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Guidelines

Perioperative management of adult diabetic patients. Postoperative period

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ABSTRACT

Follow on from continuous intravenous administration of insulin with an electronic syringe (IVES) is an important element in the postoperative management of a diabetic patient. The basal-bolus scheme is the most suitable taking into account the nutritional supply and variable needs for insulin, reproducing the physiology of a normal pancreas: (i) slow (long-acting) insulin (= basal) which should immediately take over from IVES insulin simulating basal secretion; (ii) ultra-rapid insulin to simulate prandial secretion (= bolus for the meal); and (iii) correction of possible hyperglycaemia with an additional ultra-rapid insulin bolus dose. A number of schemes are proposed to help calculate the dosages for the change from IV insulin to subcutaneous insulin and for the basal-bolus scheme. Postoperative resumption of an insulin pump requires the patient to be autonomous. If this is not the case, then it is mandatory to establish a basal-bolus scheme immediately after stopping IV insulin. Monitoring of blood sugar levels should be continued postoperatively. Hypoglycaemia and severe hyperglycaemia should be investigated. Faced with hypoglycaemia < 3.3 mmol/L (0.6 g/L), glucose should be administered immediately. Faced with hyperglycaemia > 16.5 mmol/L (3 g/L) in a T1D or T2D patient treated with insulin, investigations for ketosis should be undertaken systematically. In T2D patients, unequivocal hyperglycaemia should also call to mind the possibility of diabetic hyperosmolarity (hyperosmolar coma). Finally, the modalities of recommencing previous treatments are described according to the type of hyperglycaemia, renal function and diabetic control preoperatively and during hospitalisation.

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1. Change from intravenous insulin electronic syringe (IVES) to subcutaneous (SC) insulin

Practical sheet P summarises the main elements from this chapter.

The basal-bolus scheme is the most suitable in the postoperative period taking into account the variable nutritional supplies and insulin requirements. It more faithfully replicates the physiology of the normal pancreas: (i) basal secretion simulated by slow (long-acting) insulin which should immediately follow on from IV insulin; and (ii) prandial secretion simulated by an ultra-rapid insulin whose doses depend on the quantity of carbohydrates ingested during the meal. The comparison of this scheme to intermittent injections of rapid insulin significantly improves glycaemic control and decreases the postoperative complications [1].

According to different studies, the initial dose of slow insulin varies between 0.3 and 1.5 IU/kg [2]. Several models have been proposed to assure the transition from IVES insulin to SC insulin. The most widely used is that of Avanzini et al. [3]: the change is made when blood sugar levels are stable for at least 24 h and at resumption of feeding. Overall, half of the total dose of IV insulin corresponds to the dose of slow insulin, the other half to the doses of an ultra-rapid analogue (Fig. 1). Some groups recommend giving 80% of the IVES dose as slow insulin and adding a first dose of ultra-rapid insulin at the first meal [4–6]. For Lazar et al., it is necessary to wait until the speed of infusion is < 3 U/h before starting follow-on; a higher speed signifies an over-risk of postoperative complications [6].

If the IVES perfusion is given over a short period of time (< 24 h) in patients not previously treated with insulin and whose blood sugar levels remain raised postoperatively, it is advised to start insulin at a dose of 0.5–1 IU/kg depending on the weight of the patient (half slow insulin–half ultra-rapid analogue) and to only give half of the dose of ultra-rapid analogue anticipated if the meal is light [2].

Overall, the working group has made the following recommendations: (Practical sheet P):

- maintain the electronic syringe until stable blood sugar levels are obtained ≤ 1.80 g/L (10 mmol/L);
- stop the protocol for IVES insulin therapy at the resumption of oral feeding;
- stop the insulin if the hourly output is ≤ 0.5 IU/h, leaving the syringe in situ if the output is ≥ 5 IU/h which indicates major insulin resistance;
- make the injection of slow insulin immediately after stopping the syringe, best time = 20:00 hrs. If follow-on is started before 20:00 hrs, adapt the dose to the time of starting and then make the second injection at 20:00 hrs (total dose);
- make the injection of ultra-rapid analogue at the first meal, adapting it to the quantity of carbohydrates ingested.

2. Specific case of a patient on a personal insulin pump (practical sheet H)

In the postoperative period, the personal pump will be reconnected as soon as the patient can manage autonomously. If the patient is not autonomous, it is mandatory to initiate a basal-bolus scheme by immediate SC injection of insulin (practical sheets H and Q).

3. Management of hypoglycaemia (practical sheet S)

Monitoring of blood sugar levels should be continued postoperatively to detect hyperglycaemia. The management strategy is identical during all of the perioperative period. The measurement of capillary blood sugar levels should be done when faced with any symptom suggestive of hypoglycaemia in a hospitalised patient. Due to hypoglycaemia unawareness, it is important to scale up regular blood sugar monitoring under insulin or insulin secretors.

Faced with a hypoglycaemia of < 3.3 mmol/L (0.6 g/L), glucose should be administered immediately even in the absence of clinical signs of hypoglycaemia. Conversely, we recommend glucose administration for blood sugar levels between 0.7 and 1 g/L (3.8–5.5 mmol/L) if the patient reports signs of hypoglycaemia.

The oral route should be preferred when the patient is conscious according to Practical sheet S. In a subject who is unconscious or unable to swallow, IV glucose should be administered immediately. Oral glucose administration will be carried out when the patient regains consciousness.

4. Management of hyperglycaemia (sheet T)

Severe hyperglycaemia (notably ketoacidosis or hyperosmolarity) should be investigated by carrying out postoperative monitoring of blood sugar levels. The strategy for management is identical during the whole perioperative period (Fig. 2).

In the perioperative period, it is necessary to prioritise blood sugar measurements (possibility of recent imbalance). In the case of hyperglycaemia > 16.5 mmol/L (3 g/L) in a patient with T1D and in a patient with T2D treated with insulin, the presence of ketosis should be investigated systematically. In the absence of ketosis, the addition of an ultra-rapid analogue of insulin and good hydration should be initiated rapidly. In the presence of ketosis, the initial stages of ketoacidosis should be suspected, a duty physician should be called and the administration of an ultra-rapid analogue of insulin should be started (and the transfer to an ICU should be discussed).

In T2D patients, hyperglycaemia should also suggest diabetic hyperosmolarity (also called hyperosmolar coma) whose clinical manifestations are extremely variable and deceptive (asthenia, moderate confusion, dehydration). If in doubt, blood electrolytes should be measured as a matter of urgency. This will confirm the hyperosmolarity (> 320 mosmol/L) and will lead to specific management in an ICU. Except for a life-threatening emergency, ketosis and hyperosmolarity should lead to the postponement of surgery.

5. Follow on before discharge

The therapeutic modalities before discharge from hospital are described below and are dependent on several criteria: (i) the type of hyperglycaemia (stress, diagnosis of diabetes, known diabetes); (ii) the glycaemic control in known diabetics before the procedure (HbA1c); (iii) the doses of insulin and glycaemic control (based on capillary blood sugar levels) during hospitalisation; and (iv) the treatment before hospitalisation (non-insulin drugs or insulin).

The treatment and follow-up are adapted according to a personalised HbA1c target, remembering that for most diabetic patients it is around 7%.

5.1. T1D and T2D with multiple injections (practical sheets G, K)

In T1D, resumption of previous treatment combining basal (slow) insulin and bolus (ultra-rapid analogue) insulin is essential. Patients leave on their usual insulin scheme but at the doses they took in hospital; subsequent consultations can be planned at discharge:

- HbA1c $< 8\%$, consultation with the treating physician at one month;

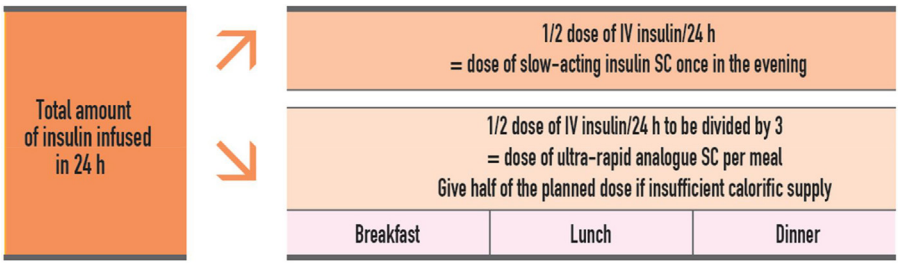

Fig. 1. Practical sheet P–Calculation of the dose for transition from IVES insulin to subcutaneous (SC) insulin. IVES: intravenous insulin by electronic syringe; SC: subcutaneous.

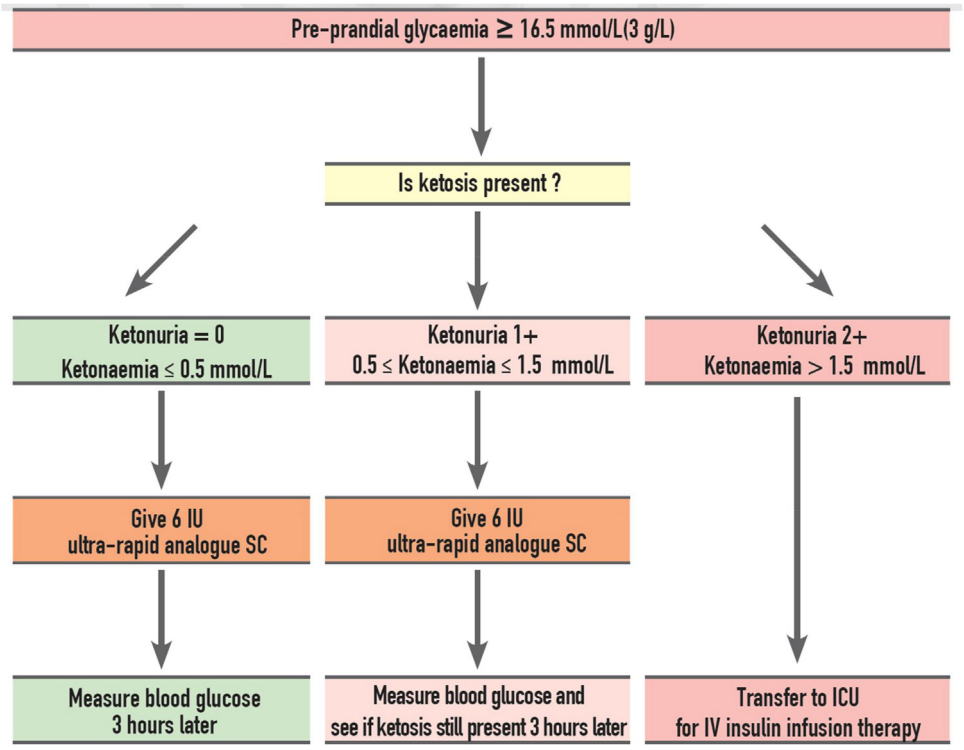

Fig. 2. Practical sheet T–Treatment of in-hospital hyperglycaemia. IVES: intravenous insulin by electronic syringe; IU: international units; ICU: intensive care unit.

- HbA1c between 8 and 9%, distant consultation with a diabetologist;
- HbA1c > 9% or if unstable blood sugar levels (> 2 g/L or 11 mmol/L), the advice of a diabetologist is requested before discharge for possible hospitalisation in a specialised service.

5.2. T2D with oral anti-diabetics (OADs) only (practical sheets J, R)

- HbA1c ≤ 8%, previous treatment is resumed at the same doses after 48 h (if clearance is > 30 mL/min for all OADs and > 60 mL/min for metformin). Ultra-rapid insulin is started and then doses are decreased progressively until it can be stopped. The treating physician is consulted within one to two weeks to discuss increases in doses of OADs if necessary (depending on the HbA1c target for the patient);
- HbA1c between 8 and 9%, the OADs are resumed at the same doses if there is no contraindication, ultra-rapid insulin is stopped, and slow-acting insulin is left in place. The patient leaves with his (her) usual OADs and an injection of slow insulin, type glargine (Lantus®). A protocol for the adaptation of doses is transmitted to a nurse who will manage the patient at home. The treating physician is consulted in the following month. A distant consultation with a diabetologist is planned;
- HbA1c > 9% and/or glycaemic control not achieved (blood sugar levels >11 mmol/L or 2 g/L), the basal-bolus scheme is left in place and the advice of a diabetologist is requested for possible hospitalisation in a specialised service.

5.3. T2D with OADs and insulin before hospital admission (practical sheet K)

In T2D patients treated with insulin preoperatively, the same strategy can be proposed:

- HbA1c < 8%: the previous treatment is resumed at the same doses as during hospitalisation. A consultation with the treating physician is advisable within one to two weeks;
- HbA1c between 8 and 9%: the previous treatment is resumed and a consultation with a diabetologist is requested for intensification of therapy;
- HbA1c > $9% or glycaemic control not achieved (blood sugar levels > 11 mmol/L or 2 g/L): the basal-bolus scheme is left in

place and the advice of a diabetologist is requested for possible hospitalisation in a specialised service.

5.4. Stress hyperglycaemia

Stress hyperglycaemia is characterised by blood sugar levels that may be raised with HbA1c $< 6.5\%$. Insulin is stopped progressively depending on capillary blood sugar levels, which normalise quickly. No treatment is necessary on discharge from hospital but monitoring is essential as 60% of these patients will become diabetic within one year according to Greci et al. [7]: fasting blood sugar levels will be measured at one month and then annually and systematically in all situations of stress. The treating physician should be informed.

5.5. Diabetic patients with previously unknown disease

Hygieno-dietary rules are instituted with the help of a dietician. The advice of a diabetologist is requested for possible establishment of treatment with OADs and then consultation with the treating physician at one month.

It is essential to provide a good basic education to ensure that the patient has understood the diagnosis of diabetes, the meaning and consequences of both hyperglycaemia and hypoglycaemia (especially in the case of treatment with insulin and/or hypoglycaemic sulphonamides/glinides), self monitoring of blood sugar levels, blood sugar targets, dietary advice and possibly injection techniques (in the case of injectable treatment) and adaptation of insulin doses [8]. Education of the patient is important since several studies have clearly shown that errors occur in taking antidiabetic drugs and many side-effects, particularly hypoglycaemia which, is linked to the absence of effective education during hospitalisation [9,10]. In addition, individually-adapted education regarding diabetes during hospitalisation permits better glycaemic control [11,12], fewer subsequent hospitalisations [11,12], decreased risk of ketoacidosis [12] and reduction of the duration of hospital stay [13]. Finally, specialised education regarding diabetes in patients hospitalised for cardiac surgery significantly reduces the frequency and duration of severe hyperglycaemias as well as the frequency of nosocomial infections [14].

This education may be provided by a mobile diabetology team, which exists in some hospitals. In other cases, the patient should be given a dietary advice, and should be informed about the steps to take in case of hypoglycaemia if the patient leaves hospital on insulin and/or hypoglycaemic sulphonamides/glinides.

Disclosure of interest

The authors declare that they have no competing interest.

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