Standard Operating Procedure (SOP):

SOP Title: Safe Use of Technology to Support Diabetes Care in the Hospital

Classification :	Standard Operating Procedure		
Authors Name:	**Jade Alin**		
Authors Job Title:	**Inpatient Diabetes Specialist Nurse - MKUH**		
Authors Division:	**Medicine - Internal**		
Departments/Group this Document applies to:	**All Clinical**		
Approval Group: **Medicine CIG**		**Date of Approval:**	28/02/2025
		Last Review:	
		Review Date:	28/02/2028
Unique Identifier: RADAR	**Status:** Approved	**Version No:** 1.0	
Scope: All Nursing & Medical Staff		**Document for Public Display:** Yes	
To be read in conjunction with the following documents: Identify associated documents i.e. policies, patient information			

Index

SOP Statement

This document is intended to raise awareness of the various devices / technology available for use in supporting diabetes care within hospital settings. These guidelines are intended for all healthcare professionals to assist in identifying and supporting people with diabetes in safely managing technology during their hospital stay.

There is a clear need for clinical guidance to ensure the safe use of current devices when managing persons with Diabetes in hospital. Best practices must be established for leveraging wearable technology and information systems to monitor care and facilitate communication among healthcare professionals. Additionally, we should prepare for future technological advancements, recognizing both the opportunities and potential risks they may bring.

Introduction

Whilst significant advances in diabetes care have emerged in recent years, particularly through technological innovations, most research and development have focused on benefits seen in outpatient settings. Although some efforts have explored the use of technology in hospitals, these have mainly emphasized safety rather than demonstrating improvements in overall care. Nevertheless, it is reasonable to infer that devices designed to enhance diabetes care outside of hospitals could offer similar benefits within them.

A survey conducted across various UK hospitals revealed considerable variation in the use of technology for diabetes management. For instance, just over half of hospitals reported using point-of-care glucose data for audits, quality improvement, or clinical decision-making. While continuous glucose monitoring may be maintained after admission to support self-management, it is rarely utilized as a specific tool for improving diabetes care.

Definitions

ATTD – Advanced Technologies & Treatments for Diabetes
BGL – Blood Glucose Level
BP – Blood Pressure
CBG – Capillary Blood Glucose
CGM – Continuous Glucose Monitoring
CSII – Continuous Subcutaneous Insulin Infusion

CT – Computerised Tomography
DKA – Diabetic Ketoacidosis
DISN – Diabetes Inpatient Specialist Nurse
DSN – Diabetes Specialist Nurse
FRIII – Fixed Rate Intravenous Insulin Infusion
GP – General Practitioner
HCL – Hybrid Closed Loop
ICR – Insulin: Carbohydrate ratio
ISF – Insulin Sensitivity Factor
ITU – Intensive Therapy Unit
IV – Intravenous
JBDS-IP – Joint British Diabetes Societies for Inpatient Care
MDT – Multi-Disciplinary Team
MKIDS – Milton Keynes Integrated Diabetes Service
MRI – Magnetic Resonance Imaging
NBM – Nil by Mouth
NOK – Next of Kin
POC – Point of Care
S/C or SC – Subcutaneous
SOP – Standard Operating Procedure
TDD –Total daily dose
VRIII – Variable Rate Intravenous Insulin Infusion

1.0 Roles and Responsibilities:

It is the responsibility of all doctors and nurses who manage persons with Diabetes in hospital to familiarise themselves with this guidance and the technology used to support/ enhance their care. If there is uncertainty after reviewing this guideline you must escalate concerns to a senior member of your team or the Diabetes MDT (Multi-Disciplinary Team- Inpatient/ Outpatient Diabetes Teams).

All Healthcare professionals who prescribe, dispense and/or administer insulin must complete 430 Diabetes Insulin Safety e-leaning on ESR (Electronic Staff Record).

The DISN Team works Monday to Friday 8-4pm. Saturday and Sunday 8:30 -12:15. We do not cover bank holidays. We also work with colleagues in the community setting (MKIDS).

The MKIDS Team is a multi-disciplinary team consisting of Diabetes Consultants and Diabetes Specialist Nurses with administrative support. This service is presently only available Monday – Friday 9-5 pm (excluding bank holidays). The MKIDS Team also work alongside colleagues in Primary Care to provide high quality, local care for people living with diabetes with a Milton Keynes GP. They are presently based at: Willen Surgery, Beaufort Drive, Willen, Milton Keynes MK15 9EY.

Hospital staff can use the referral form via eCARE or contact extension line 86018 for Inpatient Diabetes support. The Outpatient Diabetes Team can be contacted on: TDSNT@mkuh.nhs.uk. Please put patient's initials and NHS number in the subject field (the clinical system there works on NHS numbers).

2.0 Implementation and dissemination of document

This SOP will be included as an appendix to the insulin safety module and discussed at Think Glucose study days. The SOP can be accessed on the MKUH internet – Tools – Diabetes – Quick reference guides. It will also be communicated using the Trust weekly newsletter.
This document will be published on the Trust Intranet/ RADAR.

3.0 Processes and procedures

WEARABLE DIABETES TECHNOLOGY

3.1. Using a Continuous Glucose Monitor (CGM)

- Devices that are used to monitor glucose ('interstitial glucose'). These devices can monitor/ measure readings every 1-5 minutes.
- Body sites to wear the CGM are as per manufacturer's instructions, the usual sites are on the abdomen, or upper outer arms.
- These sensors usually last for 10 days, with some sensors needing to be replaced every 15 days.
- Examples include *Freestyle Libre 2, Libre 2 plus or Libre 3, Dexcom One, Dexcom G6 or Dexcom G7, Dexcom One plus, Simplera Sync, Guardian 3 or Guardian 4 sensors.*
- If using CGM in the hospital, **at least 2 capillary BG readings per day are still required.**
- **DO NOT use CGM readings with IV insulin infusions**, e.g. FRIII or VRIII.

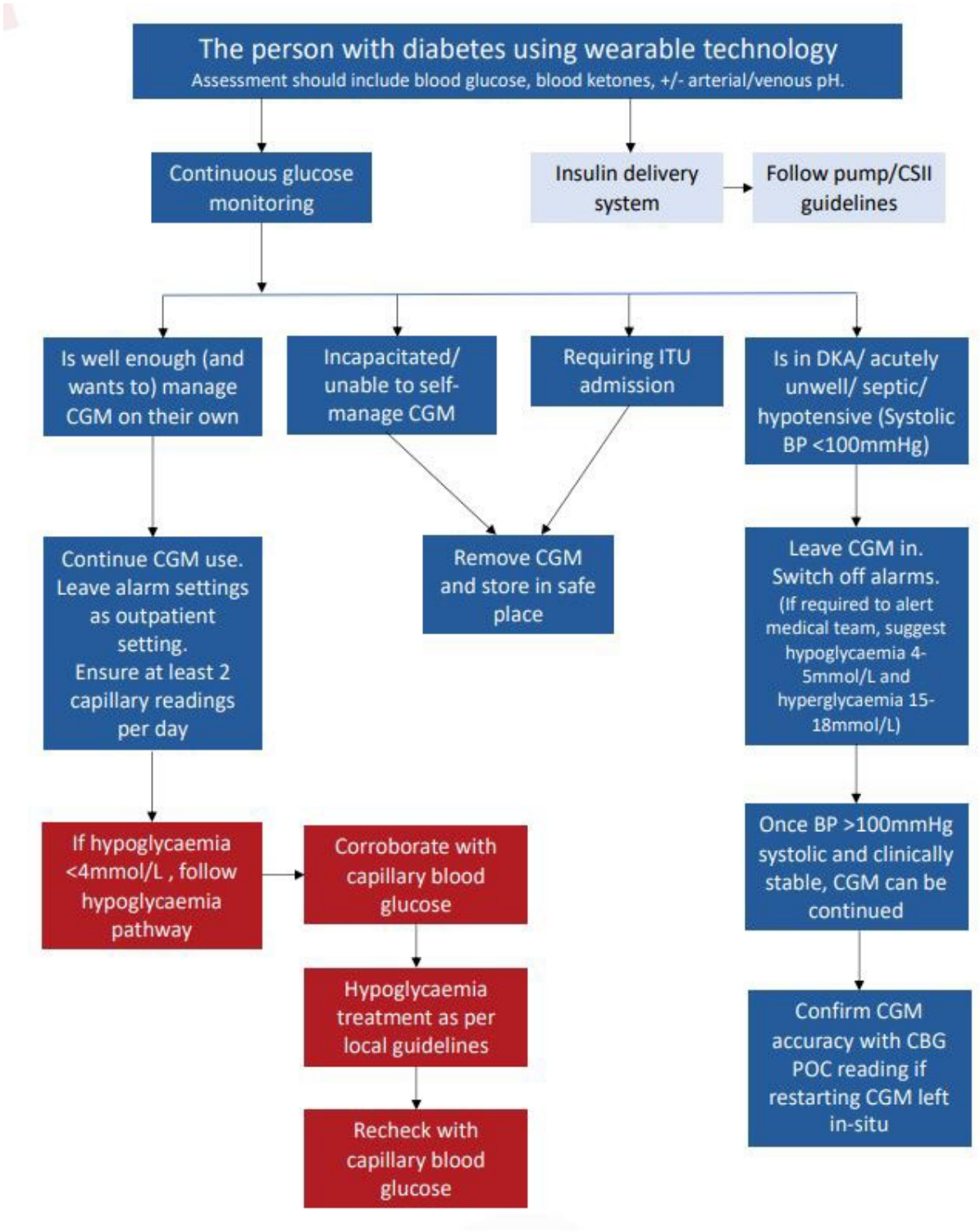


Figure 1: Adapted from: Joint British Diabetes Societies: Using technology to support diabetes care in hospital (3/24) https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf, (Page 14)

3.1.1. Glycaemic targets in hospital

The Advanced Technologies & Treatments for Diabetes (ATTD) consensus guidance recommends a target percentage time in range (3.9–10 mmol/L) in the outpatient setting of 70%, but this is reduced to 50% for those at higher risk of hypoglycaemia. (Danne T et al, 2017)

The JBDS-IP view is that during acute illness and inpatient stays, avoiding hypoglycaemia is the priority (aim for no hypoglycaemia in hospital), with the secondary aim of avoiding significant hyperglycaemia. The usual JBDS-IP glycaemic targets in hospital are 6–10 mmol/L, which apply for the acutely unwell person or 6–12 mmol/L in the elderly/frail.

If glucose is between 4 and 6 mmol/L and CGM arrow (s) are trending down, this is indicative of looming hypoglycaemia. A small carbohydrate snack (4–8 g) can arrest the fall to hypoglycaemia. Other interventions may include adding glucose to an intravenous glucose infusion or simply rechecking blood glucose levels sooner than planned.

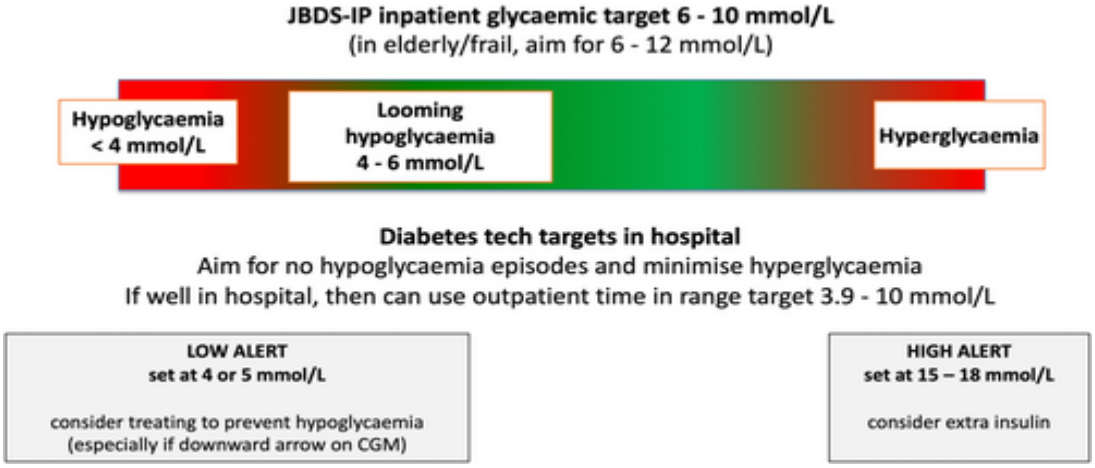


Figure 2: Inpatient blood glucose level targets. (Joint British Diabetes Societies for Inpatient Care, 2024, Page 17)

3.1.2. Capillary glucose monitoring whilst the individual wears CGM

As CGM data are not yet integrated within electronic health records (e.g. eCARE), and sensor inaccuracies may occur during acute illness, CGM can supplement but not replace CBG monitoring in the hospital. JBDS-IP recommends capillary blood glucose should be checked at least twice daily for people using CGM in hospital, irrespective of whether the device needs calibration. It should be explained to the person with diabetes, that regular CBG monitoring is necessary for safety reasons, and for alerting staff to out of range results. Nursing staff should also be aware to perform additional CBG testing in case of any concerns of discrepancy with symptoms.

3.1.3. Discrepancies between CGM and CBG readings

Potential sensor inaccuracies or discrepancies between CGM and CBG readings may be observed. JBDS-IP defines an acceptable difference based on the definition for the reference standard for integrated CGM (iCGM) devices. This is defined as %20/20 (i.e. if difference between readings is ±20% for CBG >5.6 mmol/L or within ±1.1 mmol/L (±20 mg/dL) if ≤5.6 mmol/L). (Joint British Diabetes Societies for Inpatient Care, 2024, Page 18)

If discrepancies are observed, more frequent CBG monitoring is advised for the next few hours (depending on clinical need).

For CGM devices that can be calibrated (e.g. Dexcom G6®) consider calibration with point-of-care glucose using a blood glucose meter and use if accurate. If the discrepancy persists, the sensor should be removed and replaced.

3.1.4. Documentation of glucose readings in hospital

Currently, CGM data are not integrated with most hospital electronic health records, and therefore, healthcare professionals need to be mindful of how data is documented. Due to the influx of glucose data available from CGM devices, JBDS-IP advocates a minimum standard of documentation including fasting, pre-meal and bedtime readings. Instances of hypoglycaemia and hyperglycaemia, flagged by alarms, should also be recorded, along with the methodology employed for obtaining glucose values.

3.1.5. The person with diabetes wearing CGM in hospital

Unless incapacitated or acutely unwell (i.e. haemodynamically unstable or septic), most people using CGM in a medical or surgical ward are safe to remain on CGM if admitted to hospital.

3.2. Using a Personal Insulin Pump

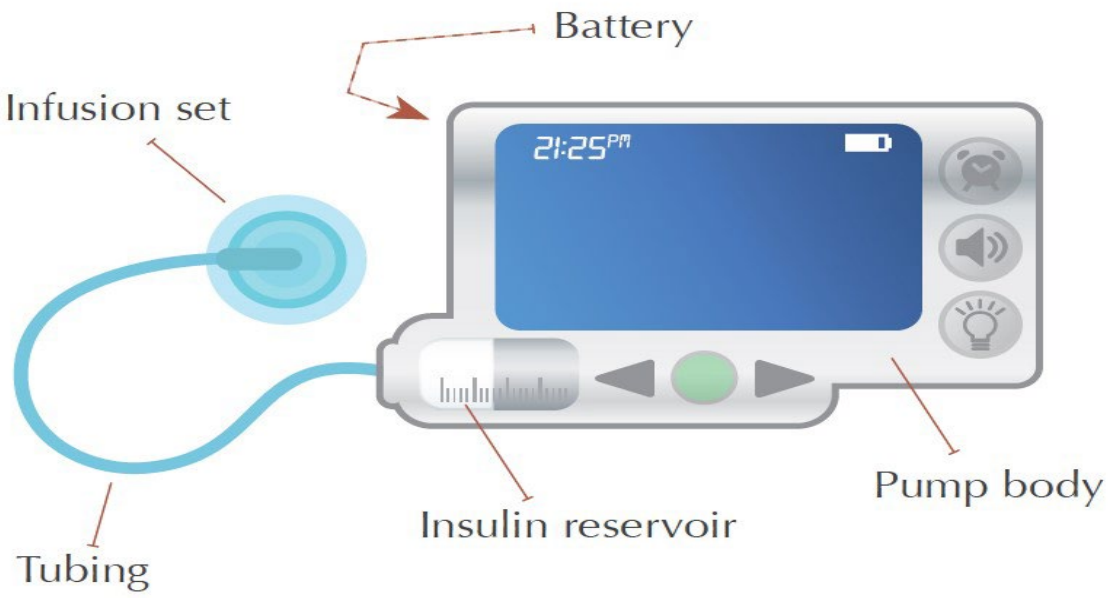
Insulin Pumps (also known as Continuous Subcutaneous Insulin Infusion (CSII) Devices

Insulin pump therapy (continuous subcutaneous insulin infusion: 'CSII') may be used by people with Type 1 diabetes to optimise blood glucose control and reduce the risk of hypoglycaemia. These patients have NO endogenous insulin production. The pump is an alternative means of delivering insulin subcutaneously but does not take over personal diabetes care. A pump is only likely to be effective if the user is engaged and motivated with their diabetes management.

Pump users undergo detailed education and training in the use of the pump by the diabetes team. They are the experts when it comes to their pump therefore **IF THE PATIENT IS NOT WELL ENOUGH TO SELF MANAGE THEIR PUMP, THEN IT SHOULD BE DISCONNECTED AND INSULIN ADMINISTERED VIA AN ALTERNATIVE ROUTE (IV or S/C)**

An insulin pump is not a complete 'artificial pancreas'. Anyone not trained in insulin pump use should not attempt to adjust settings. Insulin pumps (personal Continuous Subcutaneous Insulin Infusion (CSII) devices)

Figure 3: Components of an insulin pump (Image taken from public domain):



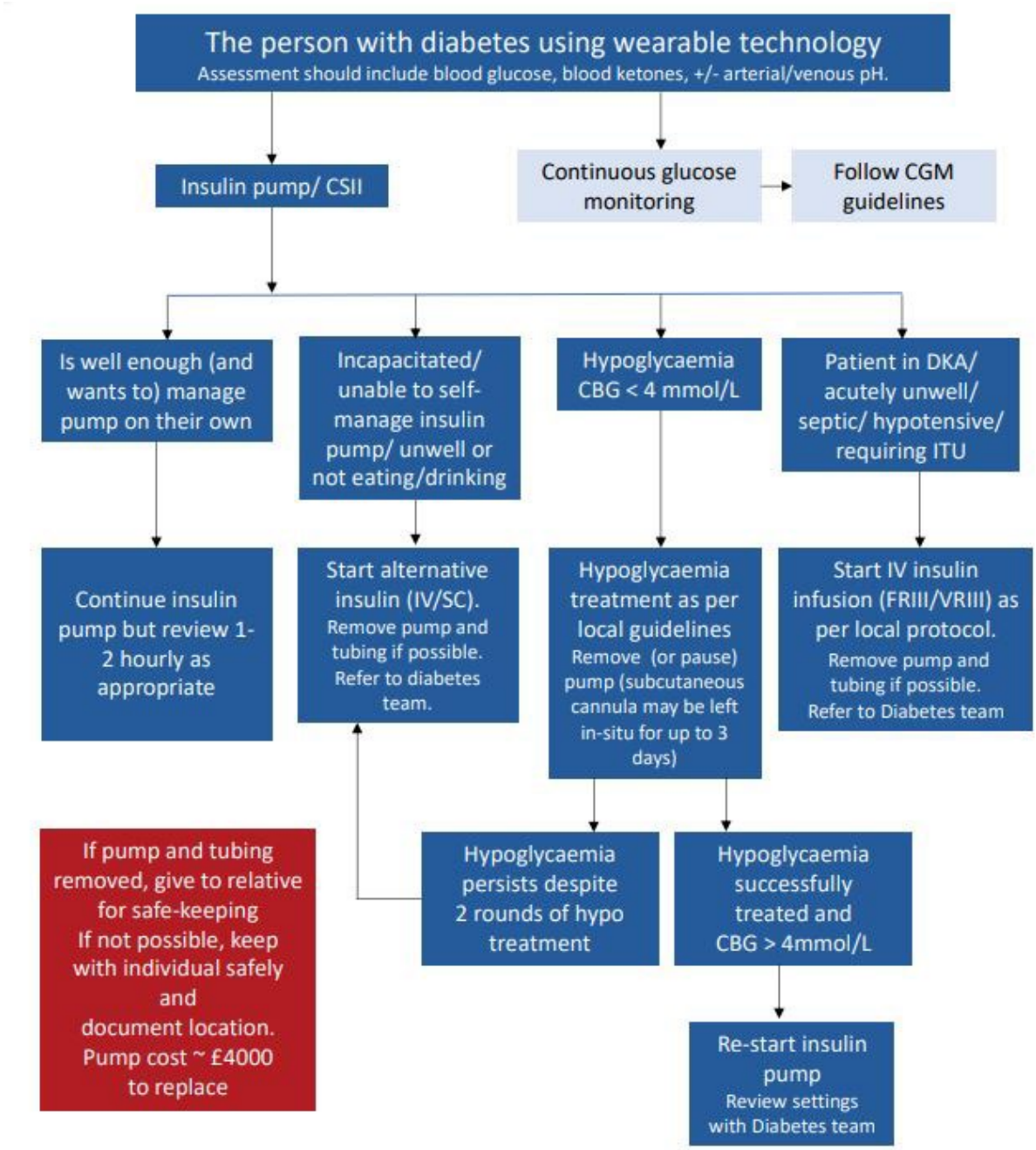


Figure 4: Adapted from: Joint British Diabetes Societies: Using technology to support diabetes care in hospital (3/24) https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf, (Page 24)

Please refer all inpatients on insulin pumps to the diabetes team.

3.2.1. Essential information about Insulin Pumps

- Insulin pumps use only Rapid acting insulin (e.g. NovoRapid, Humalog, Fiasp), long-acting insulin is NOT used in a pump.
- The insulin is infused continuously from a reservoir within the pump into a fine bore cannula placed subcutaneously, usually in the abdomen.
- The cannula needs to be changed every 2 to 3 days.

- Most pumps have tubing. The tubing and insulin cartridge needs to be changed every 4-5 days.
- The plastic tubing should **NEVER** be cut (e.g. when addressing hypoglycaemia).
- The Omnipod and the Accu-Chek Solo pump are 'patch pumps' that stick directly to the skin, they have no tubing. These pumps may be worn on the arm.
- Rapid-acting insulin is infused slowly via the pump, in small amounts, at a pre-programmed rate every few minutes.
- Additional boluses can be manually triggered for delivery to cover meals correct hyperglycaemia using usual Insulin: Carbohydrate ratio (ICR) & Insulin Sensitivity Factor (ISF- i.e. how many mmol 1 unit of rapid-acting insulin drops glucose by).
- The insulin infusion rate can be adjusted to cover for exercise or illness.
- If the pump fails to deliver insulin for any reason (e.g.; blocked tubing, kinked cannula) without an alternative provision of insulin **DKA is likely to result in 1-2 hours** because there is no reservoir of long-acting insulin. They must therefore receive insulin via subcutaneous injection or IV infusion in this situation.
- All insulin pump users should have been told to have a supply of rapid/short acting and long-acting insulins for s/c use stored at home to cover in the event of pump malfunction
- All adult insulin pump users under the Milton Keynes Insulin pump clinic should have been given a pump workbook, containing essential pump-related information.

Figure 5: Examples of insulin pumps used in MKUH:

Figure 5. Images from public domain. *Top left: Medtronic MiniMed 780G pump, top left: tandem t-Slim pump, Centre: Omnipod DASH pump*

3.2.2. Principles of Self-management of Insulin Pumps by Inpatients

- **Inpatients using insulin pumps should continue to manage, if well enough to do so.**
- If the **patient is not well enough** to self-manage the pump or is unconscious/incapacitated the pump **should be discontinued** and a variable rate intravenous insulin infusion (VRIII – old name 'sliding scale') should be commenced immediately (unless the patient is hypoglycaemic - see below).
- An insulin pump should NEVER be discontinued without immediate substitution with subcutaneous rapid acting insulin AND long-acting insulin. Patients should ALWAYS have a supply of subcutaneous insulins at home even if on a pump.
- Insulin pumps should only be adjusted by the patient or a member of the diabetes team.
- If an insulin pump is discontinued, it should be stored safely until the patient is ready to re-commence the pump. The place of storage should be documented.
- If the patient is not able to self-manage but continued intravenous insulin is not necessary (e.g. able to eat and drink normally), then the diabetes team should be asked to advise on a subcutaneous insulin injection regimen.

- When an insulin pump is re-commenced, the intravenous insulin infusion should not be discontinued until a mealtime bolus dose of insulin has been given via the pump.

3.2.3. Guidelines for Insulin Pump Therapy in Specific Situations

3.2.3.A. Hypoglycaemia in patients on a pump

- Patients able to manage their pump:

Treat hypoglycaemia with rapid acting carbohydrates (e.g. dextrose tablets) as per local protocol. Unlike patients on long-acting insulin, follow-up with long-acting carbohydrates is not usually required. Pump infusion rates may need adjustment, especially if there is a history of recurrent hypoglycaemia: consult the diabetes team.

- The unconscious/incapacitated patient:

Initial treatment of hypoglycaemia should follow standard local guidelines, as well as by disconnecting the pump. DO NOT CUT PUMP TUBING. Once blood glucose has returned to normal, re-start insulin, either by pump if patient now alert and able to self-manage, otherwise use an alternative regimen (e.g. VRIII or subcutaneous insulin); to prevent the development of ketoacidosis. The diabetes team may need to reduce the pump infusion rate following hypoglycaemia.

Do not use personal insulin pump if patient is haemodynamically unstable - replace with IV insulin infusion or multiple daily insulin injections.

3.2.3.B. Diabetic Ketoacidosis (DKA)

- Altered tissue perfusion in DKA affects insulin absorption, making CSII use unreliable
- **CSII should be temporarily discontinued in patients presenting in or diagnosed with DKA** and stored safely or taken home by NOK
- DKA should be managed as per usual protocol.
- CSII can be restarted once DKA resolved (see "restarting insulin pump" section below)
- **All patients should have specialist diabetes input** to review pump settings, which may need adjusting to prevent subsequent DKA and to re-enforce "sick day rules".
- Patients using pumps should not be discharged without specialist pump team review if there are concerns about their ability to self-manage the pump

3.2.3.C. Causes of Pump-associated Hyperglycaemia

Hyperglycaemia can develop if a pump is disconnected for more than 60 minutes without alternative insulin administration. This can increase the risk of ketogenesis and DKA.

3.2.3.C.1. 'Mechanical problems'

- Infusion Set problems
    - Cannula kept in too long – set should be changed every 2- 3 days
    - Inflammation at cannula site - look for redness around site

- Cannula inserted in hardened area of skin (lipohypertrophy)
- Reflux of blood / tissue fluids in infusion set- look at tubing
- Cannula/needle blocked or kinked
- Cannula/needle at insufficient depth/incorrect angle
- Cannula/needle partially slipped out
- Air bubbles in tubing- forgot to prime new tube or not connected properly to adaptor
- Tubing not changed often enough (occluded by crystalised insulin)

- Pump stopped deliberately or accidently or broken/not working (pump should alarm)
- Insulin cartridge: empty, leaking (pump should alarm) or not changed often enough
- Battery – low or empty: The pump should alarm regularly & increasingly insistently if the battery is about to run out

Actions to consider:

- Change the whole infusion set including subcutaneous cannula and reattach the pump as soon as possible to re-start insulin infusion
- Patients should have contact details of the relevant insulin pump company should the entire pump need replacement (see 'Technical problems.' below)
- Patients should have been provided information on how to go back to using s/c rapid and long-acting insulins (and how to calculate doses) if pump use is not possible.

3.2.3.C.2. Other causes:

- Forgotten to give bolus with last food eaten
- Rebound high glucose after hypo which may be caused either by over treating hypo or body's natural response to increase blood glucose levels
- Given too little bolus or eaten too much carbohydrate for insulin given
- Too much intake of food after hypoglycaemia (overtreated a low sugar)
- Lack of activity/bed rest
- Deteriorated insulin (having been exposed to high/low temperatures/direct sunlight)
- Stress, illness or infection
- Some medications e.g. steroids, antipsychotic agents
- Hormonal changes (pregnancy, menstruation)

Actions to consider:

- Change the whole infusion set including subcutaneous cannula and reattach the pump as soon as possible to re-start basal insulin

- If there is any doubt about the patient's ability to manage insulin pump themselves, use either s/c insulin or VRIII depending on clinical situation.

3.2.3.D. Insulin Pumps and Radiology investigations

- Pumps 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 'Restarting Insulin pump' section below)
- If any radiology-based procedure is likely to take longer than 1 hour, the insulin pump should be disconnected pre-procedure before going to radiology and the patient should be managed using a Variable Rate intravenous insulin infusion until they get back to the ward.
- **MRI & CT** - The pump must be suspended and removed prior to scanning and should not be taken into the scanning room. Pump manufacturers also advise removing the pump prior to CT scan.
- Plain x-rays - there is no need to remove the pump, unless its position obscures the area of interest.
- The patient should reconnect the pump immediately following **any** radiological investigation. A correction bolus dose of insulin via the pump may be needed if the patient is hyperglycaemic.

3.2.3.E. Restarting Insulin Pump after using intravenous/ subcutaneous insulin infusion

- **Only** restart when patient is eating and drinking **without** nausea or vomiting
- The subcutaneous insulin pump should not be restarted if there is any concern about the patient's ability to manage it, depending on their clinical situation
- A new pump cannula should be inserted and then the subcutaneous pump infusion should be re-commenced at the usual basal rate (n.b., reduce to 70% if the patient has been receiving s/c long-acting insulin which could still be active). The IV insulin infusion and fluids should be continued for at least 60 minutes before disconnecting or until the next meal insulin bolus has been given through the pump
- Blood glucose should be rechecked 1-2 hours after pump restarted
- Do not recommence pump at bedtime
- Contact Diabetes Team early for advice via eCare referral or on extension 86018.

3.2.3.F. Technical Problems with Insulin Pump

These include error warnings, alarms and pump handset failure

Technical support for the pump can be obtained 24 hours a day via pump companies

Technical support lines will not give clinical advice

If a patient's insulin pump fails, they should be given the following advice:

- To contact the relevant insulin pump company **urgently**. They must inform the company that the pump is not working and organize the delivery of a new pump. The pump will normally be delivered by the pump company directly to the patient within 24 hours.

- 24/7 Technical support for commonly used pumps:
    - Insulet (Omnipod) (tel 0800 0116132 or **https://www.omnipod.com/en-gb/current-podders**
    - Medtronic (tel 01923 205167 or **https://www.medtronic-diabetes.com/en-gb/customer-support/insulin-pumps**
    - Ypsomed (tel 01904 232864 or **https://www.mylife-diabetescare.com/en-GB/services/customer-care-helpline.html**
    - Tandem T-slim (tel 0800 0121560 or **https://www.tandemdiabetes.com/en-gb/home**
- To start back on s/c insulin injections straight away and continue these until they have received their new replacement pump. The patient should have a list of all their pump settings and should be able to tell you their total basal insulin dose for 24 hours. This dose should be given as Glargine, Levemir or Tresiba basal insulin (they should have supplies of these insulins at home).
    - e.g., if total daily insulin dose via pump = 50 units, then give 50% as basal insulin and 50% as rapid acting insulins (e.g. 25 units/3 = 6-8 units) with meals
- To test their blood sugars regularly and if blood sugars are >14mmol/L or start to run >14mmols/l, they should be advised to give a correction dose of NovoRapid/ Apidra or Humalog as a s/c injection. One of these rapid-acting insulins must be injected for all meals and snacks using their documented insulin to carbohydrate ratio.
- **If the patient does not know their equivalent subcutaneous injected insulin dose, then go back to first principles to calculate starting dose - see summary guidance below**
- Worked example:
    - Total daily dose insulin (TDD) = patient weight (kg) x 0.5, e.g,
        - For a 72 kg patient
        - TDD = 72 x 0.5 = 36 units
        - Give 50% TDD as background (basal) insulin = 36 x 0.5 = 18 units
        - Give 50% TDD as mealtime (bolus) insulin = 36 x 0.5 =18 units
        - Divide mealtime insulin into 3 meals = 18/3 = 6 units per meal and adjust as needed depending on pre and post meal BGLs
- They should also test for ketones as per 'sick day rules' guidance and take appropriate rapid acting insulin so as to reduce risk of developing DKA.

Starting basal insulin from insulin pumps (e.g. people who are unable to self-manage their pump)	
Starting basal-bolus insulin regimen	
• This is for people with T1D who are unable to self-manage their insulin pump, but do not have unstable blood sugars, are not in a hyperglycaemic emergency and are not nil by mouth (NBM) • A basal bolus regime is preferable to VRIII • **Nb:** The insulin in an insulin pump is very short acting and therefore alternative insulin must be started immediately (i.e. within 1 hour) to avoid risk of ketoacidosis. • Choice of basal insulin for the hospital admission should ideally include Lantus or Levemir. Ultra-long acting insulins (Degludec or Glargine U-300) may be more challenging when switching back to insulin pump therapy given their longer duration of action	
Calculate Total Daily Dose (TDD)	
Method 1 Pump Total Daily Dose (eg. 7 day average) Information can be obtained by individual or diabetes specialist nurse	**Method 2 Person's weight** Weight: kg x 0.5
Basal and Bolus Insulin Dosing	
Basal Rate (TDD x 0.5)	**Bolus (mealtime) insulin** (TDD x 0.5 / 3)
• Prescribe 50% of the TDD as once daily Lantus (or can be divided in to twice daily Levemir)	• For meal-time insulin (Novorapid/ Humalog/ Fiasp): 50% of TDD/3 plus a safety adjustment (e.g. minus 30%) to minimise risk of hypoglycaemia. • Titrate doses according to response • If the person is able to carbohydrate count, prescribe a variable rapid-acting insulin dose for self-adjustment
Example:	
• E.g. A person's average pump insulin TDD for last 7 days is 48 units/day • 50% of 48 units = 24 units as once daily Lantus insulin (or 12 units as twice daily Levemir insulin) • 50% of 48 units/3 = 8 units of Novorapid with each meal: after safety adjustment = 6 units	

Abbreviations: CSII, continuous subcutaneous insulin infusion; NBM; nil by mouth; TDD, total daily dose; T1D, type 1 diabetes; VRIII, variable rate intravenous insulin infusion.

Adapted from Diabetes Technology Network (DTN) UK Best Practice Guidelines for managing continuous subcutaneous insulin infusion (CSII, or 'insulin pump') therapy hospitalised patients

Figure 6: Adapted from: Joint British Diabetes Societies: Using technology to support diabetes care in hospital (3/24) https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf, (Page 48)

Restarting insulin pump therapy from basal IV/ SC insulin

Insulin pump total daily dose (TDD) calculation

Method 1 Pre-Pump Total Daily Dose	Method 2 Person's weight
Pre-pump TDD x 0.75	Weight: kg x 0.5

Clinical considerations on pump TDD:

- Average values from methods 1 and 2
- Problematic hypoglycaemia: consider lower estimated TDD
- Hyperglycaemic, elevated HbA1c, or pregnant, consider higher estimated TDD

Pump Dose adjustment

Basal Rate (Pump TDD x 0.5)/ 24hrs	Carbohydrate Ratio (I:C) ratio 400/TDD	Insulin Sensitivity Factor (ISF) 130/TDD
• Start with one basal rate, adjust according to glucose values over basal rate testing • Add additional basal according to need (e.g. Dawn phenomenon	• e.g. TDD 35units = 400/35 = 11.4, I:C ratio 1 unit:11g • Most adults require 1 unit:8-15g • Acceptable post prandial rise is ~3mmol/L • Adjust based on low fat meals with known carbohydrate quantity	• Correction insulin dose should bring glucose back to target range in 4-5 hours

Pump restart from basal SC insulin

- Individual inserts new cannula performs a fixed prime and re-starts insulin pump.
- The individual may need to temporarily reduce background insulin infusion rate (e.g. drop to a 70% temporary basal rate for 12-24hrs) while long acting subcutaneous insulin is still active, with increased glucose monitoring required (ideally use CGM).
- No further subcutaneous insulin doses should be required once insulin pump restarted.
- Capillary blood glucose should be checked 1-2 hours after insulin pump re-started

Pump restart from IV insulin

- Individual inserts new cannula performs a fixed prime and re-starts insulin pump (there is no need to wait until a meal)
- Wait 60 minutes before discontinuing IV insulin

Abbreviations: ISF, insulin sensitivity factor; IV, intravenous; SC, subcutaneous; TDD, total daily dose.

Adapted from Evans K. Clin Med (Lond). 2013 Jun;13(3):244-7 and Diabetes Technology Network (DTN) UK Best Practice Guidelines for managing continuous subcutaneous insulin infusion (CSII, or 'insulin pump') therapy hospitalised patients

Figure 7: Adapted from: Joint British Diabetes Societies: Using technology to support diabetes care in hospital (3/24) https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf, (Page 49)

3.3. Using a Hybrid Closed Loop System

HYBRID CLOSED LOOP (HCL) SYSTEM

- This is a system where a continuous glucose monitoring device (CGM) works with an insulin pump to automatically adjust insulin infusion rates, by **automatically** triggering or suspending insulin delivery (e.g. to prevent hypoglycaemia).
- Patients must manually program insulin boluses with meals.
- **Discontinue and use alternative insulin administration (e.g. IV or SC) if the patient cannot self-manage**
- Inform Diabetes team if patient is admitted - *see summary guidance below*
- **Switch pump from automatic to manual mode in unwell patients** and use as a non-closed loop personal insulin pump *(see section on 'Using a personal insulin pump') only and/or CGM only)*
- CGM sensor life is 10-14 days and cannot be re-sited if detached
- Ensure placed clear of planned surgical or procedural sites and follow local perioperative guidance.
- Inform Radiology of tech use

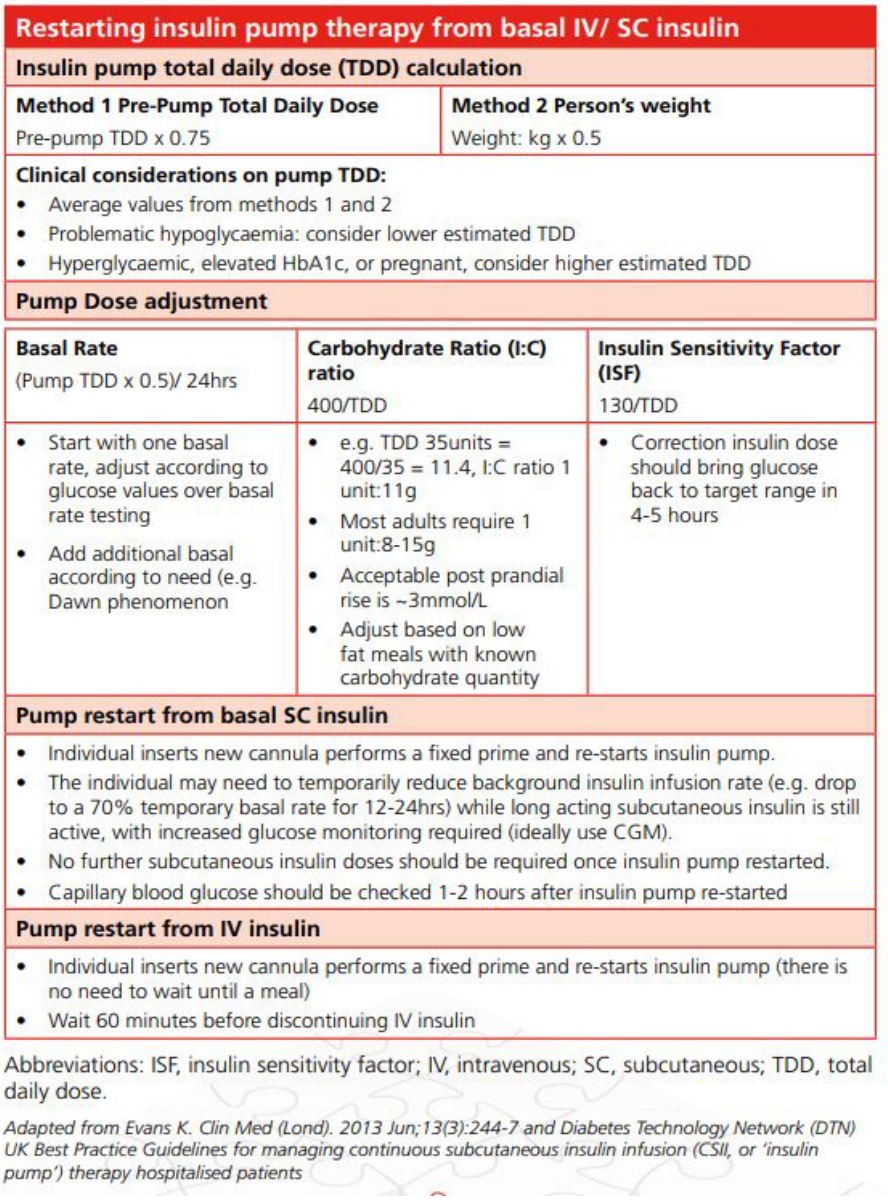
Adapted from: Joint British Diabetes Societies: Using technology to support diabetes care in hospital (3/24) https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf, (Pages 27-28)

Starting basal insulin from insulin pumps (e.g. people who are unable to self-manage their pump)	
Starting basal-bolus insulin regimen	
• This is for people with T1D who are unable to self-manage their insulin pump, but do not have unstable blood sugars, are not in a hyperglycaemic emergency and are not nil by mouth (NBM) • A basal bolus regime is preferable to VRIII • **Nb:** The insulin in an insulin pump is very short acting and therefore alternative insulin must be started immediately (i.e. within 1 hour) to avoid risk of ketoacidosis. • Choice of basal insulin for the hospital admission should ideally include Lantus or Levemir. Ultra-long acting insulins (Degludec or Glargine U-300) may be more challenging when switching back to insulin pump therapy given their longer duration of action	
Calculate Total Daily Dose (TDD)	
Method 1 Pump Total Daily Dose (eg. 7 day average) Information can be obtained by individual or diabetes specialist nurse	**Method 2 Person's weight** Weight: kg x 0.5
Basal and Bolus Insulin Dosing	
Basal Rate (TDD x 0.5)	**Bolus (mealtime) insulin** (TDD x 0.5 / 3)
• Prescribe 50% of the TDD as once daily Lantus (or can be divided in to twice daily Levemir)	• For meal-time insulin (Novorapid/ Humalog/ Fiasp): 50% of TDD/3 plus a safety adjustment (e.g. minus 30%) to minimise risk of hypoglycaemia. • Titrate doses according to response • If the person is able to carbohydrate count, prescribe a variable rapid-acting insulin dose for self-adjustment
Example:	
• E.g. A person's average pump insulin TDD for last 7 days is 48 units/day • 50% of 48 units = 24 units as once daily Lantus insulin (or 12 units as twice daily Levemir insulin) • 50% of 48 units/3 = 8 units of Novorapid with each meal: after safety adjustment = 6 units	

Abbreviations: CSII, continuous subcutaneous insulin infusion; NBM; nil by mouth; TDD, total daily dose; T1D, type 1 diabetes; VRIII, variable rate intravenous insulin infusion.

Adapted from Diabetes Technology Network (DTN) UK Best Practice Guidelines for managing continuous subcutaneous insulin infusion (CSII, or 'insulin pump') therapy hospitalised patients

Figure 8: Adapted from: Joint British Diabetes Societies: Using technology to support diabetes care in hospital (3/24) https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf, (Page 48)



Restarting insulin pump therapy from basal IV/ SC insulin

Insulin pump total daily dose (TDD) calculation

Method 1 Pre-Pump Total Daily Dose	Method 2 Person's weight
Pre-pump TDD x 0.75	Weight: kg x 0.5

Clinical considerations on pump TDD:

- Average values from methods 1 and 2
- Problematic hypoglycaemia: consider lower estimated TDD
- Hyperglycaemic, elevated HbA1c, or pregnant, consider higher estimated TDD

Pump Dose adjustment

Basal Rate (Pump TDD x 0.5)/ 24hrs	Carbohydrate Ratio (I:C) ratio 400/TDD	Insulin Sensitivity Factor (ISF) 130/TDD
• Start with one basal rate, adjust according to glucose values over basal rate testing • Add additional basal according to need (e.g. Dawn phenomenon	• e.g. TDD 35units = 400/35 = 11.4, I:C ratio 1 unit:11g • Most adults require 1 unit:8-15g • Acceptable post prandial rise is ~3mmol/L • Adjust based on low fat meals with known carbohydrate quantity	• Correction insulin dose should bring glucose back to target range in 4-5 hours

Pump restart from basal SC insulin

- Individual inserts new cannula performs a fixed prime and re-starts insulin pump.
- The individual may need to temporarily reduce background insulin infusion rate (e.g. drop to a 70% temporary basal rate for 12-24hrs) while long acting subcutaneous insulin is still active, with increased glucose monitoring required (ideally use CGM).
- No further subcutaneous insulin doses should be required once insulin pump restarted.
- Capillary blood glucose should be checked 1-2 hours after insulin pump re-started

Pump restart from IV insulin

- Individual inserts new cannula performs a fixed prime and re-starts insulin pump (there is no need to wait until a meal)
- Wait 60 minutes before discontinuing IV insulin

Abbreviations: ISF, insulin sensitivity factor; IV, intravenous; SC, subcutaneous; TDD, total daily dose.

Adapted from Evans K. Clin Med (Lond). 2013 Jun;13(3):244-7 and Diabetes Technology Network (DTN) UK Best Practice Guidelines for managing continuous subcutaneous insulin infusion (CSII, or 'insulin pump') therapy hospitalised patients

Figure 9: Adapted from: Joint British Diabetes Societies: Using technology to support diabetes care in hospital (3/24) https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf, (Page 49)

4.0 Statement of evidence/references

Flowcharts / tables adapted from Joint British Diabetes Society for Inpatient Care (JBDS 20 - Revised March 2024). Images sourced online (examples of insulin pumps, sensors).

References:

Avari P, Choudhary P, Lumb A, et al (2024) Using technology to support diabetes care in hospital: Guidelines from the Joint British Diabetes Societies for Inpatient Care (JBDS-IP) group and Diabetes Technology Network (DTN) UK, Diabetic Medicine, e15452 [Online]. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/dme.15452 [Accessed 22 January 2025]

Danne T, Nimri R, Battelino T, et al (2017) International Consensus on Use of Continuous Glucose Monitoring, Diabetes Care;40(12):1631–1640 [Online]. Available from: https://diabetesjournals.org/care/article/40/12/1631/37000/International-Consensus-on-Use-of-Continuous [Accessed 22 January 2025]
Diabetes UK (2022) Ambulance guide to diabetes technology - Diabetes UK and NHS England [Online]. Available from: https://diabetes-resources-production.s3.eu-west-1.amazonaws.com/resources-s3/public/2022-10/ambulance-guide-to-diabetes-technology.pdf [Accessed 22 January 2025]

Diabetes UK (2020) Meds & Kit [Online]. Available from: https://shop.diabetes.org.uk/products/meds-kit [Accessed 22 January 2025]

Diabetes UK (No date) Technology and diabetes [Online]. Available from: https://www.diabetes.org.uk/about-diabetes/looking-after-diabetes/technology (This is helpful for patients so may be worth adding) [Accessed 22 January 2025]

Joint British Diabetes Societies for Inpatient Care (2024) Using technology to support diabetes care in hospital: A guideline from the Joint British Diabetes Societies for Inpatient Care (JBDS-IP) Group and Diabetes Technology Network (DTN) [Online]. Available from: https://www.diabetes.org.uk/sites/default/files/2024-03/JBDS%2020%20Technology%20Guideline.pdf [Accessed 22 January 2025]

Medtronic (2025) Insulin Pump Therapy [Online]. Available from: https://www.medtronic-diabetes.com/en-gb/customer-support/insulin-pumps [Accessed 22 January 2025]

Mylife Diabetescare (2024) Customer care & helpline [Online]. Available from: https://www.mylife-diabetescare.com/en-GB/services/customer-care-helpline.html [Accessed 22 January 2025]

National Institute for Health and Care Excellence (2015, updated 2022) Type 1 diabetes in adults: diagnosis and management, NICE guideline [NG17] [Online]. Available from: https://www.nice.org.uk/guidance/ng17 [Accessed 22 January 2025]

National Institute for Health and Care Excellence (2015, updated 2022) Type 2 diabetes in adults: management, NICE guideline [NG28] [Online]. Available from: https://www.nice.org.uk/guidance/ng28 [Accessed 22 January 2025]

NHS England (No date) Digital innovations in diabetes [Online]. Available from: https://www.england.nhs.uk/diabetes/digital-innovations-to-support-diabetes-outcomes/ [Accessed 22 January 2025]

Omnipod (2025) Current Podders [Online]. Available from: https://www.omnipod.com/en-gb/current-podders [Accessed 22 January 2025]

Tandem Diabetes Care (2025) t:slim X2 Insulin Pump [Online]. Available from: https://www.tandemdiabetes.com/en-gb/home [Accessed 22 January 2025]

External weblinks:
Please note that although Milton Keynes University Hospital NHS Foundation Trust may include links to external websites, the Trust is not responsible for the accuracy or content therein.

5.0 Governance

5.1 Document review history

Version number	Review date	Reviewed by	Changes made
1.1	28/02/2025	Internal Medicine CIG	None

5.2 Consultation History

Include staff in consultation who will be required to ensure the SOP is embedded. This table should be completed in full even if no comments are received

Stakeholders Name/Board	Area of Expertise	Date Sent	Date Received	Comments	Endorsed Yes/No
Dr Asif Ali	Consultant	17/01/2025	17/01/2025	Nicely written and user friendly. I did not realise you cannot take a pump into CT. Nothing further to add.	Yes
Kelly Hodgson	DSN	17/01/2025	21/01/2025	Nothing further to add.	Yes
Anna Babu	SN	20/01/2025	25/01/2025	User friendly. Clarified regarding use of smartpens.	Yes
Katrina Caikina	SN	20/01/2025	04/02/2025	The information was very helpful and informative.	Yes
Dr Lina Alomari	Diabetes/ Endocrine SpR	17/01/2025	22/01/2025	SOP is fine, user-friendly (verbal)	Yes