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Insulin therapy with enteral and parenteral nutrition: a consensus statement endorsed by the Swiss Society for Endocrinology and Diabetology and the Swiss Society for Clinical Nutrition and Metabolism

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Summary

BACKGROUND: Nutritional support with enteral or parenteral nutrition is often required in hospitalised patients and can impair glycaemic control. Despite its clinical importance, practical and uniform recommendations for insulin therapy are lacking.

METHODS: The Swiss Society for Endocrinology and Diabetology convened an expert panel to develop consensus guidance on insulin therapy for patients receiving enteral or parenteral nutrition. The working group reviewed available evidence, international guidelines and current practice in Swiss hospitals, and harmonised approaches across regions. The resulting statement provides strategies for insulin dosing in intermittent, continuous and bolus enteral nutrition, as well as parenteral nutrition, primarily for inpatient care, but also applicable to home-based nutritional support.

RECOMMENDATIONS: The insulin dose depends on the (known or calculated) basal insulin requirement and the carbohydrate content of the enteral or parenteral nutrition bag. For intermittent enteral nutrition (infused over 12–14 hours), intermediate-acting insulin with a duration of action matching the feeding duration is recommended. For continuous enteral nutrition (over 24 hours), long-acting insulin is preferred. When enteral nutrition is administered as boluses (2–3 hours each), short-acting insulin should be injected before each bolus, similar to prandial dosing with meals. For parenteral nutrition, adding short-acting insulin directly to the parenteral nutrition bag is encouraged, as it helps maintain stable glycaemic control without increasing the risk of hypoglycaemia. Across all modalities, correction insulin should be prescribed according to institutional schemes and individualised requirements, with additional units of correction insulin incorporated into the subsequent day's basal and (par)enteral nutrition insulin dose. The statement also provides recommendations for glucose monitoring, safe transitions between regimens, and management of unexpected interruptions in nutritional therapy.

CONSLUSIONS: This consensus statement, endorsed by the Swiss Society for Endocrinology and Diabetology and the Swiss Society for Clinical Nutrition and Metabolism, represents a nationwide framework for insulin therapy in patients receiving enteral or parenteral nutrition in Switzerland. By standardising insulin use, it aims to enhance safety, reduce glycaemic variability and improve outcomes in hospitalised patients and in those receiving home-based specialised nutritional support.

Introduction

The prevalence of diabetes is increasing, and it affected an estimated 590 million people worldwide in 2024, according to the 11th International Diabetes Federation Atlas [1]. In Switzerland, the prevalence of diabetes among adults aged 20–79 years was 6.6% in 2024, representing around 433,000 individuals [1]. Switzerland has the highest annual expenditure per person with diabetes, estimated at 12,234 USD (approximately 9600 CHF at the time of writing). In addition, one third of hospitalised patients are at increased risk of malnutrition at admission, and this risk increases with age [2]. Malnutrition in hospitals also represents an additional economic burden due to longer stays and comorbid conditions [2, 3]. Thus, patients with malnutrition and diabetes incur more than 50% higher diabetes-related costs [4].

Nutritional support – whether enteral, parenteral or oral – presents unique challenges in glucose control, particularly regarding insulin dosing and timing. Variability in nutritional intake, absorption rates and metabolic response necessitates personalised insulin strategies to minimise the risk of hyper- and hypoglycaemia. Given the potential for adverse events [5-7], the American Society for Parenteral and Enteral Nutrition recommends that "insulin use in parenteral nutrition should be done in a consistent manner adhering to a defined protocol, in which healthcare personnel have adequate knowledge" [8].

This consensus statement aims to provide practical guidance on insulin administration across different nutritional regimens, including enteral nutrition (continuous, intermittent and bolus administration) and parenteral nutrition (continuous or intermittent intravenous administration), inspired by recommendations by the French Society of Clinical Nutrition (https://www.sfncm.org) [9]. The statement outlines available options for insulin prescription, detailing key considerations for dose adjustments, timing and monitoring. Insulin needs with oral nutritional supplements are beyond the scope of this statement and can usually be managed similarly to an insulin bolus administration for a meal/snack with known carbohydrate content (see https://clinicalnutrition.science/en/nutripro/ for the different nutritional support products).

This guidance is primarily intended for hospital-based healthcare providers, including residents and consultant physicians managing inpatients requiring insulin therapy, as well as the on-call diabetes team. Our goal is to enhance the safety and effectiveness of insulin use in hospitalised patients receiving specialised nutrition support, ensuring better glycaemic outcomes and overall patient care. With proper guidance and training, these protocols can also be used safely for home-based nutritional support.

The sections below suggest different insulin regimens adapted to the nutritional support. In general, we do not recommend introducing pre-mixed insulins (short- and long-acting insulins combined in a single insulin pen) or those combining insulin with a glucagon-like peptide-1 receptor agonist. Patients already on pre-mixed insulins should be switched to a regimen combining short- and long-acting insulins for better flexibility and glycaemic control. These mixed medications can be considered later for chronic management (i.e. when the insulin regimen and nutritional support are stabilised).

Enteral nutrition in patients with diabetes

When administering enteral nutrition, whether diurnal or nocturnal, we do not recommend the exclusive use of short-acting insulin (except when enteral nutrition is given as boluses to replace meals, see "option 3" below). Instead, an intermediate-acting or a long-acting insulin should be used, with a duration of action that approximately matches the duration of enteral nutrition (table 1) [10]. The use of short-acting insulin would otherwise require subcutaneous administration every 4 hours. Matching insulin pharmacokinetics to the duration of enteral nutrition simplifies insulin dose adjustments when enteral nutrition is modified (changes in product, volume or content) [11].

We generally recommend intermittent enteral nutrition (see "option 1" below) rather than continuous enteral nutrition (see "option 2" below) to allow physical activity and mobility to support preservation of muscle mass. This recommendation is based on multidisciplinary and interprofessional practice in different settings across Switzerland, where a shorter duration of enteral nutrition leaves more time for other activities without the patient being bedridden or tethered to multiple devices and pumps.

Enteral nutrition given as boluses is more common in paediatrics and at some institutions, such as to preserve the social dimension of mealtimes. If enteral nutrition support is expected to last for a long time, the use of continuous glucose monitoring should be considered, as this might reduce the risk of both unnoticed hyper- and hypoglycaemia [12].

Table 1: Overview of insulins, categorised by their duration of action.

Insulin category	Active compound	Brand name	Active time
Short-acting insulins	Insulin aspart	NovoRapid®	3–5 hours
	Insulin aspart	Fiasp® *	3–5 hours
	Insulin lispro	Humalog®	3–5 hours
	Insulin lispro	Lyumjev® *	3–5 hours
	Insulin glulisine	Apidra®	3–5 hours
	Regular insulin	Actrapid®	5–8 hours
Intermediate-acting insulins	NPH insulin	Huminsulin®	12–18 hours
Long-acting insulins	Insulin detemir	Levemir® *	12–24 hours
	Insulin glargine	Lantus® **	20–24 hours
	Insulin glargine	Abasaglar®	20–24 hours
Ultralong-acting insulins	Insulin glargine U-300	Toujeo®	Up to 36 hours
	Insulin degludec	Tresiba®	Up to 42 hours

* The exact content of this table is subject to availability. The cartridge for the insulin pump Fiasp® PumpCart®, and the cartridge for the insulin pens Levemir® Penfill® and Levemir® FlexPen® will be available until approximately the end of 2026. Lyumjev® will soon be removed from the Swiss market. ** Lantus®: 40% deductible at the time of writing. Abbreviations: NPH, Neutral Protamine Hagedorn; U, units.

Introducing insulin for enteral nutrition

Insulin cannot be added to the enteral nutrition bag, as it would be inactivated by digestive enzymes. Therefore, insulin must be administered subcutaneously. The dose of intermediate- or long-acting insulin depends on the (known or calculated) basal insulin requirement (table 2) and the carbohydrate content of the enteral nutrition (table 3). When the enteral nutrition is tapered or discontinued, insulin dosing should be adapted accordingly (table 4). The pharmacokinetics and pharmacodynamic profile of the insulin regimen should ideally match the mode of the enteral nutrition delivery (continuous, bolus or cyclic) [10, 11].

Table 2: Calculation of the basal insulin dose, independent of artificial nutrition.

If the dose is known: use the known total daily basal insulin dose.			
If the dose is unknown or unclear: calculate the daily insulin dose, as suggested below. In case of older age, frailty and multiple morbid conditions, the recommended starting dose is usually lower (0.1–0.2 IU/kg bw/day).			
Intermittent enteral nutrition: The basal (intermediate-acting) insulin is divided into two doses as outlined below, thus allowing independent adaptations of the morning and evening doses, when enteral nutrition is added or removed. When transitioning a patient from a glargine or degludec regimen to NPH insulin, increase the intermediate-acting (NPH) insulin dosage by 20% [16].			
Continuous/bolus enteral nutrition and long-acting insulin: Basal (long-acting) insulin does not need to be divided into two doses.			
Example: For a patient with a body weight (bw) of 70 kg:		**Continuous**	**Intermittent enteral nutrition**
Type 1 diabetes (T1D):	0.3 IU/kg bw/day	21 IU	10-0-0-11 IU
Pancreatogenic diabetes:	0.25 IU/kg bw/day	18 IU	9-0-0-9 IU
Type 2 diabetes (T2D), SF 0.5*:	0.6 IU/kg bw/day	42 IU	21-0-0-21 IU
T2D with higher insulin sensitivity, SF 0.8*:	0.4 IU/kg bw/day	28 IU	14-0-0-14 IU
*The sensitivity factor (SF) is used in some electronic prescription systems (e.g. at the University Hospital Zürich) to adjust for insulin sensitivity/resistance. The normal sensitivity factor (SF) is 1.0, as in T1D. A reduced sensitivity factor (i.e. between 0.5 and 0.9) occurs in patients with T2D or generally severe illnesses. Each 0.1 reduction causes a 20% increase in insulin demand. Thus, the lower the sensitivity factor, the higher the insulin resistance (IR) and the more insulin has to be administered.			
Considerations regarding the type of diabetes: The American Diabetes Association (ADA) Standards of Care [14] emphasise the importance of identifying the type of diabetes at admission, as different types require distinct management strategies and insulin dosing. Patients with T1D or pancreatogenic diabetes are more challenging because of a higher risk of hypoglycaemia, ketosis and glycaemic variability [17-19]. Therefore, extra caution is needed when choosing insulin dosage in T1D or pancreatogenic diabetes, as reflected above with fewer units of insulin per body weight. Fewer units are also required due to higher insulin sensitivity.			

Table 3: How much insulin should be added to cover the carbohydrate content of the enteral nutrition?

The insulin dose for the enteral nutrition should be added to the evening basal insulin dose (in the case of intermittent nocturnal enteral nutrition) or to the morning dose (for intermittent diurnal enteral nutrition).			
Example of intermittent enteral nutrition: For enteral nutrition containing 184 g of carbohydrates, we estimate 18 IU of intermediate-acting insulin for a patient with "medium" insulin resistance (i.e. 1 IU per 10 g of carbohydrates).			
The basal insulin is split into two doses (as suggested above), and the insulin for enteral nutrition is added to the basal dose administered at the time of enteral nutrition (in our example, during the night).			
Continuing with the same patient as in table 2:			
Type 1 diabetes (T1D):	10-0-0-11	+ 18 IU	10-0-0-29 IU
Pancreatogenic diabetes:	9-0-0-9	+ 18 IU	9-0-0-27 IU
Type 2 diabetes (T2D), SF 0.5:	21-0-0-21	+ 18 IU	21-0-0-39 IU
T2D with higher insulin sensitivity, SF 0.8:	14-0-0-14	+ 18 IU	14-0-0-32 IU
Example of enteral nutrition given as boluses: For an enteral nutrition product containing 60 g of carbohydrates administered three times a day, 6 IU of short-acting insulin should be given with each enteral nutrition bolus in a patient with "medium" insulin resistance (i.e. an insulin dose of 1 IU per 10 g of carbohydrates).			

Table 4: Adjustments or discontinuation of intermittent enteral nutrition.

Adjustments to enteral nutrition	Contact the diabetes team before any planned changes to the diet (e.g. pre-operative or diagnostic fasting, changes in nutritional targets) or to artificial nutrition, including changes to the enteral nutrition product, volume or duration of administration.
Discontinuation of enteral nutrition	If possible, taper and discontinue enteral nutrition in a planned manner.
In our example above, the intermediate- or long-acting insulin dose must be reduced to basal insulin requirements after stopping enteral nutrition (see tables 2 and 3).	
Emergency stop of enteral nutrition	If enteral nutrition must be stopped urgently and the patient has already received the full dose of intermediate- or long-acting insulin, monitor blood glucose every 2 hours for 12–24 hours and administer glucose infusion if needed. Because there is no consensus on the concentration or amount of glucose infusion to administer in case of hypoglycaemia, according to the American Diabetes Association [14], we recommend using the local hospital protocol to manage hypoglycaemia.

Option 1: Intermittent enteral nutrition (over 12–14 hours)

When administering enteral nutrition over 12–14 hours, either diurnal or nocturnal, we recommend an intermediate-acting insulin (Neutral Protamine Hagedorn, NPH) with a duration of action of approximately 12–18 hours [10, 13]. This approach reflects insulin pharmacokinetics and the feeding window, facilitating dose adjustments when enteral nutrition is modified. Importantly, NPH insulin exhibits considerable inter- and intra-individual variability in subcutaneous absorption (coefficient of variation approximately 25–50%), which can lead to unpredictable peak effects and glycaemic excursions. Therefore, closer capillary glucose monitoring is recommended when initiating NPH insulin or adjusting doses, particularly during the first 2–3 days of a new regimen.

Enteral nutrition is preferably administered at night to allow greater daytime flexibility for increased oral intake (when feasible), physical activity and mobility. However, this timing may be less physiological with respect to circadian rhythms of anabolic and catabolic states. Thus, the timing of intermittent enteral nutrition should be individualised to optimise nutritional status, physical rehabilitation and glycaemic management goals.

From a strict pharmacological perspective, intermediate-acting insulin should be administered within 1 hour before enteral nutrition is started. However, in current practice, intermediate-acting insulin is often injected when enteral nutrition is started to avoid mistakes (e.g. inadvertent delays or concerns about low/normal glycaemia), or for practical reasons (e.g. enteral nutrition and insulin administration at home). Therefore, we recommend administering intermediate-acting insulin when starting enteral nutrition, which the American Diabetes Association (ADA) considers a reasonable approach [14]. Because NPH insulin absorption varies widely between individuals, appropriate resuspension before subcutaneous injection is required [15]. Medical staff should receive proper training if they are unfamiliar with the resuspension method. Close glycaemic control is required to avoid hypo- and hyper-glycaemia (see below).

Option 2: Continuous enteral nutrition (over 24 hours)

When administering enteral nutrition over 24 hours, we recommend a long-acting insulin with a duration of action of approximately 24 hours [10].

Option 3: Bolus enteral nutrition (given as meals)

When administering enteral nutrition as boluses over 2–3 hours each, we recommend using short-acting insulin with a comparable duration of action. Insulin should be injected before starting enteral nutrition, ideally 10–15 minutes beforehand, or 5–10 minutes beforehand for ultra-fast-acting insulins, and if not possible, at the start of enteral nutrition. It must be clearly documented that if an enteral nutrition bolus is omitted (e.g. due to planned surgery, fasting for an examination or patient refusal), the corresponding short-acting insulin must also be omitted, similar to withholding prandial insulin when a meal/snack is skipped.

If additional food is eaten (including oral nutritional supplements), we recommend giving the enteral nutrition bolus together with meals, with glucose measurements before each enteral nutrition bolus/meal. The short-acting insulin dose is calculated based on the total carbohydrate content (enteral nutrition bolus + oral intake), with an additional correction dose (table 5).

Table 5: Example of a standard glucose correction scheme.

Insulin resistance	Glucose 10–12 mmol/l	Glucose 12–15 mmol/l	Glucose 15–18 mmol/l	Glucose 18–22 mmol/l	Glucose 22–25 mmol/l	Glucose >25 mmol/l
"Low": total daily insulin <20 IU	+2 IU	+3 IU	+4 IU	+6 IU	+8 IU	+10 IU
"Medium": total daily insulin 20–50 IU	+3 IU	+4 IU	+6 IU	+8 IU	+10 IU	+12 IU
"High": total daily insulin >50 IU	+4 IU	+6 IU	+8 IU	+10 IU	+12 IU	+14 IU

Example of a standard glucose correction scheme based on the patient's total daily insulin dose as a proxy for insulin resistance, to be adapted by each institution and according to the clinical context, which can affect insulin resistance.

Insulin dose

The insulin dose (any of the three options above) depends on the carbohydrate content of the enteral nutrition (table 3), the basal insulin requirement and insulin sensitivity. Information on the content of each enteral nutrition product commercially available in Switzerland is available at https://clinicalnutrition.science/en/nutripro/. The dose of intermediate- or long-acting insulin also depends on the (known or calculated) basal insulin requirement (table 2). Because insulin sensitivity is difficult to estimate in the short term, the additional correction insulin should be adjusted as required (see below).

Correction insulin should be used and adjusted to the individual's needs based on illness severity, which cannot always be determined at the beginning. Correction insulin should be added based on the glucose readings, ideally following the standard procedure or scheme at the institution if available. It should be adjusted on a continuous basis as disease severity may change over time.

The additional units of short-acting correction insulin required can be added to the subsequent enteral nutrition insulin dose after review by the daytime diabetes team. For example, if 4 IU of correction insulin was needed during the previous enteral nutrition administration, then 4 IU of intermediate-acting insulin should be added to the insulin dose for the next enteral nutrition administration the following day.

In cases of transient reduction of insulin sensitivity (e.g. severe stress, infection/sepsis, trauma, post-operative stress, post-myocardial infarction and related causes), the insulin dose may need to be adjusted as long as the cause of the increased insulin resistance persists [20].

If additional food is eaten orally, mealtime insulin should be prescribed separately, as is usually done for bolus insulin.

Capillary glucose measurements and continuous glucose monitoring (in the case of enteral or parenteral nutrition)

In hospitalised patients, point-of-care (POC) capillary blood glucose testing remains the standard method for glycaemic monitoring. For patients receiving continuous enteral or parenteral nutrition, POC testing should be performed every 4–6 hours. More frequent monitoring is indicated after medication changes (e.g. corticosteroid initiation), after discontinuation of nutritional support or in patients experiencing frequent hypoglycaemia.

Continuous glucose monitoring (CGM) offers several advantages over traditional POC testing, including early detection of hypoglycaemia (particularly nocturnal and asymptomatic episodes), reduced nursing time for glucose readings and the ability to identify glycaemic trends [21-24]. When linked to insulin dosing algorithms, whether manually or through automated insulin delivery systems, CGM has been shown to significantly increase time spent within the glycaemic target range, including in patients on nutritional support [25, 26]. However, no CGM device has yet received regulatory approval for inpatient use [14, 25, 26]. Nevertheless, with growing data supporting its safety and efficacy, current recommendations [14] suggest that for "people with diabetes using a personal CGM device, the use of CGM should be continued during hospitalization". Confirmatory POC measurements should be used for insulin dosing decisions and hypoglycaemia confirmation. Implementation requires institutional protocols [27] addressing device validation, staff training, electronic health record integration and recognition of situations where CGM may be inaccurate (e.g. hypoperfusion, vasopressor use and oedema).

In the home setting, CGM may benefit patients on home enteral or parenteral nutrition, but no efficacy trials have been performed in this population. Similarly, although care transitions such as hospital discharge predispose patients to glycaemic fluctuations, where CGM could help, no studies have addressed this specific clinical indication.

In conclusion, the standard of care remains capillary blood glucose. It should be performed when artificial nutrition (enteral or parenteral nutrition) infusion is started, then every 4–6 hours until 4 hours after stopping nutritional support. Because insulin sensitivity is difficult to estimate in the short term, adjustments must be made according to the additional correction insulin required (see above). When hospitalised patients have their own CGM device, it could be continued as long as capillary POC are performed before injecting insulin and to confirm a suspected hypoglycaemia.

Management of hyperglycaemia (in the case of enteral or parenteral nutrition)

In case of persistent severe hyperglycaemia (glycaemia >20 mmol/l for >24 hours), artificial nutrition (enteral or parenteral nutrition) should be withheld until metabolic improvement is achieved. Enteral and parenteral nutrition can be resumed once glycaemia is stable and <15 mmol/l. However, prolonged interruption of nutritional support should be avoided due to the risks of malnutrition, refeeding syndrome and ketogenesis.

Clinical case

A 59-year-old woman is admitted to a medical ward for B-cell acute lymphoblastic leukaemia. Her past medical history includes gestational diabetes in the 1990s. Blood work reveals previously undiagnosed type 2 diabetes with a glycated haemoglobin (HbA1c) of 6.6%. She never received oral antidiabetic treatment or insulin. Her habitual body weight was 75 kg, and the body mass index (BMI) was 29.3 kg/m^2, but she recently lost weight and currently weighs 66 kg (BMI 25.8 kg/m^2).

Night 1: Due to weight loss and nutritional risk (nutritional risk screening score 5/7), enteral nutrition is started with an isocaloric product (1 kcal/ml) at 500 ml for 12 hours per night. The enteral nutrition product label specifies its content: 500 kcal, 19.5 g of protein, 67.5 g of carbohydrates and 17 g of lipids.

The patient's basal insulin requirement is determined based on diabetes type, sensitivity factor and body weight (table 2). This patient has type 2 diabetes mellitus and weighs 66 kg. Thus, the calculated basal insulin dose was 0.4 IU/kg, corresponding to a total of 26.4 IU per day. This basal dose is divided into two equal administrations of 13 IU each (13-0-0-13 IU). Then, additional insulin is needed to cover the enteral nutrition carbohydrate content (table 3), corresponding to an extra 7 IU, thus a prescription of intermediate-acting insulin of 13-0-0-20 IU.

Review of night 1: Capillary glucose measurements are performed every 4 hours at midnight, 4 am and 8 am. The patient receives extra short-acting insulin units based on the correction scheme: 4 IU, 3 IU and 3 IU, respectively, for a total of 11 additional IU overnight.

Night 2: The additional 11 IU are added to the evening basal insulin dose the following day (13-0-0-31 IU). The enteral nutrition is well tolerated and is increased to 750 ml for the second night. The insulin required to cover 500 ml of enteral nutrition was calculated as 7 + 11 IU = 18 IU. As the enteral nutrition volume, and therefore glucose content, is increased by 1.5-fold, the insulin dose should be adjusted accordingly (18 IU × 1.5 = 27 IU). Thus, 27 IU should be added to the basal insulin.

Review of night 2: After the second night, the patient receives 3 IU with the correction scheme at 4 am. The total insulin dose to cover 750 ml of enteral nutrition containing 101 g of glucose is therefore 30 IU.

Night 3: Given good digestive tolerance of enteral nutrition, the isocaloric enteral nutrition is switched to a hypercaloric formula (2 kcal/ml) containing 1500 kcal, 75 g of protein, 125 g of carbohydrates and 75 g of lipids in 750 ml. To proportionally match the increased carbohydrate content, the insulin dose covering enteral nutrition was increased to 37 IU.

Note: This clinical case based on a real patient serves only as an example of how to apply the recommendations in this statement. The actual insulin prescription should be adapted to the individual patient's needs and discussed with the on-call diabetes team.

Parenteral nutrition in patients with diabetes

Except in rare circumstances, such as tailor-made parenteral nutrition for specific conditions, standard parenteral nutrition contains carbohydrates to support balanced nutritional intake. Thus, parenteral nutrition infusion can lead to hyperglycaemia, particularly in patients with pre-existing diabetes or disease-related insulin resistance [28]. Hyperglycaemia (≥11.1 mmol/l) develops in more than 50% of patients receiving parenteral nutrition [29] and is associated with higher complication rates, including increased admissions to intensive care units, prolonged hospital stays and greater mortality compared with patients without hyperglycaemia [10, 30, 31]. Management of hyperglycaemia requires insulin therapy, which may be administered subcutaneously, intravenously (infusion) or by adding insulin directly to the parenteral nutrition.

Adding short-acting insulin directly to the parenteral nutrition bag is an attractive method because it provides better glycaemic control [32] without increasing the risk of hypoglycaemia [33, 34], and is the safest way to prevent hypoglycaemia if the parenteral nutrition is stopped or interrupted [14]. While several factors may influence insulin availability in the parenteral nutrition bag (see below), this should not exclude the use of this method, as the insulin dose can be adjusted daily according to each patient's needs. Parenteral nutrition can be administered continuously or with a cyclic (intermittent) rhythm.

The insulin dose depends on the carbohydrate content of the parenteral nutrition bag (table 6). When short-acting insulin is added directly to the parenteral nutrition bag, the infusion rate does not require insulin dose adjustment, as the insulin amount is calculated based on the carbohydrate content of the entire parenteral nutrition bag. In addition, if the parenteral nutrition bag is administered partially (e.g. only ¾), a proportional amount of insulin will be infused alongside it. Properly mixing the parenteral nutrition bag after adding insulin ensures that insulin distributes throughout the solution and reduces binding to the inner plastic surface of the parenteral nutrition bag.

Table 6: Parenteral nutrition and suggested short-acting insulin to be added to the parenteral nutrition bag.

Product, volume	Nutritional content	Insulin added to parenteral nutrition bag
Smofkabiven® 493 ml	63 g carbohydrates, 550 kcal	+ 6 IU
Smofkabiven® 986 ml	125 g carbohydrates, 1100 kcal	+ 12 IU
Smofkabiven® 1477 ml	187 g carbohydrates, 1600 kcal	+ 19 IU
Smofkabiven® 1970 ml	250 g carbohydrates, 2200 kcal	+ 25 IU
Omegaflex® 625 ml	40 g carbohydrates, 480 kcal	+ 4 IU
Omegaflex® 1250 ml	80 g carbohydrates, 960 kcal	+ 8 IU
Omegaflex® 1875 ml	120 g carbohydrates, 1430 kcal	+ 12 IU
Omegaflex® 2500 ml	160 g carbohydrates, 1900 kcal	+ 16 IU
Olimel® 5.7% 1000 ml	110 g carbohydrates, 1070 kcal	+ 11 IU
Olimel® 5.7% 1500 ml	165 g carbohydrates, 1605 kcal	+ 17 IU
Olimel® 5.7% 2000 ml	220 g carbohydrates, 2140 kcal	+ 22 IU
Olimel® 7.6 % 1000 ml	73 g carbohydrates, 950 kcal	+ 7 IU
Olimel® 7.6 % 1500 ml	110 g carbohydrates, 1425 kcal	+ 11 IU
Olimel® 7.6 % 2000 ml	146 g carbohydrates, 1900 kcal	+ 15 IU

As a general principle, a patient started on parenteral nutrition containing approximately 120 g of carbohydrates should also be started on an insulin dose of 1 IU per 10 g of carbohydrates for a moderate insulin sensitivity. For more information on the content of nutritional support products available in Switzerland: https://clinicalnutrition.science/en/nutripro/

Because insulin sensitivity is difficult to estimate in the short term, daily insulin dose adjustments are often required and are determined collaboratively between the on-call diabetes and nutrition teams. Glycaemia should be measured when parenteral nutrition infusion is started, then every 4 hours until the end of parenteral nutrition infusion, with correction insulin prescribed in advance to allow individualised dose adjustments (table 5).

Basal insulin therapy with a long-acting insulin should be continued if already prescribed. Initiation of basal insulin should be considered according to the clinical situation (i.e. type 1 diabetes, after total pancreatectomy or marked insulin resistance). If parenteral nutrition with insulin in the bag is administered continuously over 24 hours, combining the insulin doses should be considered after discussion with the on-call diabetes team.

Correction insulin should be administered based on glycaemia, preferably according to institutional protocols when available. The additional units of short-acting correction insulin required over the preceding 24 hours may be added to the next parenteral nutrition bag (e.g. if 4 IU of correction insulin was needed during the previous parenteral nutrition infusion, an additional 4 IU of short-acting insulin should be added to the insulin dose in the next parenteral nutrition prescription). If additional food is eaten, mealtime insulin should be prescribed separately, as usually done for bolus insulin.

As with enteral nutrition administration, if severe hyperglycaemia persists (glycaemia >20 mmol/l for >24 hours), artificial nutrition should be withheld (see above in the enteral nutrition section). Similarly, the on-call diabetes team should be contacted before changes to the diet or artificial nutrition (table 4). If possible, parenteral nutrition should be tapered and discontinued in a planned manner.

Emergency stop of parenteral nutrition with added insulin: If parenteral nutrition must be stopped urgently, monitor blood glucose at discontinuation and 2 hours later. The patients should be switched back to long-acting insulin (and potentially short-acting insulin) if needed in consultation with the on-call diabetes team.

Insulin availability and compatibility with parenteral nutrition

Several factors influence insulin availability in the parenteral nutrition bag, including the parenteral nutrition bag material [35], the presence of intravenous lipid emulsion [36] and the addition of micronutrients such as multivitamins and trace elements [37].

One study showed that insulin recovery was significantly higher in glass parenteral nutrition bags than in ethyl-vinyl-acetate (EVA) plastic bags [35]. Nevertheless, the presence of intravenous lipid emulsion (ILE) seems to be the key factor affecting biosynthetic human recombinant short-acting insulin availability in standard parenteral nutrition contained in EVA plastic bags [36]. In this study, when lipids comprised 3.75% of the total parenteral nutrition volume, the insulin recovery was 81% at T0 and 72.5% at T+24 hours. When the lipid content was 3% of the total parenteral nutrition volume, the insulin recovery was only 20% [36]. The presence of micronutrients in the parenteral nutrition bag can also increase insulin recovery (from 5% to 95%) [37].

In Switzerland, most parenteral nutrition solutions now come in ready-to-use tri-compartment plastic bags with a known concentration in lipid emulsion. Micronutrients are always added to the parenteral nutrition bag before infusion. Manufacturer information will specify compatible insulins and the maximum insulin dose that can be added to the parenteral nutrition bag.

In conclusion, adding insulin directly to the parenteral nutrition bag is considered safe and effective, provided that the lipid content is known and micronutrients are added. Clinicians should be aware that insulin recovery may change when switching between parenteral nutrition regimens. Consistent glucose monitoring remains essential to detect and manage glycaemic variability. If in doubt, we recommend consulting the on-call diabetes team and checking the manufacturer's information and the the officially approved medicinal product information at https://swissmedicinfo-pro.ch/.

Conclusion

Given the rising prevalence of both diabetes and malnutrition, which often coexist among older patients and those with multiple morbid conditions, there is growing need for practical guidelines on the management of diabetes and artificial nutrition to improve quality of care and shorten hospital stays. This consensus statement, endorsed by the Swiss Society for Endocrinology and Diabetology (SGED/SSED) and the Swiss Society for Clinical Nutrition and Metabolism (GESKES/SSNC), provides practical and standardised guidance for insulin management in patients receiving enteral or parenteral nutrition, primarily in a hospital setting but also for home-based care. By aligning insulin pharmacokinetics with the timing of the nutritional regimen (continuous, intermittent, bolus enteral or parenteral nutrition), this consensus statement provides a harmonised approach to achieve safe, effective glycaemic control while minimising the risk of hypo- and hyper-glycaemia. Notably, short-acting insulin can be safely added directly to the parenteral nutrition bag. Daily monitoring with frequent glucose measurements and systematic insulin dose adjustment based on correction schemes is essential to ensure patient safety and optimise metabolic outcomes during hospitalisation and home care.

These recommendations should also be implemented with interprofessional education among nurses, dietitians and physicians. National and local professional societies are encouraged to review if and how this consensus statement can be applied to their respective healthcare systems to further improve quality of care. Advances such as ultra-long-acting insulin formulations (e.g. weekly injections), new incretin-based drugs and new technology-driven approaches are expected to further transform the management of malnutrition, with potential benefits for sarcopenia and preventing hypo-/hyper-glycaemia.

Notes

Use of AI: The authors declare that no generative artificial intelligence (AI) tools or AI-assisted technologies were used in the drafting, writing or creation of this manuscript.

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