☐ Increasing the use of temporary basal rates

Patients using continuous glucose monitoring

☐ Frequency of measuring the glycaemic level and trends
☐ Incorporating glycaemic trends to modify insulin doses, glucose intake
☐ System calibration
☐ Programming alerts

Appendix 2

Medical opinion procedure for drivers and employees with impaired carbohydrate tolerance and diabetes

I. Driver examinations

1. The medical opinion procedure for drivers with diabetes is governed by Appendix No. 6 of the Regulation of the Minister of Health of 17 July 2014 on medical examinations of applicants for driving licenses and drivers (Dz. U/ /Journal of Laws/ of 2017, item 250, consolidated text as amended) titled "Detailed terms and conditions of the medical examination for diabetes".
2. On the basis of the medical examination, the results of additional examinations and the conclusions from consultations, the physician authorised to examine drivers shall assess the risk to road traffic safety and include it in the medical opinion.
3. Pursuant to point 3a and 4 of the above-mentioned Appendix to the Regulation, **the obligation to obtain an opinion from a diabetes specialist or other physician treating diabetes,** also about the absence of other health contraindications to driving related to diabetes, applies to individuals who:

- are applying for or hold a driving license category C1, C1+E, C, C+E, D1, D1+E, D, D+E or a tram driving licence
- perform carriage by road within the meaning of the provisions of the Act on road transport
- drive an emergency vehicle or a vehicle used to transport valuables,
- are driving instructors or examiners,
- are applying for or hold a driving license category AM, A1, A2, A, B1, B, B+E or T – in case of a diagnosis of recurrent severe hypoglycaemia

4. The physician authorised to examine drivers can also order a diabetes consultation in case of doubt during diagnosis or decision-making.
5. **A diabetes consultation concerning driver examination**, if it is to be considered by the certifying physician, **must result in the issue of opinion in the form of a diabetes consultation card**, according to the template defined in Appendix No. 6 to the above-quoted Regulation of the Minister of Health of 17 July 2014. (see page 115).
6. When completing the consultation card, a diabetologist or other physician treating diabetes should evaluate the patient's ability to drive a vehicle, which may consequently have the following effect on the final medical opinion issued by the physician authorised to examine drivers:

- no health contraindications to driving motor vehicles:
  - » **without a time limit** resulting from the performed diagnosis of carbohydrate metabolism disorders,
  - » **with a time limit** resulting from the diagnosed carbohydrate metabolism disorders (corresponding to a low or increased risk to road traffic safety);
- health contraindications to driving motor vehicles resulting from the diagnosed carbohydrate metabolism disorders
  - » **relative** – with an indication of the next date after which the patient will be eligible for medical qualification again (corresponding to a high risk to road traffic safety with the possibility of retaking the qualifying examination);
  - » **absolute** health contraindications to driving motor vehicles (corresponding to a high risk to road traffic safety without the indication of the date of another qualifying examination)

7. For drivers who are applying for or hold a driving license category AM, A1, A2, A, B1, B, B+E or T:

- absolute contraindication to driving vehicles is impaired awareness of hypoglycaemia which occurs when in the state of wakefulness the patient experiences pathological insensitivity to low glycaemic values or has no reaction to them, despite the alert reported by the external equipment for continuous glucose monitoring (CGM), which in turn may result in severe hypoglycaemia and impaired consciousness.
- relative health contraindication is recurrent severe hypoglycaemia (i.e. at least two cases of severe hypoglycaemia in the last 12 months).

8. In the case of patients using continuous glucose monitoring, the physician authorised to examine drivers may decide that there are no contraindications to driving vehicles of categories AM, A1, A2, A, B1, B, B+E or T provided that a diabetological opinion is issued indicating:

- constant use of continuous glucose monitoring (CGM) in self-monitoring of diabetes,

- at least sufficient knowledge of the patient about self-monitoring of diabetes, including the ability to interpret CGM readings,
- correct response to CGM device alerts,
- regular diabetes care (at least 3 visits to a diabetes care unit in a year, at regular intervals every 3-4 months).

9. In the case of diagnosis of recurrent severe hypoglycaemia in persons applying for or holding a driving license category AM, A1, A2, A, B1, B, B+E or T, a physician authorised to examine drivers may decide that there are no contraindications to driving vehicles provided that a diabetological opinion is issued indicating that:

- at least 3 months have passed since the last episode of severe hypoglycaemia in the state of wakefulness,
- the degree of diabetes guarantees road traffic safety
- continuous glucose monitoring (CGM) is constantly used in self-monitoring of diabetes, including mandatory use of the CGM while driving a vehicle,
- the knowledge of the patient about self-monitoring of diabetes, including the ability to interpret CGM readings, is at least sufficient
- the patient shows correct response to CGM device alerts,
- regular follow-up medical examinations are conducted at least 3 times per year, at regular 3-4-month intervals –subject to point 13.

10. For drivers who are applying for or hold a driving license category C1, C1+E, C, C+E, D1, D1+E, D, D+E or a tram driving licence, perform carriage by road or drive an emergency vehicle or a vehicle used to transport valuables as well as driving instructors and examiners:

- absolute contraindication to driving vehicles is:
  - » any case of severe hypoglycaemia in the state of wakefulness,
  - » unawareness of hypoglycaemia in the state of wakefulness, defined in Appendix No. 6 to the above-quoted Regulation of the Minister of Health of 17 July 2014 as pathological insensitivty to low (< 70 mg/dl, i.e. < 3,9 mmol/l) glycaemic values, which is a major complication of frequent hypoglycaemic episodes,
  - » other complications related to diabetes that preclude vehicle driving
- the prerequisite for receiving a positive opinion about the ability to drive vehicles is:
  - » regular blood glucose concentration monitoring, at least four times a day for those taking insulin more than once a day; in other treatment models, once a day and during the times of the day when the patient would drive vehicles – recorded in a way that allows the assessment of the course of diabetes,
  - » documentation of the control of the disease course by the physician treating diabetes,
  - » demonstration by the subject of full awareness of the risk of hypoglycaemia in the state of wakefulness.

11. The completed consultation card shall be forwarded by the diabetes specialist, or other physician treating diabetes, via the patient to the physician authorised to examine drivers. If the opinion about the ability to drive vehicles is negative, it is recommended that the consulting physician communicate this information directly to the certifying physician who made the referral.
12. During the consultation the driver should be advised of the absolute necessity to report for a reassessment of fitness for driving vehicles if a severe hypoglycaemic episode occurs in the state of wakefulness, also when it is unrelated to driving.
13. The doctor competent to carry out the diabetes consultation is a doctor with a diabetes speciality or a physician with another speciality treating diabetes in the patient consulted.
14. In the following cases, it should be considered to send information to the territorially competent traffic department or the local self-government unit on the necessity to perform another medical examination of the patient in order to verify their fitness for driving vehicles – using a form referring to Art. 75 sec. 1 point 5 of the Act of 5 January 2011 on Vehicle Drivers (Dz. U /Journal of Laws/ of 2017 item 978 as amended) (see page 117):

- when there are reasonable indications that the patient is driving a vehicle less than 3 months after the last episode of severe hypoglycaemia,
- when the patient declaring continuous use of CGM does not report for the scheduled follow-up examinations (especially if they experience episodes of severe hypoglycaemia in the state of wakefulness) and when all available ways of effectively notifying the patient of the need for the follow-up examinations have been unsuccessful,
- after any incident of severe hypoglycaemia.

15. Any patient treated with insulin who has been certified to have no diabetes contraindication to driving motor vehicles should be required to check their glycaemia (glucometer/scanning system/CGM) each time before driving. The patient should not start driving with glycaemia below 100 mg/dL (5.6mmol/l) unless the diabetologist individually establishes a different glycaemia threshold for driving.
16. While driving, glycaemia should be checked at least every 2 hours and if it falls below 100 mg/dL, the patient should stop driving and consume an appropriate portion of carbohydrates.

II Employee examinations

1. The medical opinion procedure for employees and persons taking up employment is governed by the Regulation of the Minister of Health of 30 May 1996 on medical examinations of employees, the scope of preventive health care for employees and medical opinions issued for the purposes provided for in the Labour Code (Dz. U. /Journal of Laws/ of 2016 item 2067 as amended).
2. The physician performing the preventive examination of employees may extend its scope to include a diabetes consultation and additional examinations if the physician considers this necessary for a proper evaluation of the health condition of the person taking up employment or the employee.
3. **The diabetes consultation for preventive examination**, in order to constitute a valuable opinion allowing the physician to issue an objective decision based on the individual evaluation of the patient, **should include information crucial for the assessment of fitness for work in specific conditions and occupational requirements.** For this purpose, it is recommended to use the diabetes consultation card according to the template (see page 116).
4. On the basis of the medical examination, the results of additional examinations and the conclusions from consultations, the physician authorised to perform preventive examinations of employees issues a medical opinion about the absence or presence of medical contraindications to the performance or taking up of work in a given position.
5. **Absolute contraindications to work in positions involving higher health requirements are:**

- recurrent severe hypoglycaemia or even one medically unexplained incident of severe hypoglycaemia in the state of wakefulness in the past (drop in blood sugar levels resulting in impaired consciousness and the need for professional medical assistance),
- unawareness of hypoglycaemia in the state of wakefulness with no prospect of improvement, resulting from chronic complications of diabetes in the form of vegetative neuropathy, which impairs the ability to sense increasing hypoglycaemia and results in the lack of response of the patient to falling glycaemia,
- advanced visual complications, usually in the form of diabetic retinopathy or cataracts with visual impairment,
- other advanced chronic complications of diabetes,
- an opinion from a diabetologist, or a physician with another speciality treating diabetes in the patient consulted, indicating a high risk of hypoglycaemia, insensitivity to prodromal symptoms of hypoglycaemia in the state of wakefulness.

6. **Relative health contraindications to work requiring higher health requirements may be stated by a physician authorised to carry out preventive medical examinations of workers in the case of conditions likely to improve:**

- lack of metabolic control of the disease (HbA_{1C} ≥ 8%),
- lack of glycaemic self-control or poor glycaemic control skills,
- inadequate patient knowledge of diabetes, hypoglycaemia and how to prevent it,
- failure to comply with medical recommendations.

In such cases, the next examination should take place within 1-3 months.

Prepared in cooperation with dr n. med. Andrzej Marcinkiewicz and Prof. dr. n. med. Jolanta Walusiak-Skorupa Prof. J. Nofer Institute of Occupational Medicine in Łódź)

stamp of the health care institution or medical practice

DIABETES CONSULTATION CARD FOR DRIVER EXAMINATION

(appendix no. 6 to the Regulation of the Minister of Health of 17 July 2014 on medical examinations of applicants for driving licences and drivers (Dz. U/ /Journal of Laws/ of 2017, item 250 and 293 as amended)

PATIENT'S PERSONAL DATA

Name and surname:..... PESEL | | | | | | | | | | | |

[Personal identification number]

Name and number of an identification document for a person with no assigned PESEL.....

residence address: city/town: ..... postal code | | | – | | | |

street: ..... house/flat number: .....

Diabetes

date of diagnosis | | diabetes type: | | physician treating diabetes: | |

Entity conducting medical activity | | Diabetes outpatient clinic | |

Patient's knowledge about their disease, treatment and complications
high ☐ sufficient ☐ insufficient ☐

Ability to control glycaemia:
good ☐ acceptable ☐ low ☐

Awareness of hypoglycaemia, prevention skills:
good ☐ insufficient ☐

Presence of prodromal symptoms of hypoglycaemia: Yes ☐ No ☐

Risk of hypoglycaemia:
low ☐ acceptable ☐ High ☐
presence of chronic complications of diabetes ☐ no chronic complications of diabetes ☐
involving visual organs ☐ involving nervous system ☐ involving cardiovascular system ☐

Notes on chronic complications of diabetes:

.....

Assessment of suitability to drive:

.....

When continuous blood glucose monitoring is used 3 questions need to be answered:
1. Continuous application of CGM: Yes ☐ No ☐
2. Good knowledge of and response to CGM: Yes ☐ No ☐
3. Regular visits (at least every 3-4 months) Yes ☐ No ☐
   to the outpatient clinic with pump and CGM memory readings:

Further Notices:

.....

(date of drafting the opinion)

(stamp and signature of the diabetes specialist or other physician managing the treatment of diabetes)

stamp of the health care institution or medical practice

DIABETES CONSULTATION CARD FOR PREVENTIVE SCREENING – documenting the control of diabetes by the attending physician for the purpose of assessing health predisposition to work.

(prepared by A. Marcinkiewicz, D. Szosland)

PATIENT'S PERSONAL DATA

Name and surname:..... PESEL | | | | | | | | | | | |

[Personal identification number]

Name and number of an identification document for a person with no assigned PESEL.....

Diabetes

date of diagnosis ☐ diabetes type: ☐

physician treating diabetes: ☐ primary health care ☐ diabetology clinic

Patient's knowledge about their disease, treatment and complications
high ☐ sufficient ☐ insufficient ☐

Ability to control glycaemia:
good ☐ acceptable ☐ low ☐

Awareness of hypoglycaemia, prevention skills:
good ☐ insufficient ☐

Presence of prodromal symptoms of hypoglycaemia: Yes ☐ No ☐

Risk of hypoglycaemia:
low ☐ acceptable ☐ High ☐
presence of chronic complications of diabetes ☐ no chronic complications of diabetes ☐
involving visual organs ☐ involving nervous system ☐ involving cardiovascular system ☐

Notes on chronic complications of diabetes:

.....

Further Notices:

.....

When continuous blood glucose monitoring is used 3 questions need to be answered:
1. Continuous application of CGM: Yes ☐ No ☐
2. Good knowledge of and response to CGM: Yes ☐ No ☐
3. Regular visits (at least every 3-4 months) Yes ☐ No ☐
   to the outpatient clinic with pump and CGM memory readings:

Further Notices:

.....

(date of drafting the opinion)

(stamp and signature of the diabetes specialist
or other physician managing the treatment of diabetes)

....., date .....
city/town

name and address of directing unit:

.....

.....

.....

.....

first and last name, address, identification of the person
, to whom the notice refers:

.....

.....

.....

.....

Name of the territorially competent traffic department
or of the local authority unit*:

.....

.....

.....

.....

NOTICE

Based on Art. 75, sec.1, item 5 of the Act of 5 January 2011 on Vehicle Drivers (Dz. U /Journal of Laws/ of 2017 item 978 as ammended) we thereby inform You that:

.....

there are justified and significant grounds for doubting their state of health, which, if they hold a driving licence or a permit to drive to drive a tramway, necessitate an urgent assessment of their suitability to drive the aforementioned vehicles and verification of the medical certificate.

.....
signature of notifying person

Notes:
* territorial competence applies to the person notified

Appendix 3

pracuj z cukrzycą

RIGHTS AND OBLIGATIONS OF THE EMPLOYER AND EMPLOYEE

Diabetes is a chronic metabolic disease affecting an increasing number of people. It is estimated, that approximately 2.6 million people in Poland suffer from diabetes, of whom diabetes diagnosed and treated accounts for 60% of the cases. The current scale and an increasing prevalence of the diabetes, both type 1 and 2 have visible consequences, not only medical but also socioeconomic and the issues of prevention and effective treatment transcend the responsibility of medical staff and patients themselves.

According to the World Bank estimates, diabetes constitutes the second largest economic burden on society after ischaemic disease. These costs consist not only diagnostics and treatment costs, including the treatment of complications, but also the costs resulting from premature cessation of professional activity: inability to work and subsequent disability benefits, as well as unemployment, which affects people with diabetes particularly severely.

Due to the fact that:

- the unemployment scale among diabetes patients is more than twice as high as among healthy people, and the resulting worse economic situation may impede proper disease control,
- workplace is a significant link in the prevention process of civilisation diseases,

while, at the same time, being convinced that:

- medicines currently used in diabetes treatment, as well as a growing awareness of patients in the field of self-control, lead to increasingly longer and effective maintenance of good health and the possibility of remaining active at work
- and that the mere fact of having diabetes does not automatically make a person an inferior employee

with reference to the numerous European initiatives aimed at prevention, early detection and appropriate treatment, as well as at improving the quality of life of diabetes patients, including the European Parliament Resolution of 13 March 2012 on addressing the EU diabetes epidemic and the Copenhagen Map adopted at the European Diabetes Forum in Copenhagen on 25-26 April 2012, on the eve of World Diabetes Day 2012, the signatories of this document, representatives of medical professionals, diabetes patients and employers propose to establish a list of rights and obligations of diabetes patients and their potential employers, to strengthen patients' sense of responsibility and their position as employees on the one hand and to counteract the exclusion of diabetes patients from the labour market on the other.

Rights and obligation of a worker with diabetes

1. Everyone with diabetes should be aware that an effective diabetes control takes place both in home and at work.
2. Employee with diabetes must follow the same rules at work as they use to control the disease at home, i.e.: periodic glycaemic measurement, taking medicines as prescribed by the doctor, observing meal times and following a diet.
3. Employees with diabetes should inform their employer of their illness and, when possible, adjust their working patterns and hours so that their illness can be controlled.
4. People with diabetes should be aware of contraindications to certain occupations (e.g. pilot, public transport driver, working at heights, work requiring extremely high physical effort) and if they occupy one of these position, they should inform their employers of their condition.
5. Employees with diabetes should make their immediate colleagues aware of their condition so that, in the event of an incident of hyper or hypoglycaemia, colleagues can assist them in an appropriate manner and ensure continuity of work.

Rights and obligations of an employer

1. Every employer should be aware that diabetes does not disqualify people with this condition from engaging in active employment, and any discrimination against an employee on the basis of the presence or prevalence of diabetes is unacceptable. The key to understanding the

situation of a patient with diabetes is for the employer to have a basic knowledge of the disease.
2. In order to comply with their obligations, including the duty to provide safe and healthy working conditions, employers have the right and need to know who among their employees has diabetes.
3. The employer should enable the worker with diabetes to follow the rules of disease control in the workplace and encourage responsible behaviour in a manner that ensures work safety for them and their colleagues.
4. The employer should, as far as possible, provide the employee with diabetes with a position that allows optimal control of the disease (including possibility to give up shift work, short breaks for extra meals).
5. The employer should, when possible, provide an employee with newly diagnosed diabetes with different/equal position if the existing position could pose a risk to workplace safety or make it difficult for the employee to control the disease.
6. The employer should, as far as possible, promote rules of healthy lifestyle in the workplace, encouraging the workers to undertake physical exercises, to have a balanced diet and to undergo preventive examinations.

on behalf of the signatories
prof. Leszek Czupryniak
Chairman Diabetes Poland
from 2011 and 2015

Warsaw, 13 November 2012

Appendix 4

Recommendations of the Polish Society of Endocrinology and the Diabetes Poland on screening for thyroid disorders in type 1 and type 2 diabetes.

Type 1 diabetes

1. A clinical examination for thyroid disorders must be performed during each of the patient's visits to a diabetologist – where thyroid dysfunction is suspected, the level of TSH should be determined.
2. Measuring *thyroid-stimulating hormone* (TSH) and *autoantibodies to thyroid peroxidase* (TPOAb) titers is recommended for all patients with newly diagnosed type 1 diabetes, as well as patients with ongoing diabetes who have not yet been tested to assess the thyroid hormone function.
3. In patients with the TPOAb titer above the reference value and a TSH concentration of □2 mIU/L, it is recommended to measure *free thyroxine* (fT4) and repeat the TSH determination once a year.
4. In patients with the TPOAb titer within the reference range and a concentration of □ 2, the TSH determination should be repeated every 2 years.
5. In patients with the TPOAb titer within the reference range and a TSH concentration of < 2.0 mIU/l, the TSH determination should be repeated every 5 years.
6. In patients with a positive family history of hypothyroidism in the course of chronic autoimmune thyroiditis, the TSH level should be measured annually.
7. The TSH level should also be measured in diabetic patients with a lipid metabolism imbalance.
8. It is recommended that both the TSH level and TPOAb titer be determined in all female patients planning pregnancy (particularly in patients with an adverse obstetric history).
9. In all female patients who are 4-8 weeks pregnant (first obstetrician appointment), both the TSH level and TPOAb titer should be determined.
10. It is recommended that the TSH level and *thyrotropin receptor antibody* (TRAb) titer be measured at 4-8 weeks of pregnancy (first obstetrician appointment) in all pregnant women with a history of Graves' disease. Further, it is recommended that the TRAb titer be measured by the end of the second trimester (before the 22nd week of pregnancy).

Type 2 diabetes

1. During each of the patient's visits to a diabetologist, a clinical examination must be performed to detect any possible thyroid disorders; in the case of abnormalities, the TSH level must be measured.
2. It is recommended that the TSH level be measured in all patients with newly diagnosed type 2 diabetes, as well as patients with ongoing diabetes who have never been tested for thyroid hormone function.
3. In patients with a TSH level ≥ 2.0 mIU/l, the TPOAb titer should be measured.
4. If the TPOAb titer is above the reference value, the type of diabetes should be verified, primarily by determining the titer of antibodies to glutamic acid decarboxylase (anti-GAD, *anti-glutamic acid decarboxylase autoantibody*).
5. In patients with the TPOAb titer above the reference range and a TSH concentration of ≥ 2.0 mIU/l, the fT4 level should be determined, and the TSH level should be measured annually.
6. In patients with the TPOAb titer within the reference range and a TSH concentration of ≥ 2.0 mIU/l, the TSH determination should be repeated every 2 years.
7. In patients with the TPOAb titer within the reference range and a TSH concentration of < 2.0 mIU/l, the TSH determination should be repeated every 5 years.
8. It is also recommended that the TSH level be measured in diabetic patients with a lipid metabolism imbalance.
9. The THS level should be measured in every female patient planning pregnancy.
10. In all female patients who are 4-8 weeks pregnant (first obstetrician appointment), both the

TSH level and TPOAb titer should be determined.

11. It is recommended that the TSH level and thyrotropin receptor antibody (TRAb) titer be measured at 4-8 weeks of pregnancy (first obstetrician appointment) in all pregnant women with a history of Graves' disease. Further, it is recommended that the TRAb titer be measured by the end of the second trimester (before the 22nd week of pregnancy).

Based on: J. Sowiński, L. Czupryniak, A. Milewicz, A. Hubalewska-Dydejczyk, M. Szelachowska, M. Ruchała, A. Lewiński, M. Górska, K. Siewko, E. Wender-Ożegowska, D. Zozulińska-Ziółkiewicz, R. Junik, N. Sawicka, P. Gutaj; Zalecenia Polskiego Towarzystwa Endokrynologicznego oraz Polskiego Towarzystwa Diabetologicznego dotyczące diagnostyki i leczenia zaburzeń funkcji tarczycy w cukrzycy typu 1 i 2

Annex 5

Opinion of the Polish Association for Research on Obesity and Diabetes Poland on the usage of low-calorie sweeteners

One of the greatest 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 the WHO as an epidemic of the 21st century. The cause of the obesity epidemic is lifestyle changes such as physical inactivity and excessive consumption of highly processed, energy-dense foods, leading to a positive energy balance.

Successful prevention and treatment of overweight and obesity and their complications require permanent lifestyle changes, which is difficult due to numerous internal and external factors that, over time, reduce the motivation of the person who is forced to deny himself or herself food of his or her favourite taste. **Reducing the energy density of available food, by changing the technological processes of its production and composition, is an important element of preventive action taken at the societal level**. Making such changes, however, requires acceptance by consumers, who have to choose a reduced-calorie product, which requires producers to keep its taste attractive. A preference for sweet tastes develops in people as early as during childhood because breast milk containing lactose has a slightly sweet taste. The food industry uses low-calorie sweeteners (sweeteners) to satisfy consumers' taste for sweetness and at the same time to reduce the calorie content of foods and beverages.

Low-calorie sweeteners are compounds with a sweet taste and zero or no more than a few kilocalories of energy. Because of their intensive sweet taste, they can be used in food products in very low amounts. Currently, the sweeteners are used in production of non-alcoholic drinks, sweets, frozen desserts, yogurts, budinos and many medicines. Stevia, a low-calorie natural substance, can be used in cooking and baking due to its high temperature (up to 200°C) resistance.

Within the European Union, on the basis of safety studies and positive opinions from European Food Safety Authority and the Scientific Panel on Food Additives and Nutrients Sources, there are eleven low-calorie sweeteners have been authorised for use: acesulfame-K (E950), aspartame (E951), aspartame-acesulfame salt (E962), cyclamate (E952), neohesperidin DC (E959), saccharin (E954), sucralose (E955), taumatin (E957), neotame (E961), erythritol (E968) and steviol glycosides (E960). Under EU Regulation 1333/2008 on food additives, additional labelling is required for food products containing these substances. In addition, Regulation No 1333/2008 establishes the maximum content of individual low-calorie sweeteners in a specific food category.

The registration process for low-calorie sweeteners also includes an acceptable daily intake in mg/kg body weight/day (*ADI*), which is the amount that can be safely taken on a daily basis throughout life without adverse health effects. The ADI value for individual low-calorie sweeteners is presented in Table 1.

Other substances are rarely used in food industry, because of that they have no pre-set ADI value.

The results of studies carried out in Europe indicate that the intake of all low-calorie sweeteners is lower than their acceptable daily intake.

Regarding the reports of an alleged increased risk of certain cancers in experimental animals treated with saccharin, aspartame and cyclamate, it should be stressed that recent studies

Table 1. The ADI values for individual low-calorie sweeteners

Substance	Indication on the food product	ADI [mg/kg bw./d.]
Potassium salt of acetosulfame	E950	0–15
Aspartame	E951	0–40
Cyclamate	E952	0–7
Saccharin	E954	0–5
Sucralose	E955	0–15
Neotame	E961	0–2
Steviol glicoside	E960	0–4

performed in humans have not confirmed these claims.

Considering the above-mentioned data, **the Polish Association for Research on Obesity and Diabetes Poland confirm safety of low-calorie sweeteners and recommends their substitution for saccharin in overweight and obese individuals, particularly in the presence of carbohydrate metabolism disorders (abnormal fasting glycaemia, glucose intolerance and type 2 diabetes).**

It should be noted that the beneficial effects of low-calorie sweeteners on body weight in children and adolescents have recently been confirmed in randomised trials published in the *New England Journal of Medicine*.

Using low-calorie sweeteners during pregnancy is another issue. Saccharin, due to its passage through the placenta and its effects on the foetus, which are not fully understood, should not be used during pregnancy, while other sweeteners can be used.

Polish Association for Research on Obesity and Diabetes Poland would like to would like to draw the attention of patients and doctors to the need to analyse the calorie content of products in which sugar has been replaced by low-calorie sweeteners and which are commercially advertised as safe for consumption by people with diabetes because they do not significantly affect postprandial glucose and insulin levels. Despite this modification, some of them still may be high in energy due to their fat content and contribute to gaining weight, thereby worsening glycaemic control. To ensure that the product, in which sugar was substituted with low-calorie sweeteners is in fact low-energy, it is best to compare its calorie content to its counterpart containing sugar, while also paying attention to fat content.

The Polish Association for the Research on Obesity and the Diabetes Poland emphasise that the consumption of food products whose calorific value has been reduced through the use of low-calorie sweeteners cannot be the only element of lifestyle changes. It is only a way of satisfying the need for a sweet taste without consumption of mono and disaccharides, which can facilitate following dietary recommendations and glycaemic control. The intake of fats, especially saturated fats, also plays an important role in the development of overweight, obesity and their complications, and the amount of these in the diet should also be reduced. It should also be noted that dietary energy restriction alone causes not only a loss of fat mass, but also of muscle mass. Therefore, in order to prevent the loss of skeletal muscle mass, regular physical activity is necessary (at least 5 times a week 30 minutes of aerobic exercise, e.g.: walking, cycling, swimming in a pool).

Magdalena Olszanecka-Glinianowicz President of the Polish Association for Research on Obesity
Leszek Czupryniak Chairman Diabetes Poland in 2011–2015

Appendix 6

Recommendation concerning the principles of diabetes treatment with use of personal insulin pump.

I. Requirements for centres commencing and/or conducting treatment of diabetes patients with personal insulin pump (PIP)

Place of provision: diabetes clinic or unit with diabetes profile, centre equipped with computers for reading and analysing data from insulin pumps, *continuous glucose monitoring* (CGM) *systems.*

Staff of the centre with experience in treating diabetes with PIP: doctors with specialty in paediatric endocrinology and diabetology, doctors with specialty in diabetology with ability to treat with PIP (Certificate Diabetes Poland); nurses/educators trained in PIP therapy. Regular checking and analysis of data from PIP, glucometer and CGM systems is required during visits.

Starting therapy includes: qualifying the patient for therapy with a personal insulin pump, training the patient in continuous subcutaneous insulin infusion, connecting the insulin pump to the patient and a follow-up visit to verify the patient's skills and the achieved metabolic control of diabetes. Patients deciding on PIP therapy should be aware of the functionality and technical parameters of the different pump models. This includes: the type of bolus calculator, the option to integrate it with the continuous glucose monitoring system, the choice of the type of infusion set – with a drain or a so-called patch pump.

II. Indications and contraindications for therapy with use of personal insulin pump, financed by the National Health Fund

A. Indications for PIP refund for patients with type 1 diabetes under 26 years of age.

1. "Dawn effect" after ending of a remission period*.
2. Frequent hypoglycaemias after ending of a remission period*:

- an episode of severe hypoglycaemia, more than once a year
- Hypoglycaemic episodes < 70 mg/dl not requiring the assistance of another person ≥ 4 per week;
- failure to achieve glycated haemoglobin (HbA_{1c}) targets without frequent episodes of hypoglycaemia, i.e. ≥ 4 per week;
- distorted perception of typical hypoglycaemic symptoms.

3. Persistently elevated HbA_{1c} values > 6.5% but < 9.0%, despite intensification of treatment in a patient well-educated in the principles of intensive functional insulin therapy, cooperating with the diabetes team and adhering to the principles of self-monitoring (≥ 7 glycaemic measurements/day).
4. Shift workers whose work activity is irregular, or who travel frequently with time zone changes, with an HbA_{1c} value < 9.0%.
5. Individuals doing competitive sports or regularly performing intensive exercises, whose HbA_{1c} value is lower than 8.5%.
6. Children and/or their parents accepting this type of insulin therapy.
7. Continuation of previous treatment with PIP provided there are no contraindications**.

**Remission criteria according to Schölin A et al. Diabet. Med. 2011; 28: 156: Correct glycaemic values in a daily profile with insulin requirements < 0.3 units/kg body wt/day and C-peptide levels > 0.5 ng/ml.*

*** Patients previously treated with a personal insulin pump whose pump has failed shall be subject to the same selection as patients starting therapy. Previous treatment with the insulin pump does not mean automatic refunding of the new pump.*
The request for provision of auxiliary aids — accessories for a personal insulin pump is issued exclusively by a physician of a diabetes care outpatient clinic or a hospital ward.

In special cases, a decision on the insulin pump refund may be made by a provincial consultant in diabetology or in paediatric endocrinology and diabetology after reviewing the patient's documentation and consulting the attending diabetologist (e.g. on coexisting diseases or therapy with corticosteroids).

B. Contraindications to PIP refund by NHF for patients with type 1 diabetes under 26 years of age

1. The average value of HbA_{1c} over last year is less than or equal to 9.0%
2. Psychiatric diseases - psychosis, severe depression, also in parents of children below 16.
3. Intellect disorders, also in parents of children below 16, preventing understanding of the principles of intense insulin therapy and pump handling.
4. Eating disorder.
5. Addiction to alcohol and psychoactive substances, including in parents of children under 16.

6. Unexcused absences from medical appointments (attendance at only 1 appointment per year or no appointment) at the diabetes clinic.
7. Failure to follow or understand the principles of intensive functional insulin therapy (failure to adequately self-monitor blood glucose, failure to control the presence of ketone bodies in situations of prolonged hyperglycaemia, inaccurate estimation of meal insulin dose).
8. More than one episode of ketoacidosis over the last year.
9. Severe, rapidly progressive proliferative retinopathy before or during laser therapy.
10. Lack of acceptance of the disease despite full diabetes care and psychological support (written opinion of a psychologist experienced in diabetes-related care).
11. Disregard of personal hygiene rules.
12. Being exposed to strong magnetic field on a regular basis.

C. Contraindications to continuing treatment with use of personal insulin pump and equipment refund*** in patients with type 1 diabetes.

1. No improvement or deterioration in metabolic control of diabetes, assessed after one year of treatment with PIP.
2. More than one episode of diabetic ketoacidosis over the last year.
3. One or more episodes of severe hypoglycaemia during the treatment with insulin pen injectors.
4. Non-compliance with intensive functional insulin therapy and insufficient patient knowledge.
5. Increased skin reactions at the site of infusion set implantation despite attempts to change the type of set.
6. Irregular replacement of infusion sets (less than every 3 days).
7. Unexcused absences from medical appointments (attendance at only 1 appointment per year or no appointment).
8. Sustained HbA1c ≥ 9.0% (2 consecutive tests.

III. Qualification for initiation or continuation of therapy with PIP

The patient reporting to the centre providing the refund service shall submit:

- an application with pre-qualification from a doctor working in a diabetes clinic/department;
- glucometer report from the last 4 weeks – at least 7 readings per day are required (glucometer data may be checked at clinic); or rtCGM, iCGM/FGM report
- in some patients with unsatisfactory metabolic control, additional information on carbohydrate intake, insulin doses is recommended before qualification for PIP treatment. A proper application (electronic record) or self-control notebook can serve as a source of such information.

In case of children with newly-diagnosed diabetes, the qualification is conducted by diabetologist or paediatric endocrinologist and diabetologist working at paediatric diabetology department.

IV. Patient orientation on rules of PIP therapy

Education of the patient and/or their family to enable independent use of the pump and accessories (confirmed by a medical certificate or information sheet) (scope of education in chapter 9.6 III).

Particular attention should be paid **to dealing with PIP failures**.

Organisational requirements: 9 hours spread over at least 3 meeting is the minimal orientation time. In case of pump with CGM, it is necessary to extend the orientation by 2 hours. Courses should take place in groups of no more than 6-8 people. The participation of parents or legal guardians is required for the training of children and adolescents. The patient should be able to do practical exercises with infusion sets on mannequins. It is also recommended that an infusion set be placed in the patient's subcutaneous tissue in the period before continuous subcutaneous insulin infusion therapy begins.

Orientation should continue until the patient/caregiver is proficient in the practical aspects of using the PIP. It is the responsibility of the centre initiating therapy or the centre referring for the PIP therapy to ensure that the training is carried out correctly. Patient knowledge must be verified by the educational team. It is recommended to develop practice test based on educational materials of the centre.

It is recommended that the patient be taught to use a computer program to read data from the PIP, glucometer and CGM to enable clinically effective remote counselling.

V. Provision of PIP taking into account both the patient's preferences and their perceptual abilities, which should be taken into account in the process of education and individualisation of treatment.

The table to Annex 6 gives recommendations for the requirements for insulin pumps in centres providing insulin pump therapy. It is recommended that different types of insulin pumps be available at the centres, so that the patients are able to choose the pump that best suits their needs.

VI. Connecting an insulin pump to a patient

Initial settings of the insulin pump are made by the centre starting the therapy. These settings should also include the setup of bolus calculator function. Placing an infusion set on the patient.

For pumps with a CGM system, it is advisable to pre-set the system parameters, including alarms, taking into account the current metabolic control of diabetes, additional pump functions and patient skills.

For Appendix 6

Specifications for personal insulin pumps – 2022 recommendations of Diabetes Poland. Recommended mandatory requirements

Parameter		Description
Pump stoppage		An alarm informing that the pump has stopped working
Child lock		Electronic keypad lock
Bolus programming	Simple/standard	Accuracy of no less than 0.1 u./bolus
	Extended/rectangular	Accuracy of no less than 0.1 u./bolus Max. bolus administration time – no less than 7 hours
	Complex/double/ multiwave	Accuracy of no less than 0.1 u./bolus
Temporary basal/basal rate change	Settings	Must enable a percentage or unit increase or decrease of the basal rate every 30 minutes along with automatically returning to the basal rate once the programmed amount of time has elapsed
	Information on the active basal rate	Readily available on the home screen or upon pressing a single button
	Time	Up to 24 hour
Basal rate programming	Programming multi-hour flows (number of units per hour)	Accuracy of no less than 0.1, and in children below the age of 6, no less than 0.05 µ/hour At lest 2 additional pre-programmable basal rate profiles, which can be readily loaded from the memory and used
"Pump memory"	A history of boluses, alarms, basal rates, daily rates, temporary basal rate changes, drain fillings; the software used to read pump data should also be able to read data from glucometer strips covered by National Health Fund reimbursement as of the tender announcement date, as well as to integrate both data sets	Min. 30 days, using computer software via a reader The company must provide free access to the software (either an on-premises or cloud-based online version) and devices necessary to read the relevant data to the diabetes centre providing the therapy services (links) – software requirements are listed in Annex 1. **Available directly via the pump:** Current basal rates stored in the memory; at minimum, a record of the last 20 boluses (rate and type); data on total daily rates from the last 30 days
Bolus calculator – an integral part of an insulin delivery system (this functionality must be available directly in the insulin pump, an external device able to communicate with the pump wirelessly or via a smartphone app)		**Must enable the following:** · programming settings for various time intervals · entry by the user of carbohydrate grams or carbohydrate exchanges · active insulin calculation along with user-determined insulin acting time, which only adjusts the insulin bolus correction dose · Possibility of manually entering blood glucose values into the bolus calculator and communicating with glucometers utilising strips covered by National Health Fund reimbursement as of the tender announcement date
Automatic drain filling		Yes – unlimited number of drain fillings during the day using only the pump's functionalities
Infusion set		**Drain kits:** Insertions: metal (rigid) and plastic (flexible) – all insertion types up to the reimbursement amount Drain length – at least 2 length versions Cannula length – at least 2 length versions **Drainless kits for patch pumps:** Cannula length – at least 2 length versions

Parameter	Description
Service	Providing 24-hour phone contact with an authorised hotline (with specialists familiar with the pump's operation, as well as any possible alarms and errors), subject to review by customers. A website containing the information specified in Annex 2. Pump replacement within 24 hours (working days), Pumps to be shipped at the company's expense
Batteries – pump's power source	AA and AAA batteries (widely available at grocery stores, petrol stations, electronics stores, etc.), Pumps that utilise rechargeable batteries must enable operation while connected to a charger plugged into a socket The pump must notify the user about the battery charge level dropping below 30% through a sound alarm and a pop-up on the screen
Additional accessories needed to use a personal insulin pump	The manufacture must deliver any additional personal insulin pump accessories requiring regular replacement, as per the user manual, free of charge for the pump usage period (excluding infusion sets, insulin containers, batteries and protective cases)
Warranty	At least 4 years; pumps must be replaced with new ones in the case of failure Where the pump is replaced with a new unit, the total warranty period must be no shorter than that provided for in the offer. The warranty period must run from the day of commencement of the NHF procedure and not the day of the unit's purchase from the manufacturer.
Menu	Fully in Polish or based on icons or symbols
User's manual	Fully in Polish; the user's manual must explain all messages shown by the pump

Continuous Glucose Monitoring (CGM) system – an integral part of an insulin pump (applies to orders for insulin pumps featuring Continuous Glucose Monitoring functionality)

Applies to patients suffering from frequent episodes of hypoglycaemia or hypoglycaemia unawareness

Possibility of automatically stopping the basal rate infusion based on CGM system indications

Specifications for personal insulin pumps – 2022 recommendations of Diabetes Poland. Recommended auxiliary requirements

Parameter	Description
Infusion set replacement reminder	An alert informing the patient about the need to replace the infusion set
Infusion set filling history	Possibility of accessing the pump's memory to review the history of infusion set fillings
IPX 8 standard	IPX 8
Additional: a device allowing patients to access the pump's memory at home and send the data to their doctor	Access to software (on-premises or cloud-based online version) and a device needed for the computer to read the data
Additional basal rate infusion profiles	More than 3
Bolus calculator	Enabling the user to change blood glucose value settings to either mg/dl or mmol/l Possibility of manually entering the blood glucose value to the bolus calculator
Constant Glucose Monitoring system	A system integrated with an insulin pump or an additional CGM device supporting therapy using a personal insulin pump

For selected groups of patients, it is possible to modify the specifications of personal insulin pumps to consider the patient's educational capabilities, as well as the personal/individual nature of the therapy.

Annex 1

Requirements concerning computer software for reading the pump's memory:

- current basal rates (all must be available for access during a single read of the pump's memory; accurate time and rates must be presented on charts or in tables, along with providing the pump's basal rate delivery accuracy)
- using conversion values along with the established time intervals in the bolus calculator;
- bolus history (all administered boluses, along with indicating the bolus type and administration time, including for extended boluses);
- drain filling history;
- daily charts, which must include the following:
  - » basal rate infusion used on a given day,
  - » time-based basal rate change,
  - » indication of when the pump starts and stops
  - » blood glucose value levels, which must be sent by a glucometer and/or CGM working with the pump
- alarm history;
- providing software to patients for free;
- the software for reading pump data should simultaneously be able to read data from glucometers capable of utilising strips subject to National Health Fund reimbursement as of the tender announcement date, as well as to integrate both data sets.

Appendix 2

Required information, contained on the website:

- a helpline number to provide pump users with 24-hour information on technical problems related to the use of the PIP;
- telephone numbers of local representatives along with their office hours;
- data concerning pump accessories (types of infusions, syringes, batteries and their prices, etc.).

RECOMMENDED ADDITIONAL OPTIONS

1. Glucometer interfacing; wireless, with at least 1 glucometer; ability to turn glucometer data transfer to pump off and on; ability to record glycaemic values with bolus calculator function on or off.
2. Insulin pumps where a dedicated glucometer is part of the system should be dispensed with it.
3. Alarms to remind of boluses or glycaemic measurements at a time set by the user.
4. The price of infusion sets that does not exceed the monthly refund limit for people under the age of 26 and 30% of this limit for people above the age of 26. 16.

ADDITIONAL NOTE

The purchaser may specify additional parameters according to the needs of specific patient groups. In addition, the tender should include the necessary accessories for commencing the therapy and educational materials: serters, various types of infusion sets, insulin containers, pump batteries and cases.

When evaluating a pump in a tender, the cost of the pump should account for 60% of the evaluation and additional features should account for 40%.

Appendix 7

Recommendations of Diabetes Poland and the Polish Society of Sports Medicine concerning permissions to practise sports for patients diagnosed with type 1 diabetes

Patients diagnosed with type 1 diabetes may be qualified as capable of practising any sport by a sports medicine specialist after receiving a positive opinion from a diabetologist.

The prerequisites for being eligible to engage in physical activity include treatment with intensive functional insulin therapy and an understanding of its principles. Treatment can be provided by pen injectors or a personal insulin pump. The method that is most suitable for athletes with diabetes consists in the use of an insulin pump, which allows more physiological insulin delivery. A diabetic sportsperson is obliged to monitor his or her blood glucose level with a glucose meter at least six times a day and perform additional measurements during training and sports competitions. It is recommended that continuous glucose monitoring (CGM) or flash glucose monitoring (FGM) systems be used to further support treatment and increase safety of the athlete.

Type 1 diabetes should not be a contraindication to participation in PE classes, at any level of education, or sport at school (school sports associations, student sports associations, school competitions, etc.).

Optimal blood glucose levels in the beginning and during training should be in the range: for aerobic exercises - 126-180 mg/dl (7-10 mmol/l), for anaerobic exercises - 90-180 mg/dl (5-10 mmol/l).

I. Contraindications to participation in sport by children and adults with type 1 diabetes, which require a sports medicine specialist's opinion:

1. HbA_{1c} - the average from the last 12 months > 8.5% or a current result of ≥ 9%.
2. More than one episode of ketoacidosis in the last 12 months.
3. More than one episode of severe hypoglycaemia in the last 12 months.
4. Self-monitoring of blood glucose level: number of measurements < 6 per day with a glucometer in athletes who do not use CGM or FGM.
5. Visits to diabetes clinic: in children < 4/year, in adults < 2/year.
6. Unawareness of hypoglycaemia while awake — relative contraindication that may be overruled depending on the sports discipline and the use of CGM or FGM.
7. Chronic complications of diabetes according to their stage and sports discipline:
   - proliferative retinopathy until the completion of laser therapy — an absolute contraindication to all types of sport;
   - clinically manifested autonomic neuropathy
   - contraindication to high-intensity physical exertion;
   - macrovascular complications — qualification after cardiological diagnostics including echocardiography, exercise test, 24-hour Holter monitoring test (ECG);
   - significant proteinuria > 0.3–0.5 µg/day (A3)
   - relative contraindication, observation necessary — proteinuria check every 3–6 months, systematic checks of blood pressure and renal function*;
   - proteinuria > 0.5 g/day — temporary exclusion from sport;
   - eGFR 45-60 ml/min/1.73 m^2 (G3a) — creatinine and eGFR check at least every 3 months;
   - eGFR 30-45 ml/min/1.73 m^2 (G3b) — relative contraindication for competitive sport, temporary exclusion, creatinine and eGFR checks every 4-6 weeks;
   - eGFR < 30 ml/min/1.73 m^2 (G4) — no physical activity allowed.

**calculation of eGFR according to the Schwartz formula - up to the age of 15, according to the CKD-EPI formula - above the age of 16.*

II. Tests to be performed when qualifying an athlete with type 1 diabetes as capable of practising sport

Initial qualification: current results of tests recommended by Diabetes Poland.

HbA_{1c} values from the last 3 months, glucometer and/or CGM/FGM and insulin pump measurement reports.

III. High-risk disciplines: motor, aquatic and aerial sports, climbing

Practising sports disciplines in which hypoglycaemia poses a particularly high risk to the safety of the patient and the environment is not recommended for people diagnosed with type 1 diabetes.

They are allowed upon meeting the following conditions:

- the patient is very well-educated and meets treatment goals;
- the measurement of blood glucose level up to 15 minutes before the training shows a value of ≥ 120 mg/dl (6.7 mmol/l), blood glucose levels are monitored using a glucose meter every

60 minutes, or less frequently if CGM or FGM is applied

CGM is recommended for persons practising high-risk sports

IV. Contraindications to participation in training and sports competitions

1. Severe hypoglycaemia in the last 24 hours.
2. Hyperglycaemia above 250 mg/dl (13.9 mmol/l) with associated ketonaemia/ketonuria resulting from insulin deficiency rather than carbohydrate deficiency.
3. Ketonaemia ≥ 1.5 mmol/l is an absolute contraindication to the initiation and continuation of physical exercise.
4. Hyperglycaemia > 300 mg/dl (16.7 mmol/l) lasting more than 2 hours.
5. Any serious event requiring medical attention, such as visual disturbance, chest pain, fainting, acute infection, etc.

Prepared by the Diabetes Poland Team: Leszek Czupryniak, Andrzej Gawrecki, Przemysława Jarosz-Chobot, Tomasz Klupa, Bartłomiej Matejko, Krzysztof Pawlaczyk, Agnieszka Szadkowska, Agnieszka Szypowska, Bogumił Wolnik and Dorota Zozulińska-Ziółkiewicz, as well as the Polish Society of Sports Medicine Team: Grzegorz Biegański, Andrzej Bugajski, Anna Jegier, Jarosław Krzywański, Marek Pietruszewski, Katarzyna Szmigielska, Wiesław Tomaszewski and Andrzej Ziemba

Diabetes consultation sheet qualifying for participation in sport by patients diagnosed with type 1 diabetes*

.....

Patient's name and surname

Sports discipline .....

PESEL (Personal Identification Number) ☐☐☐☐☐☐☐☐☐☐☐

Address of residence: Place: ..... Postal code ☐☐-☐☐☐

Street: ..... House/flat number: .....

Initial qualification ..... Periodic examinations ..... Date of diabetes diagnosis.....

The ability to administer intensive functional insulin therapy:

high ☐ sufficient ☐ requiring education ☐

The ability to control blood glucose level: good ☐ acceptable ☐ insufficient ☐

Hypoglycaemia: the ability to prevent and counteract: good ☐ unacceptable ☐

The presence of antecedent signs of hypoglycaemia: YES ☐ at values: ☐ NO ☐

Risk of hypoglycaemia: low ☐ acceptable ☐ unacceptable ☐

HbA_{1c} values from the last 12 months.: .....

Severe hypoglycaemia in the last 12 months: Not present ☐ 1 ☐ ≥ 2 ☐

Ketoacidosis in the last 12 months: Not present ☐ 1 ☐ ≥ 2 ☐

Chronic complications of diabetes: Not present ☐ Present ☐

Proliferative retinopathy ..... Clinically manifested autonomic neuropathy .....

Diabetic foot syndrome ..... Nephropathy ..... Cardiovascular complications .....

Notes

.....

Are chronic complications a contraindication to qualification?

YES ☐ NO ☐ Further recommendations for treatment and control of chronic complications:

Notes concerning the qualification:

.....

Notes concerning the sports discipline (self-monitoring of blood glucose levels, disconnection of the insulin pump, reduction of the insulin dose, etc.):

.....

I hereby grant my consent to the qualification: YES ☐ NO ☐ Items constituting a temporary contraindication to qualification

Stamp of the health care unit or medical practitioner	Date, stamp of attending diabetologist

.....

*The diabetes consultation is valid for 12 months

.....

*I hereby declare that I will comply with the safety rules for patients diagnosed with type 1 diabetes when engaging in physical activity. I am educated with regard to intensive functional insulin therapy and variable insulin dosing while participating in sport.

.....

Date and signature of the patient * applies to athletes > 16 years of age

.....

**I am capable of administering insulin therapy and controlling my child's blood glucose level during sport. I undertake to systematically educate my child about the treatment of diabetes and methods of responding to hypo- and hyperglycaemia occurring in relation to sport. I undertake to provide the coach with basic information regarding my child's illness.

.....

Date and signatures of parents ** applies to athletes < 18 years of age

.....

I have been informed that the aforementioned athlete has been diagnosed with type 1 diabetes. I am aware of the risk associated with the occurrence of hypo- and hyperglycaemia. I have basic knowledge on how to recognise hypo- and hyperglycaemia. I am aware of the need to undertake necessary action when they occur.

.....

Date and signature of the coach

QUALIFICATION BY A SPORTS MEDICINE SPECIALIST:

Fit/unfit to practise sport.

Stamp of the health care unit or medical practitioner	Date and stamp of the sports medicine specialist