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Practice Guidelines of Nursing and Midwifery Diabetes Care – 2023. A position statement of Polish Federation for Education in Diabetology

Praktyczne zalecenia w pielęgniarskiej i położniczej opiece diabetologicznej – 2023. Stanowisko Polskiej Federacji Edukacji w Diabetologii

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STRESZCZENIE

PRAKTYCZNE ZALECENIA W PIELĘGNIARSKIEJ I POŁOŻNICZEJ OPIECE DIABETOLOGICZNEJ – 2023. STANOWISKO POLSKIEJ FEDERACJI EDUKACJI W DIABETOLOGII

Wprowadzenie. Historia zaleceń Polskiej Federacji Edukacji w Diabetologii (PFED) sięga roku 2006, kiedy to po raz pierwszy opracowano wytyczne dla pielęgniarek/położnych pracujących z chorymi na cukrzycę. Rozszerzenie kompetencji pielęgniarek i położnych wymaga jednak bardziej zdecydowanych, niż dotychczas działań zmierzających do przejścia od praktyki opartej wyłącznie na doświadczeniu do praktyki opartej na dowodach.

Cel pracy. Celem pracy było przygotowanie zestawu procedur opisujących sposób postępowania pielęgniarskiego w opiece diabetologicznej z uwzględnieniem aktualnie dostępnych dowodów naukowych oraz klinicznego doświadczenia specjalistów zaangażowanych w opiekę nad osobą z cukrzycą.

Materiał i metoda. Dokonano przeglądu piśmiennictwa w wybranych obszarach praktyki pielęgniarki diabetologicznej. Priorytetem przy tworzeniu materiału było wykorzystanie danych kolejno z: randomizowanych kontrolowanych badań klinicznych i ich metaanaliz, badań obserwacyjnych a także innych badań o niższym poziomie dowodów.

Wyniki. Analiza zgromadzonego materiału dała podstawę do opracowania 15 procedur oraz 2 wytycznych opisujących wybrane aspekty postępowania pielęgniarskiego, w opiece nad osobą z cukrzycą. W każdej z procedur wyszczególniono kluczowe dla opieki rekomendacje i usystematyzowano je zgodnie z przyjętym poziomem dowodów naukowych.

Wnioski. Praktyczne zalecenia w pielęgniarskiej i położniczej opiece diabetologicznej na rok 2023 rok są efektem ewaluacji dotychczas prezentowanych wersji i stanowią zaktualizowany, znacznie rozszerzony, kompleksowy, oparty na dowodach naukowych zestaw praktyk. Niewątpliwie atutem jest interdyscyplinarność zaleceń wyrażająca się między innymi w tym, iż ostateczna wersja została zaopiniowana przez konsultantów w wielu dziedzinach pielęgniarstwa oraz przez konsultanta w dziedzinie diabetologii i prezesa Polskiego Towarzystwa Diabetologicznego będących przedstawicielami środowiska lekarskiego. Ważnym elementem w formułowaniu aktualnych zaleceń było wykorzystanie doświadczeń autorów zdobyte podczas prac przy międzynarodowych rekomendacjach (ang. *New Insulin Delivery Recommendations*).

Słowa kluczowe: zalecenia, procedury, wytyczne, pielęgniarka, położna, cukrzyca

ABSTRACT

PRACTICE GUIDELINES OF NURSING AND MIDWIFERY DIABETES CARE – 2023. A POSITION STATEMENT OF POLISH FEDERATION FOR EDUCATION IN DIABETOLOGY

Introduction. The history of recommendations by the Polish Federation for Education in Diabetology dates back to 2006, when guidelines for nurses/midwifes working with diabetic patients were first drawn up. However, the development of nurses and midwifes? competences requires stronger actions that foster a transition from experience-based towards evidence-based practice.

Aim. The aim of this publication is to present a set of procedures describing nursing interventions in diabetes care, including currently available scientific evidence and clinical experience of specialists involved in the care of diabetic patients.

Material and methods. The study involved a literature review of selected areas of nursing practice in diabetes care. When compiling the material, the priority was to use data from (in order of significance): randomized controlled clinical trials and their meta-analyses, observational studies and other studies with lower levels of evidence.

Results. Based on an analysis of the collected material, 15 procedures and 2 guidelines have been developed, describing selected aspects of nursing interventions in diabetic patients. Each of the procedures details key recommendations on diabetes care, arranged in accordance of the significance ascribed to the scientific evidence analyzed.

Conclusions. The 2023 PFED guidelines on nursing diabetes care are the effect of the evaluation of the previous versions and comprise an updated, considerably more extensive, comprehensive and evidence-based set of practices. The major asset of these guidelines is their interdisciplinarity, reflected in the fact that the final version of the publication was approved by consultants in numerous nursing fields, a consultant in diabetology, and the President of the Polish Federation for Education in Diabetology, who all represent the medical community. The authors experience gained during work on international recommendations (New Insulin Delivery Recommendations) played an important role when formulating the present guidelines.

Key words: guidelines, procedures, recommendations, nurse, midwife, diabetes

INTRODUCTION

Since 2006, the Polish Federation for Education in Diabetology (PFED) publishes regularly guidelines on diabetes care for nurses and midwives working with diabetes patients [1]. The guidelines are recommended by consultants in nursing, diabetes nursing, epidemiological nursing, gynecological and obstetrical nursing, and diabetology, as well as the president of the Polish Diabetes Association. The guidelines are developed by a team of nurses and midwives with extensive experience in diabetes care.

The 2023 PFED guidelines on diabetes care have been updated based on the most recent scientific reports; key recommendations for care have been highlighted and assigned evidence levels A, B, C, and E, in line with the evidence classification described in table 1.

Please, note that the guidelines are just one of multiple considerations involved in nurses' and midwives' decision-making process regarding patient care. All guidelines should be appropriately interpreted for a specific patient and specific circumstances, the patient's values and preferences, and the clinical situation, based on one's knowledge, skills, and clinical experience. The updated version of the guidelines now includes procedures for capillary blood ketone level measurement using a glucose meter and for urine glucose and ketone level measurement. The procedure for management of hypoglycemia in a diabetic patient has been expanded with instructions for preparation and administration of nasal glucagon powder. These guidelines also account for the introduction of new ICT solutions in diabetes care and new patient treatments.

Tab. 1. Research evidence classification system used by PFED to create Practical Guidelines for Nursing Diabetes Care – 2023 (A position of the Polish Federation for Education in Diabetology)

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 controlled or uncontrolled 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**

Source: Introduction: Standards of Medical Care in Diabetes – 2022. Diabetes Care. 2022; 45 (Supplement 1): S1-S2.

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I. GLUCOSE LEVEL MEASUREMENT USING A GLUCOSE METER

Purpose: Measurement of glucose level in capillary blood using a glucose meter, providing results used in therapeutic decision-making.

Individuals authorized to perform the measurement: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 2. Key recommendations. Glucose level measurement using a glucose meter

Each patient should be trained in: technique for using the glucose meter and the dedicated accessories, self-care and self-examination of puncture sites, and principles of glucose monitoring oriented at diabetes self-management in cooperation with the treatment team. **E**
Patients performing self-monitoring of blood glucose should be continuously instructed and evaluated on their measurement technique, results, and ability to use data from self-monitoring of blood glucose to self-manage their diabetes in cooperation with the treatment team. **E**
Health care professionals should understand the impact of medication and other factors on the accuracy of measurement using a glucose meter, and should select devices for specific patients based on these factors. **E**
If it is necessary to use a single glucose meter for more than one patient, the device must be cleaned and disinfected after each use, according to the manufacturer's instructions. **C**
The first drop of blood can be used for capillary blood glucose measurement, provided that the patient has washed his hands before. **C**
In a hospital setting, it is better to use individually packed test strips. **C**
The nurse/midwife should perform physical examination of the patient's skin at puncture sites. The physical examination of the patient's skin should be performed at least once every 6 months, considering the frequency of glucose self-monitoring. **E**
During each visit, the nurse/midwife should assess the frequency of glucose level measurements performed by the patient and analyse the reasons for non-adherence to the recommended number of measurements. **E**

Sites for capillary blood sampling

In adults, the fingertip is typically the preferred site for capillary blood sampling. The puncture is performed on the palmar surface of the distal segment of the third or fourth finger, perpendicular to the lines of the fingerprint. Sides of the heel (medial or lateral aspect of the plantar surface) are only used in children and infants. The puncture is performed on the lateral or medial plantar surface, in the shaded area outside the lines going from the middle of the big toe to the heel and from the point between the fourth and fifth toe to the heel [1-4].

In children, the capillary blood sampling site is typically selected based on the patient's age and body weight. Sampling capillary blood by finger-prick is recommended in children older than 6 months and weighing more than 10 kg. Recommended fingers: middle and ring finger. Avoid collecting blood from the thumb or index finger, which may be calloused, or from the little finger due to its thin tissue [4].

Lancet length

Lancets ranging between 0.82 mm and 2.4 mm in length are typically available. Incision depth for a finger-prick should not exceed 2.4 mm. A 2.2 mm lancet is sufficient [4-5].

Incision depth for a heel-prick in children should not exceed 2.4 mm. In premature infants, a 0.85 mm lancet is sufficient [4]. Excessively deep puncture may lead to calcaneal osteomyelitis [6-7]. The recommended incision depth for a finger-prick in children is: 1.5 mm in children aged 6 months to 8 years, and 2.4 mm in children older than 8 years [4]. Finger-pricks should not be performed in infants, as this could result in nerve damage. Using automatic lancets reduces pain levels and increases comfort of newborn during heel blood sampling [8].

When performing the puncture, excessive pressure should be avoided, as this could result in a deeper puncture than necessary for obtaining an adequate drop of blood [4].

In children, make sure the skin is warm at the puncture site before blood sampling. Adult patients should wash their hands with warm water [4].

Health care institutions should consider using retractable lancets with a blade slightly shorter than the recommended incision depth, as the pressure on the device when puncture is performed results in an incision depth exceeding the nominal blade length [4].

Note! Do not use surgical lancets or hypodermic needles for the puncture. Nurses in health care institutions should not perform multiple punctures using the same lancet.

Do not sample capillary blood:

- from the thumb or index finger, as they are more sensitive than other fingers and may have calluses or scars;
- from swollen or previously punctured sites, as the accumulated fluid may contaminate the sample;
- from fingers of the hand where intravenous infusion is being performed; or from fingers on the side of the body where mastectomy has been performed [4].

Alternate site testing (AST)

Capillary blood sampling for blood glucose measurement from alternate sites (other than the fingertip).

Alternate puncture sites [9-14]:

- palm surface below the thumb,
- palm surface below the little finger,
- inner and outer forearm,
- arm,
- calf,
- outer thigh.

Puncture sites should be away from deep skin ridges or bones, with no visible veins, hair, or birthmarks.

Blood sampled from the palm surface can be used to measure the blood glucose level at all times [15-16]. Test results for other alternate sites may differ from those obtained with blood sampled by finger-prick. Such differences may occur when the blood glucose level changes rapidly [17].

AST is not recommended in the following circumstances:

- up to 2 hours after a meal, when there is a rapid increase in blood glucose [16];
- during the peak time for short-acting insulin or rapid-acting insulin analog;
- when very low glucose level is suspected [14];
- during an illness;
- during or after exercise [16];
- for continuous glucose monitoring (CGM) calibration.

Factors interfering with blood glucose measurement [18-22]

- environmental factors – described in the user manual of any glucose meter [20];
- technology-related factors [20];
- photometric technology;
- biosensor technology;
- physiological factors;
- endogenous substances in the blood: high concentrations of triglycerides, bilirubin, creatinine; hematocrit below 30% (pregnancy, anemia, chronic kidney disease, bleeding) – falsely decreased glucose readings; or above 60% (chronic respiratory diseases, dehydration from diarrhea, vomiting, diabetic ketoacidosis, hyperosmolar hyperglycemic nonketotic syndrome) – falsely elevated glucose readings;
- exogenous substances, e.g. due to improper hand hygiene – residual sugar from fruit or sweets [19-20,23]; residues of disinfectants, hand cream [17,24], or medication [20];
- extraneal solution for peritoneal dialysis contains icodextrin. Maltose, metabolite of icodextrin, may distort the readings from some glucose meters or test strips – falsely elevated glucose levels [25-27]. Systems based on glucose dehydrogenase with pyrroloquinoline quinone as a cofactor (GDH-PQQ) should not be used. To obtain information on compliance, please contact the manufacturer of the glucose meters and test strips used.

Measurement technique

Note! Do not use a drop from a venous blood sample to measure glucose level with a glucose meter.

1. Check the expiration date on the test strips (write the opening date on the package once it is first opened, if the manufacturer has specified a time for using the strips after opening).
2. In a home setting, the patient should thoroughly wash his hands with warm water and soap, but no disinfectant, and then dry them well (heat causes blood vessels to dilate, increasing blood flow in the capillaries and making blood sampling easier; if the skin is wet, the blood drop may become diluted).
3. In health care facilities, it is recommended to disinfect the skin in the capillary puncture blood collection site. Apply the product and wait for the time specified in the manufacturer's material safety data sheet.
4. Massaging the hand is recommended, from its heel towards the finger being punctured (pressure on the fingertip causes the blood to become diluted by tissue fluid).
5. Place the test strip in the glucose meter and immediately close the test strip package.
6. Puncture the skin on the side of the fingertip, considering the following:
   - select incision depth based on the individual characteristics of the patient's skin,
   - perform punctures on the sides of fingertips so as to preserve their tactile function as long as possible.

   Note! In infants who have not begun to walk yet, punctures can be also done on the toes and the heel (including the sides) [28-29].
7. Once the appropriate notification icon is displayed on the glucose meter screen, place the blood drop on the test strip (photometric measurement) or touch the drop with the end of the strip (electrochemical measurement).
8. Use the first blood drop for the measurement, as squeezing out multiple drops causes the blood to be diluted by tissue fluid. Some glucose meters have a function that allows for adding a second blood drop during a measurement (called "second chance" sampling) [19,30-32].
9. Secure the puncture site with a sterile gauze pad.

Guidelines for glucose meter users in outpatient and inpatient care

- For measuring glucose levels in capillary blood using a glucose met er, only PN–EN ISO 15197:2015–10 compliant glucose meters must be used [33-35].
- In health care institutions and care facilities, only glucose meters with external strips must be used.
- Glucose meters should be assigned to individual patients and not shared. If it is necessary to use a single glucose meter for more than one patient, the device must be cleaned and disinfected after each use, according to the manufacturer's instructions, so as to prevent the transmission of blood and pathogens [36-43]. If the manufacturer has not specified a procedure for cleaning and disinfecting the device, it must not be shared between patients.
- The glucose meter should be selected for each patient considering his age, manual skill, comorbidities, and treatment used.
- In a hospital setting, individually packed test strips are preferred for blood glucose measurement [44-47]. Test strips should not be used if the container is damaged or improperly sealed.
- When the test strip package is first opened, the opening date should be marked on the package. The test strip manufacturer specifies the time for using the strips after opening.
- Do not expose the glucose meter or test strips to humidity, excessively high or low temperatures, dust, or dirt [21].

- Patients should be trained in using their glucose meter, and handling and storing the test strips, by the nurse or midwife at the place of care [35,48-52].
- Patients should be informed on the impact of physiological and environmental factors and any medication taken on glucose measurement results [20].
- Patients should be assessed on their technique of blood glucose self-monitoring once a year [35].
- The proper function of the glucose meter should be checked whenever a malfunction is suspected, and at least once a year in an outpatient center [34-35,53-55]. The check should be recorded in the health care institution's documentation [35,54], and in the patient's self-monitoring journal.
- Before first use of the glucose meter, carefully read the instruction manual.
- Blood glucose measurement results should be reported in mg/dL or mmol/L.
- Set the current date and time on the glucose meter for data transmission purposes.
- If the diabetes patient does not have his own lancing device, the finger prick should be performed with a disposable lancing device.
- The patient should be informed about the possibility of using a mobile application and software to be used with a glucose meter, which support self-monitoring of blood glucose [56-57].

Important! The lancing device is a personal device.

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II. FLASH GLUCOSE MONITORING (FGM)

Purpose: Measurement of glucose level in the interstitial fluid by scanning: the results are not transmitted to the reader continuously and must be read by the patient.

Individuals authorized to perform the measurement: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 3. Key recommendations. Flash glucose monitoring (FGM)

Comprehensive, structured patient education on self-monitoring using an FGM system results in improved metabolic control of diabetes in patients receiving intensive insulin therapy. **A**
Each patient approved for FGM should receive education (training) on: the technique for using the device, self-care and self-examination of sensor insertion sites, and principles of glucose level monitoring oriented at diabetes self-management in cooperation with the treatment team. **A**
The nurse/midwife should perform physical examination of the patient's skin at sensor insertion sites. The physical examination of the patient's skin should be performed at least once every 6 months. **E**

The FGM system allows for measuring the glucose concentration in interstitial fluid using a sensor with an integrated transmitter, inserted subcutaneously, and a reader [1]. The FGM system should be used in accordance with the manufacturer's instructions.

- The recommended insertion site is the subcutaneous tissue of the posterior lateral part of the arm [2-3].
- Avoid areas with scars, birthmarks, stretch marks, or lumps. Select an area of skin that remains mostly flat (does not crease) during daily activities.
- Select a site at least 2.5 cm away from any insulin injection site.
- The system must not be used if the sensor packaging or the introducer seem damaged or previously opened, or if the expiration date has passed [4-5].
- The introducer contains a needle. Do not touch the inside of the sensor introducer or place it back in the sensor packaging. Do not press on the introducer until it has been placed on the properly prepared insertion site, so as to avoid injury or unforeseen outcomes [4-5].
- The FGM sensor is factory-calibrated, and measurements are performed every minute [6]. Measurement results are saved into the sensor memory every 15 minutes, and at each scan, data from the preceding 8 hours are transmitted to the reader memory.
- Scans are performed by placing the reader within 4 cm of the sensor. Glucose measurement results can be read through clothing. The LibreLink application allows for scanning the sensor using an appropriate mobile device, e.g. phone.
- The second-generation FGM system has a hypoglycemia and hyperglycemia alarm function, uses the Bluetooth technology, which allows for improved data communication, and can be integrated with insulin pumps [7].
- The sensor can be used for up to 14 days without capillary blood testing [4,8-9].
- When the sensor is scanned, the reader displays: glucose level, glucose level trend arrows, and a chart of glucose level changes in the last 8 hours. The reader memory stores data from the last 90 days [4].
- Dedicated computer software can be used to share the data with a computer for retrospective analysis. The LibreLinkUp application (carer's application) allows for continuous sending of data on current glucose levels to family members, and the LibreView platform is used for data exchange between the patient and health care providers.

- Training in technical operation and use of the FGM system should include learning to insert the sensor, turn on the reader, and record additional information such as insulin doses, meals, and exercise. The patient and his family should be educated on interpreting the results in the context of self-monitoring, and in particular, on interpreting the meaning of trend arrows displayed by the reader [10-13].
- Current readings from the FGM sensor should be verified against a capillary blood test using a glucose meter when there is a rapid change in glucose levels, when the system shows hypoglycemia or imminent hypoglycemia, and when the patient experiences symptoms inconsistent with the reading [4,10].
- Prior to sensor insertion make sure that the skin in the insertion site is not covered with body lotion or soap and that the skin is clean and any excessive hair has been trimmed.
- Skin must be disinfected before sensor insertion.
- The sensor insertion sites should be monitored for insertion-associated events such as pain, bleeding, swelling, or hardening, and for sensor-associated events such as redness, itching, or rash [14-17]. Allergic contact dermatitis can be caused by isobornyl acrylate contained in the device [16,18-22]. Patients should be informed about these issues, and sensor application sites regularly checked.
- To minimize the risk of hypersensitive response and irritant contact dermatitis, various techniques and barrier agents can be used [23].
- If skin around or under the sensor becomes severely irritated, the patient should remove the sensor and discontinue use of the system. Before resuming use of the system, the patient should consult a health care professional. Use of the sensor may cause bruising or bleeding. If the bleeding persists, remove the sensor and apply a new one in another site.
- In patients with adverse events including skin symptoms (including severe ones), these can be mitigated by using barrier agents, medication therapy or changing the insertion site [15-16].
- The entire system (sensor, transmitter, receiver) must not be exposed to X-ray or electromagnetic radiation.
- Result distorting substances: falsely elevated – ascorbic acid, falsely decreased – aspirin [24].

Insertion technique

1. Prepare the materials.
2. Prepare the sensor and reader.
3. Disinfect the puncture site (if numbing cream is used, remove any residue with a gauze pad).
4. Leave the disinfected skin to dry as required for the disinfectant to work.
5. Insert the sensor according to the manufacturer's instructions.
6. Turn on the sensor according to the manufacturer's instructions.

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III. REAL TIME CONTINUOUS GLUCOSE MONITORING (rtCGM)

Purpose: Glucose level measurement using an rtCGM system, allowing for continuously recording information about the current glucose level in the interstitial fluid.

Individuals authorized to perform the measurement: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 4. Key recommendations. Real time continuous glucose monitoring (rtCGM)

Each patient approved for rtCGM should receive education on: the technique for using the device, self-care and self-examination of sensor insertion sites, and principles of glucose level monitoring oriented at diabetes self-management in cooperation with the diabetes treatment team. **E**
Rotation of body areas and puncture sites is significant to preserving skin integrity in sensor insertion sites. **E**
The nurse/midwife should perform physical examination of the patient's skin at sensor insertion sites. The physical examination of the patient's skin should be performed at least once every 6 months. **E**

Real time continuous glucose measurement (rtCGM) systems measure the glucose level in interstitial fluid. They have an alert function for warning against excessively low or high glucose level.

Available measurement technologies [1-5].

- enzymatic electrodes,
- microdialysis-based techniques,
- fluorescence-based techniques.

Electrode-based rtCGM system elements:

- sensor (measurement electrode),
- transmitter,
- receiver (monitor).

The measurement electrode, i.e., sensor, should be replaced per the manufacturer's instructions. Approximately 1-2 hours after the placement of the sensor, the rtCGM system must be calibrated based on a capillary blood glucose test. The calibration should be performed 1 to 4 times within 24 hours (according to the manufacturer's instructions). About 1-5 minutes following calibration, the system will begin calculating mean glucose levels and displaying them on the screen (per the instructions).

Calibration should not be performed:

- after a meal,
- after a dose of insulin,
- during exercise,
- after exercise,
- when trend arrows are displayed on the screen.

Sensor insertion site. Practical guidelines [6]

Preferred sites for rtCGM sensor insertion include [7-9]:

- subcutaneous tissue on the buttock, upper part. Relatively flat surface, suitable for side sleepers and for lean children. Avoid sensor insertion in the waistline/pantline (to prevent discomfort, skin irritation or unintended sensor removal); place the tape horizontally (follow the contour of gluteal muscles), which helps to minimize sensor dislodging with clothing change. Sensor insertion in this site may cause artificially low glucose readings from the sensors, which occur when the sensors hit the muscle tissue (PISA – Pressure Induced Sensor Attenuation). This is very common when sleeping, laying or sitting on the sensor, and may be resolved by strategic placement and position changes in lean individuals or back sleepers. Site difficult for self-insertion.
- subcutaneous tissue on the abdomen. Large surface with the possibility to insert the sensor above and below the umbilicus. Insert the sensor 2.5 cm away from the umbilicus. Avoid sensor insertion in sites where the skin creases. Ask the patient to hunch over and check where the skin folds. In the case of lean individuals, sensor placement may be easier in a sitting or hunched position. In lean individuals, it might be easier to insert the cannula at an acute angle. In excessively lean individuals, the sensor may abut the muscle causing discomfort or PISA. Sensitive skin is more prone to injury caused by mechanical damage.
- subcutaneous tissue on the thigh, upper part. Discrete site, concealed under clothing, relatively flat surface. In excessively lean individuals, the sensor may about the muscle causing discomfort or PISA (lower likelihood of contact with the muscle if the sensor is placed on the outer or inner thigh as compared to the front).
- subcutaneous tissue on the arm. Good adhesion for longer sensors, good site for CGM in lean children using buttocks solely for insulin infusion sets, comparable CGM accuracy to buttocks and abdomen. Avoid placing the sensor too close to the axilla (increased risk of skin irritation by the tape). This site is less discrete, visible when wearing shirts with short sleeves. In excessively lean individuals, the sensor may abut the muscle causing discomfort or PISA.

The rtCGM measurement electrode should not remain in the subcutaneous tissue longer than specified in the manufacturer's instructions. Consequences of leaving the rtCGM sensor in the tissue for too long may include [10-13]:

- no reading,
- increased infection risk,
- skin irritation,
- scarring.

Guidelines on sensor insertion sites:

- obtain patient's history of allergies and skin sensitivities [6,14];
- infusion sets or transmitters are secured with tapes and adhesives, different products can be tested to find the best fit for the patient;

- skin should be routinely assessed for damage with every sensor change; the site should be monitored for pain, edema, erythema, local warmth or suppuration [12,15];
- skin at the planned sensor insertion site should be examined; skin with wounds, redness, irritation, abscesses, scars, bruises, cuts, as well as skin in the immediate proximity of other infusion sites should be avoided [16-17];
- allergic contact dermatitis is the most commonly reported adverse event caused by the adhesive tapes used in insulin infusion kits and glucose sensor kits for securing the device to the patient's body [18-20];
- it has been demonstrated that CGM may cause dermatological problems: erythema, pruritus, eczema, chronic dry skin, pigmentation changes, wounds [12,18,21-22];
- leave a previous sensor insertion site to heal for at least 1 week before placing a new adhesive on it;
- rotating insertion sites enables preserving skin integrity for a longer time [23-24];
- when planning an insertion site, the following factors should be considered: subcutaneous tissue volume, musculature, the patient's preferred sleeping position (side, back), activities, clothing [14]. An rtCGM sensor should not be placed in sites with insufficient subcutaneous tissue, or in areas subject to pressure (e.g. under straps or cuffs) or intensive movement;
- some patients may prefer a discreet placement of the sensor [21].

Guidelines on skin protection

- before sensor insertion, the skin should be cleansed using oil-free antibacterial soap, and dry well;
- products and swipes available in the market can be used to cleanse and prepare the skin before insertion;
- alcohol may be used to disinfect the skin (but is not required);
- the sensor should not be inserted immediately after a shower/bath or in a steamy bathroom – a dry environment is required;
- avoid using body lotion in the site where a tape will be placed;
- fragrance-free antiperspirant can be applied to perspiration-prone skin. Apply a thin layer, wait 10-15 minutes, and wipe off the excess [24-25];
- barrier films/patches used under the sensor tape may help prevent allergies and skin irritation caused by adhesives. Leave a small circle on the skin without a film/patch for rtCGM insertion [10,14,21,24-25];
- after tape placement, press it around the edges so that they adhere well to the skin;
- carefully remove tapes and adhesives to minimize the risk of tissue damage. Self-adhesive tapes should be removed slowly and with low energy. Removal aids available in the market can be used to remove adhesives and tapes; following sensor removal, the skin should be carefully and thoroughly cleansed of adhesive residues [14].

Factors interfering with blood glucose measurement with rtCGM [26-29]

- measurement in different spaces (physiological time delay of approx. 5–20 minutes),
- physiological factors,
- delay resulting from the physical properties of the sensor (hardware time lag),
- weakened sensor signal,
- delay resulting from the interpretation of the signal by the rtCGM system (software time lag),
- calibration errors.

Note! Before undertaking any therapeutic intervention, or to verify the reading when the high or low glucose level reported by the rtCGM system is inconsistent with the symptoms, the patient and/or his carer/health care provider should perform an additional capillary blood glucose test using a glucose meter [30].

Insertion technique

1. Prepare the materials.
2. Prepare the transmitter and receiver.
3. Disinfect the puncture site (if numbing cream is used, remove any residue with a gauze pad).
4. Leave the disinfected skin to dry as required for the disinfectant to work.
5. Prepare the sensor, serter (insertion device), and adhesive.
6. Connect the receiver to the transmitter.
7. Insert the sensor and remove the serter.
8. Dispose of the used sensor in a closed waste container.
9. Disinfect your hands.
10. Examine the old sensor removal site.
11. Record the sensor replacement in the medical records and the self-monitoring journal.
12. Measure blood glucose using a glucose meter 2 hours after sensor placement.

Note! The sensor may only be placed by a nurse trained in rtCGM installation and education.

Used needles and sensors must be disposed of safely.

- During X-ray examination, magnetic resonance imaging (MRI), computed tomography (CT) or any other radiographic examination, the transmitter and sensor should be disconnected and removed from the area subjected to radiation (per the manufacturer's specification).
- The sensor and transmitter are water-resistant (per the manufacturer's specification).
- The device should not be used onboard aircraft (in accordance with the instruction manual).

The patient needs preparation for the use of rtCGM systems. Diabetes education should include: the technique for using the device, interpretation of the current and retrospective results, development of skills allowing for modifying treatment based on glucose level trend arrows, care and self-examination of sensor insertion sites,

and principles of glucose level self-monitoring. As for real time glucose monitoring, the education should additionally include: sensor calibration, and the selection and programming of alarm thresholds and notifications [30-33].

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IV. SUBCUTANEOUS INSULIN INJECTION USING A PEN INJECTOR

Purpose: Subcutaneous administration of insulin using an ISO-compliant pen injector (PN-EN ISO 15197:2015–10).

Individuals authorized to perform the procedure: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 5. Key recommendations. Subcutaneous insulin injection using a pen injector

Before initiating insulin therapy, the patient should undergo assessment for pain anxiety and psychological preparation for injections. **B**
Before initiating insulin therapy, the optimal injection technique should be selected, including the injection angle, needle type, and whether to use a lifted skin fold. **B**
Each patient treated with insulin and/or their carer should be trained in using the injector and following the correct injection technique, at the health care center where they were prescribed the insulin therapy. **B**
The nurse/midwife (diabetes educator) should verify the patient's technique for injecting insulin using a pen injector and check the condition of their equipment during each visit, and at least once a year. **E**
Insulin should be injected using a dedicated injector, compliant with the ISO standard for medical devices, in accordance with the manufacturer's instructions. **E**
The injector and insulin cartridge may only be used by one patient, and must not be shared with another person even if the needle is replaced. **B**
Insulin injection with a pen injector in adults does not require lifting a skin fold if a 4 or 5 mm needle is used, but may be required if a 6, 8, or 12.7 mm needle is used. **B**
Regardless of patient age and subcutaneous tissue thickness, short needles (4 mm, 5 mm, and 6 mm) are preferred. **C**
Each patient should be informed about the need to replace the pen needle for each new injection and about the principles of needle reimbursement. **E**
Single use of the needle is associated with a lower risk of cutaneous complications, pain, and episodes of unexplained hypoglycemia. **B**
Correct insulin injection technique using a pen injector is one of the factors contributing to glycemic control and reduced cutaneous complications. **A**

For the purposes of the procedure discussed, pen injectors have been divided into two groups based on two criteria:

A) duration of use:
   a) single-use multi-dose injector – contains a built-in, non-removable insulin ampoule, without the possibility of replacement. After the insulin contained in the ampoule has been used, the injector is not fit for further use.
   b) reusable injector – contains an insulin ampoule, which can be replaced multiple times depending on the insulin use and needs.

B) mechanism of insulin release:
   a) automatic,
   b) semi-automatic,
   c) with the possibility of transferring data about medication dosing to a compatible mobile application.

Correct subcutaneous injection of insulin using an injector involves depositing the insulin in subcutaneous tissue and minimizing such risk factors as [1-4]:

- insulin leakage from the skin (insufficient injection depth),
- intramuscular infusion (excessive injection depth),
- intravascular infusion,
- cutaneous complications.

Pen injector

Each insulin pen injector consists of: a cap (protecting the medication against sunlight); the insulin cartridge (in disposable pens the cartridge is integrated with the device); and the injector body with a plunger, a knob or dial to select dosage, and a dose window.

Disposable and reusable injectors may be used with 3 mL (300 IU and 600 IU) and 1.5 mL (450 IU) insulin cartridges. Each insulin manufacturer specifies the injector it should be used with. The injector must be used in accordance with the injector manufacturer's instructions. Injectors should be compliant with international ISO standards for medical devices.

Pen injector insulin injection sites

Insulin should be injected in areas of the body with sufficient loose subcutaneous tissue.

In children[5-7]:

a. Abdomen within the following boundaries: ~1 cm over the pubic symphysis, ~1 cm below the lowest rib, ~ 1 cm away from the navel, and flanks.
b. Thighs: upper third of the anterior lateral surface of both thighs.
c. Buttocks: upper, posterior lateral surface of buttocks and flanks.
d. Arms: mid-third of the posterior surface of the upper arm.

In adults[1,3,5,8-11]:

a. Abdomen – excluding 1-2 cm around the navel and palpable bone structures. The injection should be performed while the patient is seated.
b. Thighs (**upper third of the anterior lateral** surface, starting a hand width below the great trochanter of the femur and a hand width above the knee joint). The injection should be performed while the patient is seated.
c. Buttocks (the **upper exterior surface of the buttock or flank**, demarcated by a vertical line going through the midpoint of the buttock and a horizontal line at the level of the intergluteal cleft).
d. Arm – **mid third of the posterior** surface of the upper arm (the mid third of the upper arm is an area between 4 fingers placed above the elbow joint and 4 fingers placed below the shoulder joint, on the middle posterior surface).

Before initiating insulin therapy, the optimal injection sites for the individual patient should be selected, also considering the type of insulin prescribed.

Examination of insulin injection sites [5,9,10,12]

Each injection of insulin by the patient, carer, or health care provider should be preceded by a meticulous examination of the injection site (by palpation and visually), and the patient should be informed of the technique and purpose of this examination.

The examination and any observed lesions should be recorded in the patient's records and self-monitoring journal.

When injecting insulin, avoid sites with any pathological lesions (scars, damaged skin, lipohypertrophy or lipoatrophy, allergy symptoms), visible blood vessels, birthmarks. Do not inject insulin into lipohypertrophic tissue.

The patient should be informed about the contraindication and the potential consequences of insulin administration into unhealthy tissue.

The physical examination technique is described in detail within procedure XI, Physical examination of the skin at subcutaneous insulin injection sites in primary and secondary prevention of lipohypertrophy (LH).

Rotation of injection sites and anatomical areas[5,8,9]

To minimize complications resulting from incorrect technique of insulin injection with a pen injector (daily glucose fluctuations and cutaneous complications), injection sites and areas should be rotated.

Injection site rotation: change the injection site within an area of the body for each insulin injection, moving 1 cm away from the previous injection site. An injection site may be used again no sooner than after 6 weeks of the previous injection.

Injection area rotation: the anatomical area for injections should be rotated at least every 4 weeks, e.g. injecting on the left side of the body for a week or two weeks, and then injecting on the right side of the body for a week or two weeks.

When changing the area of the body used to inject insulin, consider the potential change in the speed of absorption and its impact on blood glucose levels.

Injection technique [1,2,5,8,9,13]

Insulin injection with a pen injector may be performed at a 90-degree (most common) or 45-degree angle, with or without lifting a skin fold.

Before initiating insulin therapy, the optimal injection technique should be selected, including the injection angle, needle type, and whether to use a lifted skin fold.

A skin fold is correctly lifted with the thumb and index finger (or middle finger).

When using an injector, insulin injection into a skin fold at a 45-degree angle should be considered when:

- using a needle longer than 5 mm (with the exception of obese patients),
- administering insulin to patients younger than 6 years (even when using a 4 mm needle),
- administering insulin to patients with little subcutaneous tissue.

Insulin can be injected at a 90-degree angle without using a raised skin fold:

- when using a short needle (4 mm),
- in patients older than 6 years,
- in pregnant women who continue abdominal administration of insulin using a short needle,
- for self-injection into the upper arm using a short needle.

Injection technique using a skin fold [1,2,5,8,9,13]

1. Prepare the insulin injector – remove the injector cap, disinfect the rubber stopper on the insulin cartridge, wait for the disinfectant to dry, attach a previously selected sterile needle, prime the needle by pushing 1 unit of insulin (or the amount specified in the injector manufacturer's instructions).
2. Prepare the insulin: check the name of the insulin and its appearance, set the required dose of insulin, agitate gently (in the case of cloudy insulin).
3. Lift a skin fold.
4. Introduce the needle into the middle of the fold at a 90- or 45-degree angle (when using the 45-degree angle, position the needle bevel-up).
5. While holding the skin fold, inject the insulin.
6. Wait 10-15 seconds or count to 10.
7. Withdraw the needle, maintaining the same angle.
8. Release the skin fold.
9. Visually assess any insulin leakage.

Injection technique without using a skin fold [1,2,5,8,9,13]

1. Prepare the injector and insulin.
2. Introduce the needle into the skin at a 90- or 45-degree angle (in the latter case, position the needle bevel-up).
3. Inject the insulin.
4. Wait 10–15 seconds or count to 10.
5. Withdraw the needle, maintaining the same angle.
6. Visually assess any insulin leakage.

Note! When performing the above steps, inform the patient about the correct sequence, regardless of the written instructions provided.

Guidelines for injector users and medical personnel

- Before insulin injection using a pen injector, performed either by the patient or by another authorized person, the patient should undergo assessment for pain anxiety and psychological preparation for injections [1,2,4,5,8,14].
- Insulin can be injected with a pen injector by an authorized medical professional, or by the patient or their carer if they have been trained in the correct injection technique [1,8,15].
- Practical training in the insulin injection technique should be provided at the health center where the insulin therapy has been initiated, and should include: use of the injector with needle selection, technique for injection at the selected angle with and without lifting a skin fold, and injection site rotation and self-examination [1,5,8].

- Optimal insulin injection technique (injection angle and whether to use a lifted skin fold) should be selected individually, considering the needle length used, subcutaneous tissue thickness, and injection site, among other factors. Guidelines on injection technique should be provided to the patient/his carer/family member in writing [1,5,8,10,13,16].
- At least once every 6 months, the nurse or midwife should perform physical examination[1] of the insulin injection sites and assess the patient's skills in terms of insulin injection technique and injection site rotation.
- Pregnant diabetic patients who continue abdominal administration of insulin should perform the injections into a lifted skin fold. In the last trimester of the pregnancy, injection sites around the navel must be avoided, but injections can be performed into a lifted skin fold on the outer edges of the abdomen [5,17].
- Pen injectors, both disposable and reusable, are personal devices.
- Use a different pen injector for each insulin type. To avoid errors, different-colored injectors can be used, and each injector should be clearly labeled with the patient's first and last name, the name of the insulin, and the date of cartridge insertion.
- The pen injector should be used and stored at room temperature. Polish standards specify the expected temperature indoors (also referred to as "room temperature") depending on the type of room and the work performed there. For office rooms, this temperature is 20-24°C in the winter and 20-26°C in the summer[5,18].
- Do not use the injector if any of its parts is damaged.
- When replacing the insulin cartridge, remove it from the fridge 1-2 hours before an injection [19,20].
- Clear insulin should not be agitated before injection, while cloudy insulin requires resuspension. To resuspend the insulin, agitate it gently in a swinging motion (30 times), until the solution becomes uniform[5].
- Store the currently used insulin at room temperature, according to the manufacturer's recommendations listed in the patient information leaflet and/or the summary of product characteristics (SmPC), no longer than 4-6 weeks[11,20].
- Do not administer the insulin if: its appearance is changed, it has been shaken, it has been exposed to high temperatures, or the vial is damaged[5].
- Regardless of patient age and subcutaneous tissue thickness, short needles (4,5 and 6 mm) are preferred [3,5,9,6,21].
- Insulin injection using a pen injector should not be performed through clothing, as this prevents verifying successful injection or examining the injection site visually, and increases the risk of needle damage or infection[5,22].
- During insulin injections with a pen injector performed in health care facilities, aseptic and antiseptic technique must be strictly followed [5,23].
- Daily insulin injections with a pen injector, performed by the patient outside of health care facilities, does not require previous skin disinfection provided that proper hygiene is maintained[5].
- For short-term administration of insulin prescribed by the physician during a patient's hospitalization, insulin syringes are used[5].
- Multi-dose and reusable pen needle is a sterile medical product intended for single use [24,25].
- Since 2022, diabetic patients in Poland treated with insulin or GLP-1 analogues via subcutaneous injections can have their pen needles reimbursed from public funds[26].
- During intensive insulin therapy with the use of injectors, the patient may use subcutaneous ports. Needles used for insulin administration in such cases should be of the following size: 5-8 mm length and 28-32 gauge[27].

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[1]Described in more detail within the procedure "Physical examination of the skin in prevention of LH".

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V. SUBCUTANEOUS INJECTION OF GLP-1 RECEPTOR AGONISTS USING AN INJECTOR

Purpose: Administering GLP-1 receptor agonists by subcutaneous injection using an injector.

Individuals authorized to perform the procedure: nurse, midwife, and the patient and/or patient's carer –after proper training.

Tab. 6. Key recommendations Administering GLP-1 receptor agonists by subcutaneous injection

Treatment with GLP-1 receptor agonists should be supported by lifestyle changes (diet and exercise). **A**
Combination of insulin, sulfonylureas and/or metformin with subcutaneous GLP-1 receptor agonist injections may be associated with hypoglycemia. Blood glucose self-monitoring is recommended for these patients. **A**
To maximize the benefits of drugs from the GLP-1 group, injectors must be used correctly. Failure to follow the correct subcutaneous injection procedure may result in incorrect dosage, damage to the injector, and infection at the injection site. **E**
Health education provided to patients treated with subcutaneous GLP-1 receptor agonist injections is an indispensable part of therapy that contributes to a reduced risk of adverse effects. **E**

Incretins are gastrointestinal hormones that stimulate insulin secretion and reduce the secretion of glucagon, which acts in opposition to insulin. Incretin-based drugs reduce blood glucose levels, normalize or even reduce body weight, and do not increase the risk of hypoglycemia. There is risk of hypoglycemia when the patient is additionally treated with insulin or another antihyperglycemic agent that may cause hypoglycemia. Some incretin groups are suitable for subcutaneous administration. These include glucagon-like peptide 1 receptor agonists (GLP-1 analogues) [1-9].

- In accordance with the proposed classification of GLP-1 receptor agonists (GLP-1 analogues) by duration of activity, these substances are broken down into first--generation agents, administered multiple times a day (short-acting exenatide); second-generation agents, administered once daily (liraglutide, lixisenatide); and third-generation agents which can be administered once weekly (extended-release exenatide, dulaglutide, semaglutide). Most of the once-daily drugs should be administered 60 minutes before the same meal every day — preferably, before breakfast of the most carbohydrate-rich meal. Some drugs, however, can be used once daily and independently of meals (e.g. liraglutyd). Immediate-release drugs taken twice daily can be administered 60 minutes before the morning and evening meal (or two major meals during the day, with a break of at least 6 hours between the doses). Immediate-release products should not be taken after a meal. Extended-release products can be administered at any time of the day, with a meal or between meals (dulaglutide) [10-16].
- In some products, a GLP-1 analogue is combined with a long-acting insulin analogue in a single injector (e.g. insulin degludec and liraglutide or insulin glargine and lixisenatide). These are administered once daily [10].

Recommended injection sites

In accordance with the summary of product characteristics:

- thigh,
- abdomen,
- upper arm.

The injection site should be changed (rotated) for each injection, and anatomical areas should be rotated depending on the frequency of administration. For daily medications, the area should be changed every month. For weekly medications, the area may be changed less frequently.

Administration technique

All GLP-1 receptor agonists for subcutaneous injection are administered using disposable semi-automatic injectors containing one or multiple doses. The outward appearance of the injectors and some of their basic technical

	GLP-1 receptor agonists							GLP-1 receptor agonist / basal insulin fixed-dose combinations	
Drug name	Albiglutide	Dulaglutide	Exenatide b.i.d	Exenatide once weekly		Lixisenatide	Liraglutide	Semaglutide	Degludec / liraglutide (IDegLira)	Glargine / lixisenatide (iGlarLixi)
Pen devices for injection										
Pen devices available (maximum dose)	30 mg 50 mg	0,75 mg 1,5 mg	5 µg 10 µg	2 mg	2 mg	10 µg 20 µg	1,8 mg	0,25 mg 0,5 mg 1 mg	up to 1,8 mg (+ up to 50 IU *degludec*)	up to 20 µg (+ up to 60 IU *glargine*)
Pen for single / multiple use	single	single	multiple	single	single	multiple	multiple	multiple	multiple	multiple
Pen for pre-determined single dose / variable dosing	single	single	single	single	single	single	variable (0.6; 1.2 or 1.8 mg)	single	variable, for titration	variable, for titration
Resuspension before injection necessary?	yes	no	no	yes	no, but thorough mixing	no	no	no	no	no

■ Fig 1. Injectors for GLP-1 receptor agonists and fixed-dose combinations of GLP-1 receptor agonists with basal insulin formulations

Source: developed by Hornik B. based on [10,14].

parameters are shown in Figure 1 (fig. 1). Principles for needle length selection and using or not using a lifted skin fold are the identical as those applicable to insulin injections.

General rules for the use of the different semi-automatic injector types

- Administration of GLP-1 receptor agonists by subcutaneous injection requires the use of semi-automatic injectors, which differ considerably both in appearance and in important technical details. Some only contain a single dose of the medication (e.g. dulaglutide), while others contain enough doses for 2–4 weeks of treatment (e.g. liraglutide, semaglutide). They may have a single-chamber or dual-chamber construction – in the latter, the diluent and powdered medicine are kept separate [11-14].
- Due to the many details in which the injectors may differ, the information leaflet provided must be carefully read before the use of a pre-filled injector.
- Before first use of any new injector, check the flow by holding the injector with the needle pointing upwards, pressing the injection button and holding until the dose counter returns to "0" or another appropriate symbol. A drop of the medication should appear on the tip of the needle. If there is no drop, flow should be checked again. This check is performed up to 6 times. If the drop of medication still does not appear, discard the injector and use a new one.
- For subsequent injections with a multiple-dose injector, the dose may be set immediately. The injector need not be tested before each subsequent use, as this could cause the medication to run out before 30 full days of treatment [12].
- Before administration, check the appearance of the medication in the chamber. The liquid should be clear and colorless, with no solid particles. Do not use if the appearance is changed.
- Excessive pressure on the skin fold or release of the injection button before fully removing the needle from the subcutaneous tissue may cause some tissue to be aspirated into the injector, with some solid particles or a pink coloration visible in the chamber, especially in patients who bleed more easily or undergo anticoagulant treatment. If this happens, dispose of the injector and use a new one for subsequent injections. Proceed the same way if the button is accidentally pressed before removal of the cap.
- Dispose of all sharps (needles) safely.
- Store multiple-use injectors without a needle. This prevents medication leakage and contamination, air bubble formation, and needle clogging, and reduces the risk of injection site infection.
- Use a new disposable needle for each injection. This reduces the risk of needle clogging, medication contamination, injection site infection, or incorrect dosage.
- To ensure correct dosage, the number in the dose counter window must be aligned exactly with the indicator. In most injectors, the injection button should be pressed and held down until the dose counter returns to "0" or another appropriate symbol. A click may be heard then.
- When the dose counter returns to "0" or another appropriate symbol, leave the needle inserted into the subcutaneous tissue while counting slowly to 10 to make sure that the full dose has been administered. If the needle is removed sooner, the solution may leak out of the needle tip, and the full dose will not be administered.
- While removing the needle from the skin, the injection button should remain pressed down to keep the remaining solution in the chamber clear.
- During injection, never touch the dose counter. This could interrupt the injection.
- After administration, detach the needle and carefully dispose of it in a puncture-resistant container. Do not dispose of the injector with the needle attached.
- After each use of a multiple-dose injector, put the cap on to protect the solution from light.
- Do not press the injection button if no needle is attached. This could damage the injector.

- If the dose window shows a symbol and the dosage knob does not turn, this may mean there is not enough medication in the injector chamber to administer a full dose [11-14,17].

Technique for using semi-automatic GLP-1 analogue injectors

- Wash your hands with soap and water.
- If the injector has been stored in a refrigerator, leave it at room temperature for at least 15 minutes before use.
- Before each use, check the medication label and expiration date to ensure this is the correct medication and that it has not expired. Check the injector for damage.
- Make sure there is enough medication left in the injector to load the correct dose.
- Check the appearance of the medicine and make sure the solution inside the injector is clear, with no solid particles. For products that require the diluent and powder to be mixed, check the resulting suspension after mixing. Only use the product if the suspension is white or off-white and milky in appearance. Clumps or dry powder adhering to the injector walls are a sign of incorrect mixing. If a medication requires mixing, it must be injected immediately once mixed.
- Select the injection site – examine the skin for lipohypertrophy, inflammation, edema, ulceration, or infection. Avoid injecting around nodules, scars, tattoos, hernias, or stomas.
- Then, disinfect the injection site and allow it to dry (for approximately 60 seconds).
- Attach the needle after having disinfected the rubber stopper, and remove the outer needle shield – do not dispose of the outer needle shield, as it will be used when detaching the needle from the injector after the injection.
- Remove and discard the inner needle shield. A small drop of liquid may appear. This is normal.
- Insert the needle into the skin or press the injector firmly against the skin (depending on injector type), at a 90-degree angle from its surface, and administer the medicine in accordance with the instruction manual.
- After the plunger has been completely depressed, hold the needle in the subcutaneous tissue while counting to 10.
- Then, remove the needle from the subcutaneous tissue, maintaining the same angle as that used to insert it.
- If a small vessel is accidentally damaged, a few drops of blood may appear.
- After the needle has been removed, press a dry swab over the injection site, but do not massage the site, and if a lifted skin fold has been used, release it.
- After the injection is complete, dispose of the single-dose injector or detach the needle from the multiple-dose injector and dispose of it in a puncture-resistant container.
- If insulin administration is needed at the same time, space the injection sites at least 5 cm apart.
- Never store the injector with the needle attached. If the needle is left attached to the injector, the medicine may leak or air bubbles may form inside the chamber.
- If using a multiple-dose injector, write down the date of first use [11-14,17].

Additional guidelines for use of single-dose semi-automatic injectors (filled with dulaglutide)

- Before administering the medicine, make sure the injector is locked.
- If you accidentally unlock the injector and press the injection button before removing the cap, the injector must be disposed of correctly, and a new one used instead.
- Remove and discard the gray cap. Do not put the cap back on, as this could damage the needle.
- Firmly place the clear base flat against the skin at the injection site, unlock the injector by turning the lock ring, then press and hold the injection button; you will hear a loud click.
- Hold the clear base of the injector firmly against the skin until you hear a second click. This happens after 5–10 seconds, when the needle starts retracting.
- Do not remove the injector from the skin until you have heard the second, louder click. The dose has been delivered correctly if the gray part can be seen in the injector chamber. Only then can you remove the injector from the skin [13].

Semi-automatic injector storage

- Injectors contain glass parts and require caution during storage. Do not use an injector that has been dropped onto a hard surface. If any glass part of an injector is damaged, use a new one for any subsequent injections.
- Store injectors in a refrigerator, at a temperature between 2 and 8ºC.
- If you do not have access to a refrigerator, you may store the injector at room temperature (below 30ºC), away from direct light, for 14 to 30 days, depending on the medication (see the manufacturer's leaflet). If the expiration date has passed, discard the injector even if there is still medicine left inside.
- Do not freeze the injectors. Do not use any injector that has been accidentally frozen.
- Store the injector in its original packaging to protect it from light.
- Keep injectors out of sight and reach of children [11-14].

Note:

- Extended-release GLP-1 analogues, e.g. exenatide, are administered once weekly with a dual-chamber semi-automatic injector. They are supplied as powder and diluent (liquid) for injectable suspension, in a pre-filled injector. One chamber contains white or off-white powder, and the other contains clear diluent liquid that is colorless, pale yellow, or pale brown. Each single-dose pre-filled injector comes with a single needle. Each carton also contains one spare needle.
- Before use, attach the needle, turn the knob to allow the medicine to mix with the diluent (stop turning when you hear a click), tap the injector firmly against the palm of your hand until the medicine has mixed well

(80 times or more), turn the knob again until the injection button has been released, remove the needle cover, and then perform the injection. Make the injection right after the powder has been mixed well with the diluent. Use a new injector for each injection. Dispose of used injectors safely [11].
- An alternative administration method requires connecting a vial to a syringe using a special connector, mixing the suspension, removing the connector, attaching a needle to the syringe, filling the syringe, replacing the needle, and injecting the medicine [11].

Possible adverse effects with subcutaneous injection of GLP-1 receptor agonists

Exact adverse effects vary depending on the product, but the most common ones include:
- Nausea and vomiting which should resolve after 7–10 days (these can be minimized by following the physician's recommendations on dosage and its gradual increasing, and by performing the injections immediately prior to eating).
- Abdominal pain (which can be minimized by having a meal right after administration).
- Dehydration (monitor your hydration level and drink additional fluids if symptoms of dehydration occur).
- Formation of pea-sized fatty lumps at the injection sites, especially with extended-release formulations (these should resolve spontaneously after about six weeks).
- Anaphylaxis, which is a rare, but very dangerous complication (observe the patient, especially at the beginning of treatment, for symptoms such as trouble breathing, face and throat swelling, rapid heartbeat); if symptoms of anaphylaxis occur, seek immediate medical attention [9,10,17].

Education guidelines
- GLP-1 analogues rarely cause hypoglycemia if used as single agents, but hypoglycemia is more common when they are used in combination with insulin or other antihyperglycemic drugs. Single-agent therapy with these products does not require additional blood glucose monitoring if the patient feels well; additional blood glucose monitoring may be needed to adjust the dose of insulin or sulfonylurea derivatives. If sulfonylureas are added to the treatment protocol, the patient must be aware of the increased risk of hypoglycemia [17].
- The patient must be aware that discontinuing immediate-release GLP-1 analogues and switching to an extended-release product may result in a transient increase in glycemia, which typically resolves within 2 weeks.
- Self-monitoring of blood glucose should be performed in accordance with the general self-monitoring guidelines for diabetic patients.
- The patient must be informed that their appetite will decrease during treatment, and that they should eat slower and take smaller meals. Satiety might be a new state that the patient needs to adapt to. If the patient feels full, they should not continue eating out of habit (overeating can cause vomiting) [17].
- The patient must be informed of the need to self-monitor for symptoms of persistent, intense abdominal pain, which may also be felt in one's back and may be accompanied by vomiting; the patient must be informed that if this happens, they should stop the injections immediately and urgently seek medical advice. Treatment may only be resumed after proper examination and tests, in accordance with the physician's decision (there is a risk of pancreatitis).
- If a dose of an extended-release product is missed, the patient should take it as soon as possible if there are at least 3 days left until the next scheduled dose; if fewer than 3 days are left until the next scheduled dose, the missed dose should be skipped, and the next dose administered normally.
- Before each injection, the patient must examine their skin visually and by palpation:
  - Extended-release formulations may cause pea-sized fatty lumps to form at injection sites, which should resolve spontaneously after approximately six weeks.
  - Symptoms such as red nodules that are warm to the touch, rash, edema, itching, pain, hardening, or rarely necrotic abscesses, may appear at injection sites [18].
  - Patients must be educated on the risk of nodule formation; preventively, injection sites should be rotated and new needles used every time; injections should never be performed in areas where skin is pitted, thickened, bumpy, tender, bruised, peeling, hardened, scarred, or damaged.
  - Multiple subcutaneous nodules present in some patients suggest that the nodules are slow to resolve; in some cases, they may persist indefinitely; these symptoms can be minimized by following the guidelines for correct administration [18].
  - Any lesions observed by the patient require assessment by a nurse and/or physician who will decide whether the GLP-1 analogue should be discontinued and the injection site lesions should be treated (with antibiotics; corticosteroids – topical, systemic, injected directly into nodules; antihistamines; surgically, if needed) [17].

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VI. USE OF AN INFUSION SET IN CONTINUOUS SUBCUTANEOUS INSULIN INFUSION (CSII) THERAPY USING A PERSONAL INSULIN PUMP

Purpose: Correct use of infusion sets with a personal insulin pump for the purposes of continuous subcutaneous insulin infusion (CSII) therapy.

Individuals authorized to perform the procedure: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 7. Key recommendations. Use of an infusion set in continuous subcutaneous insulin infusion (CSII) therapy using a personal insulin pump

Before initiating insulin therapy, the patient should undergo assessment for pain anxiety and psychological preparation for infusion set insertion. **B**
Each patient undergoing therapy using a personal insulin pump should have his infusion set individually selected. **E**
The infusion set should be replaced as planned, every 24-72 hours. **B**
Incorrect insertion and use of infusion sets, as well as failing to rotate insertion sites, may cause skin lesions. **B**
Education on infusion set use is prerequisite for successful care for patients using CSII, and contributes to successful diabetes self-management. **A**

A personal infusion pump is a small programmable insulin-delivery device, which automatically delivers the individually selected base insulin dose, 24 hours a day. It also allows for administering various boluses to cover increased demand for insulin (after a meal or during a blood glucose level increase). The insulin is delivered through a thin tube connected to a subcutaneous catheter.

The infusion set consists of two parts: the tubing and the cannula (metal or PTFE). Infusion sets differ in shape, cannula and tubing length, adhesive size, connection location, and insertion angle. Each patient undergoing CSII using a personal insulin pump should have his infusion set type selected individually (based on his age, adipose tissue thickness, physical activity, proneness to skin allergies) by a physician or nurse [1].

Infusion set insertion sites:
- arm,
- abdomen,
- thigh,
- buttock [1].

When inserting an infusion set, avoid:
- areas subject to pressure (e.g. under straps or cuffs) or intensive movement,
- sites with any pathological lesions (redness, irritation, abscesses, scars, hypertrophy, bruises, cuts etc.),
- areas with little subcutaneous tissue [2,3].

Incorrect selection, insertion, and use of infusion sets, as well as failing to rotate insertion sites, may cause skin lesions that ultimately lead to blood glucose fluctuations and diabetes treatment failure.

Failure to replace the cannula regularly may result in:
- increased infection risk,
- unpredictable insulin absorption,
- lipohypertrophy,
- skin irritation,
- scarring [1,2,4-7].

Infusion set installation technique

1. Stop the pump (if specified by the manufacturer) and disconnect the tubing from the cannula.
2. Remove the reservoir from the pump.
3. Open the package containing a syringe and the infusion set.
4. Disinfect the rubber stopper on the insulin vial and wait for the disinfectant to dry.
5. Fill the syringe with insulin according to the manufacturer's instructions.

6. Remove any air from the syringe (do not tap!).
7. Connect the reservoir to the infusion set tubing and install the reservoir in the pump. Using the appropriate pump function, fill the tubing until a drop of insulin is formed at the point of the needle.
8. Disinfect the puncture site (if numbing cream is used, remove any residue with a gauze pad).
9. Leave the disinfected area of skin to dry for a time specified in the manufacturer's instructions.
10. Place the catheter manually or using the dedicated automatic device (loaded with the infusion set as per the manufacturer's instructions), taking care to correctly position the tubing.
11. If a PTFE cannula is used: withdraw the introducer needle and fill the resulting space with insulin (depending on cannula length, per the manufacturer's instructions).
12. Dispose of the used equipment in a closed waste container.
13. Disinfect your hands.
14. Record the catheter replacement in the medical records and the self-monitoring journal.
15. Remove the previously used catheter 2–3 hours after placement of the new one. To make adhesive removal more comfortable, use baby oil or a dedicated adhesive remover.
16. Examine the old catheter removal site.
17. Measure blood glucose using a glucose meter 2-3 hours after placement of the new catheter.

Guidelines on duration of use

- Cannulas must be replaced after: 48-72 hours for PTFE cannulas, 24-48 hours for metal cannulas, 24-48 in pregnant patients [1,7,8].
- The infusion set must be replaced as planned every 24-72 hours, and in case any of the following occurs: infection symptoms at the insertion site (redness, swelling, pain, itching), blood in the tubing, blood glucose increase despite correct insulin dosage [1,7-9].
- To increase patient safety, the planned infusion set replacements should be performed during the day (between 4 and 6 PM).
- Take the insulin out of the refrigerator at least 30 minutes before the planned infusion set replacement so as to prevent the formation of air bubbles.
- Measure blood glucose levels 2-3 hours after the replacement to verify whether the set works correctly.
- After placing a new catheter, leave the previous one in the subcutaneous tissue for 2-3 hours so that the deposited insulin can be absorbed.
- If any cutaneous complications occur, remove the catheter and initiate the appropriate procedure recommended by the treatment team, or contact a physician.
- Using equipment and accessories other than those recommended by the insulin pump manufacturer may pose a health hazard!
- Each patient undergoing CSII therapy should have the following items on hand in case of pump malfunction or other unforeseen circumstances associated with this treatment method:
  - fast-absorbing carbohydrates, e.g. glucose tablets, glucose solution;
  - blood glucose testing kit;
  - glucagon;
  - blood or urine ketone test strips;
  - spare infusion set, insulin reservoir, and device for placing infusion set (if applicable);
  - injector, insulin (long-acting), and physician's orders regarding insulin dosage in case of pump malfunction;
  - spare batteries for the pump and glucose meter;
  - phone numbers for the health care center where the patient is treated and for the manufacturer's help line.

Guidelines for personal insulin pump users and medical personnel

- Before initiating insulin therapy, the patient should undergo assessment for pain anxiety and psychological preparation for infusion set insertion [2,5].
- Each patient undergoing therapy using a personal insulin pump should have his infusion set individually selected [1,2].
- During infusion set installation, aseptic technique must be used [1, 9].
- Skin disinfectants should be oil-free and colorant-free.
- Infusion sets and syringes are for single use only [2].
- Infusion sets must be replaced regularly per the manufacturer's instructions to ensure proper insulin absorption while minimizing the risk of skin irritation or infection.
- Incorrect insertion and use of infusion sets, as well as failing to rotate insertion sites, may cause skin lesions [1, 2, 7-9].
- Each time before inserting an infusion set, the planned insertion site must be carefully examined (visually and by palpation) [2]. Physical examination of injection sites is described in detail within Procedure XI.
- The examination and any observed lesions should be recorded in the patient's records and self-monitoring journal. The patient should be informed about the contraindication and the potential consequences of insulin administration into unhealthy tissue.
- Education on infusion set use is prerequisite for successful care for patients using CSII, and contributes to successful diabetes self-management [1,10, 11].
- A tubeless insulin pump (Patch type) is also available in Poland.
- In Poland, there are infusion sets that can be worn for extended periods of up to 7 days [12].

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VII. MANAGEMENT OF HYPOGLYCEMIA IN A DIABETIC PATIENT

Purpose: Instructions for correct management of hypoglycemia in a diabetic patient, depending on severity.

Individuals authorized to perform the procedure: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 8. Key recommendations. Management of hypoglycemia in a diabetic patient

Duration of hypoglycemia in a diabetic patient may be shorter if real-time continuous glucose monitoring (real-time CGM) is used. **A**
The use of a continuous blood glucose monitoring system and self-monitoring may reduce the risk of hypoglycemic incidents in patients with type 1 diabetes. **A**
Structured education on diabetes self-monitoring reduces the risk of severe hypoglycemia, decreases psychological stress, and improves the patient's wellbeing. **A**
Any person at a high risk of hypoglycemia should carry glucagon on them. Family members and carers should be trained in the glucagon administration technique. **E**
Given the patient's consent, the nurse or midwife should encourage other individuals from the patient's environment to undergo education on providing assistance to a hypoglycemic patient. **E**

Hypoglycemia is an acute, life-threatening complication of diabetes. The International Hypoglycemia Study Group (2017) distinguishes three levels of hypoglycemia:

- level 1 – glucose alert level. Glucose level ≤ 70 mg/dL (≤3.9 mmol/L), which requires treatment with simple carbohydrates, and may require adjusting the dose of antihyperglycemic medication;
- level 2 – clinically significant hypoglycemia. Glucose level < 54 mg/dL (<3.0 mmol/L), indicating clinically significant hypoglycemia;
- level 3 – severe hypoglycemia. No specific threshold glucose level, instead, it is defined as hypoglycemia associated with severe cognitive impairment requiring external assistance for recovery [1].

Hypoglycemia management always depends on the patient's clinical situation. If the patient is unconscious, the European Resuscitation Council guidelines should be followed. Anyone providing assistance should be aware that loss of consciousness may also be caused by life-threatening conditions other than hypoglycemia.

Hypoglycemia risk factors:

- excessive doses of insulin and/or oral hypoglycemics;
- improper diet (missed meal, reduced carbohydrate intake);
- excessive, unplanned physical activity;
- alcohol use;
- attempt to quickly normalize glycated hemoglobin (HbA1c) levels;
- comorbidities (hypoalbuminemia, kidney failure, hyperthyroidism, hypothyroidism, adrenal insufficiency, eating disorders, cancer, septicemia, anemia, liver failure, heart failure);
- longer duration of diabetes, insulin therapy;
- low body mass index [2,3].

Management of hypoglycemia when the diabetic patient is conscious, cooperative, and able to swallow.

1. Measure blood glucose using a glucose meter (to confirm hypoglycemia).
2. Give 15 g of glucose orally, in the form of a glucose tablet, glucose solution, or glucose-sweetened drink. Sublingual administration of liquid glucose causes a more pronounced blood glucose level increase than swallowing a sweetened beverage [4].
3. Measure blood glucose after 15 minutes to make sure that the intervention was effective and blood glucose levels are increasing (the "15/15" rule) [5]. If hypoglycemia persists, administer 15 g of glucose again and measure glycemia after 15 minutes [6].
4. Establish the cause of the hypoglycemia and the risk of recurrence.
5. If blood glucose levels are increasing, give the patient a sandwich (complex carbohydrates) or advance a meal planned for later, limit physical activity, and repeat the glucose measurement after 60 minutes.
6. If a diabetic patient shows symptoms indicative of hypoglycemia, but does not have a glucose meter, assume the hypoglycemia to be confirmed.
7. Record the hypoglycemic symptoms, measured glucose levels, and type and amount of carbohydrates given to the patient in his self-monitoring journal (also electronic).

8. Inform the diabetic patient that he must not exercise until all symptoms have subsided and his glucose levels have returned to normal.
9. Inform the patient's carers/relatives about the hypoglycemic episode.
10. Educate the patient and others in their environment on self-monitoring for hypoglycemia symptoms and on hypoglycemia management.
11. Always attempt to verify the cause of hypoglycemia and develop a strategy for its prevention with the patient.
12. Pay attention to controlling the insulin doses taken by the diabetic patient.
13. Develop a strategy for minimizing fear of hypoglycemia with the patient and his family.

Nursing management of hypoglycemia when the diabetic patient is unconscious, has impaired consciousness, or is unable to swallow.

Nursing management should be performed in line with the cardiopulmonary resuscitation guidelines of the European Resuscitation Council, physician's orders, and/or the locally applicable procedures for Rapid Response Teams.

1. When ordered by the physician, administer a 10-20% solution of glucose (0.2-0.5 g of glucose per 1 kg BW) intravenously. If there is a risk of another drop in blood glucose level, maintain the intravenous infusion of a 10% glucose solution, while monitoring glycemia [6].
2. Measure the blood glucose level using a glucose meter or another available method.
3. Observe the patient's physical status parameters.
4. Document all nursing interventions.
5. Establish the cause of hypoglycemia, assess the risk of recurrence, and continue management in accordance with the diagnosis.

In case of difficulty in peripheral intravenous cannulation, administer one of two glucagon formulations:

- 1 mg of glucagon for intramuscular or subcutaneous injection (0.5 mg in children under 6 years) [7],
- 3 mg of nasal glucagon powder in diabetic patients aged 4 years and older [8].

Management of hypoglycemia in an unconscious diabetic patient in a community setting (home, workplace, school, public place, other)

A. A witness of the incident should call an emergency service and follow the emergency dispatcher's instruction, if he has not completed first aid training.
B. A witness of the incident who has completed first aid training should:
   1. Administer one of two glucagon formulations:
      - 1 mg of glucagon for intramuscular or subcutaneous injection (0.5 mg in children under 6 years),
      - 3 mg of nasal glucagon powder in diabetic patients aged 4 years and older.
   2. Place the diabetic patient in the recovery position.
   3. Not give the patient anything to eat or drink.
   4. Perform a blood glucose level measurement using a glucose meter or use another available method of blood glucose level determination.
   5. Call an emergency service.
   6. Monitor the blood glucose level, breathing, and consciousness of the patient.
   7. Once the symptoms have subsided and the diabetic patient has regained consciousness, they must not undertake any exercise.
   8. Always attempt to establish the cause of hypoglycemia.
   9. Assistance from another individual is absolutely necessary, including observation for hypoglycemia recurrence.
   10. After a hypoglycemic episode with loss of consciousness and/or impaired consciousness, the patient must always consult a physician.

Glucagon administration in cases of hypoglycemia with loss of consciousness and/or impaired consciousness

1. A subcutaneous or intramuscular injection of 1 mg of glucagon typically increases glucose levels within 8-10 minutes.
2. Glucagon does not cross the placental barrier, and has no adverse effects towards the pregnancy or the health of the fetus or newborn. In breastfeeding mothers, very small amounts of glucagon are naturally released into the milk. Glucagon nasal powder may be used during pregnancy and breastfeeding [7, 8].
3. Injectable glucagon should be stored at between 2°C and 8°C. It may be stored below 25°C for 18 months, subject to the expiration date. Protect from light [7].
4. Glucagon nasal powder in its intranasal dispenser must be stored under 30°C. The single-dose container should be stored in the shrink-wrap protected tube until it is needed for use, to protect it from moisture [8].
5. Store the glucagon in accordance with the manufacturer's instructions. The patient should always have glucagon on hand.
6. In patients with type 2 diabetes treated with sulfonylurea derivatives, glucagon administration is not contraindicated, but the patients require hospitalization due to the risk of hypoglycemia recurrence.
7. Contraindications to glucagon administration include:
   - non-pancreatic malignancies,
   - being under the influence of alcohol,
   - hypersensitivity to glucagon or lactose,
   - phaeochromocytoma.
   - insulinoma,
   - pheochromocytoma [7, 8].

Keep in mind that injected or nasally administered glucagon may not produce the intended therapeutic effect in patients who had fasted for a prolonged period; are hypothermic; have a low adrenalin concentration, adrenal insufficiency, chronic hypoglycemia (low blood glucose levels persisting over a long period), or low blood glucose level due to alcohol consumption; or have been diagnosed with a glucagon- or insulin-secreting tumor. In accordance with the summary of product characteristics, glucagon should not be administered to patients diagnosed with an adrenal tumor [7].

Preparation instructions for intramuscular or subcutaneous glucagon injections

1. Check the expiration date on the package.
2. The kit contains a glucagon vial and a syringe with a solution used to dilute the glucagon.
3. The glucagon may be injected subcutaneously or intramuscularly, preferably into the patient's buttock, arm, or thigh.
4. Remove the orange cap from the glucagon vial.
5. Inject all the solution from the syringe into the vial.
6. When the glucagon has fully dissolved in the solution, draw the mixture back into the syringe.
7. For children under 6 years, administer half the dose, 0.5 mg; for all other patients, administer the full dose, 1 mg [7].

Preparation instructions for glucagon nasal powder

Glucagon nasal powder is ready to use and does not need to be mixed or measured. The medication does not need to be inhaled. It is absorbed through the nasal mucosa.

1. Check the expiration date on the package.
2. Remove the shrink wrap by pulling on the red stripe.
3. Remove the single-dose container from the tube without pressing down the plunger.
4. Hold the single-dose container between your thumb and fingers.
5. Remember that the intranasal dispenser only contains a single dose of glucagon. It can be used only once.
6. Gently insert the tip of the single-dose container in one of the nostrils.
7. Push the plunger all the way in. The dose is complete when the green line is no longer showing [8].

Guidelines and notes for the treatment team

- Severe hypoglycemia requires the assistance of a third person.
- In patients treated with acarbose, give pure glucose orally.
- In patients with type 2 diabetes treated with insulin and sulfonylurea derivatives, prolonged hypoglycemic episodes may occur, sometimes requiring prolonged infusions of glucose solution.
- If glucagon administration is required in diabetic patients and in individuals under the influence of alcohol, hospitalization is necessary.
- Consider hospitalization whenever a severe hypoglycemic incident occurs.
- In patients undergoing intensive insulin therapy, using insulin analogs or a personal insulin pump, give 15 g of glucose orally and measure blood glucose levels after 15 minutes. If glucose levels remain low, repeat glucose administration and measure blood glucose levels after another 15 minutes (the "15/15" rule) [5,6,9]. In patients treated using a personal insulin pump, if oral administration of simple carbohydrates is not possible, discontinue insulin administration (stop and/or disconnect the pump), and perform a blood glucose measurement again.
- Duration of hypoglycemia in a diabetic patient may be shorter if real-time continuous glucose monitoring (real-time CGM) is used [10-12].
- The use of a continuous blood glucose monitoring system and self-monitoring may reduce the risk of hypoglycemic incidents in patients with type 1 diabetes [13,14].
- Structured education on diabetes self-monitoring reduces the risk of severe hypoglycemia, decreases psychological stress, and improves the patient's wellbeing [15–18].
- Any person at a high risk of hypoglycemia should carry glucagon on them. Family members and carers should be trained in the glucagon administration technique [5, 19].
- Given the patient's consent, the nurse or midwife should encourage other individuals from the patient's environment to undergo education on providing assistance to a hypoglycemic patient [19].
- Repeat education on preventing hypoglycemia at each follow-up visit and hospitalization.
- Train the diabetic patient in self-monitoring for early signs of hypoglycemia, and in hypoglycemia prevention and management.

Guidelines for patients and carers

- Wear an identifier (wristband, emergency card, ICE card).
- The ICE card informs first responders who to contact in case of an accident or another emergency. Two common formats are used:
  - the phone number of the emergency contact is entered on the contact list of one's mobile phone, prefixed with "ICE". If multiple emergency contacts are listed, they are prefixed "ICE1", "ICE2", etc.
  - the full name and contact number of the person is written on a business-card sized piece of cardboard or plastic (an actual "ICE card"). The card should be carried on one's person, but not in the wallet.
- Always carry simple carbohydrates (glucose tablets, glucose solution) and an additional sandwich.
- Always carry glucagon (in the case of children with diabetes, the glucagon should be available on site: at their pre-school, school, kept by a trained member of the staff) [5-19].
- Always carry a glucose meter.

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VIII. REDUCING PERIOPERATIVE COMPLICATION RISK

Purpose: Preparing a diabetic patient for a surgical procedure.

Authorized individuals: nurse, midwife

Tab. 9. Key recommendations. Reducing perioperative complication risk

Correct psychological and physical preparation of a diabetic patient for a surgical procedure reduces the risk of intraoperative and postoperative complications or acute complications of diabetes. **E**
Insulin administered by intravenous infusion should be used in accordance with the information leaflet. **E**
Infusion pump settings and the intravenous catheter insertion site should be checked at the beginning of each shift, during shift handover, and at every syringe/infusion line replacement. **E**

In diabetic patients, any surgical procedure carries more risk of life-threatening complications than in the general population. This risk increases particularly in patients with diabetes complications or with multiple risk factors, including coronary artery disease, history of myocardial infarction, or heart failure. In diabetic patients, as in the case of other patients, surgical procedures may be elective or emergent. Perioperative management depends on the mode of admission (elective or emergency), type of diabetes, antihyperglycemic treatment used, and type of procedure [1-3]. Preparation of a diabetic patient for surgery and/or tests should include both psychological and physical preparation. The patient should be made aware that all the preparation activities reduce their complication risk.

Important components include hygienic preparation, and specifically dental care, treatment of skin inflammations, antibacterial bath before the procedure and on the day of the procedure, ongoing oral hygiene; as well as other preparations, e.g. protection against hypothermia during the procedure.

Blood glucose monitoring in surgical patients with diabetes reduces complication risk [4-8]. Recommended blood glucose targets in the perioperative period are 100-180 mg/dL [3].

Patients treated with insulin in the preoperative period should continue this type of treatment, whereas patients treated with oral antihyperglycemic agents in type 2 diabetes usually require temporary insulin therapy [3].

- Elective same-day surgery may be planned in patients treated with intensive insulin therapy, with good metabolic control, and in patients with type 2 diabetes who do not require temporary insulin treatment in the perioperative period, i.e. in patients who undergo minor surgeries that do not require any nutritional changes. In patients who are required to fast for >12 hours preoperatively, it is recommended to administer intravenous infusion of glucose-insulin-potassium solution.
- Major elective surgeries require hospitalization and treatment changes. In patients with type 2 diabetes treated with 2-3 antihyperglycemic medications, who will not be eating their meals on the day of the procedure, or who are being prepared to undergo major surgery with an increased risk of hemodynamic instability, it is recommended to administer temporary insulin therapy [3].
- Patients who use insulin pumps should continue their current treatment until the day of surgery.
- If preparation for surgery requires patients to follow a strict (nil by mouth) regimen on the day/days preceding the surgery, it is recommended to use intravenous infusion of: 10% glucose solution with 12 units of short-acting (rapid-acting) insulin and 10 mmol of KCl instead of meal.
- On the day of the surgery, intravenous infusion of glucose, insulin, and potassium is used with glucose level monitoring:
  - in patients with absolute insulin deficiency, it is recommended to administer separate continuous intravenous infusion of insulin using infusion pumps. Solution concentration: 1 unit of short-acting human insulin in 1 mL 0.9% NaCl and 5-10% glucose solution,
  - in patients with type 2 diabetes and preserved insulin secretion, glucose, insulin, and potassium solution can optionally be administered: 500 mL of 10% glucose with 12-16 units of short-acting insulin and 10-20 mmol of KCl [3].

Intravenous insulin infusion preparation technique

1. Prepare the insulin solution for infusion with the following proportions: 1 unit of short-acting insulin/fast-acting insulin analog per 1 mL of 0.9% NaCl.
2. For instance, draw 50 units of short-acting insulin/fast-acting insulin analog, or 0.5 mL, into an insulin syringe (1 mL insulin syringe = 100 units, insulin concentration 100 units/mL).
3. Transfer the insulin to the 50 mL light-protected syringe used in the infusion pump. Add 49.5 mL of 0.9% NaCl up to 50 mL total, attach light-protected tubing, mix in a swinging motion, and manually remove air while filling the tubing.
4. For infants and small children, prepare a less concentrated insulin solution, e.g. 10 units in 20 mL (1 mL = 0.5 units), or even 2 units in 20 mL (1 mL = 0.1 units).
5. Depending on the type of infusion pump used, the syringe should be clearly marked with the date and time of preparation and the composition. For example: Concentration: 50 units of insulin in 50 mL.
6. Fit the syringe on the pump, making sure that the cylinder flange and base are firmly pressed in.

A diabetic patient should bring the following items to the hospital:

- glucose meter and test strips,
- insulin injectors and a supply of insulin,
- chronically used medication,
- infusion sets and insulin reservoirs for the insulin pump,
- spare batteries for the pump and glucose meter,
- self-monitoring journal,
- test results from before the hospitalization (medical records).

Guidelines for medical personnel

- Prepare medication as prescribed in writing by the physician.
- Check the insulin manufacturer's recommendations on the specific type of infusion pump to be used.
- The stability time for a solution with a given concentration is specified by the insulin manufacturer, in accordance with the summary of product characteristics.
- Insulin solutions should be protected against light (using light-protected syringes and tubing or by covering the system).
- If possible, the intravenous catheter used for the insulin infusion should not be used for administering any other medication (so as not to interfere with blood glucose monitoring).
- Use short-acting insulin or fast-acting insulin analogs for intravenous infusion.
- Check infusion pump settings and the intravenous catheter insertion site at the beginning of each shift, during shift handover, and at every syringe/infusion line replacement.
- During intravenous insulin infusion, it is recommended to monitor glucose level every 1 hour, and with a stable glucose level obtained in 3 consecutive measurements – every 2 hours [3].

Nursing personnel tasks, performed to increase diabetic patients' safety in the perioperative period, include [9-12]:

- monitoring the patient's vital signs and consciousness;
- monitoring blood glucose levels;
- monitoring fluid balance;
- examining the postoperative wound and dressing;
- keeping medical records;
- monitoring the patient for clinical symptoms indicative of acute diabetes complications (impaired consciousness, vomiting, increased thirst, polyuria, abdominal pain, dry mucous membranes, tachycardia, Kussmaul breathing, acetone smell in breath).

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IX. DIABETIC PATIENT FOOT EXAMINATION

Purpose: Preparing the diabetic patient for foot self-examination and self-care to reduce the risk of developing diabetic foot syndrome.

Individuals authorized to perform the procedure: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 10. Key recommendations. Diabetic patient foot examination and care

Health care providers should perform foot examinations to identify diabetic patients at risk of lower extremity ulceration and amputation at least once a year, and more frequently in high risk patients. **B**
The examination should include assessment for neuropathy, skin lesions (e.g. calluses, ulcers, infection), peripheral artery disease (e.g. pulse and skin temperature), and structural abnormalities (e.g. range of motion in ankle and toe joints, bone deformities). **B**
All diabetes patients require basic education on foot self-examination and self-care. **B**
Diabetic patients at high risk of foot ulceration should be educated on foot care (including counseling on avoiding foot injury), and should be provided with professionally fitted footwear. **B**
If foot complications occur, the patient should be promptly referred to a health care professional trained in foot care. **B**

Foot self-examination and self-care is one of the basic preventive procedures in diabetic patients. Regular foot examination, as well as developing patients' ability to perform foot self-care, are key components that directly contribute to a lower risk of developing the so-called diabetic foot syndrome and to better quality of life in diabetic patients[1].

Factors increasing the risk of foot ulceration and amputation:

- uncontrolled diabetes,
- peripheral neuropathy,
- smoking,
- foot deformities,
- bunions or calluses on the feet,
- peripheral vascular disease,
- history of foot ulcers,
- history of amputation,
- injuries (ill-fitting footwear, walking barefoot, foreign body in shoes),
- impaired vision,
- chronic kidney disease (especially in patients on dialysis),
- social and economic factors (e.g. limited access to health care facilities, limited access to reimbursements).

Components of foot examination by medical personnel

Assessment for neuropathy:

- Vibration sensation – the dysfunction of nerve fibers that transmit vibration sensation is an early symptom of diabetic neuropathy. The test is performed using a traditional calibrated tuning fork or a 128 Hz Rydel-Seiffer tuning fork to produce vibration.
- Pressure sensation – using a Semmes-Weinstein monofilament (5.07/10 g) to apply standardized pressure to the skin (10 g/cm2).
- Pain sensation – using a sharp Neurotips pin.
- Temperature sensation – using a TIP-THERM device.
- Macrocirculation – palpating dorsalis pedis artery pulse on both feet, ankle-brachial index (ABI) measurement.
- Visual examination of foot deformities, skin and nail condition.
- Examination of deep tendon reflexes with a Tromner neurological reflex hammer.
- Assessment of peripheral neuropathy symptoms with NSS – Neuropathy Symptom Score.
- Assessment of the occurrence and/or exacerbation of pain during the day and night using NRS – Numeric Rating Scale[2-3,7-9].

Assessment for lower limb ischaemia:

- Pulse measurement includes: femoral and popliteal arteries and foot arteries (dorsalis pedis, posterior tibial and hallucal).
- Temperature measurement in both feet – the examination should be performed symmetrically in both feet and compared with tissues above the foot.
- Skin assessment for ischemia (thin, parchment-like, tight, shiny, cool, pale or bluish).
- ABI (ankle-brachial index) measurement.
- TBI (toe-brachial index) measurement[2-3,7-9].

Assessment for the anatomy and function of the feet:

- Visual assessment for overload-related defects and changes (toes: hammer toe, claw toe, and mallet toe; feet: pes cavus, pes planus, pes valgus, pes varus, hallux valgus).
- Anthropometric measurements of the feet: Clarke's angle and the Wejsflog index measurements, static and dynamic foot imprinting, measurements with computer-assisted devices: podoscope with in-built camera, foot scanner, tensometric mats for measuring plantar pressure (these measurements allow for rapid detection of changes indicating structural degradation – increased contour and circumference of the foot, fallen arches) [7-9].

Assessment of skin and toenail condition:

- Toenail assessment for lesions (the observation allows for detecting bacterial or fungal toenail infections, ingrown nails, involuted nails, claw nails).
- Foot skin assessment for lesions (the observation allows for detecting fissures and cracks, viral, bacterial and fungal skin infections, hyperkeratoses, calluses, injuries and wounds on the feet) [7-9].

A complete foot treatment program includes patient's education, regular foot examination, and categorization of ulcer risk. These activities contribute to significant reduction of foot lesions. In any diabetes care center, there should be a risk assessment system for diabetic foot syndrome in diabetes patients, involving the assessment of

patients' feet in line with the Polish Wound Management Association guidelines on managing patients with diabetic foot syndrome, which are based on guidelines by the International Working Group on the Diabetic Foot (IWGDF):

- No signs of sensory neuropathy – follow up annually.
- Signs of sensory neuropathy – follow up every six months.
- Signs of sensory neuropathy and peripheral vascular disease and/or foot deformities – follow up every 3 months.
- History of ulceration – follow up every 1-3 months[3,8].

Education on diabetic foot prevention

Education aims at developing patients' health-related behaviors and motivating patients to comply with physicians' and nurses' recommendations regarding diabetes self-monitoring. Education is based on setting individual foot care goals, considering risk factors for diabetic foot syndrome development, including improper foot hygiene, improper footwear, and presence of calluses or foot deformities. Lack of metabolic control of diabetes (resulting in advanced diabetic neuropathy and/or lower extremity ischemia) is also a significant contributor to diabetic foot syndrome development. Structured, organized, and recurrent education plays a major role in the prevention of foot ulcerations in diabetes.

A health care team member should provide structured education to patients, individually or in small groups, over several sessions, with regular reinforcement, using a variety of teaching methods. It is important to verify whether the diabetic patient (and optimally, every family member or carer) understands the purpose of education and is motivated to comply. Moreover, health care professionals who provide patient education should receive regular training themselves to enhance their skills in terms of care for patients at high risk of foot ulceration.

Patients at risk of foot ulceration should learn to recognize ulcers and symptoms that precede them, and know what to do when such problems occur[5,8].

Any preventive actions should begin no later than 5 years from the diagnosis of type 1 diabetes and immediately after the diagnosis of type 2 diabetes.

Scope of patient education

The scope of education provided by a nurse to a patient at risk of foot ulceration should include:

- Verifying whether the patient is able to perform a foot self-examination. If not, discuss who could assist him. Patients who have significantly impaired vision or are physically unable to examine their feet cannot properly perform self-monitoring.
- Explaining the need for daily examination of the entire surface of both feet, including the skin between the toes.
- Ensuring that the patient knows how to notify a health care professional if the measured foot temperature is elevated or if they notice blisters, cuts, scratches, or ulcers during a foot self-examination.
- Discussing the following practices with the patient:
  - avoiding walking barefoot, in socks but with no footwear on, or in thin-soled slippers, both at home and outside;
  - avoiding footwear that is tight, has rough edges or protruding seams;
  - visually and manually checking the inside of footwear before wearing it;
  - wearing seamless socks or stockings, avoiding tight--fitting socks or knee socks (pressure stockings should only be prescribed in coordination with the foot care team), changing socks daily;
  - daily washing of feet (always in water below 37°C) and careful drying of skin between the toes;
  - avoiding the use of heaters or hot water bottles to warm one's feet;
  - avoiding the use of chemicals to remove corns or calluses;
  - avoiding the removal of corns or calluses by the patient;
  - using emollients on dry skin, but not between the toes;
  - regularly trimming toenails straight across by filing;
  - principles of daily self-monitoring of the feet (the patient should immediately report any distressing symptoms to a nurse, physician) [8].

Scope of foot care

- Daily foot care. Use of specialized products for daily foot care is recommended, including mild soaps with a pH of 5.5, clinically-tested foot skin and nail care products containing 10% or 25% of urea, and skin-neutral lipid products; the composition should be selected based on the care problems observed in each individual patient. When selecting urea-containing products, consider the individual indications for each patient, as follows: 10%-urea foot care products for normal and thin skin, and 25%-urea products for dry skin with corns and calluses[10]. Feet should be washed in water below 37°C, for a short time: 2-3 minutes, after which they should be carefully dried, with particular attention to the skin between the toes.
- Foot care in case of hyperkeratosis and calluses. Corns or calluses on the feet should not be removed by the patient, neither manually nor using chemical agents, e.g. ones containing salicylic acid. In case of difficulties in foot self-care, the patient should regularly visit a foot care specialist (podologist) or a nurse performing foot and nail care on a daily basis[8].
- Prevention of fungal infection. This mainly includes following the general rules of proper foot hygiene and always carefully drying the feet and the skin between the toes after washing, as well as not leaving any foot care products on the skin between the toes. Pay particular attention to keeping skin between the toes clean and dry at all times. Wear protective footwear in swimming pools, saunas, physical therapy rooms and other places where the feet need to be protected against potential exposure to pathogenic fungi; only wear outdoor and indoor footwear and socks made from natural materials that ensure air flow to the skin and protect it from overheating. If necessary due

to previous incidents of fungal foot or nail infection, use foot care products containing anti-fungal ingredients.
- Aseptic dressing of micro-injuries and minor skin injuries on the feet. Patients should have a first aid kit containing an antiseptic product and sterile gauze pads, bandages, and adhesives, and in case of recurring ulceration, specialist antibacterial dressings. In case of ulceration in patients with diabetic foot syndrome, the wound healing process and the dressings applied by the patient should be assessed, and patients should be instructed on aseptic wound dressing technique and wound management at home.
- Socks. Binding, medical socks made from natural fibers – cotton or bamboo.

Only individually-fitted insoles may be used.
- Toenail trimming. Toenails should be trimmed once a month so as to ensure that the toe-tip is protected by the nail.
- Preparing feet for exercise.
- Daily foot self-examination.

All signs of infection within the feet should be reported. If any alarming symptoms appear, e.g. inflammation, pain, redness, or blisters, the patient should immediately contact a diabetes specialist or primary care physician. Patients who have difficulties in performing foot self-care and are unable to follow some basic hygiene practices, e.g. trim their toenails, can be referred to a foot care specialist (podologist).
- Selection of preventative footwear.

Diabetic patients should be reminded that their footwear needs to be adapted to the shape and function of the feet. Lack of sensation and ill-fitting footwear are one of the most common causes of neuropathic ulceration. Dynamic features of footwear are most important, as they change over time (new, used, worn out) and thus must be monitored in order to adjust the footwear or replace it with new one. The main purpose of footwear is to reduce plantar pressure below the threshold values that cause ulceration. Due to the high risk of skin damage in diabetic patients wearing preventative footwear, the latter should display the following features:
- inner upper and lining made from natural leather and padded heel counter,
- thicker flexible outsoles reducing pressure and allowing for unrestrained body weight shift from the heels to the toes when walking,
- footwear design must provide for full stability and amortization of the heel, as the heel bears the greatest load during the landing phase when walking,
- adequately wide and flexible vamp, preventing rubbing and pressure on the dorsal part of the foot, particularly recommended for patients with toe deformities,
- adequate size, well-fitting, but not too small and not too large; when using insoles, additional space is needed within the footwear,
- easy to put on and remove, best with flexible Velcro straps,
- fully enclosed, without inner seams and made from supple leather[4].

Depending on the degree of foot deformity and the patient's activity level, footwear should be selected based on its fit to the shape of the feet and adequate lining, rather than biomechanical correction, to reduce the risk of injury. At different stages of the disease, patients can use various types of footwear as long as it does not lead to injuries or cause ulceration.

Selection of therapeutic footwear.

If ulceration is not offloaded, it will not cure even with sufficient blood supply.

Patients with ulceration should be instructed to limit walking to the minimum necessary and not to walk without appropriate offloading devices.

Additional offloading can be achieved by instructing patients to use crutches, a walker or a wheelchair, depending on the degree of ulceration, or in most severe cases – to stay in bed [6,8].
- Use of insoles.

In-shoe orthoses called insoles are shaped in such a way as to be placed inside the footwear. The major principle of insole design is that it accommodates the foot, not the footwear. Therefore, it is necessary to allow for an adequately bigger size of the footwear, so that the insole can be placed in the shoe, or replace the insole in one's footwear with custom insole if possible.

Preventative and therapeutic function of insoles:
- maintaining correct foot placement,
- changing foot positioning,
- offloading the painful section of the foot,
- correcting deformations,
- changing the mobility range of the foot or its individual sections[4].

Insoles come in various shapes and forms, are used for preventative and therapeutic purposes, and can be classified as:
- **prefabricated** (orthotic inserts and pads, flat insoles, profiled insoles, and biomechanical orthotics); examples of orthotic inserts and pads include the commonly used metatarsal pads, corn cushions, longitudinal arch support orthotics, and heel cushions and cups; these are made from various materials such as felt, leather, silicone or polymer gel; a disadvantage of this type of solution is the difficulty in correct fitting,
- **custom** (accommodative and functional), functional insoles are most commonly used in the case of elastic deformations, which can be subjected to correction, and their role involves changing the way the foot comes in contact with the ground; accommodative insoles are usually used in the case of more stiff deformations, as they reduce pressure on the protruding osseous elements [4].

In young patients with newly diagnosed diabetes, with no symptoms of neuropathy and with the ligament-skeletal system preserving joint flexibility, custom functional insoles should be considered. Especially in patients already presenting signs of flat feet and/or forefoot deformities,

like hallux valgus or hammer toe, claw toe, and mallet toe, who are at risk of calluses. This does not apply to patients with symptoms of neuropathy and/or considerable foot deformity, e.g. in the case of Charcot neuroarthropathy or after completed ulceration treatment in diabetic foot syndrome. In such cases, it is recommended to exclusively use accommodative insoles, whose purpose is to evenly distribute plantar pressure, preventing overload (only individually-fitted insoles may be used) [4].

- Toenail trimming. Toenails should be trimmed once a month so as to ensure that the toe-tip is protected by the nail
- Preparing feet for exercise.
- Daily foot self-examination.

All signs of infection within the feet should be reported. If any alarming symptoms appear, e.g. inflammation, pain, redness, or blisters, the patient should immediately contact a diabetes specialist or primary care physician [8,11]. Patients who have difficulties in performing foot self-care and are unable to follow some basic hygiene practices, e.g. trim their toenails, can be referred to a foot care specialist (podologist).

Since 2021, education in the profession of podologist in Poland has been offered in the system of a two-year post-secondary school.

In children with diabetes:

- Education on proper foot care and signs of inflammation should start as soon as the disease is diagnosed, and education scope should be adjusted to the child's age. The purpose of such education is to minimize the adverse consequences of incorrect foot care and the lack of proper footwear while the motor system of the foot is developing.
- In children with diabetes under 12 years old, both the child and their guardians should be educated on basic foot care.
- Patients aged 12–17 years should have their feet screened annually by a pediatric diabetes care team, and should receive education on foot care. If a foot problem is identified or suspected, the pediatric care team should refer the young patient to the appropriate specialist.

Correct preventive procedures should apply to all patients as soon as they are diagnosed, but an education program should also be followed to prevent further ulcerations resulting from diabetic foot syndrome.

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X. CARE SKIN HYGIENE IN DIABETIC PATIENTS

Purpose: Assisting the patient and preparing them to maintain skin hygiene so as to reduce the risk of complications associated with skin dryness and itching.

Authorized individuals: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 11. Key recommendations. Skin hygiene in diabetic patients

Diabetic patients are at a higher risk of skin dryness and cornification. **C**
Patients' skin should be regularly examined. **E**
Use of urea-containing products and emollients reduces skin dryness in diabetic patients. The concentration of urea should be adjusted to the skin condition and care goals. **B**
Health education provided to diabetic patients with a low risk of foot ulceration improves their foot-care behaviors and reduces risk factors for ulceration: dry skin, corns, and calluses. **C**

If the skin examination shows dryness and itching, interventions should be undertaken to ensure proper skin care and hygiene to prevent further complications.

Hyperglycemia and reduced insulin sensitivity may disturb epidermal homeostasis by decreasing hydration and weakening the function of sebaceous glands. Therefore, in almost all diabetic patients, the skin is excessively dry, sensitive, and prone to itching [1-3].

Dry skin is more susceptible to damage, irritation, and infection [4]. This produces a number of bothersome symptoms, such as redness, burning sensation, irritation, cracking, excessive peeling and cornification of the epidermis. As a result, patients experience chronic discomfort and tend to develop complications that may require a specialist's intervention.

Proper skin hygiene and self-care positively affects its overall condition and should be followed as a basic preventive procedure, contributing to better quality of life in diabetic patients.

Skin condition assessment by medical personnel

- Visual examination of the skin – to assess irritation, redness, peeling, coarseness, dryness on a simple 0–3 scale (0 – no irritation, 1 – slight irritation, 2 – moderate irritation, 3 – intense irritation).
- Examining hyperkeratosis and calluses on the feet.
- Increased dryness and thickening of the corneous layer of the epidermis are associated with increased risk of developing calluses on the feet. These processes may precede necrosis and lead to ulceration, a symptom of diabetic foot. Calluses are particularly often formed over bony prominences or protruding heads of the metatarsal bones. They are caused by increased plantar pressure in the area and foot skin dryness caused by diabetic neuropathy.
- The patient's subjective assessment of dryness, itching, and overall discomfort on a 0-3 scale (0 – no discomfort, 1 – slight discomfort, 2 – moderate discomfort, 3 – intense discomfort).

Education on prevention of complications associated with excessive skin dryness

Maintaining proper skin hygiene and hydration in diabetes is one of the easiest ways of preventing skin problems. Providing appropriate education as soon as the diabetes is diagnosed contributes to minimizing the cutaneous complications of the disease [5-6]. Education aims at developing patients' health-related behaviors and motivating patients to maintain skin hygiene by explaining its importance in diabetes. One important part of such education should involve explaining the rules for using individually-selected skin care products and moisturizers.

Guidelines for patients and carers

- Keep skin clean and dry. For daily care, use specialized moisturizing soaps that do not disturb the natural pH and hydrolipidic film of the skin. Diabetic patients should avoid drying and irritating products.
- Avoid hot baths – keep water temperature under 37°C. Wash your entire body within 5-7 minutes, and thoroughly dry your skin with no excessive rubbing. Dry skin folds and skin between the toes with particular care. Pay particular attention to keeping skin between the toes clean and dry at all times.
- Keep your skin moisturized and avoid scratching to prevent cracks and secondary bacterial or fungal infection.
- Dryness and itching prevention requires the patient to regularly use appropriate emollients, or topical products moisturizing and lubricating the skin. This accelerates the regeneration of the epidermal barrier, making the skin less sensitive to external factors [7-8].
- Daily care using emollients and products topically moisturizing and lubricating the skin not only strengthens the epidermal barrier by restoring adequate normal lipid levels, but also reduces dryness, peeling, eczema, bacterial and fungal infections, and itching [9].
- Emollients available on the market differ in composition. When selecting the appropriate product, consult a pharmacist and consider the diabetic patient's needs [10].
- Use of products containing various complementary moisturizing substances (including urea, natural oils and lipids) as well as nutrients, prebiotics, and vitamins is beneficial, contributing to the maintenance of proper hydration and reducing itchiness [3,11].
- To achieve the expected benefits of using appropriately selected topically moisturizing and lubricating products, use them regularly.

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XI. PHYSICAL EXAMINATION OF THE SKIN AT SUBCUTANEOUS INSULIN INJECTION SITES IN PRIMARY AND SECONDARY PREVENTION OF LIPOHYPERTROPHY

Purpose: Performing the physical examination of the skin visually and by palpation for early identification of lipohypertrophy (LH) and monitoring of existing LH lesions

Individuals authorized to perform the procedure: nurse, midwife, and the patient and/or patient's carer – for diabetes self-control after proper training.

Tab. 12. Key recommendations. Physical examination of the skin at subcutaneous insulin/injection sites in primary and secondary prevention of lipohypertrophy

LH is the most common skin lesion in patients using injectable insulin. **C**
Correct rotation of injection sites and correct use of needles are significant factors in LH prevention. **B**
Do not inject insulin into lipohypertrophic tissue. **A**
Insulin injection into lipohypertrophic tissue may contribute to blood glucose level fluctuations. **C**
Single use of needles is associated with a lower risk of lipohypertrophy. **A**
Insulin injection sites should be examined by medical personnel at each visit, depending on the type of insulin therapy, at a minimum once every 6-12 months. **E**
Physical examination of skin for LH and other complications associated with subcutaneous injection should also be performed in patients treated with medications other than insulin. **E**
The nurse/midwife should educate diabetic patients and their families/carers on the principles of LH prevention and self-examination of injection sites. **E**
To reduce the risk of cutaneous complications and the resulting impairment of the distribution of insulin and other medications to tissues, patients and their families/carers should be educated on the injection technique and preventative examination of injection sites **A**

Multiple, subcutaneous injections of insulin (and of GLP-1 receptor analogues, increasingly used in Poland) may contribute to cutaneous complications in the injection site, including: LH – lipohipertophy, atrophy, pain, bruises, minor bleeding [1,2]. What is significant in the clinical aspect is pain, due to the discomfort experienced by the patient, and lipohipertophy, which is a subcutaneous tissue dysfunction that may affect blood glucose fluctuations. Lipohipertophy is described as adipose hypertrophy and edema and/or lumps of the adipose tissue in the subcutaneous insulin injection site. LH is also associated with changes in blood vessels and nerve fibers[1,3]. Insulin absorption may be impaired if it is injected in sites with LH [4-6].

To reduce the risk of cutaneous complications and the resulting impairment of the distribution of insulin and other medications to tissues, patients and their families/carers should be educated on the injection technique and preventative examination of injection sites[7-9].

Examination technique

1. Prepare the room and equipment. The examination is best performed in a room with a temperature of 20-25°C, with both overhead and oblique lighting (at a 35-40 degree angle) [10-12]. Using a gel, e.g. ultrasound gel, is recommended.
2. Explain the purpose and procedure of the examination to the patient (carer, accompanying person) and obtain his consent [13].
3. Take the patient's history, including information on the course of diabetes, insulin injection technique, type(s) of insulin used, injection site self-examination.
4. Perform physical examination, including visual examination and palpation.
   A) Visual examination of the skin at insulin injection sites, using both overhead and oblique lighting [9]. The following components of skin condition should be examined: color (overall, local discolorations), tension, integrity; presence and condition of scars, wounds, birthmarks; course and condition of subcutaneous blood vessels; discharge – presence, volume, color, odor, consistency; hair; tattoos and piercings; lipohypertrophy symptoms[9,12] – change in skin surface, mounds or areas of raised skin due to hypertrophic subcutaneous tissue at and around injection sites.

B) Palpation:

- The nurse or midwife applies warmed gel to the examined skin surfaces (insulin injection areas), except for sites where tissue integrity is broken (e.g. grazed skin, wounds). Particular attention should be paid to avoid lesions associated with discharge, suspect cancerous lesions, areas of inflammation or allergy, and scars.
- The nurse or midwife then places three fingers (index, middle, and ring finger) on the patient's skin, parallel to its surface. Maintaining soft pressure, the nurse or midwife palpates the skin along parallel lines, in a slight circular motion [9,10] (fig. 2).
- During the palpation exam, the patient should be observed for any reaction to the touch, and asked about discomfort or pain. If the patient experiences pain, its intensity should be evaluated using a pain scale.
- Follow the above procedure for each insulin injection area, either potential or indicated by the patient.
- If abnormal subcutaneous tissue is detected, the nurse should attempt to lift a fold of skin with subcutaneous tissue. Tissue resistance to fold lifting, tissue consistency within the fold, and the patient's experience during fold lifting are assessed[9,11].

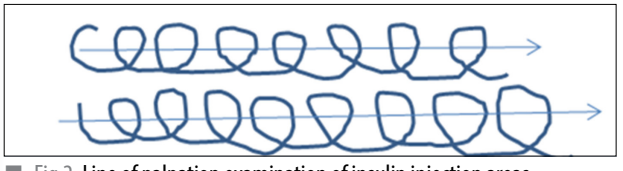

Fig 2. Line of palpation examination of insulin injection areas

Source: own development Tobiasz-Kałkun N.

Guidelines for medical personnel

- Nurses and midwifes are qualified to perform physical examinations of patients' skin in primary and secondary prevention of cutaneous complications of insulin injection (lipohypertrophy), under the Polish Minister for Health Regulation of February 28, 2017 on the type and scope of preventive, diagnostic, therapeutic, and rehabilitation services performed independently by a nurse or midwife without a physician's orders (Journal of Laws: Dz. U. 2017 item 497). Specific requirements are listed in section 3(2)[14].
- Physical examination of the skin[2] should also be performed at sites used for continuous glucose monitoring system (CGM or FGM) sensor insertion or capillary blood sampling for measurement using a glucose meter.
- The examination should be performed at least once every 6 months, depending on injection frequency (excessively frequent examination, several times a month, does not increase the rate of lesion detection) [12].
- Do not palpate the injection sites immediately after insulin injection, as this may cause the medication to leak[12].
- Ultrasound gel is recommended[12], use of oils should be avoided to prevent permanent staining of the patient's clothing.
- The examination and its results should be documented (including description and pictures of the lesions and their locations).
- Verify and improve the patient's/carer's injection technique, specifically including remembering the most recent and previous injection sites, rotation procedure, needle replacement[15].
- In case of doubt as to the nature of any identified lesion, a more experienced nurse or midwife (and/or a physician) should be consulted [16].

Guidelines for patients and carers

- Follow the correct technique for subcutaneous insulin injections (in the prevention of cutaneous complications of insulin injection, particular attention should be paid to rotating injection sites and areas, and changing needles) [7,10,14].
- Injection sites should be examined for LH regularly, every 6 months, but not immediately after an insulin injection [12].
- Sites used for subcutaneous insertion of glucose monitoring sensors and capillary blood sampling for measurement using a glucose meter should be examined as well.
- All abnormalities identified during an examination should be consulted with nurse/midwife/diabetes educator.
- Never inject insulin into sites with any pathological lesions [12].
- When the insulin injection area is changed, the insulin dosage may need to be modified [15,17,18].

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XII. ORAL GLUCOSE TOLERANCE TEST (OGTT)

Purpose: Correct performance of an oral glucose tolerance test (OGTT).

Individuals authorized to perform the test: nurse, midwife

Tab. 13. Key recommendations. Oral glucose tolerance test (OGTT)

Patient preparation for the OGTT is among the factors that affect its diagnostic value. The nurse/midwife should instruct the patient on how to prepare for the oral glucose tolerance test and what to do during and after the test. **E**
Nurses and midwives should instruct women diagnosed with gestational diabetes mellitus to undergo screening for diabetes once a year. **E**

In an OGTT, the patient drinks a solution of glucose in water. Then, glucose levels in venous blood plasma are measured strictly in accordance with the test protocol. The results reflect the mechanism of glucose level regulation in the patient's body.

The test is used for diagnosis of glucose metabolism disorders, and for early diagnosis of prediabetes and all types of diabetes. The test involves administering glucose to the patient and observing his reaction, specifically insulin release, rate of blood glucose level regulation, and rate of glucose absorption in the tissue [1].

Preparation

- The patient is informed by the referring physician that they should fast overnight and that any medication which could increase blood glucose levels (such as glucocorticoids, diuretics, beta-blockers, L-thyroxine) should only be taken once the test is completed. This means that the patient should not eat anything for at least 8 hours, and may only drink water. For at least 3 days before the test, the patient should not modify his diet, lifestyle, or amount of exercise [2-7].
- In the pre-test interview, the nurse/midwife makes sure the patient is correctly prepared.
- Before the test, the patient should always be informed by the nurse/midwife that he may experience some pain during blood sampling, and that nausea and dizziness may occur after drinking the glucose solution.

Test technique

The test must be performed using aseptic and antiseptic technique.

1. For adults, dissolve 75 g of odorless glucose in 250 ml of boiled water (for children, the dose is 1.75 g of glucose per kg BW, maximum dose 75 g).
2. Draw a venous blood sample for the fasting baseline to measure the glucose level and other diagnostic parameters, e.g. insulin or plasma C-peptide levels, in accordance with the physician's orders.
3. Instruct the patient to drink the glucose solution within 5 minutes.
4. After drinking the solution and until the end of the test, the patient remains seated.
5. The patient may experience nausea, sweating, and dizziness after drinking the glucose solution.
6. Once the patient has drank the solution, if vomiting occurs, stop the test and inform the physician.
7. Venous blood samples are drawn at 0 and 120 minutes, per the physician's orders.
8. Until all samples have been collected, the patient may not eat, exercise, smoke, or take medication.
9. Until all the subsequent sample have been collected, the patient should not undergo intravenous infusions.

Note!

- Blood samples are drawn in accordance with the physician's orders and referrals.
- In pregnant women, the test is performed using 75 g of glucose, during week 24–28 of the pregnancy, and blood glucose is measured at 0 (fasting baseline), 60 and 120 minutes.
  T0 is the time of venous blood sampling for the fasting baseline.
- In patients after bariatric surgery (gastrectomy or gastric bypass), oral administration of glucose causes it to reach the intestine too rapidly, resulting in dumping syndrome and associated hypoglycemia [5].
- Patients may be referred for an OGTT by a physician or authorized nurse or midwife after a physical examination [8].

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XIII. MEASUREMENT OF THE LEVEL OF KETONE BODIES IN CAPILLARY BLOOD USING A GLUCOSE METER

Purpose: Measurement of the level of ketone bodies in capillary blood using a glucose meter, whose results form the basis for monitoring the symptoms of diabetic ketoacidosis.

Individuals authorized to perform the measurement: nurse, midwife, and the patient and/or patient's carer after proper training.

Tab. 14. Key recommendations. Measurement of the level of ketone bodies in capillary blood using a glucose meter

In diabetes, the lack or deficiency of insulin may cause severe metabolic disorders, including diabetic ketoacidosis. The patient should be educated on the principles and technique of measuring the level of ketone bodies in capillary blood using a glucose meter. **E**
Metabolic disorders in diabetes are characterized by hyperglycemia. Therefore, one should monitor the levels of both glucose and ketone bodies in capillary blood. **A**
A reliable and relevant reading of the level of ketone bodies in capillary blood is possible to obtain only if one follows the instructions provided in the manual for the glucose meter used for the measurement. **E**

Diabetic ketoacidosis (DKA) is a severe complication of diabetes, which is life-threatening to the diabetic patient. DKA is diagnosed based on the assessment of: the patient's level of consciousness, plasma glucose level above **250 mg/dl (13.9 mmol/l)**, presence of ketone bodies in blood and urine. Accumulation of ketone bodies in blood and their increased excretion through urine point to enhanced ketogenesis [1].

Ketone bodies are produced in the liver by the breakdown of fatty acids as a source of energy during periods of caloric restriction, physical effort and in individuals with insulin deficiency. Their presence in the blood of diabetic patients might indicate the risk of diabetic ketoacidosis. Ketone bodies are formed when insulin level is too low to prevent lipolysis [1].

The presence of ketone bodies in the blood is called **ketonemia**. Capillary blood β-hydroxybutyrate testing is recommended for detecting the level of ketone bodies. The measurement should be **performed in the morning, on an empty stomach, at least 12 h** after the last meal, which allows for obtaining the most reliable result. The test should be repeated 2-3 hours after having a meal [2]. Viral infection in diabetic patients, just like any acute inflammation, may lead to an abrupt increase in blood glucose and increases the risk of DKA, especially in patients with type 1 diabetes [3-4].

Suspicion of DKA is an absolute indication for hospital admission. Therefore, it is important to monitor the level of ketone bodies in capillary blood using a glucose meter, as it allows for taking immediate therapeutic actions.

The nurse/midwife should educate the patient/patient's carer about the principles of DKA prevention and rules to be followed when DKA symptoms occur, and situations in which the patient should measure the level of ketone bodies in capillary blood. These include: symptoms of infection, malaise or capillary blood glucose level above 250 mg/dl (13.9 mmol/l) in the case of type 1 diabetes and above 300 mg/dl (16.7 mmol/l) in the case of type 2 diabetes [4]. The results of ketone body level measurement determine the management in hyperglycemia and prevention or treatment of diabetic ketoacidosis [5].

Technique of measuring the level of ketone bodies in capillary blood using a glucose meter [5-14]:

1. Perform the measurement in accordance with the instruction manual for the glucose meter and test strips.
2. Check the expiration date on the test strip and use it immediately after removing it from the package.
3. Test strips should not be used if the container is damaged or improperly sealed.
4. Perform hygienic handwashing and instruct the patient that in the house setting he should thoroughly wash his hands with warm water and soap, and then dry them well.
5. In health care facilities, disinfect the skin in the capillary puncture blood collection site before measuring the level of ketone bodies in capillary blood using a glucose meter.
6. In adults, the fingertip is typically the preferred site for capillary blood sampling. To measure the level of ketone bodies in capillary blood, you should only use blood samples collected from a fingertip.

7. When performing 2 measurements at the same time (glucose and ketone bodies), collect blood samples from two different fingers!
8. Use a disposable finger-prick for sampling and transfer the blood sample onto the test strip.
9. Having checked the result, remove and dispose of the used strip in accordance with the applicable procedure of handling medical waste.
10. Record the result after completing the test [6].

Instruments measuring ketone bodies in capillary blood and in urine using test strips detect different ketone bodies and the results obtained are not interchangeable [2]. The measurement performed in capillary blood detects β-hydroxybutyrate, and in urine – acetoacetate. Table 15 shows how to interpret the results of the measurement of the level of ketone bodies in capillary blood and in urine [8].

Tab. 15. Comparison of the level of ketone bodies in capillary blood and urine

Level of ketone bodies in capillary blood	Level of ketone bodies in urine	Result interpretation
Below 1.5 mmol/l	negative	It is recommended to measure the level of ketone bodies in capillary blood at least every 4-6 hours.
1.6 to 2.9 mmol/l	+or++	Increased risk of DKA. **It is necessary to measure the levels of glucose and ketone bodies in capillary blood every 2 hours.**
Above 3.0 mmol/l	+++or++++	High risk of DKA. **Contact your diabetes team/GP/closest emergency medical care facility.**

Source: Own work based on [1-15].

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XIV. MEASUREMENT OF THE URINARY LEVELS OF KETONE BODIES AND GLUCOSE

Purpose: Measurement of the urinary levels of ketone bodies and glucose, whose results form the basis for monitoring the symptoms of diabetic ketoacidosis.

Individuals authorized to perform the measurement: nurse, midwife, and the patient and/or patient's carer for diabetes control/self-control after proper training.

Tab. 16. Key recommendations. Measurement of the urinary levels of ketone bodies and glucose

In diabetes, the lack or deficiency of insulin may cause severe metabolic disorders, including diabetic ketoacidosis. The patient should be educated on the principles and technique of measuring the urinary levels of ketone bodies and glucose. **E**
Metabolic disorders in diabetes are characterized by hyperglycemia. Therefore, one should monitor the levels of both glucose and ketone bodies in urine. **A**
A reliable and relevant reading of the urinary levels of ketone bodies and glucose is possible to obtain only if one follows the instructions provided in the manual for the diagnostic tests used for the measurement. **E**

Hyperglycemia can be detected with a glucose urine test. Normal urine should not contain glucose or ketone bodies [1].

Note! Remember that in the case of reagent test strips, the detection threshold for glucose in urine is **50 mg/dl** [1].

Glucosuria occurs when the renal threshold for glucose (RTG) is exceeded. In the majority of people with normal renal function, RTG is about 180-200 mg/dl (about 150 mg/dl in pregnant women) [2].

According to the reference range, **ketone bodies** should not be present in urine. In diabetic patients, the presence of ketone bodies may indicate inadequate diabetes treatment or diabetic ketoacidosis, usually accompanied by intense hyperglycemia.

Ketonuria may also point to:
- starvation lasting more than 10 hours,
- excessive physical effort,
- treatment with SGLT2 inhibitors (flozins),
- use of ketogenic diets [3].

In cases listed above, intense hyperglycemia is usually not diagnosed [4]. The patient/patient's carer should be informed that indications for measuring the urinary level of ketone bodies as part of self-monitoring are as follows: infection, fever, vomiting, pregnancy, periods of starvation [5].

Technique of measuring the levels of ketone bodies and glucose in urine [6-9]:

1. Collect a 30 ml sample of urine into a clean dry container.
2. Follow the instruction manual for test strips.
3. Perform hygienic handwashing, check the expiration date on the test strips, open the package and remove one test strip holding it by the plastic ending; do not touch the reagent area of the test strip.
4. Immerse the reagent area of the strip in urine and take it up immediately. To remove the excess urine, run the edge of the strip against the rim of the container with urine.
5. After dipping, wait for the exact time specified in the manufacturer's instruction manual and read the level of ketone bodies comparing the result on the strip with the color chart on the package.
6. Next, follow the instruction manual as to the exact time you need to wait after dipping and read the level of glucose comparing the result on the strip with the color chart on the package.

NOTE! It is necessary to follow the manufacturer's instructions as to the total waiting time. Changes in the reagent area color beyond the time specified should be ignored.

7. Having read the result, dispose of the used strip and urine container in accordance with the applicable procedure of handling medical waste.
8. Record the obtained results.

Test strip storage conditions [6-10]

To preserve proper quality of the test strips, closely follow the directions provided by the manufacturer:

1. Do not touch the reagent area with your finger or with any object before the test.
2. The strips should be stored at a room temperature between 15°C-30°C (59°-86° F).
3. To preserve unchanged activity of the reagent contained in the test strip, avoid exposing the bottle with test strips to direct sunlight, moisture and heat.
4. Discolored or darkened reagent area may indicate poor quality of the test. If the reagent area of the strip is discolored or darkened, toss this strip and take a new one from the packaging.
5. Test strips which are not being used should be stored in the original packaging with a tightly sealed cap.
6. Promptly replace the cap tightly each time you take out a strip.
7. Never put the test strips into another packaging.
8. Do not remove the drying agent from the bottle. The drying agent absorbs moisture and keeps the test strips dry.

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XV. GENERAL GUIDELINES REGARDING SKIN – PENERTATING PROCEDURES

A. **For the patient or his family members** [1,2]

1. Wash your hands before performing a blood glucose measurement, insulin injection using a pen injector, infusion set insertion, or glucose monitoring sensor insertion.
2. If skin disinfection is required, wipe the skin with a gauze pad soaked in disinfectant (single-packed pre-soaked pads may be used).
3. After a finger-prick, secure the site with a sterile gauze pad.
4. If numbing cream is used, remove any residue with a wet gauze pad before disinfecting the skin. Apply the disinfectant only after the skin has dried.
5. Dispose of any sharp equipment (needles, lancets) safely.

B. **For nursing staff** [1,2]

1. Disinfect your hands before performing a clean/aseptic procedure.
2. Disinfect your hands after contact with a patient.
3. If skin disinfection is required, wipe the skin with a gauze pad soaked in disinfectant.
4. After a finger-prick, secure the site with a sterile gauze pad.
5. Wear diagnostic gloves if exposure to a patient's blood is expected.
6. In health care facilities, use safe equipment, i.e. insulin needles and disposable lancing devices, to prevent wounding incidents among nurses.
7. If a nurse/midwife performs insulin injection with a pen injector, the needle should be changed each time.
8. If numbing cream is used, remove any residue with a wet gauze pad before disinfecting the skin. Apply the disinfectant only after the skin has dried.

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XVI. ORAL ANTIHYPERGLYCEMIC AGENT ADMINISTRATION GUIDELINES

Purpose: To improve patient adherence and minimize the adverse effects of oral antihyperglycemic agents.

Guidelines for: nurses, midwifes.

Tab. 17. Key recommendations. Assistance in treatment with oral antihyperglycemic agents

Regardless of diabetes type, antihyperglycemic treatment comprises health education, diet, exercise, and pharmaceutical treatment. **A**
To maximize the benefits oral antihyperglycemic agents, they must be taken strictly in accordance with the relevant guidelines. **A**
Health education provided to patients treated with oral antihyperglycemic agents is an indispensable part of therapy, contributing to a reduced risk of adverse effects from the medication and of chronic diabetes complications. **B**
Patients treated with oral antihyperglycemic agents from the SGLT-2 group should be taught to increase their fluid intake and maintain good intimate hygiene. **E**
Patients' adherence to medication should be monitored. Educational interventions improve patients' health literacy in terms of adherence to treatment. **A**

In type 2 diabetes, the body retains some ability to produce insulin. There is, however, increased insulin resistance, which can be reduced by appropriate medication. Antihyperglycemic pharmaceutical treatment is a component of multidisciplinary treatment for type 2 diabetes. The key treatment objective is to prevent acute diabetes complications, as well as the development and progression of chronic neurovascular complications producing such clinical manifestations as retinopathy, diabetic kidney disease, neuropathy, and cardiovascular disease. The natural course of metabolic disorders leading to type 2 diabetes development is associated with increasing insulin deficit, and so treatment must be adjusted to the growing severity of the disorders. Type 2 diabetes treatment must be progressive and adapted to the subsequent stages of disease development [1]. Treatment success, especially in chronic disease, depends on multiple factors. Patient cooperation with the therapeutic team and adherence to all treatment recommendations is among the key factors for treatment effectiveness. Diabetes is a chronic disease that requires patients to take medication correctly and regularly for years. In each case of diabetes, and especially type 2 diabetes, the patient's attitude and education level must be taken into account when defining treatment objectives and selecting treatment strategies [2].

The category of oral antihyperglycemic agents includes the following groups: sulfonylurea derivatives, biguanide derivatives, intestinal α-glucosidase inhibitors, dipeptidyl peptidase-4 (DPP-4) inhibitors – gliptins, sodium-glucose cotransporter-2 (SGLT2) inhibitors – gliflozins, thiazolidinedione derivatives – PPAR-γ agonists (pioglitazone).

Biguanides

Metformin in currently the most commonly used oral antihyperglycemic agent, administered to obese patients with characteristics of metabolic syndrome and to patients

with impaired glucose tolerance. It reduces liver gluconeogenesis, increases glucose uptake in tissues, reduces intestinal glucose absorption, reduces hunger, contributes to lower body weight, and improves lipid concentrations. Due to the risk of impaired renal function in elderly patients, metformin dosage is determined based on a renal function assessment performed before treatment initiation, and then modified during the course of treatment based on regular follow-up. Estimated glomerular filtration rate (eGFR) should be determined before the initiation of treatment with any product containing metformin, and then at least once a year [3]. If eGFR is between 45 and 30 mL/min, metformin dosage should be halved, and at eGFR < 30 mL/min, metformin should be discontinued.

- In patients at risk of further renal function impairment and in elderly individuals, renal function should be evaluated more frequently, every 3–6 months.
- Intravenous administration of iodine-based contrast media may lead to contrast-induced nephropathy, leading to metformin accumulation and increasing the risk of lactic acidosis. Metformin should be withheld before or during imaging examination, and for at least 48 hours afterwards, after which it can be restarted if a new renal function assessment shows stable renal function [3].
- Metformin should be withheld directly before any surgical procedure performed under general, subarachnoid, or epidural anesthesia. Treatment can be restarted no earlier than 48 hours after the surgery or after resumption of oral feeding, provided that a new renal function assessment shows stable renal function [3].

Notes:

- The initial dose of metformin is usually between 500 mg and 850 mg 2 or 3 times daily, during or after a meal. Gastrointestinal disorders such as nausea, vomiting, diarrhea, abdominal pain, or appetite loss may appear at the beginning of treatment and usually resolve spontaneously. To prevent these symptoms, the patient should take their metformin in 2 or 3 daily doses, during or after a meal. Increasing the dose slowly over time may improve the gastrointestinal tolerance.
- Extended-release forms of metformin (marked XR or SR) should be taken once daily, with the evening meal, and the tablets should not be split or chewed.
- Excessive alcohol intake during treatment with Etsform SR increases the risk of lactic acidosis.

Sulfonylurea derivatives stimulate insulin secretion by acting on the ATP-sensitive potassium channel in pancreatic β-cells. Their additional effects include the inhibition of glucagon secretion by pancreatic α-cells and increased insulin sensitivity in peripheral tissues, which may be due to the extrapancreatic action of these drugs or reduced glucotoxicity.

Contraindications include: type 1 diabetes, ketoacidosis, precomatose state and diabetic coma, severe kidney or liver failure, pregnancy and breastfeeding, hypersensitivity to sulfonylureas, and conditions associated with increased demand for insulin (burns, trauma, surgery, fever, acute stage of myocardial infarction) [4].

Notes:

- Modified-release gliclazide should be taken in one dose, before the morning meal, with the tablet(s) swallowed whole. If a dose is missed, the next day's dose should not be increased.
- Glimepiride should be taken immediately before or during breakfast or another major meal, with the tablets swallowed whole and washed down with some fluid.
- The patient should be informed that skipping the meal after taking the medication, taking the medication earlier than at the beginning of the meal, or incorrect dosage increases the risk of hypoglycemia leading to loss of consciousness.
- The patient should be educated on possible hypoglycemia symptoms, such as headache, intense hunger, drowsiness, fatigue, nausea, vomiting, agitation, aggressiveness.

Dipeptidyl peptidase 4 (DPP-4) inhibitors — gliptins

The incretin hormones glucagon-like peptide (GLP) 1 and gastric inhibitory peptide (GIP, also known as glucose-dependent insulinotropic polypeptide) are intestinal hormones involved in the regulation of glucose homeostasis. Normally, they are continuously secreted at low baseline concentrations, which increase after a meal. In type 2 diabetes patients, the action of incretins is disturbed, with significantly reduced GLP-1 secretion and impaired activity of GIP.

Gliptins (or DPP-4 inhibitors) are very strong, selective, reversible, and competitive dipeptidyl peptidase (DPP-4) inhibitors. They inhibit the inactivation of GLP-1, improve the sensitivity of β islet cells to glucose, increase glucose-dependent insulin secretion, and improve the glucose sensitivity of α-cells, resulting in a more glucose-dependent glucagon secretion. The very low risk of hypoglycemia is a strength of these drugs, as is their neutral effect on body weight. The substances are very well tolerated and particularly recommendable in elderly patients [3].

Increased insulin/glucagon ratio during hyperglycemia, resulting from higher incretin concentrations, results in reduced glucose release from the liver, both when fasting and postprandially, and consequently, in lower glycemia. DPP-4 inhibitors also have a beneficial impact on lipid profile parameters:

- ↓ total cholesterol level,
- ↓ LDL cholesterol level,
- ↓ triglyceride level,
- ↓ HDL cholesterol level in the serum [4].

Notes:

- The tablets may be taken independently of meals, at any time of the day. If a dose is missed, the patient should take it as soon as they remember.
- Patients should not take a double dose on the same day.
- Tablets should be swallowed whole.

Oral GLP-1 analogue – the main effects of GLP-1 consist in stimulating insulin secretion (i.e. acting as an incretin hormone) and inhibiting the secretion of glucagon, thus contributing to the reduction of postprandial blood glucose spikes. It also inhibits gastrointestinal motor and secretory function, acting as an enterogastrone and forming part of the "ileal brake" mechanism. GLP-1 also seems to be a physiological regulator of appetite and feeding. The drug has the form of oral tablets taken once daily, on an empty stomach, at any time of the day. The tablet should be swallowed whole, with a small amount of water (half a glass, or 120ml). The tablets must not be split, crushed, or chewed, as the impact on semaglutide absorption is unknown. Patients should wait at least 30 minutes before eating, drinking, or taking any other oral medication. A break shorter than 30 minutes will reduce the absorption of semaglutide. Any missed doses should be skipped, and the next one taken normally on the next day [3].

Sodium-glucose cotransporter-2 (SGLT2) inhibitors – gliflozins

SGLT2 inhibitors, also known as gliflozins, are drugs that reduce renal glucose reabsorption and cause glucose to be eliminated with urine, thus lowering the blood glucose level. Mechanism of action:

- They block the action of the SGLT2 cotransporter, reducing glucose reabsorption and causing glucose elimination with urine.
- They reduce both fasting and postprandial blood glucose levels.
- They cause body weight reduction through glycosuria, and are slightly diuretic, producing a moderate blood pressure reduction [4].

Notes:

- Patients treated with gliflozins should be informed of the risk of urinary tract infection associated with glycosuria.
- Patient education should include the following topics: drinking at least 7 glasses of fluids a day (more when physically active), proper hygiene, with particular attention to intimate areas, avoiding baths, avoiding excessive holding of urine, urinating at least once every 4 hours, wearing loose-fitting cotton underwear, increasing one's fluid intake if urine is dark (more concentrated). Female patients should regularly see a gynecologist, while male patients should see a urologist in case of frequent urination or difficulties when urinating.
- The drugs can be taken with a meal or independently. Tablets should be swallowed whole and washed down with water.
- Drugs from this group cannot be used during prolonged fasting periods.
- In stressful situations, e.g. during severe infection or in perioperative periods, the patient should consult with their physician regarding the withholding of the medication.
- Treatment with these drugs is associated with glycosuria, and potentially, with ketonuria.

Thiazolidinedione derivatives – PPAR-γ agonists (pioglitazone)

Pioglitazone may be used as a single agent in obese patients with type 2 diabetes who cannot use metformin due to intolerance or contraindications. Pioglitazone appears to be particularly indicated in obese patients with a high degree of insulin resistance [4].

Mechanism of action: reduction of insulin resistance in peripheral tissues, reduction of liver gluconeogenesis, and reduction of blood glucose level accompanied by reduced levels of free fatty acids and triglycerides, and higher level of HDL cholesterol. This results in a positive effect of thiazolidinediones on the functioning of β islet cells. Adverse effects may include fluid retention, increased body weight, and higher liver enzyme levels, which may suggest liver toxicity [5].

Notes:

- Pioglitazone tablets should be taken once daily, with a meal or between meals.
- The tablets should be washed down with one glass of water.

Alpha-glucosidase inhibitors

Intestinal α-glucosidase inhibitors act on enzymes present in the brush border of the small intestine that are responsible for the decomposition of disaccharides into glucose and its subsequent absorption in the digestive tract. In the intestine, these drugs inhibit carbohydrate digestion, thus reducing glucose absorption and lowering postprandial glycemia. Due to significant individual differences in terms of glucosidase activity in the intestinal mucosa, there is no fixed dosage – treatment should be adjusted to the clinical response and tolerance for intestinal adverse effects. In adults, the recommended initial dose is 50 mg three times a day [6].

Notes:

- The tablets are only effective when swallowed whole, with a small amount of fluid, right before a meal or at the start of a meal.
- In the initial treatment period (first 6-12 months), liver enzyme levels must be monitored.
- When using Glukobay, patients should not consume foods containing sucrose, as this may cause diarrhea [7].

A chronically progressive course of diabetes requires combination therapy. To improve patient cooperation and simplify treatment protocols, combination drugs, most commonly containing metformin and gliptins or gliflozins, are increasingly often used in diabetes treatment. Products combining gliptins and gliflozins are also available [8].

Combination products containing 2 active substances with antihyperglycemic effects: dapagliflozin and metformin. The two substances have different mechanisms of action, and their combined use aims at improving blood glucose control in patients with type 2 diabetes [9-10].

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XVII. GUIDELINES FOR USING INFORMATION AND COMMUNICATION TECHNOLOGIES IN NURSING DIABETES CARE

Purpose: Supporting nurses and midwives in making decisions regarding patient care. Providing nursing care in accordance with the current state of knowledge, competences and resources using information and communication technologies.

Guidelines for: nurses and midwives

Tab. 18. Key recommendations. Use of information and communication technologies in nursing diabetes care

Telenursing may support maintaining good metabolic control of diabetes, providing therapeutic education, reducing treatment costs, improving patient quality of life and reducing the number of patient visits to health care facilities and the number of nurse house calls. **C**
A teleappointment must not be the only form of service used in diabetic patient care and cannot replace periodical direct visits. It is recommended to use a hybrid therapy model. **C**
Using telemedicine is a good supplement to traditional forms of patient care especially in preparing patients for self-care and limiting acute complications of diabetes. **C**

Introduction

- Information and Communication Technologies (ICT) belong to the field of information technologies and combine telecommunication with tools and technologies related to the exchange and transmission of information. ICT includes hardware and software used for sending, presenting and protecting the data collected. The major services provided by nurses to diabetic patients using ICT are teleappointments, teleeducation and remote monitoring [1,2].
- According to the International Council of Nurses (ICN) telenursing is "the use of telecommunication technology in nursing to enhance patient care" [3]. The telenursing practice combines 3 areas: information technologies, nursing care and modern medical equipment. Telenursing practice allows for overcoming the issue of distance and providing support to individuals who do not have access to outpatient clinics or health services due to the time of day, distance or limited mobility caused by their condition [1,2,4].
- Telenursing must be practiced within the limits of professional qualifications. The guidelines presented herein are to support the nurse/midwife in cooperating with other members of a diabetes treatment teams. They are intended for use in conjunction with national standards including the Recommendations of Diabetes Poland (DP) [1,2].
- Telenursing is a developing discipline which uses innovative technologies to improve nursing care standards. However, it does not change the character of professional practice [5,6].
- Teleappointment is a health service provided remotely using ICT systems or communication systems [2,7].
- Teleeducation is defined as health and therapeutic education provided using ICT systems or communication systems independently of health care services as part of comprehensive telemedical care. DP recommendations and the results of studies on the effectiveness of diabetes teleeducation provided by nurses indicate that there is potential in this type of service for diabetic patients and that developing and implementing it is justified. Teleeducation will improve access to therapeutic education experts and the patients will benefit from a broader spectrum of therapeutic education. There should be a possibility to provide diabetes education using telemedicine solutions [1,8].
- Teleconsultation is a health service provided by medical personnel (nurse/physician) calling the patient on the phone [2,6,7].
- Videoconsultation is a new method for providing medical services which allows for using modern technologies to improve communication between the patient and the physician/nurse/midwife. During a videoconsultation session the patient can connect from any location using a secure IT platform to participate in a medical consultation [5].
- Telemonitoring is a service that involves ongoing continuous supervision of the patient's health through the analysis of data provided by monitoring devices or a dedicated application and taking appropriate actions in life- and health-threatening situations [9].

- To provide effective cooperation between service providers it is recommended to introduce dedicated health services allowing for trilateral communication between the patient, medical professional (providing care to the patient as part of the service) and the diabetes specialist [5].

1. Infrastructure, technical requirements, software used in telenursing

Telenursing and teleeducation require adapting the service provider's digital infrastructure to offer high-quality telemedicine services. The teleconsultation office infrastructure should create an environment conducive to consultation.

- The room in which synchronous teleconsultation services are provided should be located far away from sources of noise. Patients and nurses should not be sitting with their backs towards the window as it produces a backlight effect that reduces image quality. If such arrangements cannot be made, curtains should be used to reduce the unwanted lighting effect.
- The primary tools required for providing telenursing services are: land-line or mobile telephone connection, social media account, email account and the capability of the system or product to guarantee technically effective exchange of patient information with other systems or products. Secure and stable Internet connection is required to organize videoconferences and provide uninterrupted communication. It is recommended to use at least two Internet providers to maintain reliable communication with patients [10].
- A computer system comprises software and hardware. The types of hardware most commonly used in telenursing consultations are desktop and laptop computers or tablets. Other required pieces of hardware include a camera and a microphone. A high resolution camera should be installed at eye level. Maintaining a professional image of the service provider during teleconsultations is very important for building relations with patients. Another important aspect of teleconsultations is active listening and maintaining eye contact (i.e. looking into the camera). The patient must always be informed if the nurse is making notes when obtaining their medical history, so that it is not perceived as a lack of focus. It is best to use a low-noise microphone with appropriate sensitivity and gain.
- The software should be easy to use and adaptable and it should provide uninterrupted communication with the patient. It is recommended to use a solution that is popular among the general public and provides full data security [6].

2. Communication methods used in telenursing

Similarly to telemedicine, telenursing uses all channels of communication with the patient available on IT platforms including voice, images, text and digital data exchange. Communication methods are further divided into synchronous and asynchronous. Each of these methods has its advantages and limitations when used for providing nursing care.

Synchronous communication methods

- Telephone: convenient, quick, unlimited range; it is an optimum solution for urgent cases; does not require separate infrastructure; provides greater privacy for the patient; allows for real-time interaction. The disadvantages of this method include the risk of non-verbal cues going unnoticed; the need to carefully identify the patient; not suitable for situations that require visual inspection of e.g. skin or tongue [5,10,11].
- Videochat using communication platforms: a real-time interaction; a method most closely resembling an actual direct consultation. The advantages of this method include: patient identification is easy; the nurse can see the patient; the nurse can discuss the problem with the carer; visual cues can be seen; the condition of the patient can be inspected visually. The disadvantages include: the risk of invading the patient's privacy; communication depends on high-quality Internet connection that must be uninterrupted on both ends, otherwise it leads to less-than-optimal exchange of information [10,11].

Asynchronous communication methods

- Email, fax: a convenient and simple communication method that is easy to document; it is more useful when sending test reports or other data collected using monitoring devices; does not require an app to receive images, data or reports; does not require separate infrastructure. The disadvantages include: no real-time interaction, information sent one way at a given time; based on data/information provided by the patient; identification of the patient is based only on difficult to verify documents; no non-verbal cues; possible delays in response because the service provider may not receive messages immediately after they are sent by the patient; increased risk of data security breach. It is required to use encryption and strong passwords.

Methods combining synchronous and asynchronous communication

- Contact based on text messaging (e.g. webchat, mobile applications, SMS): convenient and quick communication method, identification features may be built into the communication platform; can be used in urgent cases and for observation; allows for easy consultation with other specialists and does not require separate infrastructure. Real-time as well as asynchronous contact possible. Limitations include: uncertainty regarding the identity of the service provider and patient, no live image and no verbal communication; possible delays in messages reaching the service provider [6,10].

3. Rules for providing services using ICT

- Test the hardware (camera, microphone, Internet connection) before the planned contact with the patient. Make sure that you know whom to contact to get technical support and make sure you have an alternative channel of communication.

- Inform the patient that their privacy and personal information is protected. Do not conduct telenursing consultations in noisy rooms or in open spaces.
- Requirements for effective communication:
  - First, identify the patient and greet them. Use a soft speaking voice so that the patient feels safe. Listen actively, without interrupting the patient. Present substantial information but use simple language that is understandable for the patient without referring to complex medical terminology. Use body language, e.g. lean towards the camera.
  - Do not express any signs of nervousness or impatience through e.g. facial expression.
  - React to verbal, non-verbal, emotional and behavioral cues from the patient. Ask open-ended questions, making sure to put them in a logical order to collect reliable information about the patient.
  - Listen to the fears expressed by the patient and make sure to engage the patient in making decisions regarding the therapy. Be careful to treat the patient as a person and make sure that they are an empowered participant of the therapeutic process.
  - Do not make any decisions on the diabetic patient's behalf. Reinforce the patient's adherence by providing education and shaping self-care skills [12,13].
  - Do not overwhelm the patient with unnecessary information. Always close the consultation with appropriate courtesies [11].

4. Professional responsibility

- The nurse bears professional responsibility for the care and therapeutic education provided via telenursing. Constantly monitor the educational needs of diabetic patients, including those related to the technical progress in telemedicine and telenursing.
- Telenursing services must be provided in accordance with strictly specified professional roles, standards and guidelines. Do not provide any advice outside of your professional competences.
- The nurse should be aware of the professional responsibility when using videoconference tools and social media (Facebook, WhatsApp etc.), especially with regard to security of private and sensitive information.
- The entire treatment team is obliged to maintain professional secrecy. Do not provide any information and/or send images/videos related to the patient to anyone. Do not copy email messages from the patient without their permission.
- Act on behalf of your patients and provide them with technological solutions that protect their rights and interests. Conduct personnel training in the fields of telenursing and teleeducation.
- Remain within the boundaries of professional contact with the patient.
- Telenursing may involve greater risks as it does not allow for providing identical care as in the case of direct care. To mitigate these risks clearly establish the duties, employment conditions and policies that support telenursing.
- Nurses providing care using modern technological solutions should be engaged in identifying and documenting risks as well as in risk management and risk mitigation.
- Nurses providing telenursing services and/or diabetes teleeducation must constantly expand their knowledge on diabetic patient care, improve their professional interpersonal communication competences and technical skills related to using modern telemedicine solutions [5].
- Some patients feel a strong need to create personal relations with their physician/nurse ("face to face contact") and as a result consider telemedicine services inappropriate. If this is the case, do not impose using telemedicine solutions.

5. Legal and ethical considerations

- Privacy and protection of personal information must be guaranteed when collecting and processing data, especially information regarding patient's health. Always take into consideration the possibility of a failure or technical defect. Protection of privacy and data security are paramount for building trust in telemedicine solutions [14].
- The secrecy of patient information must be maintained at all times. Always inform the patient if other members of the treatment team will have access to personal information regarding their health. Do not disclose information regarding the patient without their permission to any third-party, including the patient's family.
- Nurses must take all the steps necessary to protect the patient against accidental disclosure of communications to unauthorized persons. This is particularly important if sound or images are transmitted when providing services.
- Telenursing and teleeducation are conducted based on the legal regulations in force, the Code of Conduct for Nurses and Midwives, the Nurses and Midwives Act and current standards. Provide security solutions in accordance with the regulation on the protection of natural persons with regard to the processing of personal data (GDPR).
- Using the technical infrastructure as well as legislative means will provide full access to the patient's medical data and will impact the effectiveness of health services.
- When providing services using ICT it is possible that situations will arise which require the provider to notify appropriate institutions about the encountered problems (e.g. suspected abuse of a child / elderly person). This must be done in accordance with the legal regulations in force, regardless of the patient's requests to maintain secrecy [1,6].

6. Framework for telenursing practice

- Telenursing may be practiced in public and in private healthcare. It is important to supplement this practice with consultations between the nurse and the primary care physician, diabetologist and experts in other fields of nursing as well as other members of an interdisciplinary team. Consultations between nurses and phy-

sicians are particularly important in the case of poorly controlled diabetes.
- All consultations should be based on a nursing diagnosis. The nursing staff should be well prepared to decide if ICT-based consultations are a sufficient form of contact or if it is required to conduct a videoconsultation involving a physician or if a personal consultation with a nurse and/or physician is required. Do not continue to use telenursing if the patient is not interested in such form of consultation or if they ask for a personal consultation. Additionally, both the patient and the nurse have the right to terminate a teleconsultation. Nursing consultations should be anonymous.

7. Documentation
- Documentation may be collected on paper or in electronically and should be stored in accordance with the legal regulations in force (e.g. in a patient summary form). Every telenursing consultation should be documented in accordance with the legal regulations in force and other regulatory requirements and should reflect the nursing process. Never remove data from medical documentation. When creating telenursing consultation documentation follow the general principles of creating medical documentation. Pay close attention to the precision and correctness of the nursing diagnosis, make sure that the data is complete and that all information is up to date and organized logically using a correct layout and sequence of information. Only use abbreviations, symbols and acronyms that are found in the currently applicable list of abbreviations symbols and acronyms.
- Start creating the telenursing consultation documentation by entering the date and time and close it with the nurse's signature and nursing license number. Always note down the patient's name and surname, their telephone number, reason for consultation, information provided by them / collected, the advice provided, further recommendations and plan for future care. Insufficiently precise information will result in incorrect decisions regarding patient care. Using a chronological layout in documentation makes it clearer.
- Each of the documents should be signed by the service provider. To provide cohesion and precision of the telenursing documentation, the nurses should work with their employers to develop appropriate procedures. Employers should provide nurses with detailed guidelines regarding the documentation, containing suggestions on what documentation template should be employed in the telenursing practice.

8. Phases of telenursing consultation

The telenursing/teleeducation consultation should comprise the following phases:
- **Selection of communication method**

The most common communication methods include videoconference, telephone call or text (e.g. webchat, images, messages, email, fax, information collected from monitoring devices). The communication method should be suitable to the current situation and the patient's needs [10,11].
- **Identification of nurse and patient**

During the telenursing consultation the nurse and the patient should know each other's identity. The nurse should verify the identity of the patient – their name, surname, age, sex, home address, email address and phone number. Present a form for collecting the patient's data. An adult must be present during telenursing consultation with children (individuals under the age of 18). The nurse should obtain the patient's / patient family's permission to transfer the patient's information to a physician and other treatment team members. The nurse is identified by the nursing license number.
- **Obtaining patient's consent**

Before providing telenursing services using ICT the patient must express their informed consent. Telenursing is subject to the same legal regulations regarding patient's consent as nursing care provided in direct contact. Patient's consent may be implicit or explicit. If the patient initiates the telenursing consultation, their consent is implicit. Explicit patient's consent is required if the telenursing consultation is initiated by the nurse, by another healthcare employee or the patient's family. The explicit consent may be presented in any form, e.g. sent by email, SMS, voice/video message or a consent form, and must be recorded. The patient may express their consent for telephone contact or videoconsultation with the nurse using simple language. The patient's consent statement must be recorded in the patient summary form. Nurses providing telenursing services should work with their employees to develop procedures for obtaining the patient's informed consent.
- **Initial evaluation**

In this phase the initial evaluation of patient condition and of the risks related to remote contact is performed.
  - The nursing staff should use their clinical skills and nursing skills to evaluate the condition of the patient and decide if telenursing consultation is the appropriate form of care in the given situation or if direct nursing consultation or consultation with a physician is required. Establish the preliminary purpose of the consultation and any new complaints. After resolving any issues with a physician the nursing staff should help the patient decide what type of care is needed on a given day. The service provider should develop protocols for preliminary patient evaluation to support the nurse in making decisions regarding the patient, also in an emergency situation. If there are no new complaints the consultation should continue based on the diagnosed nursing needs, including educational needs. Always maintain the same high nursing care standard as during direct consultations. This applies to preliminary visits, follow-ups as well as during consultations based on a referral from another specialist. The first visit, regardless of its purpose, should be performed in direct contact and telemedicine using ICT should be introduced during the following visits.
  - The nurse should consider if and to what extent the limited access to the patient's documentation and the inability to directly evaluate the patient's condition may affect the ability to provide comprehensive nursing care.

- Regardless whether the patient-nurse relation is developed in person or using ICT, they must be based on the evaluation of the patient's health and nursing needs. Therapeutic relations should always take into account the patient's cultural context (including language), spiritual needs and psychosocial preferences. Refer the patient to other specialists immediately if it is found that their needs exceed the knowledge, skills and competences of the nurse.

- **Nursing diagnosis**

The first telenursing consultation should be conducted in the presence of a physician, while further consultations can be conducted by the nurse alone [7]. Before formulating the nursing diagnosis, collect and analyze all information about the patient. It is easier to formulate a diagnosis if patient information is collected one or two days before the scheduled telenursing consultation. It is recommended that the patient sends general information about themselves to the email address provided. The information should include their current complaints, the occurrence of severe hypoglycemia, severe hyperglycemia or ketoacidosis since the previous direct or telenursing consultation, bodyweight, height, injection site condition, self-monitoring and insulin therapy. In the case of functional insulin therapy, the patient should provide the name of the insulin used, the number of injections and dose of insulin taken with meals, the total number of injections and correction doses from the preceding 3 days, the dose of insulin usually injected with individual meals and the number of carbohydrate exchanges per meal. When using pen injectors, the patient should specify the name and dose of basal insulin per day and the time of administration. When using an insulin pump, the patient should provide the basal dose at specified times of day and read out the following information from the bolus calculator: meal equivalent (number of insulin units per 1 carbohydrate exchange or quantity of carbohydrates in grams per 1 unit of insulin), insulin sensitivity (by how many mg% the glucose level decreases when administering 1 unit of insulin) and the target glucose level range. If the insulin pump has an integrated sensor, the patient should provide the „low glycaemia" alert setting value. The patient should provide readouts from glycaemia monitoring devices from the preceding 2–4 weeks (if the patient uses such devices), e.g. from monitoring devices integrated in the insulin pump, continuous glucose monitoring device (CGM) or flash glucose monitoring device (FGM), which present daily trends and weekly summaries. If the patient does not use any monitoring devices or is unable to send readouts from the insulin pump or reports from the application working with the glucose meter, they should note down the glycaemia value during the preceding 14 days in a journal or in a spreadsheet (e.g. Excel file) and send the image of this journal or the spreadsheet file to the nurse. If the patient uses an insulin pump, they should also note down other information stored in the insulin pump memory: basal insulin, meal equivalents and insulin sensitivity. The patient should note down the glucose level results and the dose of bolus insulin at meals and corrections from several preceding days. The patient should also note down the results of the last HbA1c measurement [15]. Patients with type 2 diabetes who take oral medications or subcutaneous injections of GLP-1 receptor analogues should provide detailed information on the names and doses of the medications administered and report any adverse symptoms. The patients should also provide their blood pressure self-monitoring journal and the results of any biochemical tests performed recently, especially total cholesterol, triglycerides, LDL and HDL cholesterol fractions, creatinine, the last glomerular filtration rate (GFR), results of the last urine sample test and information whether proteinuria or microalbuminuria has been diagnosed in the preceding year. It is recommended that the diabetic patient provides discharge documentation if the hospitalization was related to diabetes and any other medical documentation.

It is recommended that the patient performs a fasting glycaemia measurement and urinary acetone level or blood ketone level measurements on the day of teleconsultation. Before the telenursing consultation, the patient should inform the nurse if they need any prescription medications or medical products (e.g. catheters, containers, sensors, transmitters) [7].

The nurse can run the patient's entire documentation (if it is agreed so), including medical records, collect test results and information on the treatment regimen ordered by physicians as well as any care provided by the nursing staff in accordance with the selected nursing care delivery model e.g. in accordance with the International Classification for Nursing Practice (ICNP). The classification provides standardized nursing terminology that facilitates the exchange of information [3].

9. Teleeducation in diabetes nursing

- Therapeutic education should be preceded by an interview to evaluate the readiness of the diabetic patient for self-monitoring and self-care. Establish individual therapeutic goals, prepare a diabetes education plan and provide the patient with information based on their individual therapeutic goals [13].
- The scope of education provided using telenursing is very broad and can cover: nutrition; physical activity; calculation of carbohydrate exchanges and protein-fat exchanges in food; self-monitoring and self-observation techniques; collecting information in a paper or electronic self-monitoring journal and analyzing them; insulin administration techniques; correcting insulin doses; administration of oral antidiabetic medications; causes and symptoms of hypoglycemia and hyperglycemia; the importance of periodical specialist consultations; feet monitoring techniques as well as primary, secondary and tertiary a prophylaxis of diabetic foot; wound dressing and management; stress management techniques; detrimental effects of alcohol consumption.
- If the patient is a smoker and does not intend to quit, remind the patient about the detrimental effects of smoking during each teleeducation session and note the patient's refusal to quit in the medical documentation.
- Evaluate the progress made by the patient and prepare a reeducation plan for the following sessions every time.

- Over the course of the teleeducation process use various didactic tools and methods e.g. educational videos on self-injecting insulin, observation of injections sites, limiting glycaemia using various methods etc.
- Acting as an advisor the nurse provides information on the disease itself, the importance of following medical recommendations, follow-ups and tests to be conducted before the next session [12].
- The nurse is one of the mainstays of the emotional support system for the patients and their families.
- Maintain medical documentation related to diabetes teleeducation, documenting the provided recommendations (the formal – planned – and informal -unplanned- materials used for educational purposes, teaching methods, patient and/or their family engagement, evaluation of goal completion by the patient and/or their family, validation of their understanding, all future actions to be taken) [15].
- The goal of the nursing staff in diabetic care is to support the patient in following the treatment regimen ordered by the physician. The nurse often initiates additional teleconsultations with a physician to provide the patient with the best possible care [16].
- The nurse may use remote systems to monitor patient parameters and should verify if the patient adheres to the medication regimen, evaluate the condition of wounds (if present) and recommend applying the correct dressing, provide advice regarding foot care, consolidate skills in using a pen injector, a glucose meter and an insulin pump, provide advice on correcting the insulin dose, provide advice on administering GLP-1 receptor antagonists as subcutaneous injections, provide advice on administering oral antidiabetic medications [9,12].
- During teleeducation sessions the nurse should remind the patient of the required follow-ups with specialists and motivate them to attend these appointments as well as help provide the patient with referrals to physiotherapists, dietitians, psychologists, social workers and other members of an interdisciplinary team [17].

10. Telemonitoring – remote monitoring devices

- Monitoring the completion of therapeutic goals in diabetic patients is possible using modern medical devices, e.g. remote glucose monitoring systems – real time continuous glucose monitoring (rtCGM) or flash glucose monitoring (FGM) / intermittently scanned continuous glucose monitoring (isCGM), as well as other products and applications.
- Standard glucose meters with dedicated apps can also be used. Additionally there are pen injectors and insulin pumps that can be a source of data provided by the patient. This data can be collected using apps whose purpose is integrating and sending data from the patient to the service provider. The applications work with smartphones or tablets. In addition to blood glucose level monitoring, these applications allow for recording insulin doses, consumption of carbohydrate exchanges and protein-fat exchanges, identification of hypo- and hyperglycemia, alerting the patient to take medications or adjusting the operation of insulin pumps. There are also applications for diabetes education, for online contact with specialists and separate applications for pregnant diabetic patients.
- An electronic medical report at an outpatient telemedicine center allows for storing data from numerous health monitoring devices (tele-ECG; tele-spirometry; digital pulse oximeter; interactive stethoscope; remote monitoring of blood pressure, blood glucose level, temperature, body weight; fall detector; motion sensors and others) at a single site. The sensors collect information which is then transmitted wirelessly to an external mobile receiver, e.g. a mobile phone or smartphone. Then they are retransmitted in real time via telecommunication networks to the medical center where they are stored and analyzed. The patient is then sent feedback information with recommendations for further action in the form of an SMS, email or, in case of an emergency, a phone call. Measurements can be taken at a specified time e.g. during a planned teleconsultation with a nurse/physician or independently, based on the patient's needs. The results are sent to a database and archived there. They can be accessed at any time by a nurse/physician or by the patient.
- Remote monitoring solutions may also use artificial intelligence (AI) to create systems that automatically analyze data sent by monitoring devices and inform the service provider about any alarming changes in the patient's condition [10].
- Some patients, especially the elderly, may experience uncertainty and insecurity when using modern technical solutions. This stems from the lack of knowledge and skills required to operate electronic devices. Additional problems are related to the impediment of their motor and cognitive functions. As a result, the elderly find it more difficult to understand new information and adapt to ever-changing technologies and new self-monitoring solutions. It is important to prevent the digital exclusion of the elderly [9].

Telenursing – advantages and challenges

- Telenursing may involve greater risks as it does not allow for providing identical care as in the case of direct contact. Clearly establish the duties, employment conditions and policies that support the nursing practice involving ICT to mitigate these risks. Nurses providing telenursing care should be engaged in identifying and documenting risks [15].
- Telenursing may improve access to diabetic nursing care and improve the patient's comfort be reducing or eliminating their need to travel to a healthcare facility. However, these benefits cannot outweigh the safety of patient care. A thorough initial nursing examination combined with a physical examination is needed, which means that it may be necessary to organize a direct meeting [11,15,17-21].
- If at any point of the ongoing nurse-patient relation telenursing becomes insufficient, immediate steps must be taken to continue providing nursing care in direct contact.

- Telenursing as well as teleeducation that forms its part are dynamic processes in the nurse-patient relation, whose purpose is to meet the needs of the patient, based on trust and respect and protection of the patient's interests.
- Effective communication is necessary in developing all nurse-patient relations, but it is particularly important when using ICT [16].
- Nursing care delivery models are expanded thanks to the use of modern technologies. The telenursing practice will be continued and will evolve in the future [10,11,15,22,23].

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