Guidance for the management of adult inpatients with hyperglycaemia

This guidance is to aid the management of inpatients with diabetes who have hyperglycaemia at times when access to specialist diabetes nursing team is limited e.g. out of hours and at the weekend. It should be used alongside usual clinical judgement, it is not intended to replace liaison with the specialist inpatient diabetes nurse teams.

The evidence base for optimal glycaemic control for inpatients remains controversial (1). However, a pragmatic blood glucose (BG) target of between 6.0-10.0 mmol/l is generally recommended with occasional values of between 4.0-12.0 mmol/l being acceptable (1). However, patients with persistent hyperglycaemia and values consistently above 14.0 mmol/l should have treatment intensified and be discussed with the specialist diabetes team as a review of treatment may be required.

- Two values above 14.0 mmol/l should prompt review of treatment. i.e. supervising medical team to review on next ward round

- Two values above 18.0 mmol/l needs more urgent treatment i.e. same day review by team or on call team out of hours

Blood glucose meters can measure hyperglycaemia up to a concentration of 27.8 mmol/l, above this level glucose is reported as >27.8mmol/l or Hi. In this situation a laboratory blood glucose should be checked to confirm the degree of hyperglycaemia and to assess the response to treatment until BG returns to the measurable range (<27.8 mmol/l)

1. Prioritise

Ensure that the patient has not decompensated into Diabetic ketoacidosis (DKA) or Hyperosmolar hyperglycaemic state (HHS). These are medical emergencies and require immediate management according to hospital guidelines.

2. Categorise Does the patient have type 1 diabetes mellitus (T1DM) or type 2 diabetes (T2DM)?

Type 1 Diabetes:

Patients with T1DM have absolute insulin deficiency. Insulin may be adjusted but NEVER stopped. Intercurrent illness may cause glucose control to deteriorate and increase the risk of DKA. Please ensure:

- Careful monitoring of blood glucose and blood ketone*levels are very important in patients with T1DM who are unwell.
- Aim to keep target BG between 6.0 - 10.0 mmol/l
- Use correction doses of insulin as per the recommendations in **Section 4** if blood glucose is above 14.0 mmol/l on two consecutive occasions.
- If the patient is vomiting, clinically deteriorating **or** blood glucose is persistently elevated (>14.0 mmol/l) ensure blood ketones* are checked to exclude DKA
- If unable to eat or drink, patients may need treatment according to the variable rate intravenous insulin infusion (VRII) guideline
- If there is evidence of DKA then treat according to DKA protocol

* In the absence of access to a blood ketone meter check urinary ketones and venous pH to exclude DKA.

Blood ketone interpretation

Ketones are produced from metabolism of fat in the absence of insulin. Patients with type 1 diabetes are prone to ketone formation as are other patients such as those with longstanding insulin treated type 2 diabetes, those treated with SGLT2 inhibitors or post pancreatectomy. The presence of moderate or large amounts of ketones in the blood (or urine > 2+) suggests insulin deficiency. Ketones are cleared by the administration of additional insulin and adequate hydration.

Ketone below 0.6 mmol/L – Low risk DKA Readings below 0.6mmol/l are in the normal range. No additional treatment at this point.
Ketone 1.5 mmol/L – 2.9 mmol/l Moderate risk DKA Consider additional insulin and ensure adequate hydration. Repeat ketones after 1 hour to ensure ketones are falling.
Ketone result greater than 3.0 mmol/L – High risk DKA High risk of DKA, investigate for DKA (ABG), give additional insulin and ensure adequate hydration (likely to need IV fluids) Repeat after 1 hour.

HbA1c

Remember all patients with Diabetes who are admitted to hospital should have their HbA1c updated as this reflects long term glycaemic control and aids management.

Type 2 Diabetes

The spectrum of T2DM is wide ranging, from patients who are managed with diet and lifestyle to patients who take multiple insulin injections daily. Patients admitted with acute illness are prone to hyperglycaemia and may require a temporary increase in the dose of their glucose lowering drugs and/or additional treatment with insulin.

3. Treat

1. Starting oral agents for hyperglycaemia

Patients who have T2DM, and are well, may be suitable for management with reinforcement of dietary advice and close monitoring of BG. However, if blood glucose is slightly above the acceptable range of (6.0 - 12.0 mmol/l) for example <15.0 mmol/l then oral agents can be considered initially. First line treatment in the absence of contraindication and eGFR >40 ml/min/1.73m^2 is Metformin. Alternatively, NICE (2) recommends **Gliclazide as a rescue therapy for those with more significant hyperglycaemia as its speed of onset is quicker. A reasonable starting dose is 40 mg bd** with breakfast and the evening meal.

If above 70 years of age or if eGFR is below 60ml/min/1.73m^2 then a lower starting Gliclazide dose of 40mg od maybe considered. Continue to monitor the blood glucose response to treatment.

We recommend to ensure specialist diabetes input following initiation of glucose lowering therapy as this may require adjustment for longer term management.

2. Corrective doses of insulin

If blood glucose fails to respond to oral therapy **or if oral therapy is thought not appropriate** (BG > 15.0 mmol/l) then the next option is a corrective dose of rapid acting insulin (e.g. Novorapid, Fiasp, Humalog or Apidra).

- If BG above 14.0 mmol/l and no insulin administered in the previous 4 hours then use a corrective dose of rapid acting insulin. The corrective dose will take effect over 1-4 hours

- In a patient not previously treated with insulin an appropriate corrective dose can be decided according to body weight (3). See table 1.

Blood glucose (mmol/l)	Weight < 50kg	Weight 50-100kg	Weight > 100kg
14.0-14.9	1	1	2
15.0-16.9	2	2	3
17.0-18.9	2	3	4
19.0-20.9	3	3	5
21.0-22.9	3	4	6
23.0-24.9	4	5	7
25.0-27.0	4	5	8
Over 27.0	5	6	9

Table 1. Suggested insulin dose (units) according to level of blood glucose and body weight.

- Re-check blood glucose after 4 h or before next meal as further action may be needed.
- Aim to achieve a target BG of 6-10 mmol/l aiming for the higher end of the target range

3. Starting basal insulin

If 2 or more corrective doses required in the previous 24 h. Add basal insulin such as **Humulin I** (an intermediate acting basal insulin) at a starting dose of 0.125 units/kg/12h

Example: 80 kg patient

0.125 x 80 = 10 units/12h.

***Humulin I** start at 10 units bd to commence with breakfast and evening meal.*

If patients are: older (> 70 years), frail or serum creatinine > 175 µmol/l

Use a reduced starting dose of 0.075 units/kg/12h

Example: 80 kg patient 0.075 x 80 = 6 units/12h

Humulin I start at 6 units bd to commence with breakfast and evening meal.

Other options for basal/long acting insulin include Levemir which is typically used BD. Alternative options are Lantus or Abasaglar which are administered once daily at a dose of 0.25 units/kg/24h

Remember to check BG <u>at least</u> four times daily in patients treated with insulin

Next Review Due: September 2026

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4. Adjusting insulin doses for patients in hospital.

i) Rapid acting insulin

For patients with diabetes treated with insulin, deterioration of blood glucose control can occur as a consequence of acute illness. Failure to address hyperglycaemia increases adverse outcomes and the risk of DKA or HHS. These patients will need adjustment of their usual insulin dose.

If BG > 14.0 mmol/l and no insulin administered in previous 4 hours then consider using a corrective dose of rapid acting insulin (Novorapid, Fiasp, Humalog, Apidra) (3).

- Target blood glucose is 6.0-10.0 mmol/l aiming for the higher end of range

Dose can be decided using one of 3 factors, in order of importance (3):

1. If the patient has a personal corrective dose *e.g. 1 unit insulin lowers blood glucose by 3.0 mmol/l* this should be used
2. If the person using insulin doesn't have a corrective dose, use their total daily insulin dose (TDD) in units to calculate the corrective dose
3. If person is not previously using insulin use their body weight

Blood glucose (mmol/l)	Corrective dose 1unit:4 mmol/l Total Daily dose < 50units/24h Weight < 50kg	Corrective dose 1 unit:3 mmol/l Total Daily Dose 50-100units/24h Weight 50-100kg	Corrective dose 1 unit:2 mmol/l Total Daily Dose >100 units/24 Weight > 100kg
14.0-14.9	1	1	2
15.0-16.9	2	2	3
17.0-18.9	2	3	4
19.0-20.9	3	3	5
21.0-22.9	3	4	6
23.0-24.9	4	5	7
25.0-27.0	4	5	8
Over 27.0	5	6	9

Table 2. Suggested corrective insulin dose (in units) according to the level of hyperglycaemia

If the patient has rapid acting insulin with each meal the corrective dose can be added to their meal time insulin dose.

If 2 or more corrective doses are required within a 24-hour period then consider increasing the usual rapid acting and basal insulin dose. A typical increase in dose would be 10-15% (usually 2-4 units), which can be titrated daily. It's also important to consider the time of day BG is elevated when making adjustments.

ii) Dose adjustment for long-acting insulin once daily basal insulin

Pre dose Blood glucose (mmol/l)	Dose adjustment
<4.0	Reduce by 20%
4.1-6.0	Reduce by 10%
6.1-12	No change
12.1-18.0	Increase by 10%
>18.0	Increase by 20%

Table 3. Suggested adjustment of once daily basal insulin dose according to blood glucose concentration

For those already on long acting insulin. Doses can be titrated daily, although long acting insulin may take 48-72h to reach steady state. Dose adjustments will affect BG throughout the day (3).

iii) Dose adjustment for twice daily basal insulin

Blood glucose level (mmol/l)	Before morning dose	Before evening dose
<4.0	Reduce evening dose 20%	Reduce morning dose 20%
4.1-6.0	Reduce evening dose 10%	Reduce morning dose 10%
6.1-12.0	No change	No change
12.1-18.0	Increase evening dose 10%	Increase morning dose 10%
>18.0	Increase evening dose 20%	Increase morning dose 20%

Table 4. Suggested adjustment to twice daily basal insulin dose according to blood glucose concentration

iv) Pre-mixed insulin e.g. Novomix 30 or Humalog mix 25

These patients can also receive corrective doses of rapid acting insulin outlined in table 2. They may also require up-titration of their usual insulin doses if 2 or more correction doses are required within a 24 h period. Increasing the doses by between 2-4 units depending on when glucose is elevated is a reasonable approach. Insulin can be titrated on a daily basis.

If adjustments are made to insulin doses it is important to ensure review by the diabetes specialist team as soon as practically possible.

5. Intravenous insulin infusions

Use of the variable rate intravenous insulin infusion (VRIII) protocol for the management of medical inpatients with hyperglycaemia who are not in DKA or HHS can be a short-term approach. However, it is restrictive for patients, labour intensive and requires very close monitoring of blood glucose, electrolytes and fluid balance. Circumstances when the VRIII maybe the preferred choice include patients who are **nil by mouth, vomiting, very unwell** or when reasonable blood glucose control cannot be achieved by other means. **For patients undergoing surgery please see the specific surgical guidance (CID 126).** For patients treated with a VRIII it is recommended that the basal insulin (Lantus, Detemir, Degludec, Abasaglar, Humulin I, Insulatard) should continue while on the VRIII infusion as this facilitates the eventual discontinuation of VRIII treatment. Maintenance fluid should run alongside the IV insulin to maintain hydration and electrolyte homeostasis especially potassium and sodium balance which should be closely monitored. It's important that patients are promptly reviewed by the specialist Diabetes nursing teams to facilitate conversion to alternative management regimes as soon as is practical.

References

1. JBDS-IP The use of variable rate intravenous insulin infusion (VRIII) in medical inpatients. October 2014. Available at http://www.diabetologists_abcd.org.uk/JBDS/JBDS.htm
2. Type 2 diabetes in adults: management. NICE guideline [NG28] Published date: (2015) Last updated: Aug 2019 available at https://www.nice.org.uk/guidance/ng28
3. Adapted from Rayman G, Lumb A, Kennon B, Cottrell C et al. New Guidance on Managing Inpatient Hyperglycaemia during the COVID 19 Pandemic. Diabetic Med. 37, 1210-1213 (2020)

Appendix 1.

Adjusting insulin doses or using corrective insulin doses for patients in hospital

This summary advice is designed to be used in conjunction with the hospital hyperglycaemia policy.

For patients with diabetes a deterioration of blood glucose control can occur whilst in hospital. This can increase the risk of adverse outcomes or emergencies such as DKA or HHS. Patients experiencing hyperglycaemia may need to either commence insulin or have adjustment of their usual insulin dose.

1. Ensure patients haven't decompensated into DKA or HHS
2. If BG > 14.0 mmol/l and no insulin has been administered in previous 4 hours, consider administering a corrective dose of rapid acting insulin (eg Novorapid, Fiasp, Humalog, Apidra)
3. The corrective dose for any level of hyperglycaemia can be decided using one of 3 factors, in order of preference:
   a. If the patient has a known personal correction ratio *e.g. 1 unit insulin lowers glucose by 3.0 mmol/l* this should be used
   b. If the person using insulin **doesn't have** a known personal corrective dose, use their total daily insulin dose (TDD) in units to calculate the corrective dose
   c. If a person is not previously using insulin use their body weight to calculate a corrective dose

Blood Glucose (mmol/l)	Corrective dose 1unit:4 mmol/l Total Daily dose < 50 units/24h Weight < 50kg	Corrective dose 1unit:3 mmol/l Total Daily Dose 50-100 units/24h Weight 50-100kg	Corrective dose 1unit:2 mmol/l Total Daily Dose >100 units/24 Weight > 100kg
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23.0-24.9	4	5	7
25.0-27.0	4	5	8
Over 27.0	5	6	9

Suggested corrective insulin dose in units according to the level of hyperglycaemia

4. Target blood glucose is 6.0-10.0 mmol/l aiming for the higher end of range

If the patient has rapid acting insulin with each meal then the corrective dose can be added to their meal time insulin dose.

Subsequently:

In patients already taking insulin

If 2 or more corrective doses are required within 24-hours. Consider increasing the regular rapid acting and basal insulin as recommended in the hyperglycaemia policy. A typical increase in dose being 10-15% (usually 2-4 units).

For patients not already taking insulin

If 2 or more corrective doses are required within a 24 hour period then add a basal insulin eg ***Humulin I*** *at a dose of* ***0.125 units/kg/twice daily. eg 80 kg patient would start on 0.125 units x 80 = 10 units BD. Use 0.075units /kg/twice daily in patients who are older (>70 years), frail or creatinine > 175 µmol/l***

Ensure regular blood glucose monitoring is ongoing and liaise with the Diabetes Specialist team

Appendix 2

- Target for blood glucose 6.0 - 10.0 mmol/l
- Acceptable range 4.0-12.0 mmol/l
- Threshold for intensification of treatment and specialist review two consecutive readings above 14.0 mmol/l
- Threshold for priority/same day review two consecutive readings above 18.0 mmol/l