DOI: 10.2478/pielxxiw-2020-0022
© 2020 Uniwersytet Medyczny w Lublinie.
This is an open access article distributed under the Creative Commons Attribution-NonComercial-No Derivs licence (http://creativecommons.org/licenses/by-nc-nd/3.0/)

Practical Guidelines for Nursing and Midwifery Diabetes Care – 2020 A position of the Polish Federation for Education in Diabetology

Praktyczne zalecenia w pielęgniarskiej i położniczej opiece diabetologicznej – 2020
Stanowisko Polskiej Federacji Edukacji w Diabetologii

Alicja Szewczyk[1,2], Natasza Tobiasz-Kałkun[2,3], Anna Stefanowicz-Bielska[2,4,5], Ewa Kobos[2,6], Mirosława Młynarczuk[2,7], Justyna Kapuściok[2,8], Jolanta Michałowska[2,9]

[1]The Children's Memorial Health Institute, Department of Endocrinology and Diabetology; Diabetes Clinic, Warsaw/
Klinika Endokrynologii i Diabetologii; Poradnia Diabetologiczna Instytut „Pomnik-Centrum Zdrowia Dziecka" w Warszawie
[2]Polish Federation for Education in Diabetology/Polska Federacja Edukacji w Diabetologii
[3]Department of Nursing, University of Warmia and Mazury in Olsztyn/Katedra Pielęgniarstwa, Uniwersytet Warmińsko Mazurski w Olsztynie
[4]Laboratory of Pediatric Nursing, Department of Internal and Pediatric Nursing, Institute of Nursing and Midwifery Faculty of Health Sciences with Institute of Maritime and Tropical Medicine, Medical University of Gdansk/
Pracownia Pielęgniarstwa Pediatrycznego, Zakład Pielęgniarstwa Internistyczno-Pediatrycznego, Instytut Pielęgniarstwa i Położnictwa, Wydział Nauk o Zdrowiu z Instytutem Medycyny Morskiej i Tropikalnej, Gdański Uniwersytet Medyczny
[5]Department of Pediatric Diabetology, Department of Paediatrics, Diabetology and Endocrinology, University Clinical Center in Gdansk – Hospital of the Medical University of Gdansk/
Oddział Diabetologii Dziecięcej, Klinika Pediatrii, Diabetologii i Endokrynologii, Uniwersyteckie Centrum Kliniczne w Gdańsku – Szpital Gdańskiego Uniwersytetu Medycznego
[6]Department of Development of Nursing, Social and Medical Sciences, Faculty of Health Sciences, Medical University of Warsaw/
Zakład Rozwoju Pielęgniarstwa, Nauk Społecznych i Medycznych, Wydział Nauk o Zdrowiu, Warszawski Uniwersytet Medyczny
[7]Diabetes and Internal Medicine Department, University Clinical Center, Central Teaching Hospital, Medical University of Warsaw/
Klinika Diabetologii i Chorób Wewnętrznych, Uniwersyteckie Centrum Kliniczne Warszawskiego Uniwersytetu Medycznego, Centralny Szpital Kliniczny w Warszawie
[8]The Complex of Post-Secondary Medical and Social Schools in Bytom; Individual Nursing Practice/
Zespół Policealnych Szkół Medyczno-Społecznych w Bytomiu; Indywidualna Praktyka Pielęgniarska
[9]1st Department of Internal Diseases with the Department of Diabetology and Metabolic Disorders and the Department of Endocrinological Diagnostics of Bielanski Hospital Warsaw/
I Oddział Chorób Wewnętrznych z Pododdziałem Diabetologii i Zaburzeń Metabolicznych i z Pododdziałem Diagnostyki Endokrynologicznej Szpital Bielański w Warszawie

CORRESPONDING AUTHOR:
Ewa Kobos
Zakład Rozwoju Pielęgniarstwa, Nauk Społecznych i Medycznych, WUM
ul. Erazma Ciołka 27, 01-445 Warszawa
e-mail: ekobos@wum.edu.pl

STRESZCZENIE

PRAKTYCZNE ZALECENIA W PIELĘGNIARSKIEJ I POŁOŻNICZEJ OPIECE DIABETOLOGICZNEJ – 2020 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 naukowych.

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 odpowiednim statusie naukowym.

Wyniki. W efekcie pracy zespołowej uzyskano 11 procedur 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 2020 rok są efektem ewaluacji dotychczas prezentowanych wersji i stanowią 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 (New Insulin Delivery Recommendations).

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

ABSTRACT

PRACTICAL GUIDELINES FOR NURSING AND MIDWIFERY DIABETES CARE – 2020
A POSITION OF THE 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 an adequate scientific status.

Results. This joint study yielded 11 procedures 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 2020 PFED guidelines on nursing and midwifery diabetes care are the effect of the evaluation of the previous versions and comprise a 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, nurse, midwife, diabetes**

RECOMMENDATION OF GUIDELINES

Maria Kózka	National consultant in nursing
Grażyna Iwanowicz-Palus	National consultant in gynecological and obstetrical nursing
Anna Szczypta	National consultant in epidemiological nursing
Alicja Szewczyk	National consultant in diabetes nursing
Krzysztof Strojek	National consultant in diabetes
Dorota Zozulińska-Ziółkiewicz	President of the Polish Diabetes Association
Mirosława Młynarczuk	Masovian regional consultant in diabetes nursing
Joanna Stanisławska	Greater Poland regional consultant in diabetes nursing
Teresa Świątkowska	Kujawsko-Pomorskie regional consultant in diabetes nursing
Danuta Pyczek	Świętokrzyskie regional consultant in diabetes nursing
Bożena Guściora	Subcarpathian regional consultant in diabetes nursing
Agnieszka Karczewska	Lublin regional consultant in diabetes nursing
Agnieszka Olińska	Warmińsko-Mazurskie regional consultant in diabetes nursing
Iwona Trzepiałowska	Western Pomerania regional consultant in diabetes nursing
Magdalena Świątek	Łódź regional consultant in diabetes nursing
Anna Tracz	Lubuskie regional consultant in diabetes nursing
Krystyna Popławska	Podlaskie regional consultant in diabetes nursing
Iwona Pilarczyk – Wróblewska	Lower Silesia regional consultant in diabetes nursing
Grażyna Mamzer	Opole regional consultant in diabetes nursing

INTRODUCTION

Since 2006, the Polish Federation for Education in Diabetology (PFED) has published guidelines on diabetes care for nurses and midwives working with diabetes patients. 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 2020 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.

Tab. 1. Research evidence classification system used by PFED to create Practical Guidelines for Nursing and Midwifery Diabetes Care – 2020 (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 – 2019. Diabetes Care. 2019; 42(1): S1-S2.

SELF-MONITORING OF BLOOD GLUCOSE (SMBG)

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.

Sites for capillary blood sampling

In adults, the fingertip is typically the preferred site for capillary blood sampling (Fig. 1a). Sides of the heel (medial or lateral aspect of the plantar surface) are only used in children and infants (Fig. 1b). Earlobes are sometimes used for capillary blood sampling in screening or research.

Tab. 2. Recommendations. Self-monitoring of blood glucose

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. The devices should be used in accordance with the manufacturer's instructions. **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 SMBG 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**

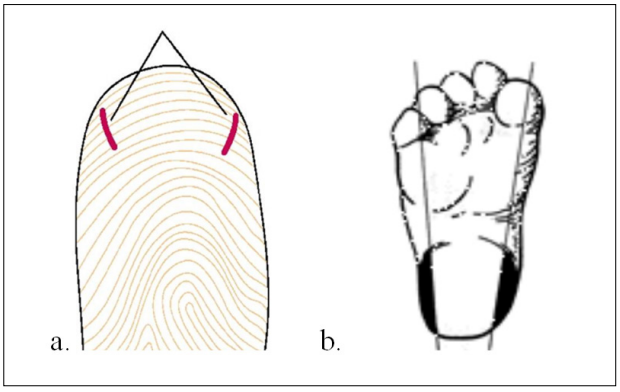

Fig 1. Puncture sites

a) Fingertip. 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.

b) Heel, in infants <1 year old. 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.

Source: Rodak BF. Diagnostic Hematology. Philadelphia: W.B. Saunders; 1995. Accessed: March 10, 2020. https://doctorlib.info/hematology/rodak-hematology-clinical-principles-applications/4.html

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.

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.

Incision depth for a heel-prick in children should not exceed 2.4 mm. In premature infants, a 0.85 mm lancet is sufficient. Excessively deep puncture may lead to calcaneal osteomyelitis. 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. Finger-pricks should not be performed in infants, as this could result in nerve damage.

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.

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

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.

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.

Alternate site testing (AST)

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

Alternate puncture sites:

- 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. 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.

AST is not recommended in the following circumstances:

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

Factors interfering with blood glucose measurement

- environmental factors – described in the user manual of any glucose meter;
- technology-related factors;
- photometric technology;
- biosensor technology;
- physiological factors:
  - endogenous substances in the blood: high concentrations of triglycerides, bilirubin, creatinine; hematocrit below 30% (anemia, chronic kidney disease, bleeding) or above 60% (dehydration from diarrhea, vomiting, diabetic ketoacidosis, hyperosmolar hyperglycemic nonketotic syndrome);
  - exogenous substances, e.g. due to improper hand hygiene – residual sugar from fruit or sweets; residues of disinfectants, hand cream, or medication.

Measurement technique

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. 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. 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).
4. Place the test strip in the glucose meter and immediately close the test strip package.
5. 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).

6. 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).
7. 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).
8. 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 meter, only PN–EN ISO 15197:2015–10 compliant glucose meters must be used.
- 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. 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. 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.
- 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.
- Patients should be informed on the impact of physiological and environmental factors and any medication taken on glucose measurement results.
- Patients should be assessed on their technique of blood glucose self-monitoring once a year.
- 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. The check should be recorded in the health care institution's documentation, 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.

Important! The lancing device is a personal device.

REFERENCES

1. Abril Martin JC, Aguilar Rodriguez L, Albiñana Cilveti J. Flatfoot and calcaneal deformity secondary to osteomyelitis after neonatal heel puncture. J Pediatr Orthop B 1999; 8(2): 122–124.
2. Al-Rubeaan KA, Saeb AT, AlNaqeb DM, et al. The bacterial contamination rate of glucose meter test strips in the hospital setting. Saudi Med J. 2016; 37(9): 985-995.
3. American Diabetes Association. 7. Diabetes technology: Standards of Medical Care in Diabetes – 2019. Diabetes Care. 2019; 42(1): S71–S80.
4. American Diabetes Association. Standrads of Medical Care in Diabetes – 2019. Diabetes Care 2019; 42(1): 1-204.
5. Bina DM, Anderson RL, Johnson ML, et al. Clinical Impact of Prandial State, Exercise, and Site Preparation on the Equivalence of Alternative-Site Blood Glucose Testing. Diabetes Care 2003; 26(4): 981-985.
6. Canale ST, Manugian AH. Neonatal osteomyelitis of the os calcis: a complication of repeated heel punctures. Clin Orthop Relat Res. 1981; 156: 178–182.
7. Cheng L, Sit JWH, Choic KC, et al. Effectiveness of a patient-centred, empowerment-based intervention programme among patients with poorly controlled type 2 diabetes: A randomised controlled trial. International Journal of Nursing Studies. 2018; 79: 43-51.
8. Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. Patient Educ Couns. 2016; 99(6): 926-943.
9. Cobaugh DJ, Maynard G, Cooper L, et al. Enhancing insulin-use safety in hospitals: practical recommendations from an ASHP Foundation expert consensus panel. Am J Health Syst Pharm. 2013; 70: 1404–1413.
10. D'Orazio P, Burnett RW, Fogh-Andersen N, et al. International Federation of Clinical Chemistry Scientific Division Working Group on Selective Electrodes and Point of Care Testing. Approved IFCC recommendation on reporting results for blood glucose (abbreviated). Clin Chem. 2005; 51: 1573–1576.
11. Erbach M, Freckmann G, Hinzmann MR, et al. Interferences and Limitations in Blood Glucose Self-Testing. An Overview of the Current Knowledge Diabetes. Sci Technol. 2016; 10(5): 1161–1168.
12. Farmer L, Winfield C, Quatrara B, et al. Does Site Matter? Comparing Accuracy and Patient Comfort of Blood Glucose Samples Taken From the Finger and Palm of the Perioperative Patient. J Perianesth Nurs. 2017; 32(6): 573-577.
13. Folk LA. Guide to capillary heelstick blood sampling in infants. Adv Neonatal Care 2007; 7(4): 171-8.
14. Ginsberg BH. Factors Affecting Blood Glucose Monitoring: Sources of Errors in Measurement. Journal of Diabetes Science and Technology. 2009; 3(4): 903-913.
15. Guidelines on the management of diabetic patients A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1): 1-103.
16. Hellinger WC, Grant RL, Hernke DA, et al. Glucose meters and opportunities for in-hospital transmission of infection: Quantitative assessment and management with and without patient assignment. Am J Infect Control. 2011; 39: 752-756.
17. Hellman R. Niedokładności w pomiarach stężenia glukozy za pomocą glukometrów. Diabetologia po Dyplomie. 2012; 9(4): 40-45.

18. Hortensius J, Slingerland RJ, Kleefstra N, et al. Self-monitoring of blood glucose: the use of the first or the second drop of blood. Diabetes Care. 2011; 34(3): 556-560.
19. Jacoby MJ. An Analysis of Alternate Site Tests to Improve Patient Compliance with Self-Monitoring of Blood Glucose. Journal of Diabetes Science and Technology. 2010; 4(4): 911-912.
20. Klonoff DC, Perz JF. Assisted monitoring of blood glucose: special safety needs for a new paradigm in testing glucose. J Diabetes Sci Tech. 2010; 4:.1027–1031.
21. Krleza LL, Dorotic A, Grzunov A, et al. Capillary blood sampling: national recommendations on behalf of the Croatian Society of Medical Biochemistry and Laboratory Medicine. Biochemia Medica. 2015; 25(3): 335–358.
22. Li M, Wang X, Shan Z. Deciding between using the first or second drop of blood for the self-monitoring of blood glucose. Prim Care Diabetes. 2014; 8(4): 365-369.
23. Lilien L, Harris VJ, Ramamurthy RS, et al. Neonatal osteomyelitis of the calcaneus: complication of heel puncture. Journal of Pediatrics. 1976; 88(3): 478–480.
24. Lucidarme N, Alberti C, Zaccaria I, et al. Alternate-Site Testing Is Reliable in Children and Adolescents With Type 1 Diabetes, Except at the Forearm for Hypoglycemia Detection MD1. Diabetes Care. 2005; 28(3): 710-711.
25. Ng R. Multicenter evaluation of bacterial contamination of glucose test strips. Clin Chim Acta. 2012; 413: 1485-1487.
26. Palese A, Fabbro E, Casetta A, et al. First or Second Drop of Blood in Capillary Glucose Monitoring: Findings from a Quantitative Study. J Emerg Nurs. 2016; 42(5): 420-426.
27. Panek M, Kwinta P. Nakłucie pięty u noworodka – najważniejsze zasady. Postępy Neonatologii. 2018; 24(1): 73-79.
28. Pérez-Ayala M, Oliver P, Rodríguez Cantalejo F. Prevalence of bacterial contamination of glucose test strips in individual single-use packets versus multiple-use vials. J Diabetes Sci Technol. 2013; 7(4): 854-862.
29. Rajendran R, Rayman G. Point-of-Care Blood Glucose Testing for Diabetes Care in Hospitalized Patients: An Evidence-Based Review. Journal of Diabetes Science and Technology. 2014; 8(6): 1081–1090.
30. Rodak BF. Diagnostic Hematology. Philadelphia: WB. Saunders; 1995.
31. Saini S, Kaur S, Das K, et al. Using the first drop of blood for monitoring blood glucose values in critically ill patients: An observational study. Indian J Crit Care Med. 2016; 20(11): 658-661.
32. Saththasivam P, Umadevan D, Ramli N, et al. Venipuncture versus heel prick for blood glucose monitoring in neonates. Singapore Med J. 2009; 50(10): 1004-1007.
33. Schaffzin JK, Southwick KL, Clement EJ, et al. Transmission of hepatitis B virus associated with assisted monitoring of blood glucose at an assisted living facility in New York State. American Journal of Infection Control. 2012; 40: 726-731.
34. Schreiber-Zamora J, Zielińska A, Wilkos E, i wsp. Bezpieczne pobieranie krwi włośniczkowej u noworodków. Postępy Neonatologii. 2019; 25(1): 37-40.
35. Stacherzak-Pawlik J, Rak A, Smaciarz J, i wsp. Badania w miejscu opieki nad pacjentem – glukometr jako narzędzie POCT. Wdrożenie systemu kontroli jakości. Diagn Lab. 2017; 53(4): 211-216.
36. Systemy do badań diagnostycznych in vitro – Wymagania dotyczące systemów monitorujących poziom glukozy we krwi do samokontroli u chorych na cukrzycę. PN-EN ISO 15197:2015-10.
37. Thompson ND, Perz JF. Eliminating the blood: ongoing outbreaks of hepatitis virus infection and the need for innovative glucose monitoring technologies. J DiabSci Technol 2009; 3: 283-288.
38. Thompson ND, Schaefer MK. "Never Events": Hepatitis outbreaks and patient notifications resulting from unsafe practices during assisted monitoring of blood glucose, 2009-2010. J Diab Sci Tech. 2011; 5: 1396-1402.
39. Tomasik P. Co nowego w normach ISO, wytycznych i prawnych regulacjach dotyczących badań w miejscu opieki? Diagn Lab. 2018; 54(1): 45-52.
40. Type 2 diabetes in adults: management. https://www.nice.org.uk/guidance/ng28 Accessed: 21.03.2020.
41. Vanhaeren S, Duport C, Magneney M. Bacterial Contamination of glucose test strips: Not to be neglected. Am J Inf Control. 2011; 39: 611-613.
42. WHO guidelines on drawing blood best practices in phlebotomy (Eng) 2010. Accessed: 10.03.2020. http://www.euro.who.int/__data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf?ua-1

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. 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. **C**
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. **E**
The FGM system should be used in accordance with the manufacturer's instructions. **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**

The FGM system allows for measuring the glucose concentration in interstitial fluid using a sensor with an integrated transmitter, inserted subcutaneously, and a reader.

- The recommended insertion site is the subcutaneous tissue of the posterior lateral part of the arm. Avoid areas with scars, birthmarks, stretch marks, or lumps. Select an area of skin that remains mostly flat (does not crease) during daily activities. The site should be 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.
- The introducer contains a needle. Do not touch the inside of the 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.
- The FGM sensor is factory-calibrated, and measurements are performed every minute. 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 sensor can be used for up to 14 days without capillary blood testing.
- 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.
- 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.
- 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.
- 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. Allergic contact dermatitis can be caused by isobornyl acrylate contained in the device.
- 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.

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.

REFERENCES

1. Aerts O, Herman A, Bruze M, et al. FreeStyle Libre: contact irritation versus contact allergy. Lancet. 2017; 390: 1644.
2. Asarani NAM, Reynolds AN, Boucher SE, et al. Cutaneous Complications With Continuous or Flash Glucose Monitoring Use: Systematic Review of Trials and Observational Studies. J Diabetes Sci Technol. 2019; 27: 1932296819870849.
3. Bailey T, Bode BW, Christiansen MP, et al. The Performance and Usability of a Factory-Calibrated Flash Glucose Monitoring System. Diabetes Technology & Therapeutics. 2015; 17(1): 787-794.
4. Bolinder J, Antuna R, Geelhoed-Duijvestijn P, et al. Novel glucose-sensing technology and hypoglycaemia in type 1 diabetes: a multicentre, non-masked, randomised controlled trial. Lancet. 2016; 388(10057): 2254-2263.
5. Diabetes UK Consensus Gudeline for flash Glucose Monitoring, Diabetes UK 2017. Accessed: 10.03.2020. https://www.diabetes.org.uk/resources-s3/2017-09/1190_Flash%20glucose%20monitoring%20guideline_SB_V9%5B4%5D.pdf
6. Dzida G, Fichna P, Jarosz-Chobot P, i wsp. Expert Opinion: Recommendation of diabetes experts on the use of FreeStyle Libre in diabetic patients in Poland. Clin Diabetol. 2019; 8: 2.
7. Edge J, Acerini C, Campbell F, et al. An alternative sensor-based method for glucose monitoring in children and young people with diabetes. Arch Dis Child. 2017; 102(6): 543-549.
8. Fokkert MJ, van Dijk PR, Edens MA, et al. Performance of the FreeStyle Libre Flash glucose monitoring system in patients with type 1 and 2 diabetes mellitus. BMJ Open Diabetes Res Care. 2017; 17,5(1): e000320.
9. Guidelines on the management of diabetic patients A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1); 1-103.
10. Haak T, Hanaire H, Ajjan R, et al. Flash Glucose-Sensing Technology as a Replacement for Blood Glucose Monitoring for the Management of Insulin-Treated Type 2 Diabetes: a Multicenter, Open-Label Randomized Controlled Trial. Diabetes Ther. 2017; 8(1): 55-73.
11. Heinemann L, Freckmann G. CGM versus FGM; or, continuous glucose monitoring is not flash glucose monitoring. J. Diabetes Sci. Technol. 2015; 9: 947–950.
12. Herman A, Aerts O, Baeck M, et al. Allergic contact dermatitis caused by isobornyl acrylate in Freestyle Libre, a newly introduced glucose sensor. Contact Dermat. 2017; 77: 367–373.
13. Herman A, Darrigade AS, de Montjoye L, et al. Contact dermatitis caused by glucose sensors in diabetic children. Contact Dermatitis. 2019; 28.
14. Hermanns N, Ehrmann D, Schipfer M, et al. The impact of a structured education and treatment programme (FLASH) for people with diabetes using a flash sensor-based glucose monitoring system: Results of a randomized controlled trial. Diabetes Res Clin Pract. 2019; 150: 111-121.
15. Hyry HSI, Liippo JP, Virtanen HM. Allergic contact dermatitis caused by glucose sensors in type 1 diabetes patients. Contact Dermatitis. 2019; 81(3): 161-166.
16. Kamann S, Aerts O, Heinemann L. Further evidence of severe allergic contact dermatitis from isobornyl acrylate while using a continuous glucose monitoring system. J Diabetes Sci Technol. 2018; 12: 630–633.
17. Leelarathna L, Wilmot EG. Flash forward: a review of flash glucose monitoring. Diabet Med. 2018; 35(4): 472-482.
18. Mancini G, Berioli MG, Santi E, et al. Flash Glucose Monitoring: A Review of the Literature with a Special Focus on Type 1 Diabetes. Nutrients. 2018; 10(8): 992.
19. Ólafsdóttir AF, Attvall S, Sandgren U, et al. A clinical trial of the accuracy and treatment experience of the flash glucose monitor Free Style Libre in adults with type 1 diabetes. Diabetes Technol. Ther. 2017; 19: 164–172.
20. Pintusa D, Sze M. Ng. Freestyle libre flash glucose monitoring improves patient quality of life measures in children with Type 1 diabetes mellitus (T1DM) with appropriate provision of education and support by healthcare professionals. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2019; 13(5): 2923-2926.
21. The Free-Style Libre Flash Glucose Monitoring. Healthcare Professional and Patient Training – London. 2018. Accessed: 10.03.2020. http://www.londonscn.nhs.uk/wp-content/uploads/2018/05/dia-FreeStyle-Libretraining-pack-for-HCP-and-patients-052018.pdf
22. Tobiasz-Kałkun N, Szewczyk A. red. Standardy i procedury pielęgniarskiej praktyki klinicznej na stanowisku edukatora do spraw diabetologii. Warszawa: Wydawnictwo Lekarskie PZWL; 2018.
23. Tobiasz-Kałkun N. Konspekt Edukacji Diabetologicznej – Teoretyczne założenia i praktyczne zastosowania. [w:] Szewczyk A, red. Edukacja w pielęgniarstwie diabetologicznym – konspekty. Warszawa: Wydawnictwo Lekarskie PZWL; 2017.

CONTINUOUS GLUCOSE MONITORING (CGM)

Purpose: Glucose level measurement using a CGM 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. Recommendations. Continuous glucose monitoring (CGM)

Each patient approved for CGM 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**

Continuous glucose measurement (CGM) 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:
- enzymatic electrodes,
- microdialysis-based techniques,
- fluorescence-based techniques.

Electrode-based CGM 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 CGM 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

Preferred sites for CGM sensor insertion include:
- subcutaneous tissue on the arm,
- subcutaneous tissue on the abdomen,
- subcutaneous tissue on the thigh,
- subcutaneous tissue on the buttock.

The CGM measurement electrode should not remain in the subcutaneous tissue longer than specified in the manufacturer's instructions. Consequences of leaving the CGM sensor in the tissue for too long may include:
- no reading,
- increased infection risk,
- lipohypertrophy,
- skin irritation,
- scarring.

Guidelines on sensor insertion sites:
- 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;
- 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;
- 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;
- 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. A CGM 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.

Guidelines on skin protection:
- before sensor insertion, the skin should be cleansed using oil-free antibacterial soap, and dry well;
- 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;
- fragrance-free antiperspirant can be applied to perspiration-prone skin. Apply a thin layer, wait 10-15 minutes, and wipe off the excess.

Factors interfering with blood glucose measurement with CGM
- 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 CGM 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 CGM 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.

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. Wash/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 CGM 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).

REFERENCES

1. Chen GY, Lancaster DG, Monro TM. Optical Microfiber Technology for Current, Temperature, Acceleration, Acoustic. Humidity and Ultraviolet Light Sensing Sensors 2018; 18: 72.
2. Deiss D, Irace C, Carlson G, et al. Real-World Safety of an Implantable Continuous Glucose Sensor Over Multiple Cycles of Use: A Post-Market Registry Study. Diabetes Technol Ther. 2020; 22(1): 48-52.
3. Deiss D, Szadkowska A, Gordon D, et al. Clinical Practice Recommendations on the Routine Use of Eversense, the First Long-Term Implantable Continuous Glucose Monitoring System. Diabetes Technology & Therapeutics. 2019; 21(5): 254-264.
4. Englert K, Ruedy K, Coffey J, et al. Skin and adhesive issues with continuous glucose monitors: a sticky situation. J Diabetes Sci Technol. 2014; 8: 745–751.
5. Evert A, Trence D, Catton S, et al. Continuous glucose monitoring technology for personal use: an educational program that educates and supports the patient. Diabetes Educ. 2009; 35(4): 565-580.
6. Guidelines on the management of diabetic patients A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1): 1-103.
7. Hermanides J, Wentholt IM, Hart AA, et al. No apparent local effect of insulin on microdialysis continuous glucose – monitoring measurements. Diabetes Care. 2008; 31(6): 1120-1122.
8. Hyry HSI, Liippo JP, Virtanen HM. Allergic contact dermatitis caused by glucose sensors in type 1 diabetes patients. Contact Dermatitis. 2019; 81(3): 161-166.
9. Ives B, Sikes K, Urban A, et al. Practical aspects of realtime continuous glucose monitors: the experience of the Yale Children's Diabetes Program. Diabetes Educ. 2010; 36: 53–62.
10. Lombardo F, Passanisi S, Caminiti L, et al. High prevalence of skin reactions among pediatric patients with type 1 diabetes using new technologies: the alarming role of colophonium. Diabetes Technol Ther. 2020; 22(1): 53–56.
11. Mazze RS, Strock E, Philip S, et al. A Novel Methodology to Evaluate Continuous Glucose Monitoring Accuracy and Clinical Representation of Glucose Exposure and Variability. Diabetes. 2007; 56(1): A107-A107.
12. Medtronic Diabetes: Tape Tips and Site Management. Accessed: 20.03.2020. https:// www.medtronicdiabetes.com/sites/default/files/library/downloadlibrary/workbooks/Tape%20Tips%20and%20Site%20 Management.pdf
13. Messer LH, Berget C, Beatson C, et al. Preserving Skin Integrity with Chronic Device Use in Diabetes. Diabetes Technology & Therapeutics. 2018; 20(2): S252-S264.
14. Rebrin K, Steil GM, van Antwerp WP, et al. Subcutaneous glucose predicts plasma glucose independent of insulin: implications for continuous monitoring. Am J Physiol. 1999; 277(3): E561-E571.
15. Sharma S, Huang Z, Rogers M, et al. Evaluation of a minimally invasive glucose biosensor for continuous tissue monitoring. Anal Bioanal Chem. 2016; 408: 8427–8435.
16. Tobiasz-Kałkun N, Szewczyk A. red. Standardy i procedury pielęgniarskiej praktyki klinicznej na stanowisku edukatora do spraw diabetologii. Warszawa: Wydawnictwo Lekarskie, PZWL; 2018.
17. Tobiasz-Kałkun N. Konspekt Edukacji Diabetologicznej – Teoretyczne założenia i praktyczne zastosowania. [w:] Szewczyk A, red. Edukacja w pielęgniarstwie diabetologicznym – konspekty. Warszawa: Wydawnictwo Lekarskie PZWL; 2017.

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.

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

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

Pen injector

Two types of pen injectors are available: disposable and reusable.

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

Tab. 5. 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 (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**
In health care institutions, pen injector needles are for single use only. **E**
Correct insulin injection technique using a pen injector is one of the factors contributing to glycemic control and reduced cutaneous complications. **A**

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 (fig. 2).

In children:

1. 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.
2. Thighs: upper third of the anterior lateral surface of both thighs.
3. Buttocks: upper, posterior lateral surface of buttocks and flanks.
4. Arms: mid-third of the posterior surface of the upper arm.

In adults:

1. Abdomen – excluding 1-2 cm around the navel and palpable bone structures. The injection should be performed while the patient is seated.
2. 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.
3. 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).
4. 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.

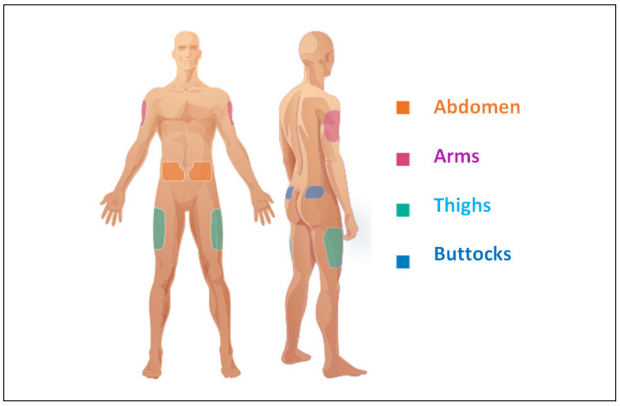

Fig 2. Subcutaneous insulin injection sites for use of an injector

Source: Frid AH, Kreugel G, Grassi G. et al. New Insulin Delivery Recommendations 2016. Mayo Foundation for Medical Education and Research. Mayo Clin Proc. 2016; 91(9): 1231-1255.

Examination of insulin injection sites

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 IX, *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

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.

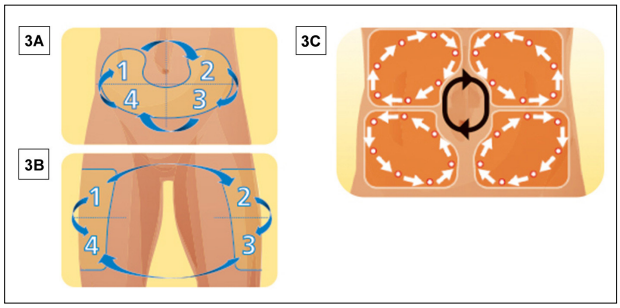

Fig 3. Example of body area rotation (fig. 3 A and 3.B), example of injection site rotation on the abdomen (fig. 3.C)

Source: Frid AH, Kreugel G, Grassi G. et al. New Insulin Delivery Recommendations 2016. Mayo Foundation for Medical Education and Research. Mayo Clin Proc. 2016; 91(9): 1231-1255.

Injection technique

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. 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. 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.

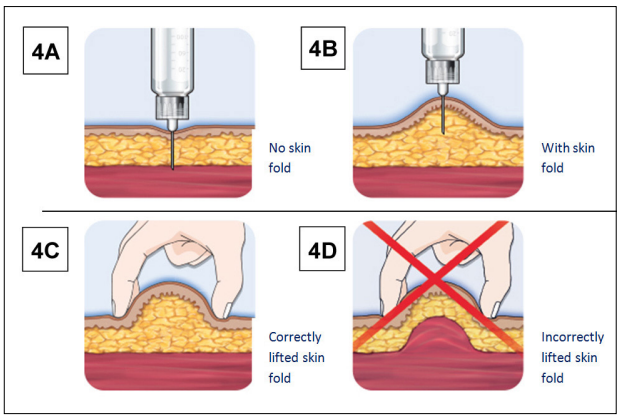

Fig 4. Figures 4 A and B show differences in subcutaneous tissue thickness when injecting with and without lifting a skin fold. Figures 4 C and D show the correct and incorrect way of lifting a skin fold.

Source: Frid AH, Kreugel G, Grassi G. et al. New Insulin Delivery Recommendations 2016. Mayo Foundation for Medical Education and Research. Mayo Clin Proc. 2016; 91(9): 1231-1255.

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.
- 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.
- 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.
- 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.
- At least once every 6 months, the nurse or midwife should perform physical examination 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- Regardless of patient age and subcutaneous tissue thickness, short needles (4.5 and 6 mm) are preferred.
- 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.
- During insulin injections with a pen injector performed **in health care facilities**, aseptic and antiseptic technique must be strictly followed.
- 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.
- For short-term administration of insulin prescribed by the physician during a patient's hospitalization, insulin syringes are used.

REFERENCES

1. Baruah MP, Sanjav KS, Septarshi BS, et al. An Audit of Insulin Usage and Insulin Injection Practices in a Large Indian Cohort. Indian J Endocrinol Metab. 2017; 21(3): 443–452.
2. Fleming D, Jacober SJ, Vanderberg M, et al. The safety of injecting insulin through clothing. Diabetes Care. 1997; 20: 244-247.
3. Gorman KC. Good hygiene versus alcohol swabs before insulin injections (Letter). Diabetes Care. 1993; 16: 960-961.
4. Grassi G, Scuntero P, Trepiccioni R, et al. Optimizing insulin injection technique and its effect on blood glucose control. J Clin Transl Endocrinol. 2014; 1: 145–150.
5. Heise T, Nosek L, Dellweg S, et al. Impact of injection speed and volume on perceived pain during subcutaneous injections into the abdomen and thigh: a single-centre, randomized controlled trial. Diabetes Obes Metab. 2014; 16(10): 971-976.
6. Hirsch LJ, Strauss KW. The Injection Technique Factor: What You Don't Know or Teach Can Make a Difference. Clin Diabetes. 2019; 37(3): 227-233.
7. LaRosa C, Makkar H, Grant-Kels JM. Approach to the total body skin examination in adults and children: Kids are not just little people. Clinics in Dermatology 2017; 35(6): 500–503.
8. Lim STJ, Hui YCA, Lim PK, et al. Ultrasound-guided measurement of skin and subcutaneous tissue thickness in children with diabetes and recommendations for giving insulin injections. J Clin Transl Endocrinol. 2018; 12: 26–35.
9. Lo Presti D, Ingegnosi C, Strauss K. Skin and subcutaneous thickness at injecting sites in children with diabetes: ultrasound findings and recommendations for giving the injection. Pediatr Diab. 2012; 13(7): 525–533.
10. McKay M, Compion G, Lytzen LA, et al. Comparison of insulin injection needles on patients' perceptions of pain, handling, and acceptability: a randomized, open-label, crossover study in subjects with diabetes. Diabetes Technol Ther. 2009; 11(3): 195-201.
11. Misnikova IV, Gubkina VA, Lakeeva TS, at al. A Randomized Controlled Trial to Assess the Impact of Proper Insulin Injection Technique Training on Glycemic Control. Diabetes Ther. 2017; 8(6): 1309-1318.
12. Olmo DZ, Vlacho B, Fernández J, et al. Safety of the reuse of needles for subcutaneous insulin injection: A systematic review and meta-analysis. Int J Nurs Stud. 2016; 60: 121-132.
13. Pettis RJ, Muchmore D, Heinemann LJ. Subcutaneous Insulin Administration: Sufficient Progress or Ongoing Need? Diabetes Sci Technol. 2019; 13(1): 3-7.
14. Polish Diabetes Association. Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1): 1-103.
15. Rini C, Roberts BC, Morel D, et al. Evaluating the Impact of Human Factors and Pen Needle Design on Insulin Pen Injection. Diabetes Sci Technol. 2019; 13(3): 533-545.
16. Rozporządzenie Ministra Zdrowia z dnia 28 lutego 2017 r. w sprawie rodzaju i zakresu świadczeń zapobiegawczych, diagnostycznych, leczniczych i rehabilitacyjnych udzielanych przez pielęgniarkę albo położną samodzielnie bez zlecenia lekarskiego (Dz.U. 2017 poz. 497).
17. Song Z, Guo X, Ji L, et al. Insulin Injection Technique in China Compared with the Rest of the World. Diabetes Ther. 2018; 9(6): 2357-2368.
18. Tobiasz-Kałkun N, Szewczyk A. red. Standardy i procedury pielęgniarskiej praktyki klinicznej na stanowisku edukatora do spraw diabetologii. Warszawa: Wydawnictwo Lekarskie PZWL; 2018.

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. 6. 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.

Infusion set insertion sites:

- arm,
- abdomen,
- thigh,
- buttock.

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.

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.

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.
- 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.
- 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

- During infusion set installation, aseptic technique must be used.
- Skin disinfectants should be oil-free and colorant-free.
- Infusion sets and syringes are for single use only.
- 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.

Each time before inserting an infusion set, the planned insertion site must be carefully examined (visually and by palpation). Physical examination of injection sites is described in detail within procedure IX.

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.

A tubeless insulin pump is also available in Poland.

REFERENCES

1. American Diabetes Associtation. Standards of Medical Care in Diabetes – 2019. Diabetes Care. 2019; 42 (1): 1-204.
2. Ehrmann D, Kulzer B, Schipfer M, et al. Efficacy of an Education Program for People With Diabetes and Insulin Pump Treatment (INPUT): Results From a Randomized Controlled Trial. Diabetes Care. 2018; 41(12): 2453-2462.
3. Frid AH, Kreugel G, Grassi G, et al. New Insulin Delivery Recommendations. Mayo Clin Proc. 2016; 91(9): 1231–1255.
4. Heinemann L, Krinelke I. Insulin infusion set: the Achilles heel of continuous subcutaneous insulin infusion. J Diabetes Sci Technol. 2012; 6(4): 954-964.
5. Kerr D, Morton J, Whately-Smith C, et al. Laboratory-based non-clinical comparison of occlusion rates using three rapid-acting insulin analogs in continuous subcutaneous insulin infusion catheters using low flow rates. J Diabetes Sci Technol. 2008; 2(3): 450-455.
6. Overland J, Molyneaux L, Tewari S, et al. Lipohypertrophy: does it matter in daily life? A study using a continuous glucose monitoring system. Diabetes Obes Metab. 2009; 11(5): 460-463.
7. Phillip M, Battelino T, Rodriguez H, et al. Use of insulin pump therapy in the pediatric age-group: consensus statement from the European Society for Paediatric Endocrinology, the Lawson Wilkins Pediatric Endocrine Society, and the International Society for Pediatric and Adolescent Diabetes, endorsed by the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care. 2007; 30(6): 1653–1662.
8. Polish Diabetes Association. Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1): 1-103.
9. Schmid V, Hohberg C, Borchert M, et al. Pilot study for assessment of optimal frequency for changing catheters in insulin pump therapy-trouble starts on day 3. J Diabetes Sci Technol. 2010; 4(4): 976–982.
10. Thethi TK, Rao A, Kawji H, et al. Consequences of delayed pump infusion line change in patients with type 1 diabetes mellitus treated with continuous subcutaneous insulin infusion. J Diabetes Complications. 2010; 24(2): 73-78.
11. van Faassen I, Razenberg PP, Simoons-Smit AM, et al. Carriage of Staphylococcus aureus and inflamed infusion sites with insulin-pump therapy. Diabetes Care. 1989; 12 (2): 153-155.

ORAL GLUCOSE TOLERANCE TEST (OGTT)

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

Individuals authorized to perform the test: nurse, midwife.

Tab. 7. Recommendations. Oral glucose tolerance test (OGTT)

Each patient should be properly prepared for an OGTT. **E**

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 sugar level regulation, and rate of glucose absorption in the tissue.

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.
- In the pre-test interview, the nurse makes sure the patient is correctly prepared.
- If the fasting blood glucose level exceeds 126 mg/dL, do not proceed with the OGTT.
- Before the test, the patient should always be informed by the nurse 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.

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.

Time 0 – is the time of venous blood sampling for the fasting baseline.

REFERENCES

1. American Diabetes Association. Standards of Medical Care in Diabetes – 2019. Diabetes Care. 2019; 42 (1): 1-204.
2. HAPO Study Cooperative Research Group, Metzger BE, Lowe LP, et al. Hyperglycemia and adverse pregnancy outcomes. N Engl J Med. 2008; 358(19): 1991–2002.
3. Ode KL, Moran A. New insights into cystic fibrosis-related diabetes in children. The Lancet Diabetes & Endocrinology. 2013; 1(1): 52–58.
4. Polish Diabetes Association. Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1): 1-103.

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. 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**
Structured education on diabetes self-monitoring reduces the risk of severe hypoglycemia, decreases psychological stress, and improves the patient's wellbeing. **A**
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.

Hypoglycemia management always depends on the patient's clinical situation. If the patient is unconscious, the European Resuscitation Council (2015) 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 (kidney failure, hypothyroidism, adrenal insufficiency, eating disorders).

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.
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)
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.

The nursing procedures should be performed in line with the physician's orders, considering the European Resuscitation Council guidelines.

1. When ordered by the physician, administer a 20% solution of glucose (0.2 g of glucose per 1 kg BW) intravenously, followed by an intravenous infusion of a 10% solution of glucose. In case of difficulty in cannulation, make an intramuscular or subcutaneous injection of 1 mg of glucagon (0.5 mg in children under 6 years).
2. Monitor blood glucose levels 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.

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. Place the diabetic patient in the recovery position.
2. Not give the patient anything to eat or drink.
3. Make an intramuscular or subcutaneous injection of 1 mg of glucagon (0.5 mg in children under 6 years).
4. Monitor blood glucose levels using a glucose meter.
5. Call an emergency service.
6. Once the symptoms have subsided, the patient must not undertake any exercise.
7. Always attempt to establish the cause of hypoglycemia.
8. Assistance from another individual is absolutely necessary, including observation for hypoglycemia recurrence.
9. 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.
3. Store the glucagon in accordance with the manufacturer's instructions. The patient should always have glucagon on hand.
4. 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.
5. Contraindications to glucagon administration include:
   - non-pancreatic malignancies,
   - being under the influence of alcohol,
   - hypersensitivity to glucagon or lactose,
   - phaeochromocytoma.

Preparation instructions for the GlucaGen 1 mg Hypokit

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.

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). 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 measure blood glucose level again.
- 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).
- Always carry a glucose meter.

REFERENCES

1. American Diabetes Association. Standards of Medical Care in Diabetes – 2019. Diabetes Care. 2019; 42(1): 1-204.
2. Choudhary P, Amiel SA. Hypoglycaemia: current management and controversies. Postgrad. Med. J. 2011; 87(1026): 298–306.
3. Choudhary P, Rickels MR, Senior PA, et al. Evidence-informed Clinical Practice Recommendations for Treatment of Type 1 Diabetes Complicated by Problematic Hypoglycemia. Diabetes Care. 2015; 38(6): 1016–1029.
4. Gimenez M, Tannen AJ, Reddy M, et al. Revisiting the Relationships Between Measures of Glycemic Control and Hypoglycemia in Continuous Glucose Monitoring Data Sets. Diabetes Care. 2018; 41(2): 326-332.
5. Hopkins D, Lawrence I, Mansell P, et al. Improved Biomedical and Psychological Outcomes 1 Year After Structured Education in Flexible Insulin Therapy for People With Type 1 Diabetes. Diabetes Care. 2012; 35(8): 1638–1642.
6. International Hypoglycemia Study Group. Glucose concentrations of less than 3 mmol/L (54 mg/dL) should be reported in clinical trials: a joint position statement of the American Diabetes Association and European Association for the Study of Diabetes. Diabetes Care 2017; 40: 155–157.
7. International Hypoglycemia Study Group. Minimizing Hypoglycemia in Diabetes. Diabetes Care. 2015; 38(8): 1583-1591.
8. Little SA, Leelarathna L, Walkinshaw E, et al. Recovery of hypoglycemia awareness in long-standing type 1 diabetes: a multicenter 2 × 2 factorial randomized controlled trial comparing insulin pump with multiple daily injections and continuous with conventional glucose self-monitoring (HypoCOMPaSS). Diabetes Care. 2014; 37(8): 2114-2122.
9. Polish Diabetes Association. Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1): 1-103.
10. Seaquist ER, Anderson J, Childs B, et al. Hypoglycemia and diabetes: a report of a work group of the American Diabetes Association and the Endocrine Society. Diabetes Care. 2013; 36: 1384–1395.

REDUCING PERIOPERATIVE COMPLICATION RISK

Purpose: Preparing a diabetic patient for a surgical procedure.

Authorized individuals: nurse, midwife

Tab. 9. 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. 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. Recommended blood glucose targets in the perioperative period are 100–180 mg/dL.

Mode of admission

- An elective outpatient surgery does not require significant modifications of therapy, and only involves skipping or moving a meal. It can only be planned for patients undergoing intensive insulin therapy with good metabolic control, or patients with type 2 diabetes successfully treated with diet or diet and metformin. Metformin must be withheld at least 24 hours before the planned procedure.
- Major elective procedures or emergency procedures require hospitalization and significant modifications of therapy (temporary insulin therapy in patients treated with oral medications and therapy intensification in those already treated with insulin).
- For major surgical procedures, insulin must be administered intravenously, which facilitates both blood glucose fluctuation control and dose modification.
- If preparation for the surgical procedure requires a strict diet, on the day(s) preceding the operation, an intravenous infusion of a 10% glucose solution with 12 units of a short/fast-acting insulin preparation and 10 mmol of KCl is recommended in place of a meal.

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.

Nursing personnel tasks, performed to increase diabetic patients' safety in the perioperative period, include:

- 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).

REFERENCES

1. Aldam P, Levy N, Hall GM. Perioperative management of diabetic patients: new Controversies. British Journal of Anaesthesia. 2014; 113: 906–909.
2. Boreland L, Scott-Hudson M, Hetherington K, et al. The effectiveness of tight glycemic control on decreasing surgical site infections and readmission rates in adult patients with diabetes undergoing cardiac surgery: A systematic review. Heart & Lung. 2015; 44: 430e–440e.
3. Clinical Support Guide. Intravenous Insulin Infusion (MR-INF-A) (MR-INF-B), 2019. Accessed: 20.03.2020. https://www.chsadiabetes.org.au/clinicalpractice/Intravenous%20Insulin%20Infusion_Clinical%20Support%20Guide_Final_2019.pdf
4. Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clin Diabet. 2019; 8: 1.
5. Kotagal M, Symons RG, Hirsch IB et al. Perioperative hyperglycemia and risk of adverse events among patients with and without diabetes. Ann Surg. 2015; 261: 97-103.
6. Martin ET, Kaye KS, Knott C. et al. Diabetes and risk of surgical site infection: a systematic review and meta-analysis. Infect Control Hosp Epidemiol. 2016; 37: 88-99.
7. Westbrook A, Sherry D, McDermott M, et al. Examining IV Insulin Practice Guidelines in the Cardiac Surgery Patient Nurses Evaluating Quality Outcomes. J Nurs Care Qual. 2016; 31(4): 344–349.

DIABETIC PATIENT FOOT EXAMINATION AND CARE

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.

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

Tab. 10. 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**

diabetic foot syndrome and to better quality of life in diabetic patients.

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,
- impaired vision,
- chronic kidney disease (especially in patients on dialysis).

Foot examination by medical personnel

In type 2 diabetes and adult type 1 diabetes patients, the foot exam should include the following components:

- 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.

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.

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.

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;
  - using emollients on dry skin, but not between the toes;
  - trimming toenails straight across by filing;
  - having one's feet regularly examined by a health care professional.

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. 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.
- 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.
- Selection of therapeutic footwear.
  Wear footwear specially designed for diabetic patients, and non-binding, seamless socks made from natural fibers – cotton or bamboo.
- 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.
- Use of insoles.
  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).

Note! In Poland, the profession of podologist was included in the classification of occupations and specialties on January 1, 2017, under code no. 323014. However, no formal education in podology that would provide specific professional competences is available.

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.

REFERENCES

1. Aalaa M, Tabatabaei Malazy O, Sanjari M, et al. Nurses' role in diabetic foot prevention and care; a review. Journal of Diabetes & Metabolic Disorders. 2012; 11: 24.
2. Ahmad Sharoni SK, Minhat HS, Mohd Zulkefli NA, et al. Health education programmes to improve foot self-care practices and foot problems among older people with diabetes: a systematic review. Int J Older People Nurs. 2016; 11: 214–239.
3. American Diabetes Association. 11. Microvascular complications and foot care: Standards of Medical Care in Diabetes – 2019. Diabetes Care. 2019; 42(1): S124–S138.
4. Arad Y, Fonseca V, Peters A, et al. Beyond the monofilament for the insensate diabetic foot: A systematic review of randomized trials to prevent the occurrence of plantar foot ulcers in patients with diabetes. Diabetes Care. 2011; 34: 1041–1046.
5. Bonner T, Foster M, Spears-Lanoix E. Type 2 diabetes-related foot care knowledge and foot self-care practice interventions in the United States: a systematic review of the literature. Diabet Foot Ankle. 2016; 7: 29758.
6. Boulton AJ, Armstrong DG, Albert SF, et al. Comprehensive foot examination and risk assessment: a report of the task force of the foot care interest group of the American Diabetes Association, with endorsement by the American Association of Clinical Endocrinologists. Diabetes Care. 2008; 31(8): 1679–1685.
7. Crawford F, Inkster M, Kleijnen J, et al. Predicting foot ulcers in patients with diabetes: A systematic review and meta-analysis. QJM. 2007; 100: 65–86.
8. Dargis V, Pantelejeva O, Jonushaite A, et al. Benefits of a multidisciplinary approach in the management of recurrent diabetic foot ulceration in Lithuania: A prospective study. Diabetes Care. 1999; 22: 1428–1431.

9. Elraiyah T, Domecq JP, Prutsky G, et al. A systematic review and metaanalysis of débridement methods for chronic diabetic foot ulcers. J Vasc Surg. 2016; 63: 37S–45S, e2.
10. Feng Y, Schlösser FJ, Sumpio BE. The SemmesWeinstein monofilament examination is a significant predictor of the risk of foot ulceration and amputation in patients with diabetes mellitus. J Vasc Surg. 2011; 53: 220–226, e1-5.
11. Guidelines on the management of diabetic patients A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1); 1-103.
12. NICE guideline. 2015. Diabetic foot problems: prevention and management. Accessed: 10.03.2020. www.nice.org.uk/guidance/ng19
13. Zhang P, Lu J, Jing Y, et. al. Global Epidemiology of Diabetic Foot Ulceration: A Systematic Review and Meta-Analysis. Annals of Medicine. 2016; 49(2): 106-116.
14. Rakowska B, Jawień A, Sopata M, i wsp. Organizacja opieki nad chorymi z zespołem stopy Cukrzycowej. Wytyczne Polskiego Towarzystwa Leczenia Ran. Leczenie Ran 2015; 12(3): 83–112.
15. Schaper NC, van Netten JJ, Apelqvist J, et al. International Working Group on the Diabetic Foot (IWGDF)IWGDF Guidelines on the prevention and management of diabetic foot disease. 2019. Accessed: 22.03.2020.
16. Somajaji R, Elliott JA, Persaud R, et al. The impact of team based interprofessional comprehensive assessments on the diagnosis and management of diabetic foot ulcers: a retrospective cohort study. PLoS One. 2017; 12(9): e0185251.
17. Tan TW, Shih CD, Concha-Moore KC, et al. Disparities in outcomes of patients admitted with diabetic foot infections. PLoS One. 2019; 14: e0211481.
18. Valk GD, Kriegsman DM, Assendelft WJ. Patient education for preventing diabetic foot ulceration. A systematic review. Endocrinol Metab Clin North Am. 2002; 31: 633–658.
19. Van Netten JJ, Price PE, Laverty LA, et al. Prevention of foot ulcers in the at-risk patient with diabetes: a systematic review. Diabetes Metab Res Rev. 2016; 32(1): 84–98.

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. 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.

Dry skin is more susceptible to damage, irritation, and infection. 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. 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.
- 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.
- Emollients available on the market differ in composition. When selecting the appropriate product, consult a pharmacist and consider the diabetic patient's needs.
- 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.
- To achieve the expected benefits of using appropriately selected topically moisturizing and lubricating products, use them regularly.

REFERENCES

1. Campos de Macedo GM, Nunes S, Barreto T. Skin disorders in diabetes mellitus: an epidemiology and physiopathology review. Diabetol Metab Syndr. 2016; 8: 63.
2. Fan L, Sidani S, Cooper-Brathwaite A, et al. Improving foot self-care knowledge, self-efficacy, and behaviors in patients with type 2 diabetes at low risk for foot ulceration: a pilot study. Clin Nurs Res. 2014; 23(6): 627–643.
3. Federici A, Federici G, Milani M. An urea, arginine and carnosine based cream (Ureadin Rx Db ISDIN) shows greater efficacy in the treatment of severe xerosis of the feet in Type 2 diabetic patients in comparison with glycerol-based emollient cream. A randomized, assessor-blinded, controlled trial. BMC Dermatol. 2012; 12: 16
4. Martini J, Huertas C, Turlier V, et al. Efficacy of an emollient cream in the treatment of xerosis in diabetic foot: a double-blind, randomized, vehicle-controlled clinical trial. J Eur Acad Dermatol Venereol. 2017; 31(4): 743-747.
5. Nguyen TPL, Edwards H, Do TND, et al. Effectiveness of a theory-based foot care education program (3STEPFUN) in improving foot self-care behaviours and foot risk factors for ulceration in people with type 2 diabetes. Diabetes Res Clin Pract. 2019; 152: 29-38.
6. Papanas N, Papazoglou D, Papatheodorou K, et al. Evaluation of a new foam to increase skin hydration of the foot in type 2 diabetes: a pilot study. Int Wound J. 2011;8:297–300.
7. Pham HT, Exelbert L, Segal-Owens AC, et al. A prospective, randomized, controlled double-blind study of a moisturizer for xerosis of the feet in patients with diabetes. Ostomy Wound Manag. 2002; 48: 30–36.
8. Piérard GE, Seité S, Hermanns-Lê T, et al. The skin landscape in diabetes mellitus. Focus on dermocosmetic management. Clinical, Cosmetic and Investigational Dermatology. 2013; 6: 127-135.
9. Polaskova J, Pavlackova J, Vltavska P, et al. Moisturizing effect of topical cosmetic products applied to dry skin. J Cosmet Sci. 2013; 64: 329–340.
10. Seite S, Khemis A, Rougier A, et al. Importance of treatment of skin xerosis in diabetes. J Eur Acad Dermatol Venereol. 2011; 25: 607–609.

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. 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**
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**

The most common cutaneous complications of insulin therapy include lipodystrophy and its specific forms: lipohypertrophy, lipoatrophy, and amyloidosis. Lipoatrophy involves localized loss of subcutaneous tissue. Another form of lipodystrophy is amyloidosis, or localized extracellular build-up of abnormal protein called amyloid. In turn, the clinical symptom of lipohypertrophy is described as a hypertrophy of adipocytes and swelling and/or hardening of adipose tissue at the insulin injection site. LH is also associated with alterations in blood vessels and nerve fibers. Insulin absorption may be significantly disturbed if it is injected into sites with any lesions. To reduce the risk of cutaneous complications and the resulting impairment of insulin distribution in the tissue, diabetic patients must be educated in proper injection technique and preventive examination of injection sites. Beside self-examination by the patient and/or his carer, regular examination of injection sites by a nurse or midwife is also very important.

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). 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.
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 of the skin at insulin injection sites, using both overhead and oblique lighting. 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 – change in skin surface, mounds or areas of raised skin due to hypertrophic subcutaneous tissue at and around injection sites.
   - 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 (fig. 5).
     - 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.

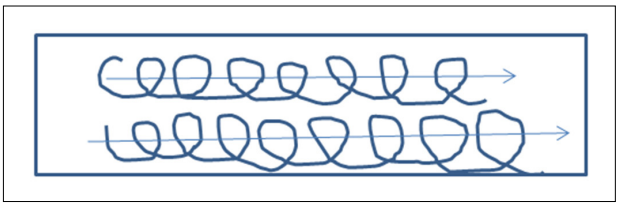

Fig 5. Line of palpation examination of insulin injection areas

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).
- Physical examination of the skin 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).
- Do not palpate the injection sites immediately after insulin injection, as this may cause the medication to leak.
- Ultrasound gel is recommended, use of oils should be avoided to prevent staining 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.
- 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.

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).
- Injection sites should be examined for LH regularly, every 6 months, but not immediately after an insulin injection.
- 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 your nurse/midwife/diabetes educator.
- Never inject insulin into sites with any pathological lesions.
- When the insulin injection area is changed, the insulin dosage may need to be modified.

General guidelines regarding skin-penetrating procedures

A. For the patient or his family members

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. 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 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.

REFERENCES

1. Al Ajlouni M, Abujbara M, Batieha A, et al. Prevalence of lipohypertrophy and associated risk factors in insulin-treated patients with type 2 diabetes mellitus. Int J Endocrinol Metab. 2015; 13(2): e20776.
2. American Diabetes Association. Standards of Medical Care in Diabetes – 2019. Diabetes Care. 2019; 42 (1): 1-204.
3. Ariza-Andraca CR, Altamirano-Bustamante E, Frati-Munari AC, et al. Delayed insulin absorption due to subcutaneous edema. Arch Invest Med. 1991; 22: 229-233.
4. Barola A, Tiwari P, Bhansali A, et al. Insulin-Related Lipohypertrophy: Lipogenic Action or Tissue Trauma? Front Endocrinol (Lausanne). 2018; 9: 638.
5. Blanco M, Hernandez MT, Strauss KW, et al. Prevalence and risk factors of lipohypertrophy in insulin-injecting patients with diabetes. Diabetes Metab. 2013; 39(5): 445-453.
6. Chowdhury TA, Escudier V. Poor glycaemic control caused by insulin induced lipohypertrophy. Brit Med J. 2003; 327: 383-384.
7. Frid A, Linden B. Computed tomography of injection sites in patients with diabetes mellitus. Injection and Absorption of Insulin. Stockholm: Thesis, 1992.
8. Frid AH, Kreugel G, Grassi G, et al. New Insulin Delivery Recommendations 2016 Mayo Foundation for Medical Education and Research. Mayo Clin Proc. 2016; 91(9): 1231-1255.
9. Gupta SS, Gupta KS, Gathe SS, et al. Clinical Implications of Lipohypertrophy Among People with Type 1 Diabetes in India. Diabetes Technol Ther. 2018; 20(7): 483-491.
10. Hambridge K. The management of lipohypertrophy in diabetes care. Br. J. Nurs. 2007; 16: 520-524.
11. Hauner H, Stockamp B, Haastert B. Prevalence of lipohypertrophy in insulin-treated diabetic patients and predisposing factors. Exp. Clin. Endocrinol. Diabetes. 1996; 104: 106-110.
12. Hayek AA, Robert AA, Braham RB, et al. Frequency of lipohypertrophy and associated risk factors in young patients with type 1 diabetes: a cross-sectional study. Diabetes Ther. 2016; 7(2): 259–267.
13. Hernar I, Haltbakk J, Broström A. Differences in depression, treatment satisfaction and injection behavior in adults with type 1 diabetes and different degrees of lipohypertrophy. J Clin Nurs. 2017; 26(23-24): 4583–4596.
14. Ji L, Sun Z, Li Q, et al. Lipohypertrophy in China: Prevalence, Risk Factors, Insulin Consumption, and Clinical Impact. Diabetes Technol Ther. 2017; 19(1): 61-67.
15. Johansson U, Amsberg S, Hannerz L, et al. Impaired Absorption of insulin Aspart from Lipohypertrophic Injection Sites. Diabetes Care. 2005; 28: 2025-2027.
16. LaRosa C, Makkar H, Grant-Kels JM. Approach to the total body skin examination in adults and children: Kids are not just little people. Clinics in Dermatology. 2017; 35(6): 500-503.
17. Manash P, Baruah MP, Sanjay K, et al. An Audit of Insulin Usage and Insulin Injection Practices in a Large Indian Cohort. Indian J Endocrinol Metab. 2017; 21(3): 443–452.
18. Nagase T, Iwaya K, Iwaki Y, et al. Insulin-derived Amyloidosis and Poor Glycemic Control. A Case Series The American Journal of Medicine. 2014; 127: 450–454.
19. Olmo DZ, Vlacho B, Fernández J, et al. Safety of the reuse of needles for subcutaneous insulin injection: A systematic review and meta-analysis. Int J Nurs Stud. 2016; 60: 121-132.
20. Overland J, Molyneaux L, Tewari S, et al. Lipohypertrophy, Does it matter in daily life? A study using a continuous glucose monitoring system. Diab, Obes Metab. 2009; 11: 460-463.
21. Polinski JM, Kim SC, Jiang D, et al. Geographic patterns in patient demographics and insulin use in 18 countries, a global perspective from the multinational observational study assessing insulin use: Understanding the challenges associated with progression of therapy (MOSAIc) BMC. Endocr Disord. 2015; 15: 46.
22. Polish Diabetes Association. Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clinical Diabetology. 2019; 8(1): 1-103.
23. Rozporządzenie Ministra Zdrowia z dnia 28 lutego 2017 r. w sprawie rodzaju i zakresu świadczeń zapobiegawczych, diagnostycznych, leczniczych i rehabilitacyjnych udzielanych przez pielęgniarkę albo położną samodzielnie bez zlecenia lekarskiego (Dz.U. 2017 poz. 497).
24. Saez-de Ibarra L, Gallego F. Factors related to lipohypertrophy in insulin-treated diabetic patients; role of educational intervention. Pract Diab Int. 1998; 15: 9-11.
25. Vardar B, Kızılcı S. Incidence of lipohypertrophy in diabetic patients and a study of influencing factors. Diabetes Res Clin Pract. 2007; 77(2): 231–236.
26. Young RJ, Hannan WJ, Frier BM, et al. Diabetic lipohypertrophy delays insulin absorption. Diabetes Care. 1984; 7: 479-480.

ORCID

Alicja Szewczyk https://orcid.org/0000-0003-4167-0361
Natasza Tobiasz-Kałkun https://orcid.org/0000-0002-1184-1871
Anna Stefanowicz-Bielska https://orcid.org/0000-0002-1896-5551
Ewa Kobos https://orcid.org/0000-0001-7231-8411

Manuscript received/Praca zgłoszona do czasopisma: 01.04.2020
Manuscript accepted/Praca zaakceptowana do druku: 21.04.2020

Translation/Tłumaczenie: Przetłumacz.to translation agency (Maciej Witalewski, Agnieszka Rybacka, Rob Pagett)