



CLINICAL GUIDELINE:

**Guidelines for managing
continuous subcutaneous insulin infusion
(CSII, or 'insulin pump') therapy
in hospitalised patients**

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FOREWORD

The authors are to be congratulated on producing this much needed and comprehensive guideline which should improve the care and experience of inpatients with diabetes treated by subcutaneous insulin infusion (CSII) pump therapy. Though multi-professional it has been produced with a high level of user involvement ensuring that the guideline is firmly grounded in patient experience. It will be of great value to diabetes inpatient teams as well as to the large variety of other health care professionals who care for this group of inpatients.

Insulin pump therapy in the UK is almost exclusively confined to people with type 1 diabetes of which 10-15% are treated by CSII. Only 7% of the in-patient diabetic population has type 1 diabetes thus, at most only 1% of inpatients with diabetes are treated with CSII. Over 90% are admitted for a variety of non-diabetes related reasons and as such they will be primarily under the care of non-diabetes specialist teams with little or no experience of insulin pump therapy. Indeed, given the rarity of this group most healthcare professionals will not have seen an insulin pump and almost certainly not be familiar with all of the many different pumps and 'pods'. Under these circumstances non-specialist will often discontinue pump therapy in favour of familiar therapies such as variable rate intravenous insulin infusion or intermittent boluses of subcutaneous insulin much to the frustration of patients particularly if this destabilises their glucose control. Furthermore, the return to pump therapy can be tricky often prolonging the inpatient stay.

This guidance supports the continued use of CSII during the inpatient stay and where appropriate encourages health care professionals to allow the person with diabetes to manage their own pump therapy. The most important messages are the early involvement of the inpatient diabetes team in all scenarios and the recognition that most pump users are more than capable of managing their insulin pump therapy provided they are well enough to do so.

The document highlights what can go wrong and what to look out for to prevent harms from happening. It also addresses for both specialists and non-specialists common but not often considered scenarios such as what to do with the pump during MRI scanning, safe disconnection from the pump, insulin therapy during the pump free period, managing hypoglycaemia on insulin pump therapy, safe storage of a removed pump and safe re-establishment of pump therapy. There is increasing use of CSII in pregnancy as its benefits are being increasingly recognised. In this context there is a very useful section on CSII in pregnancy including during steroid treatment and in labour.

I have no doubt that this comprehensive guideline will be welcomed by health care professionals and patients as it will help promote improvements in the care, outcomes and experience of people with diabetes on insulin pump therapy.

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1. STATEMENT, IMPLEMENTATION AND AUDIT

Continuous subcutaneous insulin infusion (CSII, Insulin pump) therapy is used by 10-15% of people with type 1 diabetes, and by some patients with type 2 diabetes. It is an effective option for day to day insulin delivery, but one that may not be familiar to health care professions caring for these people in an in-patient hospital setting. Therefore, patients on CSII therapy are often unnecessarily switched to alternative modes of insulin delivery on admission to hospital, or alternatively, CSII therapy maybe mismanaged.

There are currently no national level guidelines for the inpatient management of CSII in the UK.

These guidelines are designed to support the in-patient care of people with type 1 diabetes managed on CSII therapy. They were developed by a multi-disciplinary group of health care professionals and a patient on behalf of the Diabetes Technology Network and the Association of British Clinical Diabetologists. It has been further reviewed by national diabetes societies. It conforms to other national guidelines for diabetes / pregnancy care.

It is intended that the guideline will be useful to clinicians and service commissioners in planning, organising and delivering high quality diabetes inpatient care. There remains, however, an individual responsibility of healthcare professionals to make decisions appropriate to the circumstance of the individual patient. When implementing this guideline full account should be taken of the local context and in line with statutory obligations required of the organisation and individual.

These guidelines will be next reviewed in September 2018.

Quality Indicators

- ✔ Every Trust should have a local management plan in place based on these or other authoritative guidelines. These guidelines should be current and should not be used if the review date has expired.
- ✔ Every Trust should have a health care professional leading the implementation of these guidelines, and performance indicators should be used to assess the quality of care given.
- ✔ The purpose of standards are to maximise patient safety, improve patient satisfaction, support best clinical practice, reduce cost to the Trust relating to litigation and complaints, and contribute to reduced length of stay.
- ✔ Performance indicators will include
 - adverse events relating to insulin pump use (hypoglycaemia, DKA)
 - delayed discharge due to conversion onto/off CSII
 - patient satisfaction with inpatient management of CSII therapy
 - 'loss' of insulin pumps removed from patients



2. OVERVIEW OF CONTINUOUS SUBCUTANEOUS INSULIN INFUSION (CSII) THERAPY

Continuous subcutaneous insulin infusion (CSII, also known as 'insulin pumps') are used by people with type 1 diabetes (T1DM) (and some with type 2 diabetes) to improve glucose control and/or reduce the risk of hypoglycaemia.^{1,2} Modern CSII are portable and discrete, and utilise smart technologies, such as bluetooth transmission of capillary glucose level from glucometer to CSII, and the ability to download CSII data to a computer for analysis. Examples of commonly used 'pumps' are provided in Appendix 4. Contrary to the hopes of many individuals with T1DM, CSII is not a fully automatic "artificial pancreas", and therefore requires a high level of user involvement.

How it works

CSII involves a continuous basal infusion of short acting insulin (the hourly rate typically varies over a 24 hour period), in combination with meal-time boluses of the same insulin. Both basal and bolus insulin are delivered by CSII, which infuses insulin through a catheter (tubing), or directly via a pod. Both the tubing and pod attach to a fine bore subcutaneous cannula. The cannula is typically sited in the abdomen, though other sites (arms, legs, buttocks) can also be used, and is changed every 2-3 days. Any short acting insulin can be used (Novorapid/insulin aspart, Humalog/insulin lispro, Apidra /insulin glulisine, Fiasp/ faster acting insulin aspart/). The basal infusion rate is pre-programmed by the patient (or their diabetes specialist team) and will continue to run until the insulin cartridge is empty. The basal rates can be temporarily increased/decreased to accommodate fluctuations in blood glucose levels e.g. as a consequence of increased activity, or ill health. Boluses are delivered under the patient's direction, to cover carbohydrate intake and to correct for high blood glucose levels. Most CSII users make use of an inbuilt 'bolus calculator', which utilises known variables for that individual (insulin:carbohydrate ratio, insulin sensitivity and target blood glucose range) in conjunction with situation-specific data (current capillary glucose level, estimated carbohydrate intake and time since last insulin bolus). Some CSII work in conjunction with a continuous glucose sensor to temporarily suspend insulin delivery if hypoglycaemia is developing.

What can go wrong

People on CSII do NOT take any long acting insulin so if there is any interruption to insulin delivery (e.g. if the cannula is blocked/dislodged/removed) hyperglycaemia and then ketoacidosis can develop very quickly.

In these situations, the problem has to be identified and rectified, e.g. by re-siting the cannula, changing the tubing, or starting alternative insulin such as an intravenous infusion. Technical problems can occur; the CSII manufacturing companies offer round-the-clock telephone support and are typically able to provide a replacement pump within 24hrs if required. All patients using CSII are advised to retain a supply of their pre-CSII insulin pens for use in an emergency situation, for example, in case of 'pump failure' or damage.



The CSII user in hospital

Unless incapacitated, most people using CSII are safest remaining on CSII if admitted to hospital.³

If he/she is unable to manage the CSII, and no specialist advice is immediately available, remove CSII and start a conventional intravenous insulin infusion or S/C basal-bolus insulin regimen. CSII is expensive and steps should be taken to ensure they are not lost when a patient is admitted to hospital. CSII should only be adjusted by its owner (who has received extensive training) or a member of the Diabetes team in possession of the correct knowledge and skills.⁴

Please discuss all CSII patients with a member of the diabetes team

3. CSII MANAGEMENT FOR DKA AND THE UNCONSCIOUS/INCAPACITATED PATIENT

i See appendix 1 for summary

It is usually best for the patient to continue to self-manage their diabetes with CSII except:

- If unconscious, confused or incapacitated e.g. if illness/pain prevents self-management
- If undergoing major procedures under General Anaesthetic lasting >2 hours
- Diabetic ketoacidosis (DKA)

The unconscious or incapacitated patient

If patient unable to self-manage their CSII: detach pump and tubing. **Place pump in a safe place and document.** This is the ideal because it allows the diabetes team to subsequently 'interrogate' and adjust the pump. Alternatively, ask a relative to take the pump home for safekeeping. Immediately start alternative insulin e.g. variable rate IV insulin (refer to local guidelines) or subcutaneous insulin (see below: "alternatives to CSII") unless hypoglycaemic. If hypoglycaemic, start alternative insulin **once** hypoglycaemia is treated. CSII can be restarted once patient recovered (see below: "stopping and restarting CSII").

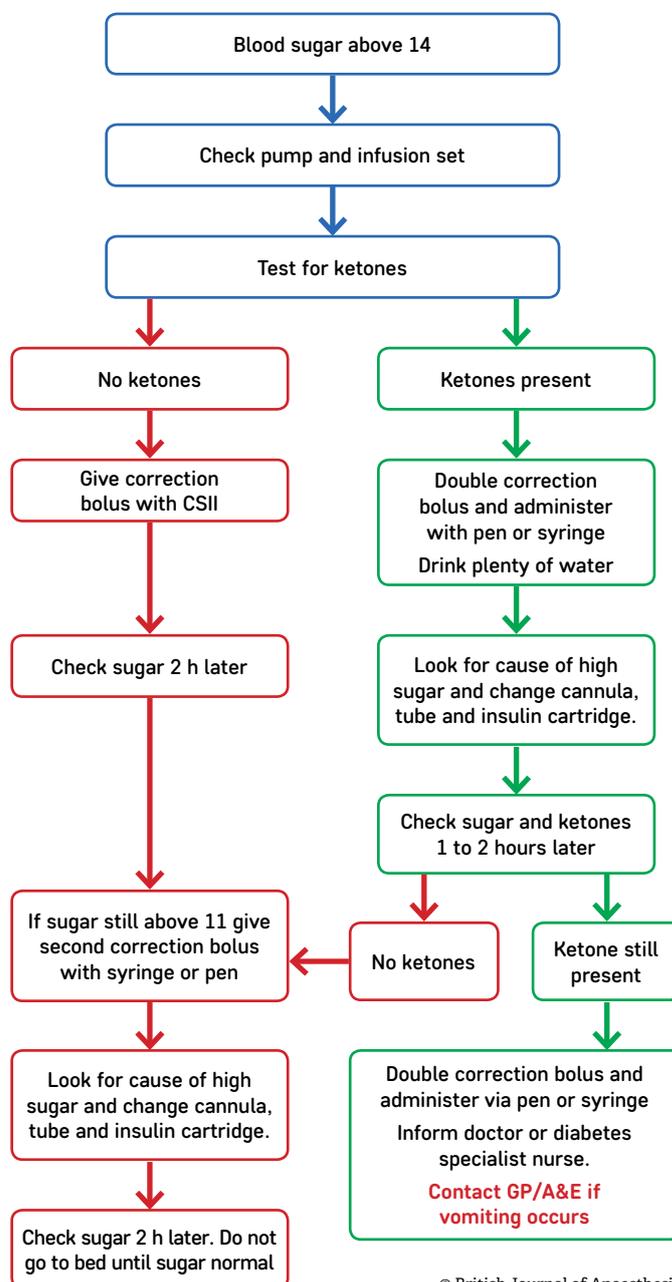
Diabetic ketoacidosis (DKA):

The altered tissue perfusion in DKA affects insulin absorption, making CSII unreliable. CSII should be temporarily discontinued in patients presenting in DKA: remove cannula/detach pump/pod. For further management, follow standard DKA protocol. CSII can be restarted once DKA is treated (see below: "stopping and restarting CSII"). **All patients should have specialist diabetes input before discharge** to review CSII settings which may need adjusting to prevent subsequent DKA and to re-enforce "sick day rules".

Managing high glucose levels

Patients admitted to hospital often have elevated blood glucose levels due to illness and stress. They should use their standard 'Sick Day Rules' to manage these glucose values. If they do not have their own system, or are too unwell to manage them, then a simple algorithm is outlined across

Sick Day Rules' algorithm for managing high blood sugar on CSII⁵



4. CSII AND RADIOLOGY INVESTIGATIONS

Current manufacturers guidelines state that CSII must be suspended and removed along with any metal cannulae prior to MRI, CT scan, X Ray or any other type of exposure to radiation, and should not be taken into the scanning room. However it is likely that some of this advice is based on lack of evidence rather than evidence of harm. Therefore these guidelines should be individualised by each centre. Many centres continue the use of CSII for non magnetic imaging such as X Ray, and CT scans.

The patient should reconnect CSII **immediately** following any radiological investigation. CSII can be safely suspended/removed for up to an hour at a time without needing alternative insulin. A correction bolus may be needed on reconnecting the pump (see page 10: Stopping and re-starting CSII).



5. CSII MANAGEMENT FOR SURGERY

📌 See appendix 2 for summary

Fasting is not usually a problem for CSII users, so being “nil by mouth” does not necessarily mean removal of CSII or need for IV insulin.⁶ Most patients will be able to manage their CSII post sedation/anaesthesia as safely as any patient using standard insulin pen injection therapy, and are more likely to achieve stable glucose control. Hence it is not necessary to admit day-case patients overnight for variable rate IV insulin infusion simply because they manage their diabetes by CSII. However, some patients will feel unable to self-manage post-procedure and should discuss this with their diabetes team in advance; they may require alternative management such as prior conversion back to insulin pens (see below: “alternatives insulin regimens”), or hospital admission. If continuing on CSII, patients should ensure SC CSII cannula is sited away from operative site and accessible to healthcare team.

Major surgical procedures (>2 hours duration, or where they are likely to miss more than one meal, or surgery requiring diathermy):

Patient should remove their CSII for these procedures, and this should be stored safely. Once CSII removed, start variable rate IV insulin infusion immediately (refer to local guidelines). CSII can be restarted once patient recovered and able to manage it (see: “stopping and restarting CSII”).

Minor procedures (<2 hours and expected to eat/drink within 2-3hrs) under general anaesthetic or sedation:

Patient should ensure blood glucose is in the acceptable range pre-procedure i.e. ideally 6-10mmol/l, but 4-12 acceptable with more frequent testing. If glucose is not in the acceptable range, then one round of bolus correction via the CSII is allowed before starting variable rate IV insulin (as for major surgical procedures). Whilst on CSII (or VR II), the healthcare team must monitor patient’s capillary glucose levels **at least hourly**; Post procedure, the patient on CSII should also use a correction bolus if capillary glucose >10 mmol/l. Consider starting VR II if BG > 12mmol/l⁷

If the CSII alarms during the procedure, do not attempt to rectify; monitor blood glucose every 30 mins and start IV insulin if >12mmol/l. If the CSII alarm becomes intrusive, remove CSII plus cannula, allow CSII to continue to run (the amount of insulin “lost” is minimal) and store safely.

If VR II used during procedure, see below for transferring back to CSII (“stopping and restarting CSII”); a correction bolus is less likely to be required in this situation.

Minor procedures without sedation:

The CSII can be continued with regular glucose monitoring as for any person with diabetes.

6. CSII MANAGEMENT FOR PREGNANT WOMEN

i See appendix 3 for summary

Introduction

The goal of insulin therapy in diabetes management during pregnancy is to maintain blood glucose levels as close to normal as possible in order to improve the outcome of pregnancy and reduce the risk to both mother and baby. The aim of glycaemic control for delivery is to safely maintain near-normal glucose levels until delivery and to safely manage the transition to post-delivery when insulin requirements fall and there is an increased risk of hypoglycaemia.⁸

Antenatal and postpartum Care

Obstetric care will follow established protocols for patients with diabetes. The diabetes team are responsible for CSII management including glycaemic control and addressing any educational needs.

Inpatient use of CSII

Please inform the Diabetes Specialist antenatal team of any pregnant woman using CSII therapy admitted to hospital.

CSII may continue providing the patient or partner is able to self-manage the CSII and perform the required blood monitoring.

Inpatient use of steroids during Pregnancy

- Please inform the Diabetes Specialist antenatal team before (or as soon as possible after) steroids are started.
- CSII may continue. The Diabetes Specialist antenatal team will instruct the patient regarding any change in CSII settings. A temporary increase in basal rate of 30% or more may be required, and needs to be individualised based on patient requirements
- Patients will be responsible for the management of CSII and glucose testing.
- Patients will be required to test their glucose levels 1-2 hourly; levels of 4- 7.8mmol/L should be aimed for.
- If glycaemic targets are not achieved, Midwifery or obstetric staff should contact a DSN or Diabetes Consultant. Consider commencing VRII (without IV glucose). This should be prescribed in advance where possible. Note: CSII may be continued alongside VRII in this situation.

Managing glycaemic control through delivery in women with Type 1 Diabetes on CSII

Women on CSII may be converted to VRII plus glucose for delivery (traditional management). Woman who chose, may continue to use their CSII through delivery, provided their blood glucose levels are within the **target range of 4 – 7 mmol/L** and patient/partner able to manage their CSII. The decision regarding the patient's suitability to self-manage CSII through delivery will be made by the diabetes specialist antenatal team and documented in the patient's case sheets. The diabetes team will educate the woman and her partner, and provide written instructions, regarding cannula siting, guidelines for using CSII through delivery, and situations where CSII treatment may need to be discontinued and traditional management instigated with VRII plus IV glucose. The individualised VRII should be prescribed in advance.

Staff responsibilities

While the woman remains on CSII, the patient and her partner are responsible for checking glucose hourly, giving corrections via CSII, adjusting basal rates and other pump settings as required including at delivery. The midwife is responsible for ensuring the patient/partner remains able and willing to manage their CSII, that glucose is checked and documented hourly, and that if glucose is persistently (see below) above 7mmol/l, VRII plus IV glucose is started and the CSII stopped.

Once the patient is on VRII plus glucose, the midwife is responsible for checking glucose hourly and adjusting VRII rates as prescribed.

Protocol for managing glycaemic control through delivery using CSII

Measure and record blood glucose levels hourly using approved hospital blood glucose meter. The patient should continue her usual basal infusion rates, aiming to keep blood glucose levels between 4 - 7mmol/L. Bolus correction doses should be made by the patient via CSII to maintain target blood glucose levels 4 to 7mmol/l.

If patient/partner unable to manage CSII, or if blood glucose >7mmol/l for >2 hours despite correction doses, switch from CSII to individualised VRII plus IV glucose. (Remove CSII and tubing and place in suitable container; no need to turn off CSII nor to remove SC cannula)

Correction doses during labour:

If blood glucose greater than 7mmol/l, a correction bolus dose should be given via CSII, aiming for a blood glucose of 5mmol/l, using the patient's personal correction factor (also known as "ISF" = insulin sensitivity factor) or if not known, calculate 1 unit of insulin to reduce blood glucose levels by 2.5mmol/l e.g. if blood glucose 10.0 mmol/l, give 2 units bolus. After 1 hour, if that correction bolus is ineffective i.e. blood glucose still above 7.0 mmol/l, another correction bolus dose should be given via CSII (using the same calculation advice as above). After a further ½ hour, if blood glucose levels still not below 7.0 mmol/l, then switch to VRII plus IV glucose as above.

Hypoglycaemia during labour:

If blood glucose < 4.0mmol/l, treat hypoglycaemia as per hospital policy. If the woman has one unexplained hypoglycaemic event, she should reduce her current basal rate by 25 - 50% using a temporary basal rate setting. If having further episodes of hypoglycaemia despite original reduction, she should reduce by another 25% or more as required. A lower basal rate is usually required throughout the rest of labour. After delivery, the basal rate should change to the post-delivery basal rate which should have been defined.



Post-delivery

Planned post-delivery CSII settings should be determined towards the end of pregnancy, in conjunction with the diabetes team, and documented. The basal profile is typically the same as pre-pregnancy basal profile often with a 10-20% reduction, or if CSII started during pregnancy, 50% of pre-delivery basal rates. This post-delivery basal profile can be entered into the pump memory in advance. The planned post-delivery insulin:carbohydrate ratio, ISF and targets will need to be programmed after delivery **but before the first bolus dose.**

If there is no documentation of post partum doses then the basal rate can be set to 0.5 units/hour, insulin: carbohydrate ratio 1:15g, insulin sensitivity factor 4mmol/L, and BG targets 6-8mmol/L. These should be reviewed and adjusted in conjunction with the diabetes specialist team before discharge

If the women continues on CSII for delivery, the basal rate should be changed to the planned post-delivery basal rate immediately at delivery and the bolus calculator settings changed as soon as possible **but before the first bolus dose.**

If managed with VRII, CSII can be recommenced once the patient is able to self-manage the pump. Ensure all pump settings are changed to post-delivery settings as above. The VRII should continue for **60 minutes after restarting CSII.**

For women who are breastfeeding, settings may need reducing by a further 10-20% or even more as feeding is established.

7. HYPOGLYCAEMIA IN PATIENTS ON CSII

Patients able to manage their CSII:

Treat hypoglycaemia according to local protocol, and this is likely to include rapid acting carbohydrates (e.g. dextrose tablets). Unlike patients on long acting insulin, follow-up with long acting carbohydrates is not usually needed. CSII infusion rates may need adjustment, especially if history of recurrent hypoglycaemia: **consult diabetes team.**

The unconscious/incapacitated patient:

Initial treatment of hypoglycaemia is as standard local protocol. If persistent hypoglycaemia occurs, remove cannula and pump. Once normoglycaemic, re-start insulin, either CSII if patient now alert and able to self-manage, or alternative regimen (see below); this is needed to prevent the development of ketoacidosis.

8. STOPPING AND RE-STARTING CSII

Stopping:

The pump together with its tubing may be removed leaving only the SC cannula in place, unless cannula site is infected or in surgical field. Clearly this will not apply to CSII without external tubing such as the Omnipod®. It is important not to cut tubing or disconnect the pump from the tubing as the remaining insulin in the tube may infuse quickly risking hypoglycaemia. Place the CSII into a suitable container and do not attempt to turn off; the amount of insulin "lost" into the container will be minimal. Document where the CSII is stored, or to whom it has been given. The insulin in a CSII is very short acting therefore **alternative insulin must be started immediately i.e. within an hour** (see below) to avoid risk of ketoacidosis. If the patient is able to do so, he/she should make a record of their current basal and bolus settings, as this data may be lost if the pump is stopped for any significant length of time.

Restarting:

The person with diabetes is ideally best placed to restart the CSII because they will have received training in this process and will be experienced. If this is not possible, and CSII has been only temporarily removed or suspended (i.e. no IV insulin infusion has been required) and SC cannula still in position, patient should perform a "fixed prime" to refill the dead space within the tubing, then simply reconnect CSII, and restart basal infusion. If capillary glucose >10mmol/l, he/she should bolus a correction dose once CSII re-connected, using their personal correction ratio or ISF (insulin sensitivity factor).

If transferring from IV insulin infusion: ask patient to insert new cannula and re-start CSII after performing a fixed prime (there is no need to wait until a meal); wait 60 minutes before discontinuing IV insulin.

If transferring from subcutaneous insulin: patient inserts new cannula, performs a fixed prime and re-starts CSII. CSII settings may need to be re-programmed. Patient may need to temporarily reduce background insulin infusion rate (e.g. drop to a 70% temporary basal rate for 24hrs) while long acting subcutaneous insulin is still active - increased glucose monitoring may be required. No further subcutaneous insulin doses should be required once CSII restarted. Re-check blood glucose 1-2 hours after CSII re-start. Contact diabetes team for further advice.

9. ALTERNATIVE INSULIN REGIMENS FOR HOSPITALISED PATIENTS UNABLE TO CONTINUE ON CSII

All the guidance below should be used in accordance with local guidelines and protocols:

The appropriate alternative insulin regimen depends on the clinical scenario:

- For **patients with DKA**, use a fixed rate IV insulin infusion as per local guidelines.
- For **patients who are fasted and/or have unstable glucose levels** (but not DKA), use aVRII as per local guidelines.
- For **patients who are unable to self-manage their CSII, but do not have unstable blood glucose levels** and are not NBM, a basal-bolus insulin regimen is preferable to VRII.

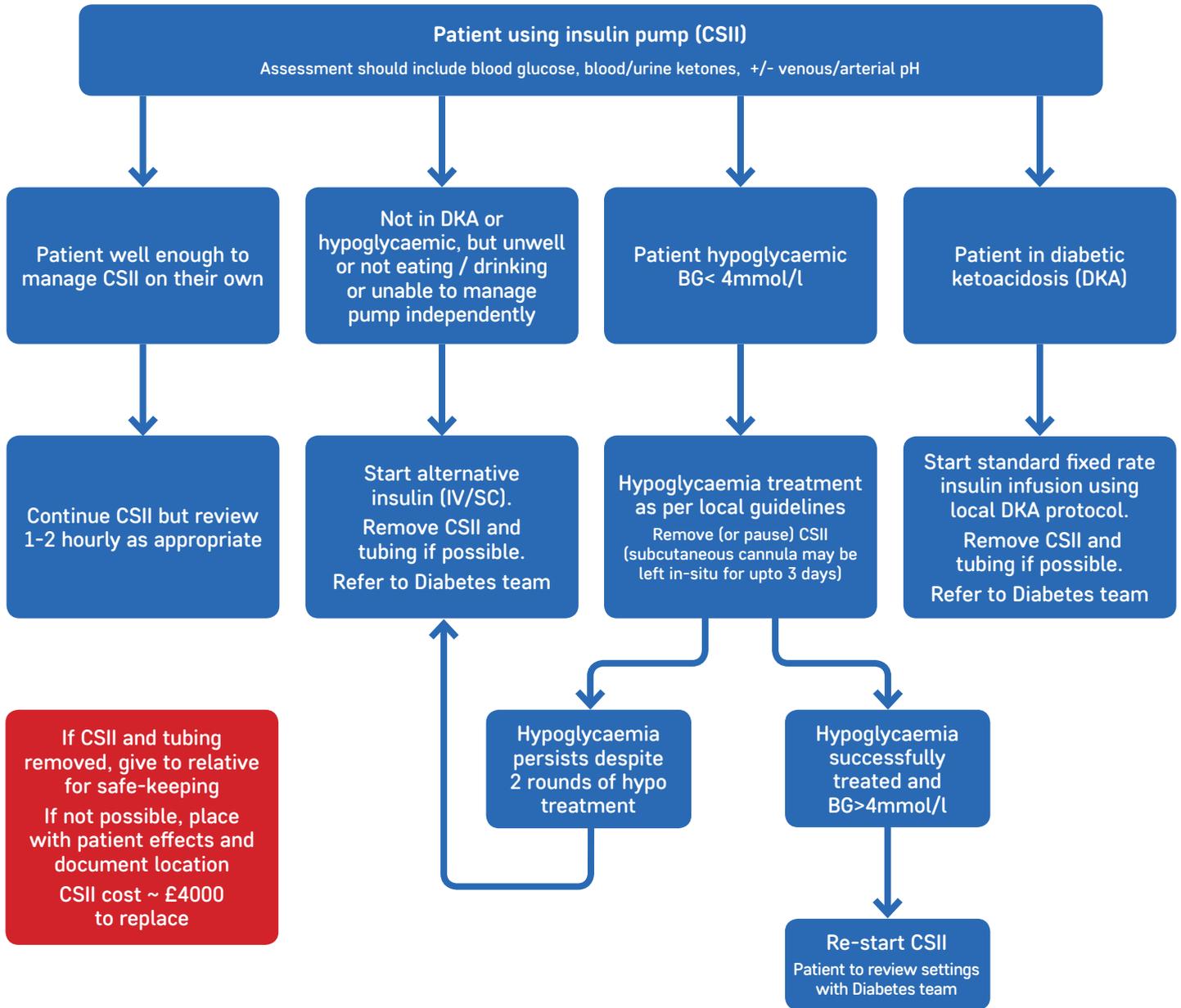


How to calculate multiple daily injection insulin requirements

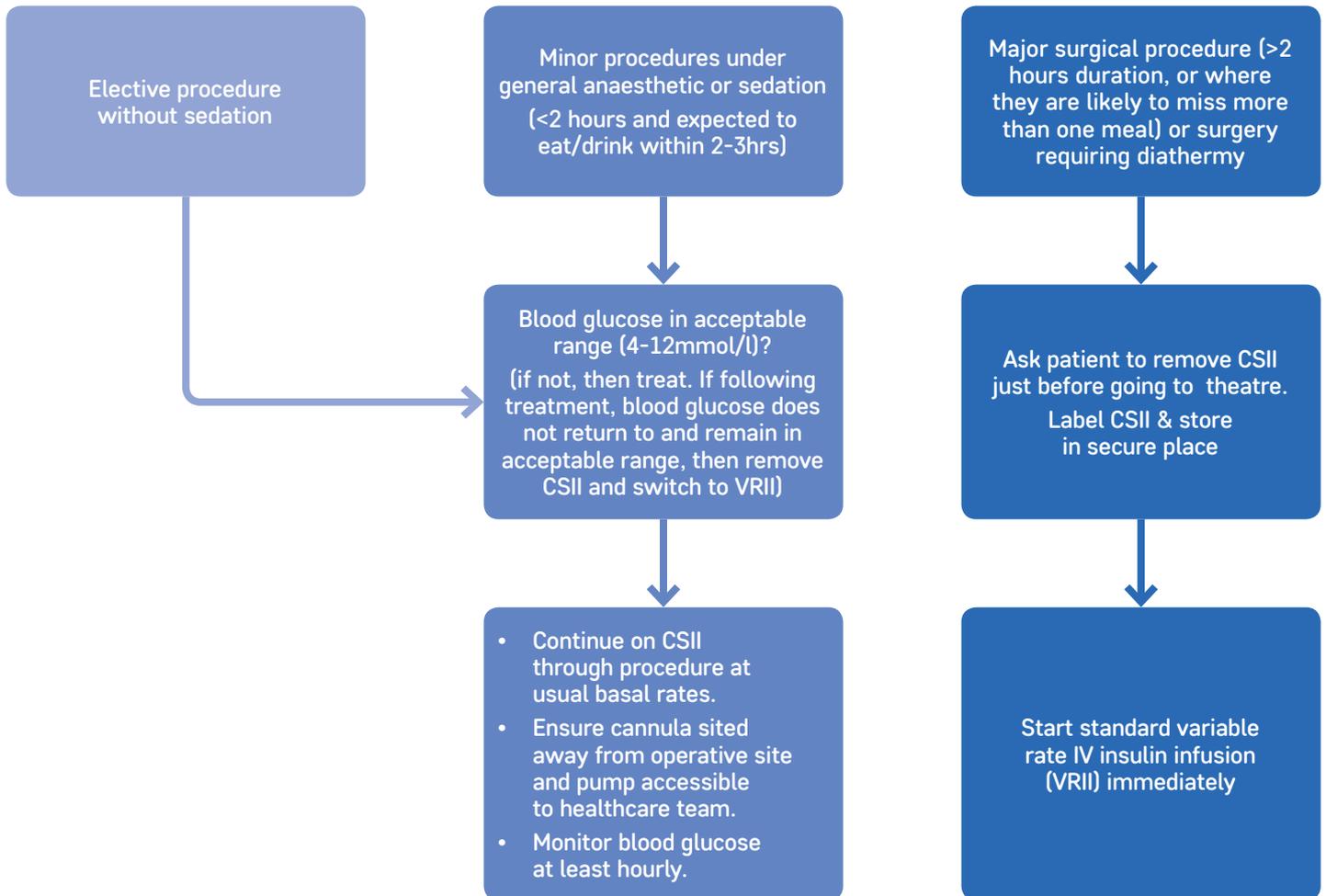
Calculate appropriate starting doses based on the patient's recent (e.g. 7day) average total daily insulin dose (TDD); this information can be obtained by the patient or DSN from the pump.

- Prescribe 50% of the TDD as Levemir insulin (as per NICE guidelines), initially split equally in a bd insulin regime
- For meal-time (rapid acting) insulin dose: $50\% \text{ of TDD} / 3$ plus a safety adjustment (e.g. minus 30%) to minimise risk of hypoglycaemia. Titrate doses according to response. Alternatively, if the patient is able to continue to carbohydrate count, prescribe a variable dose for self-administration.
- E.g. a patient's average CSII insulin TDD for last 7 days is 48 units/day. $50\% \text{ of } 48 \text{ units} = 12 \text{ units bd daily Levemir}^{\circledR} \text{ insulin}$. $50\% \text{ of } 48 \text{ units} / 3 = 8 \text{ units of rapid acting insulin with each meal}$: after safety adjustment = 6 units. If the patient is trained in carbohydrate counting (and they often are), it would be preferable for them to inject insulin doses according to their insulin : carbohydrate ratio.

APPENDIX 1: EMERGENCY ADMISSIONS AND CSII MANAGEMENT

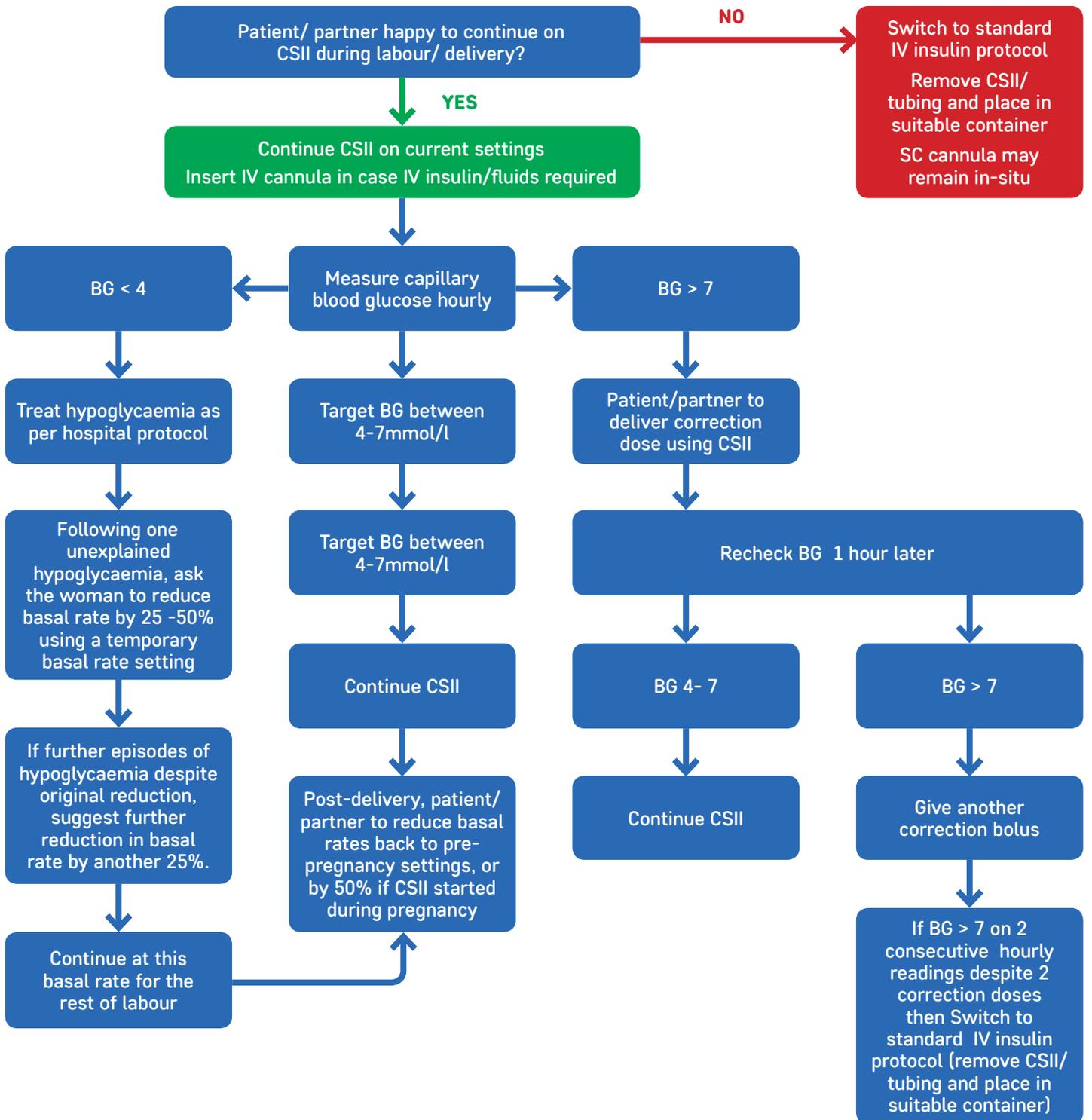


APPENDIX 2: CSII MANAGEMENT FOR ELECTIVE SURGICAL PROCEDURES UNDER SEDATION OR ANAESTHESIA



- If blood glucose < 4, follow local hypoglycaemia protocol; re-test every 10-15 mins. Post hypo recovery, test glucose every 30 min until end of procedure
- Leave CSII in place and do not attempt to adjust settings
- If CSII alarms during procedure, don't try to rectify; leave CSII in place, monitor blood glucose every 30mins.
- If alarm becomes intrusive, or patient has more than one hypo, remove CSII and tubing (do not attempt to switch off CSII), Label CSII & store in secure place. Start VRII.

APPENDIX 3: WOMEN USING CSII ADMITTED IN LABOUR OR FOR ELECTIVE CAESAREAN SECTION



APPENDIX 4: COMMONLY USED PUMPS & ASSOCIATED CONSUMABLES

i Information subject to change but correct at time of printing.



Animas

- AA batteries
- Infusion sets
- Cannulas

Tech support: 0800 0556606



Medtronic Paradigm veo

- Contour Next test strips
- AAA Batteries
- Infusion set
- Cannula

Tech support: 01923 205167



Accu-chek combo:

- Test strips
- Cartridges
- Infusion set
- AA & AAA batteries

Tech support: 0800 7312291



Accu-chek Insight

- i Pre-filled cartridge. Only uses 1.6ml Novorapid pump cart**
- Infusion sets
- Cannula
- AAA batteries

Tech support: 0800 7312291



Mylife Omnipod

- Abbott freestyle test strips
- Alkaline AAA batteries for hand-set
- Pod (syringe and needle inside pod)

Tech support: 08448 567820



Cellnovo

- Consists of 2 pumps, each lasting 3 days)
- Rechargeable pump & hand-set
- Charging dock
- One-touch test strips

Tech support: 0203 0581250



Medtronic 640g

- Contour Next test strips
- Infusion set
- Cannula
- AA lithium batteries

Tech support: 01923 205167



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