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Practical tips for the use of automated insulin delivery systems in individuals with diabetes during minor procedures performed under sedation or anesthesia and during labor

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ABSTRACT

Introduction: Automated insulin delivery (AID) systems have become a standard of care in type 1 diabetes and are increasingly used across all age groups, including during pregnancy. As their use expands, clinicians are increasingly encountering patients using AID systems in perioperative and peripartum settings. However, guidance regarding continuation of AID therapy during procedures under anesthesia, sedation, or during labor remains limited.

Objectives: This document provides practical, consensus-based recommendations for the use of AID systems during minor procedures, selected major surgeries, and throughout labor and delivery, aiming to support anesthesiologists, surgeons, and other procedural specialists, obstetric teams, and diabetes specialists in clinical decision-making.

Methods: Eleven experts in pediatric and adult diabetology, each with extensive clinical experience in managing AID users in outpatient and inpatient settings, conducted a comprehensive literature review and synthesized available evidence with collective clinical experience.

Results: The authors outline criteria for continuation of AID therapy during procedures, including requirements related to the patient, procedural team, and type of procedure. Detailed perioperative algorithms are provided. Recommendations for labor emphasize adjustments of AID parameters, glucose targets, and postpartum modifications. While AID continuation may be appropriate for many minor procedures and selected major surgeries, intravenous insulin therapy remains preferable in situations associated with hemodynamic instability or high metabolic risk.

Conclusions: With appropriate preparation and interdisciplinary coordination, continuation of AID therapy during selected procedures and childbirth can be safe and effective, reducing glycemic variability and treatment burden. As evidence remains limited, further clinical studies are urgently needed to validate and refine these recommendations.

INTRODUCTION

The availability of the first commercial automated insulin delivery (AID) systems, including in Poland since the early 2020s, proved to be a revolution in the approach to the treatment of type 1 diabetes and marked significant changes in clinical practice. AID systems have brought multifaceted benefits both in terms of improving glycemic control, including reducing the risk of severe hypoglycemia associated with impaired awareness of hypoglycemia, and reducing the psychosocial burden of the disease, becoming the recommended standard of care for the treatment of type 1 diabetes [1,2,3]. Recognition of AID systems as a recommended standard requires the development of recommendations regarding their use in various situations, both in everyday and clinical settings. As these are frequent, it is necessary to define the possibilities and principles for the safe use of AID during procedures under sedation or anesthesia as well as during labor [4,5].

Currently, case reports are available that present positive experiences in this area; however, published scientific evidence is limited. It should be noted that no AID system, including MiniMed™ 780G and CamAPS® FX™, is currently FDA- or CE-approved for perioperative use [6,7].The topic of continuing insulin therapy using personal insulin pumps and their specific form, namely AID systems, during procedures is also beginning to appear in the relevant recommendations of scientific societies [8,9,10]. In 2023, the Association of British Clinical Diabetologists' Diabetes Technology Network allowed continuation of treatment using a personal insulin pump, including an AID system, during short surgical procedures; in turn, in 2024, recommendations of the American Society for Ambulatory Anesthesia (SAMBA) regarding ambulatory procedures in adult individuals with diabetes were published, in which the authors also mention the option of using CGM systems and insulin pumps, including AID [8,9] . A more detailed approach to this issue was published in 2025 in *Anesthesia & Analgesia* by Paulina Cruz et al., who, based on a literature review, presented the possibilities for perioperative management of individuals using new diabetes technologies [11].

Previous publications and the personal clinical experience of the authors of this document indicate that, compared to other insulin delivery methods, continuation of treatment using AID in the periprocedural period, in selected clinical situations, may be safe and less burdensome for individuals with diabetes. At the same time, AID allows for better glycemic control during this period, with less involvement of medical teams. These "practical tips" are intended to facilitate the work of clinicians, especially anesthesiologists and entire procedural teams, with patients using AID. Considering the use of AID in other types of diabetes, including type 2 diabetes, or diabetes developed after pancreatic resection, and with expanding regulatory indications for AID systems, this advice may be useful not only in individuals with type 1 diabetes, but also in other patient groups [12,13].

This document was developed by a group of 11 specialist physicians with clinical experience in inpatient and outpatient diabetes care, working with adults and children using AID systems. Their experience in the topic results from numerous consultations for patients being prepared for inpatient or ambulatory procedures, the vast majority of which required cooperation with an anesthesiologist. Preparation of this document was preceded by discussions among specialists, which indicated the need to systematize personal experience and data from the literature regarding the use of AID during procedures. The co-authors conducted a detailed analysis of the available literature on this topic, which they supplemented with the clinical experience of their centers. After preparation of the individual chapters, meetings of all co-authors were held, during which the individual chapters were discussed, and consensus was reached regarding the scientific content of the entire manuscript. Clinically significant recommendations were assigned a level of evidence from A to E in accordance with the system used by the American Diabetes Association (ADA) [14].

AUTOMATED INSULIN DELIVERY SYSTEMS

An AID system consists of a personal insulin pump, a CGM system, and an algorithm in the insulin pump or an external device that – in so called "automated mode" - continuously modifies insulin delivery, aiming to achieve an individually set target glucose value in the device (**Figure S1**). In AID systems, like in other insulin pumps, only rapid or fast-acting insulin analogues (or regular insulin) are used. Despite the high level of automation of insulin dosing, currently commercially available hybrid AID systems still require user involvement in initiating mealtime boluses, accounting for physical activity, and responding to notifications/alarms.

In Poland, two AID systems are reimbursed: MiniMed™ 780G (by Medtronic with SmartGuard™ technology) and CamAPS® FX™ (integrating the mylife™ YpsoPump® with Dexcom G6® CGM sensors; compatibility with Dexcom G7® and Libre 3/3plus planned) –

status as of February 2026. A detailed characterization of both systems is presented in the Polish Society of Pediatric Endocrinology and Diabetes (PTEiDD) and Pediatric Section of Diabetes Poland (PolPeDiab) recommendations regarding insulin therapy using AID in children and adolescents in Poland, and briefly **in Supplementary Table S1** [10,15-17]. In other countries, other systems of this type are also available, some of which are occasionally used by individuals with diabetes in Poland as well (including: Insulet Omnipod 5, Tandem t:slim X2 or Mobi with Control-IQ, Kaleido with the DBLG1 algorithm, TouchCare Nano System). There is also a group of patients using so-called "do-it-yourself" (DIY) systems, which users operate at their own risk, usually without a manufacturer warranty (e.g., systems using the Android APS algorithm). The perioperative and peripartum recommendations presented in this document apply to two commercially available AID systems: MiniMed™ 780G and CamAPS® FX™; users of DIY/open-source AID systems require individualized management plans.

In certain situations (e.g. CGM malfunction, or when chosen by the user in case of a very high or very low glucose concentration), AID systems may operate in so called "manual mode", i.e. like conventional insulin pumps. In manual mode, an automated dosage of insulin by AID algorithm is disabled, and settings of basal insulin delivery and bolus calculator entered by the user (according to medical professional advice) are used by the device. When working without active CGM sensor, high and low glucose level alert alarms are not active.

CONTINUOUS GLUCOSE MONITORING SYSTEMS – ADVANTAGES AND LIMITATIONS DURING PROCEDURES

Continuous glucose monitoring is a key component of the AID system. Several CGM systems are available in Poland. The MiniMed™ 780G system works with the Guardian™ 4 sensor (requiring a transmitter) or Simplera Sync™. In this system, glucose readings can be viewed on the pump and additionally in a smartphone application. The CamAPS® FX system operates

with the Dexcom G6® sensor which requires a transmitter (status as of February 2026). In this case, glucose values are available only on the smartphone. In both systems, it is possible to add a "follower" person — respectively via the CareLink™ Connect application (for MiniMed™ 780G) and the CamAPS® FX Companion function (for the CamAPS® FX system with YpsoPump®) [10]. Patients with diabetes treated with other methods may also use CGM systems such as FreeStyle Libre 2, Dexcom One®, Dexcom G6®, Dexcom G7®, Eversense® E3, and others. Depending on the selected system, glucose readings can be viewed on a dedicated receiver or in a smartphone application [18].

Principles for the use of CGM in the periprocedural period:

• The continuous glucose monitoring sensor should be inserted optimally 24–36 hours before the procedure. A procedure should not be scheduled with a sensor inserted less than 6 hours before the procedure, nor during the last two days of the expected sensor wear time—during both of these periods, readings may be less accurate, and the likelihood of interruptions in sensor function is higher. E

• The sensor insertion site must comply with the manufacturer's recommendations and be distant from the surgical/procedure field and not exposed to pressure (compression of subcutaneous tissue may cause falsely low glucose readings, so-called compression hypoglycemia). E

At least twice within the last 2 hours before the procedure, it is recommended to verify the consistency of CGM glucose values with capillary blood glucose measurements performed at the bedside (point-of-care test, POCT, e.g., using a glucose meter). E

• During the procedure, despite the use of CGM, POCT glucose measurements must be performed every hour. E

• The possibility of interference with CGM readings caused by fluoroscopy, electrocautery, certain medications (acetaminophen —- primarily in intravenous form, hydroxyurea, salicylic acid, vitamin C, lisinopril, albuterol, and atenolol**, Supplementary Table S2**) should be taken into account; abnormal hematocrit may also affect CGM glucose readings (low hematocrit may falsely elevate and high hematocrit may falsely lower the reading) [11,19]. C

Currently, few studies are available regarding the use of CGM during procedures under anesthesia. One of the reasons is the lack of formal approval of these devices for periprocedural use by the U.S. Food and Drug Administration (FDA). However, an increasing number of clinical observations and studies confirm the effectiveness and safety of CGM in hospitalized patients who are not critically ill, including, among others, individuals undergoing dialysis, abdominal surgery, and solid organ transplantation [20-28].

An important issue remains the need to use the patient's smartphone during the surgical procedure when the CGM system application is installed on it, as this raises concerns regarding data confidentiality, the risk of device loss or damage, and the need to maintain aseptic conditions. Before bringing the phone into the operating room, the password required to unlock the system should be documented and the device should be disinfected using an appropriate agent. An alternative may be the use of a dedicated receiver for the given CGM system [11] (however, the patient would need to obtain it in advance), or a partner application installed on a hospital team smartphone. The use of separate hospital-owned platforms receiving CGM data has been tested, but they are currently not widely available.

It is important that members of the procedural team (at least one of them, in particular the anesthesiologist) are familiar not only with how to read CGM data but are also aware of the limitations of this equipment, including the so-called "lag time," that is, the possible delay of

CGM readings compared with actual blood glucose levels at a given moment, especially during rapid glucose changes indicated by trend arrows.

It should be emphasized that, particularly in patients using AID in the periprocedural period, in whom proper CGM function directly determines proper AID algorithm performance and thus patient safety, only sensors meeting appropriate quality standards should be used [~~28~~ 29]. In the case of AID systems reimbursed in Poland, the sensors with which they operate (Guardian™ 4, Simplera Sync™, Dexcom G6®) meet the above-mentioned standards.

INSULIN PUMP AND AID SYSTEM – CONDITIONS AND PRINCIPLES FOR CONTINUATION OF THEIR USE DURING A PROCEDURE

A procedure under anesthesia in an individual with diabetes using an insulin pump, including a pump operating in AID mode, requires special attention. Maintaining recommended glucose values in the periprocedural period depends not only on the diabetes care team but also on the procedural team, including the anesthesiologist. A procedure under anesthesia may be performed using a personal insulin pump in a patient who understands the principles of pump therapy, is hemodynamically stable, is undergoing a scheduled procedure, has well-controlled diabetes, and has been previously prepared by the therapeutic team [20,30,31]. Metabolically stable patients who meet the requirements for CGM use in the periprocedural period and who understand the principles of management during this period may—also during short procedures performed in an expedited or emergent setting—continue to use AID systems, provided that procedural team consents to this. The preferred setting for performing the procedure is a facility with a diabetes care team available to provide support during the procedure. It is important that the patient and/or their caregiver expresses the wish to maintain AID therapy during the procedure and that this information is documented in the medical record. The final decision regarding the type of insulin therapy in the periprocedural period is made by the procedural

team. If continuation of AID therapy (and/or insulin pump therapy) is not possible, the diabetes equipment must be disconnected and secured [11].

Tables 1 and 2 present suggested criteria for continuation of insulin therapy using AID during a procedure under anesthesia or sedation, as well as certain situations in which a personal insulin pump may be used without the possibility of using the AID automated mode, for example, CGM sensor failure.

GENERAL PRINCIPLES FOR THE PRE- AND PERIPROCEDURAL PERIOD IN AN INDIVIDUAL WITH DIABETES TREATED WITH AID

During the planning of a procedure, appropriate preparation of the patient by the diabetes care team is important in order to assess glycemic control (laboratory tests and CGM data from the last 2–4 weeks) and, if no contraindications are identified, to establish a formal management plan regarding insulin therapy (including appropriate AID system settings) in the pre-, peri-, and postoperative periods, taking into account the type of planned procedure and how it will be performed. The developed management plan should also include verification of manual mode settings to allow a smooth transition to manual mode if necessary. It should also be verified whether the patient has alert alarms activated for low (e.g., 70 mg/dL (3.9 mmol/L)) and high glucose levels (e.g., 180–200 mg/dL (10-11.1 mmol/L)); if not, they should be activated [32,33].

When scheduled procedures are performed in medical facilities where physicians experienced in AID therapy are not employed, it is recommended to provide the patient with written instructions regarding AID management in the periprocedural period (including criteria for continuation of this insulin therapy method, **Table 1**). This information should be provided by the patient to the procedural team in advance so that they can decide whether they plan to maintain AID therapy during the procedure.

If, prior to admission to the medical facility, the patient has not received periprocedural instructions from their diabetes care team, a diabetes consultation should be performed during hospitalization. Minor urgent procedures under sedation or short general anesthesia (up to 30 minutes) may be performed without a diabetes consultation if the patient (or their caregiver) is able to independently manage AID in the periprocedural period.

In case of doubts regarding pump therapy in AID mode, including lack of experience of the procedural center staff with AID therapy and a decision to temporarily discontinue it in the periprocedural period, generally accepted principles of perioperative management should be followed, in accordance with current guidelines, for example those of Diabetes Poland [32]. The final decision regarding continuation of pump therapy in AID mode during the procedure or transition to alternative insulin therapy (e.g., intravenous) is made by the anesthesiologist and/or the procedural team after consideration of the above elements.

In the periprocedural period, efforts should be made to maintain optimal glucose levels in the range of 100 (90)–180 mg/dL (5.6 (5.0)-10 mmol/L); however, glucose values up to 250 mg/dL (13.9 mmol/L) (without signs of diabetic ketoacidosis) do not preclude initiation and continuation of the procedure [32,33]. C

Despite the patient's use of CGM, glucose levels in the periprocedural period should be assessed using capillary blood POCT (e.g., with a glucose meter) every hour, and in the case of glucose <100 mg/dL (5.6 mmol/L), every 15 minutes until values above 100 mg/dL (5.6 mmol/L) are achieved [11].C

MANAGEMENT BEFORE, DURING, AND AFTER THE PROCEDURE IN AN INDIVIDUAL TREATED WITH AID

Below, periprocedural management in patients treated with AID who have been qualified to continue this therapy (or insulin pump therapy without AID mode, i.e. in manual mode) during

the procedure is described in detail and presented schematically. The management algorithm in the preprocedural period and during the procedure depending on glucose level and clinical situation is presented in **Figures 1A** and **1B** and in **Tables 3, 4 and 5.**

I. Management before the procedure

Teflon infusion sets are preferred for the duration of the procedure (due to the potential interference of metal infusion sets with electrocautery).

It is necessary to verify:

• that the infusion set (insertion site) and CGM sensor are located on the patient's body in a position allowing safe performance of the procedure. E

• proper functioning and reliability of CGM readings by comparison with capillary blood glucose measurements (POCT) performed at least twice within the 2 hours preceding the procedure. E

II. Management during the procedure

● MiniMed™ 780G system

The insulin pump should be positioned in such a way that the anesthesiologist/anesthesia nurse can see the glucose values on the screen (use of an infusion set with a long tubing is recommended). Before the procedure, it is recommended that the patient/caregiver disable "lock mode" on the pump. E

● CamAPS® FX

The patient's smartphone along with the passcode/PIN should be made available to the anesthesiologist for the periprocedural period. (If this is not possible, the procedural team will

not have full access to CGM glucose data. To view these data and/or operate the pump, the phone must be unlocked and the CamAPS® FX application opened. In some smartphones, however, a widget with current CGM glucose value and trend arrow may be enabled in notification settings.) The patient's smartphone with the AID application must be placed no farther than 6 meters from the patient (optimally <4 m). E

III. Management in the postoperative period

Additional notes regarding the postoperative period

A patient using AID with automated mode maintained during the procedure or using the system with automated mode disabled - thus functionally in manual mode:

• If AID/pump settings were modified for the procedure, the original (daily) AID settings should be restored together with the patient and the diabetes care team or in accordance with their recommendations. E

Every patient in whom the pump was turned off during the procedure (and alternative insulin delivery was started, e.g. intravenous):

• Once glucose levels have stabilized and the patient feels able to resume control of their pump (or the caregiver assumes control), in cooperation with the diabetes care team (or according to their recommendations), AID/pump settings used before the procedure should be restored and intravenous insulin therapy should be gradually discontinued. E

• If intravenous insulin therapy was used and the patient's pump therapy is being resumed, intravenous insulin therapy should be continued for at least 30–60 minutes after restarting the subcutaneous insulin delivery via personal pump. E

MANAGEMENT DURING VAGINAL DELIVERY AND CESAREAN SECTION IN AN INDIVIDUAL WITH DIABETES USING AID DURING PREGNANCY

A pregnant woman with type 1 diabetes treated with an AID system should be managed in a multidisciplinary center and have access to a diabetologist experienced in AID therapy. Both commercially available AID systems in Poland (CamAPS® FX and MiniMed™ 780G) do not have contraindications for use during pregnancy The CamAPS FX system was the first automated insulin delivery (AID) system approved for use during pregnancy in Europe and the UK, receiving CE marking in March 2020. The MiniMed 780G system was approved for use during pregnancy in Europe on 21 July 2025. The safety and efficacy of the MiniMed 780G system during pregnancy were demonstrated in the CRISTAL study. Regulatory approval was based, among other evidence, on the results of clinical trials such as CRISTAL These studies showed that the advanced algorithm enabling automated basal insulin delivery and automated correction boluses in the MiniMed 780G system effectively and safely supports the achievement of strict glycemic targets while minimizing the risk of severe maternal hypoglycemia and fetal exposure to hyperglycemia. We do not recommend the use of DIY (do-it-yourself) closed-loop systems during pregnancy. Instead, we advise the use of systems with approved indications for pregnancy, such as CamAPS FX and MiniMed 780G [5,34-42]. B, C

The peripartum period is defined as the time from 24 hours before delivery to 48 hours after delivery [44]. Effective AID therapy requires appropriate preparation of the woman in labor and/or her support person, including written instructions regarding peripartum recommendations established with the diabetes care team. The final decision regarding continuation of AID therapy during labor is made by the anesthesiology-obstetric team and depends on multiple factors, such as the technical feasibility of continuing therapy during labor, the center's experience, availability of support from the diabetes care team, urgency of delivery,

anticipated postpartum difficulties, and the patient's preferences. Preparation of a pregnant woman using AID in the pre-delivery period is presented in **Table 6** [5,30,38-42,45-50].

During the peripartum period AID system use may be continued; however, it is necessary that birthing woman or her support person be able to manage diabetes during this time. If they are unable to manage diabetes therapy during labor or if glucose values are not maintained within the target range, intravenous insulin therapy should be initiated [32,34,40-43,45,46,51]. E, C

The main management goals in the peripartum period are presented in **Table 7** [32,40,45,46].

Target glucose values in pregnant women and during labor are lower than in individuals with diabetes who are not pregnant. After delivery, insulin requirements decrease rapidly, which requires modification of AID system settings in the postpartum period [32,35,40-46,52,53].

Detailed recommendations for peripartum management

I. Early labor period – 6–24 hours before active delivery

1. From the onset of labor, glucose levels should be monitored every hour using POCT and CGM (including observation of glucose trend arrows) [32,40-45].
2. Maternal glucose levels should be maintained on average within 100–130 mg/dL (5.6–7.2 mmol/L) [32,40-46]. C
3. Continuation of AID therapy – the following settings should be entered into the system [5,35,40,49,53-58]:

• Increase the insulin-to-carbohydrate ratio (ICR) in grams by 10–30% compared to the current value (reduction of bolus doses).

• In the case of planned cesarean section, which is usually of shorter duration, the following settings are recommended in AID automated mode to reduce the risk of hypoglycemia:

– MiniMed™ 780G – target glucose 100 mg/dL (5.6 mmol/L) and active insulin time 2 hours;

– CamAPS® FX – target glucose 100 mg/dL (5.6 mmol/L).

• In the case of vaginal delivery, which is typically longer in duration, a higher target glucose level should be set in automated mode to improve safety and reduce the risk of hypoglycemia:

– MiniMed™ 780G – 120 mg/dL (6.7 mmol/L) and active insulin time 2 hours or 2.5 hours;

– CamAPS® FX – 120 mg/dL (6.7 mmol/L). E, C

4. Transition to intravenous insulin therapy should occur if the woman in labor or her support person is unable to manage diabetes during labor, or if two consecutive POCT glucose measurements exceed 144 mg/dL (8 mmol/L), or if ketone levels are elevated (urine ++ or higher, or blood beta-hydroxybutyrate >1.5 mmol/L). The personal insulin pump should be secured.

• In case of suspected diabetic ketoacidosis, blood gas analysis should be performed and, if possible, ketone levels should be measured (preferably in capillary blood); if confirmed, appropriate treatment of ketoacidosis should be initiated immediately. E, C

5. Fluid therapy in a woman in labor using AID should follow general obstetric principles—using 0.9% NaCl with 5% glucose and 15% KCl; solutions containing glucose alone should be avoided due to increased risk of hyponatremia.

• If intravenous insulin therapy is used for more than 6 hours, electrolytes should be monitored every 4–6 hours. C

6. Energy support: if the patient is not consuming food, e.g., during prolonged labor, intravenous access should be secured and an intravenous solution containing 5% or 10% glucose should be administered at 100–125 mL/hour (approximately 1000 kcal/day), with simultaneous intravenous administration of KCl [40-46,56]. B

II. Active delivery

1. Glucose monitoring as in early labor (every hour using POCT and CGM, including observation of glucose trend arrows). Glucose should be maintained within 100–130 mg/dL (5.6–7.2 mmol/L). B
2. AID SYSTEM SETTINGS SHOULD REMAIN AS IN EARLY LABOR. E
3. If two consecutive POCT glucose measurements exceed 144 mg/dL (8 mmol/L), transition to intravenous insulin therapy is recommended.
4. In case of hypoglycemia, POCT monitoring every 15 minutes until glucose >70 mg/dL (3.9 mmol/L). C

Sensor glucose values visible on the insulin pump display or on the patient's smartphone should be verified. According to general principles, electrolytes, hydration status, blood pressure, coagulation parameters, and complete blood count should be monitored. In case of maternal hypoglycemia or prolonged labor, adequate caloric supply should be ensured by slow infusion of 10% glucose [40-46,55]. C

III. Postpartum period – from placental delivery to 48 hours after delivery

Insulin requirements decrease rapidly after delivery by approximately 50% compared to the end of pregnancy. This increases, among others, the risk of nocturnal hypoglycemia associated with breastfeeding. In AID systems, postpartum modification of settings is necessary to minimize hypoglycemia risk. The following changes should be introduced:

Higher automated mode glucose target: in both MiniMed™ 780G and CamAPS® FX – 120 mg/dL (6.7 mmol/L);

• Extend active insulin time to 2.5–3 hours (relevant for automated mode in MiniMed™ 780G and during bolus delivery outside automated mode in CamAPS® FX);

• Increase ICR by 20–50% compared to pre-delivery values. E

1. In patients at significant risk of hypoglycemia, activation of the “Ease Off” function in CamAPS® FX and the “Temporary Target” (150 mg/dL) in MiniMed™ 780G is recommended. E
2. Target glucose values should be maintained within 70–180 mg/dL (3.9–10.0 mmol/L). B
3. If intravenous insulin therapy was used during delivery, restarting the patient’s personal pump is possible once she or her support person is able to manage diabetes and make therapeutic decisions. After restarting personal pump therapy, intravenous insulin may be discontinued after 30–60 minutes. E
4. Until the patient fully resumes control of diabetes management, capillary blood glucose monitoring with POCT every hour should be maintained, optimally for up to 24 hours postpartum (this is the period of highest hypoglycemia risk due to rapidly changing insulin requirements). E
5. Patients using AID most women may not require a prandial bolus insulin for the first small postpartum meal (proximately 20 g carbohydrates) after delivery [32,40,45,46,54-58]. E

MAJOR SURGERY AND THE USE OF AID

Currently, there is insufficient scientific evidence, including randomized clinical trials, regarding the safety and effectiveness of continuing insulin therapy using AID systems during major surgical procedures. **Therefore, we do not recommend continuation of AID-based insulin therapy during major surgical procedures, particularly those associated with the risk of significant blood loss, impaired subcutaneous insulin absorption, hemodynamic and electrolyte disturbances, or shock. In such situations, intravenous insulin therapy**

tailored to the patient's age remains the preferred model, for example in accordance with the recommendations of Diabetes Poland [32,33]**. E**

However, in the case of certain standard and planned procedures within this group (major surgical procedures lasting >2 hours), during which the risk of the above-mentioned disturbances is minimized, performed mainly using laparoscopic techniques (including uncomplicated appendicitis or cholecystectomy, removal of postoperative intra-abdominal adhesions, inguinal hernia repair, etc.), as well as certain open procedures (orthopedic procedures including hip, knee, or spine surgery, plastic and reconstructive surgery, thyroid surgery, gynecologic procedures including hysterectomy, etc.), continuation of insulin therapy using a personal insulin pump with an AID system may be considered [59-61]. E

A condition for safe and effective performance of major surgery under general anesthesia in a patient using an AID system is cooperation between the procedural team (in particular the anesthesiologist) and a specialist experienced in insulin pump therapy with AID, as well as full acceptance of this form of insulin therapy by the procedural team and the patient/their caregiver. Cooperation between the procedural team and the patient and/or their caregiver is also important. However, these recommendations are based primarily on limited anecdotal evidence, including case reports, and therefore the decision to continue AID-based insulin therapy during major surgery should be individualized, with institutional experience, perioperative monitoring capabilities, and procedural-team expertise taking precedence.

SUMMARY

The criteria proposed by the authors of this document for qualification to continue the use of AID systems and the outlined periprocedural management are intended to enable the safe use of these systems during selected procedures performed under general anesthesia, sedation, and local anesthesia, as well as during labor and delivery. Awareness of potential risks associated

with the use of AID and preparedness for such risks, including the availability of alternative methods of insulin therapy, are essential to avoid complications related to hypoglycemia, hyperglycemia, and diabetic ketoacidosis. It should be emphasized that the management recommendations contained in this document are based on currently published clinical observations, literature review, and the authors' clinical experience, and may require modification in the future. There is an urgent need for further clinical studies, including randomized trials, regarding the feasibility of treatment using AID systems during procedures under anesthesia and during labor, especially since these systems have already become part of modern insulin therapy standards, particularly in individuals with type 1 diabetes [62,63].

Article information

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Table 1. Suggested criteria for continuation of insulin therapy using an automated insulin delivery (AID) system during a procedure under sedation or anesthesia – related to the procedure and the procedural team. E

CONDITIONS FOR CONTINUATION OF AID DURING A PROCEDURE UNDER ANESTHESIA OR SEDATION – RELATED TO THE PROCEDURE AND ITS TEAM	
1.	**Conditions related to the type of procedure**
	- scheduled or unscheduled procedure/diagnostic procedure under anesthesia, sedation, or local anesthesia only, lasting up to 2 hours
	- no significant impact of the procedure on glucose levels is anticipated (particularly procedures lasting up to 30 minutes)
	the patient's position during the procedure will not interfere with proper functioning and use of AID, and its components will not be exposed to accidental removal/damage
	- AID components will not interfere with the procedure
	- during the procedure, devices and energy modalities contraindicated/not approved for use with AID will not be used, e.g., X-ray radiation (including fluoroscopy), magnetic resonance imaging, extreme temperatures* it is suggested to avoid electrocautery near the inserted sensor (i.e., on the same limb)
	- the type of procedure and the postoperative period will not interfere with the patient's (or caregivers') ability to assume control of the insulin pump and AID system immediately after the procedure

CONDITIONS FOR CONTINUATION OF AID DURING A PROCEDURE UNDER ANESTHESIA OR SEDATION – RELATED TO THE PROCEDURE AND ITS TEAM	
	examples of procedures during which continuation of AID may be considered: • endoscopic procedures, insertion/replacement of vascular ports, invasive dermatologic procedures, short surgical procedures including selected laparoscopic procedures (e.g., appendectomy), selected orthopedic procedures, ophthalmologic procedures (e.g., cataract surgery), otolaryngologic procedures (e.g., adenectomy) • during labor, continuation of AID therapy is possible – according to separate recommendations
2.	**Performance of the procedure in an ambulatory setting**
	- ambulatory procedures – provided the conditions in point 1 are met – without contraindications to AID
	- ability to measure capillary blood glucose as frequently as needed during the procedure in a given patient (e.g., glucose meter or other point-of-care testing device, POCT)
	-ability to administer intravenous fluids (including 10% or 20% glucose)
3	**Performance of the procedure in a hospital setting**
	- provided the conditions in points 1 and 2 are met
	-ability to transition to intravenous insulin therapy should be available
4.	**Conditions related to the procedural team** (operator, anesthesiologist, nursing team)

CONDITIONS FOR CONTINUATION OF AID DURING A PROCEDURE UNDER ANESTHESIA OR SEDATION – RELATED TO THE PROCEDURE AND ITS TEAM	
	The procedural team must consent to continuation of AID during the procedure and possess basic knowledge and skills required in this area (at least one person continuously present during the procedure), meaning that:
	- they have been informed in advance about the planned continuation of AID therapy during the procedure
	- they know that insulin is delivered via pump tubing and a subcutaneous infusion site
	- they have at least basic knowledge of the components and functioning of the AID system*
	- they will tolerate and, if necessary, appropriately respond to AID system alarms (especially those related to hypoglycemia, but also interruption of insulin delivery/suspension, persistent lack of glucose readings, loss of communication between AID components, hyperglycemia) *
	- they are able, at least at a basic level, to use the AID system/pump, in particular to view the current glucose level and CGM trend (this may not apply to very short procedures, e.g., up to 30 minutes—when immediately before and after the procedure the patient or caregiver controls the system, and to procedures under local anesthesia—when the patient or caregiver maintains control throughout)
	- they know that in case of urgent need to interrupt insulin delivery (e.g., persistent hypoglycemia <70 mg/dL (3.9 mmol/L)), they may stop/disconnect the pump. The pump should be restarted when glucose is >100 mg/dL (5.6 mmol/L). If removal of the

CONDITIONS FOR CONTINUATION OF AID DURING A PROCEDURE UNDER ANESTHESIA OR SEDATION – RELATED TO THE PROCEDURE AND ITS TEAM	
	subcutaneous infusion set is necessary, alternative subcutaneous or intravenous insulin administration should be planned within 60 minutes
	- it is not recommended that the procedural team, if not proficient in the specific AID system/pump used by the patient, administer insulin or modify its delivery using that system
	- it is recommended that before the procedure, in the presence of the patient/caregiver, the pump and/or smartphone be cleaned/disinfected without damaging them
	- if access to current CGM glucose values requires unlocking the pump or smartphone, then accordingly the pump should remain unlocked during the procedure or a member of the procedural team should know the unlocking PIN**

* if this condition is not met, continuation of subcutaneous pump therapy is possible

** if this condition is not met, continuation of subcutaneous pump therapy is possible or AID mode may be maintained with glucose verification using POCT

Table 2. Suggested criteria for continuation of insulin therapy using an automated insulin delivery (AID) system during a procedure under sedation or anesthesia – related to the patient and/or their caregiver. E

CONDITIONS FOR CONTINUATION OF AID DURING A PROCEDURE UNDER ANESTHESIA OR SEDATION – RELATED TO THE PATIENT AND/OR CAREGIVER	
1.	**Diabetes control and knowledge and skills of the patient and/or caregiver**
	- diabetes should be adequately controlled prior to elective surgery. In accordance with current guidelines, a preoperative HbA1c goal <8% (<64 mmol/mol) within the preceding 3 months is recommended, with an individualized risk-to-benefit assessment. Alternatively, a 14-day glucose management indicator (GMI) <8% and/or time in range (TIR) >50% may also be used to assess glycemic control before the procedure
	- the patient/caregiver wishes to continue AID therapy during the procedure, and this has been approved by the physician managing the patient's diabetes, who has discussed with the patient/caregiver how to prepare and how to act in the periprocedural period
	- possesses the knowledge and skills necessary for effective operation of the AID system and troubleshooting the most common problems related to its functioning – applies to the preprocedural and postoperative periods
	- understands the settings of their AID and insulin pump in manual mode in order to provide necessary information to the procedural team if needed - manual mode settings should have been verified/updated by the physician managing the patient's diabetes optimally within the last 2–4 weeks

CONDITIONS FOR CONTINUATION OF AID DURING A PROCEDURE UNDER ANESTHESIA OR SEDATION – RELATED TO THE PATIENT AND/OR CAREGIVER	
	- low (usually 70 mg/dL (3.9 mmol/L)) and high glucose alerts (usually 180–200 mg/dL (10-11.1 mmol/L)) are set in the AID/pump
	- is able to efficiently switch to manual mode of the insulin pump and, if necessary, also to insulin pen therapy and glucose monitoring using a glucose meter
	- will be able to assume control of the insulin pump and AID system immediately after the procedure
2.	**Responsibilities of the patient/caregiver regarding AID**
	- the infusion set should optimally be inserted on the day before the procedure up to 4 hours before bedtime. If later replacement is necessary, it is recommended that it be inserted at least 6 hours before the procedure. In individuals using Teflon infusion sets, the set may be inserted up to 48 hours before the procedure; in the case of metal infusion sets and in young children, up to 24 hours before the procedure
	- the CGM sensor should be inserted optimally 24–36 hours before the procedure (the procedure should not be scheduled with a sensor inserted less than 6 hours before the procedure, nor during the last two days of the expected sensor wear time) *
	- it is necessary to verify battery charge level of the pump and CGM transmitter* before the procedure, and, if applicable, charge the smartphone*

* if this condition is not met, continuation of subcutaneous pump therapy is possible.

Table 3. Modification of diabetes therapy 4–6 hours before a planned procedure [11,32,33].

Glucose level	**MANAGEMENT- 4-6 HOURS BEFORE THE PROCEDURE**
<70 mg/dL (3.9 mmol/L)	• treat hypoglycemia (iv glucose 0.2–0.5 g/kg as a 10% or 20% solution); assess glucose level with POCT every 15 minutes until >100 mg/dL (5.6 mmol/L) is achieved. E
70-99 mg/dL (3.9-5.5 mmol/L)	• verify whether AID is correcting hypoglycemia; assess glucose level with POCT every 15 minutes until >100 mg/dL (5.6 mmol/L) is achieved. E
100- 179 mg/dL (5.6 -9,9 mmol/L)	• MiniMed™ 780G: enable Temporary Target (i.e., 150 mg/dL (8.3 mmol/L) for 8 hours). E
	• CamAPS® FX: set target to 150 mg/dL (8.3 mmol/L) (for the next 8 hours). E
180-250 mg/dL (10.0-13.9 mmol/L)	• verify whether AID is correcting hyperglycemia; leave automated mode unchanged until glucose decreases to <180 mg/dL (10 mmol/L), then proceed as above (i.e., as for <180 mg/dL (10 mmol/L)). E
>250 mg/dL (13.9 mmol/L)	• Verify whether the pump is correcting hyperglycemia, check active insulin, verify and replace the infusion set together with the reservoir and insulin. • If hyperglycemia persists for >1 hour, administer a manual correction bolus calculated to a target glucose of 150 mg/dL (8.3 mmol/L) or 2/3 of the dose calculated by the pump bolus calculator. • If it persists for >3 hours – assess acid-base balance, electrolytes, and, if possible, ketonemia/ketonuria.

	• In the absence of diabetic ketoacidosis, initiate intravenous insulin therapy according to current guidelines, e.g., those of Diabetes Poland, for procedures under anesthesia. • In the case of diabetic ketoacidosis – correction of metabolic disturbances is required, and the procedure should be postponed E, C

Table 4. Modification of diabetes therapy during the procedure [11,32,33].

Glucose level	**MANAGEMENT DURING THE PROCEDURE**
<70 mg/dL (3.9 mmol/L)	● Suspend insulin delivery (e.g., disconnect the pump) and treat hypoglycemia (iv glucose 0.2–0.5 g/kg as a 10% or 20% solution); assess glucose level with POCT every 15 minutes until >100 mg/dL (5.6 mmol/L) is achieved. C
70-99 mg/dL (3.9-5.5 mmol/L)	● Treat hypoglycemia (iv glucose 0.2–0.5 g/kg as a 10% or 20% solution) and assess glucose level with POCT every 15 minutes until >100 mg/dL (5.6 mmol/L) is achieved (AID mode remains enabled). E
100- 179 mg/dL (5.6 -9,9 mmol/L)	● MiniMed™ 780G system: maintain Temporary Target (150 mg/dL (8.3 mmol/L)) during the procedure until the patient is able to eat.
	● CamAPS® FX: maintain target 150 mg/dL (8.3 mmol/L) until the patient is able to eat. E
180-250 mg/dL (10.0-13.9 mmol/L)	● Verify whether the pump is correcting hyperglycemia (CGM readings and/or POCT glucose values); leave automated mode unchanged until

	glucose decreases to <180 mg/dL (10 mmol/L) and then proceed as above. ● If intravenous glucose-containing solutions are being administered, consider temporary reduction or suspension of their infusion. E
>250 mg/dL (13.9 mmol/L)	● If persistent for >60 minutes, initiate intravenous insulin therapy according to current guidelines, e.g., those of Diabetes Poland for surgical procedures. ● If intravenous glucose-containing solutions are being administered, temporarily suspend their infusion. C

Table 5. Modification of diabetes therapy in the postoperative period [11,32,33].

Glucose level	**MANAGEMENT IN THE POSTOPERATIVE PERIOD**
<70 mg/dL (3.9 mmol/L)	● Treat hypoglycemia (iv glucose 0.2–0.5 g/kg as a 10% or 20% solution); assess glucose level with POCT every 15 minutes until >100 mg/dL (5.6 mmol/L) is achieved.
70-99 mg/dL (3.9-5.5 mmol/L)	● Verify whether AID is correcting hypoglycemia; assess glucose level with POCT every 15 minutes until >100 mg/dL (5.6 mmol/L) is achieved. E
100- 179 mg/dL (5.6 -9,9 mmol/L)	● In the MiniMed™ 780G system, maintain Temporary Target (150 mg/dL (8.3 mmol/L)) until oral intake is possible.
	● In CamAPS® FX – maintain target 150 mg/dL (8.3 mmol/L) until oral intake is possible.
180-250 mg/dL (10.0-13.9 mmol/L)	● In the MiniMed™ 780G system, disable Temporary Target until glucose decreases to <180 mg/dL (10 mmol/L). (Note: disabling Temporary Target will activate auto-corrections in AID, i.e., delivery of additional insulin doses by the pump.) E
	● In CamAPS® FX, return to the patient's usual glucose target until glucose decreases to <180 mg/dL (10 mmol/L).
>250 mg/dL (13.9 mmol/L)	● Verify whether accidental damage/dislodgement of the infusion set has occurred or whether the reservoir is empty. If malfunction is confirmed, replace the infusion set/replace the reservoir and refill insulin; enable automated mode with standard system settings.

	● After excluding infusion set malfunction, in MiniMed™ 780G disable Temporary Target; in CamAPS® FX return to the patient's usual glucose target, unless these settings had been previously modified. ● If glucose >250 mg/dL (13.9 mmol/L) persists for more than 1 hour, administer a correction bolus calculated to a target glucose of 150 mg/dL (8.3 mmol/L) or 2/3 of the dose calculated by the correction bolus calculator. ● If glucose does not decrease after a correction bolus delivered via the insulin pump, administer correction using an insulin pen and replace the infusion set. E

Table 6. Preparation of a pregnant woman with type 1 diabetes using an AID system in the pre-delivery period. E

PRE-DELIVERY PREPARATION OF A WOMAN
● The woman in labor/support person must be prepared by the diabetes care team for the delivery period, with written instructions provided and safe glucose targets and individual therapy options defined (AID / personal pump in manual mode / transition to intravenous insulin therapy). ● The obstetrician is responsible for scheduling the timing of delivery; for patients with type 1 diabetes without complications – after 38 weeks of gestation. ● Implementation of delivery-specific settings in the AID system 6 to 24 hours before delivery. ● The ability to maintain CGM as a self-monitoring tool during AID use must be ensured. ● Additional glucose monitoring with POCT every 1–2 hours, despite the use of CGM.

● Insertion of a new infusion set and/or sensor (if possible 24–36 hours before delivery). ● The infusion set and CGM sensor insertion site should be located away from the potential surgical/procedural field (recommended: lateral abdomen, posterior aspect of the upper arms). ● A Teflon infusion set is preferred, optimally with long tubing. ● In the case of a mobile application, access to the smartphone must be ensured.

Table 7. Main treatment goals a pregnant woman with type 1 diabetes in the peripartum period.

C

MAIN TREATMENT GOALS IN THE PERIPARTUM PERIOD
● Reduction of the risk of maternal hyperglycemia and its consequences in the form of neonatal hypoglycemia
● Reduction of the risk of maternal and fetal hypervolemia and hyponatremia
● Target glucose values (POCT) – mean 100–130 mg/dL (5.6–7.0 mmol/L): ○ in patients at low risk of hypoglycemia: 72–126 mg/dL (4–7 mmol/L) ○ in patients at higher risk of hypoglycemia: 90–144 mg/dL (5–8 mmol/L)

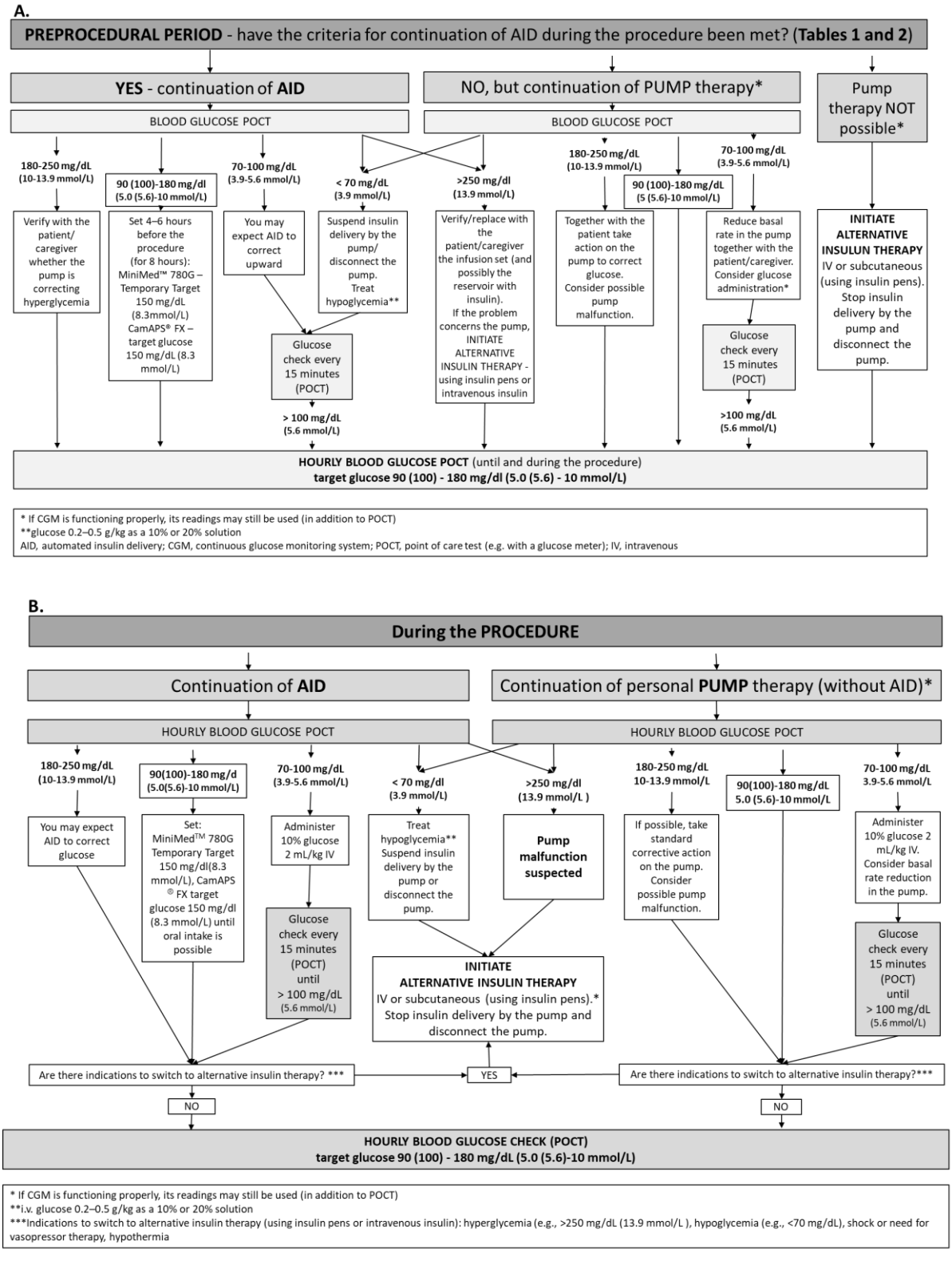

Figure 1. Periprocedural diabetes management in individuals treated with automated insulin delivery (AID) systems: A - in the preprocedural time and B - during a minor procedure

performed under sedation or anesthesia. (partly based on Cruz P, McKee AM, Chiang HH. *Perioperative Care of Patients Using Wearable Diabetes Devices.* Anesth Analg. 2025;140(1):2–12; McGill JB, Hirsch IB, Ringenberg K, et al.)[11]. E, C

SHORT TITLE: AID systems in minor procedures and labor in diabetes