

Insulin Pump Failure

Kit

Insulin pumps, including AID/APS (Automated Insulin Delivery, Artificial Pancreas systems) offer many benefits, but they are subject to occasional failure. For this reason every pump user needs a “pump failure” kit. As a bare minimum this should include:

- **A copy of all insulin pump settings (photos of pump/PDM settings or screenshots of AID/APS settings, as well as filling out the Notebook below for backup)**
- **rapid insulin pen (such as lispro (brand = Admelog or Humalog), /aspart (brand = Fiasp, Trurapi or NovoRapid), or /glulisine (brand = Apidra) ~~or regular insulin~~)**
- **Blood glucose meter ~~finger-poke glucose testing device~~ with teststrips and a poker**
- **Ketone testing supplies (urine ketostix or blood ketone strips for Libre/Libre2 reader or Precision Neo ketone meter)**
- **sugar/rapid carb source**
- **~~(or glucagon)~~**

Ideally the kit also includes long-acting insulin for 12+ hr emergencies:

- **long-acting insulin pen (glargine, brand = Basaglar or Lantus ~~degludec, detemir or NPH~~)**

Treatment

1. If your **Sugar > 15, Ketones >= 0.7, and/or you are feeling unwell** you need to follow [sick day management](#) closely. In brief, immediately take a correction dose of rapid insulin according to [this calculator](#) (see section 1, be sure to read the explanatory 3 pages below afterwards), & consume lots of salty liquids like vegetable broth. Your ultimate sugar target is <10.
Note: Do not attempt to bolus with a pump/pod. If the pump is defective or the tubing kinked or damaged, you will be unable to determine your insulin on board (IOB) and risk DKA or hypoglycemia.
2. Fix your pump. If you anticipate being off your pump:
 - a. **< 12 hrs:** take rapid insulin every 3 hours using [this online calculator](#) following section 2a (read explanation of formulas below) equal to your basal insulin for those 3 hours plus any rapid insulin needed for correction and meals.
 - b. **> 12 hrs:** take long acting insulin equal to your basal insulin & continue taking rapid insulin for correction and meals using section 2b of [this online calculator](#). If you do not have long acting insulin, you will need to give rapid insulin every 3 hours as described in 2a, even through the night.

Formulas used for calculations

Note: Ideally you have access to your pump settings either on your PDM or App. For looping patients, you can navigate to your Nightscout profiles for your details. Medtronic and Tandem can view Carelink/t:connect/Glooko.

1. ~~Initial Correction Dose for High BG with ketones (see table above) Potential DKA (use only if you are sick, sugar high or you have ketones)~~

Values needed: TDD

Calculation for correction:
$$\frac{81 * (\text{Current Blood Glucose}) * TDD * ((\text{Current Blood Glucose}) - 7)}{69425}$$

2a. Less than 12 hrs before pump working (use this every 3 hours until pump working correctly)

Values needed: TDB, ICR, ISF, Current Glucose, Carbs to be Consumed

$$\text{Calculation every 3 hrs: } \frac{TDB}{8} + \frac{(\text{Current Blood Glucose} - 7 \text{ mmol/L})}{ISF} + \frac{\text{Carbs}}{ICR}$$

2b. Greater than 12 hrs before pump working (use until pump working correctly *Note if long acting insulin is given, set temp basal of 0 u/h once pump is resumed, until 24h after last dose of long acting)

Values needed: TDB, ICR, ISF, Current Glucose, Carbs to be Consumed

Calculation for Long Acting: TDB

$$\text{Calculation for Meals/Corrections: } \frac{(\text{Current Blood Glucose} - 7 \text{ mmol/L})}{ISF} + \frac{\text{Carbs}}{ICR}$$

Glossary

- Insulin Sensitivity Factor OR ~~Insulin~~-Correction Factor (ISF or ~~CF~~/ICR)
 - Units: mmol/L/U
 - Definition: How much 1 unit of rapid insulin lowers one’s blood glucose over say 3 hours
 - Example: A ISF of 3 mmol/L/U means 1 unit of rapid insulin lowers glucose by 3 mmol/L
- Insulin Carbohydrate Ratio (ICR)
 - Units: g/U
 - Definition: The amount of carbohydrates covered by 1 unit of insulin insulin over say 3 hours
 - Example: A ICR of 15 g/U means 15 g of carbs requires 1 unit of rapid insulin
- Total Daily Basal (TDB)
 - Units: U
 - Definition: The total insulin delivered as basal over 24 hours
 - Example: A patient has three basal rates as follows. When calculated, their TDB is 27 U

| Time | Basal Rate per hour | Formula | Units of Insulin |
|---------------|---------------------|-------------------|------------------|
| 00:00 - 06:00 | 1.0 U | (6 - 0) * 1.0 U | 6 U |
| 06:00 - 22:00 | 1.2 U | (22 - 6) * 1.2 U | + 19.2 U |
| 22:00 - 24:00 | 0.9 U | (24 - 22) * 0.9 U | + 1.8 U |
| | | | Total: 27 U |

- Total Daily Dose (TDD)
 - Units: U
 - Definition: The total amount of insulin delivered over 24 hours. This can vary day-to-day based on the patient’s corrections and mealtime insulin
 - Example: A patient has a TDB of 27 U, and has bolused 20 U of rapid insulin: TDD = 27+20 = 47 U

FAQ

1. Where can I retrieve these values?

You can retrieve your ISF, ICR, and TDB values by navigating to your pump or software settings for basal and bolus insulin. They may be named slightly differently based on pump manufacturer. Your TDD may be retrieved on your pump overview or history screens, your online pump portal, or estimated by summing your TDB and the total amount you bolus daily for meals.

2. What if I cannot find my settings (my phone is lost, my PDM is broken, etc.)?

It is for this reason that we strongly recommend all insulin pump users ~~This is a difficult situation. Ideally you~~ have noted down these settings elsewhere, such as in the sheet below. If it is an emergency, and you do not have a copy of your settings, the following formulas can be used for rough estimates:

- TDD = (Patient Weight in kg) * 0.5 U/kg
- TDB = TDD / 2
- ICR = 500 / TDD

- $ISF = 100 / TDD$

Example for a 100 kg patient:

- $TDD = (\text{Patient Weight in kg}) * 0.5 \text{ U/kg} = 100 \text{ kg} * 0.5 \text{ U/kg} = 50 \text{ U}$
- $TDB = TDD / 2 = 50 \text{ U} / 2 = 25 \text{ U}$
- $ICR = 500 / TDD = 500 / 50 \text{ U} = 10 \text{ g/U}$
- $ISF = 100 / TDD = 100 / 50 \text{ U} = 2 \text{ mmol/L/U}$

Please note that these formulas provide estimates that WILL need adjustment. Use your best judgment. When you have the time, you can do a series of [insulin experiments](#) to determine each value.

My Pump Values Notebook

Please Save a Copy for Your Records

[Online Calculator](#)

| | |
|--|----------------|
| Insulin Sensitivity Factor/Insulin Correction Factor (ISF/ICF) | _____ mmol/L/U |
| Insulin Carb Ratio (ICR) | _____ g/U |
| Total Daily Basal (TDB) | _____ U |
| Total Daily Dose (TDD) | _____ U |

1. Correction Dose for Potential DKA

| Type | Formula | Calculation | Units Rapid |
|----------------------|--|--|-------------|
| Correction Dose: | $(81 * (\text{Glucose}) * TDD * ((\text{Glucose} - 7)) / 69425)$ | $(81 * (\text{_____ mmol/L}) * \text{_____ U} * (\text{_____ mmol/L} - 7)) / 69425$ | _____ U |
| Total Rapid Insulin: | | | _____ U |

2a. Less than 12 hrs off pump

| Type | Formula | Calculation | Units Rapid |
|--|---|--|-------------|
| Basal Dose: | $TDB / 8$ | _____ U / 8 | _____ U |
| Correction Dose: | $(\text{Glucose} - 7 \text{ mmol/L}) / ISF$ | $(\text{_____ mmol/L} - 7 \text{ mmol/L}) / \text{_____ mmol/L/U}$ | + _____ U |
| Meal Dose: | Carbs / ICR | _____ g / _____ g/U | + _____ U |
| Total Rapid Insulin (every three hours): | | | _____ U |

2b. Greater than 12 hrs off pump

| Type | Formula | Calculation | Units Long |
|---|---------|-------------|------------|
| Long acting: | TBD | _____ U | _____ U |
| Total Long Acting Insulin (once a day): | | | _____ U |

| Type | Formula | Calculation | Units Rapid |
|---|--|--|----------------------------|
| Correction Dose: | $(\text{Glucose} - 7 \text{ mmol/L}) / \text{ISF}$ | $(____ \text{ mmol/L} - 7 \text{ mmol/L}) / ____ \text{ mmol/L/U}$ | $______ \text{ U}$ |
| Meal Dose: | $\text{Carbs} / \text{ICR}$ | $____ \text{ g} / ____ \text{ g/U}$ | $+ ______ \text{ U}$ |
| Total Rapid Insulin (for every meal and/or correction event): | | | $______ \text{ U}$ |

Example Notebook

| | |
|--|------------|
| Insulin Sensitivity Factor/Insulin Correction Factor (ISF/ICF) | 2 mmol/L/U |
| Insulin Carb Ratio (ICR) | 10 g/U |
| Total Daily Basal (TDB) | 15 U |
| Total Daily Dose (TDD) | 25 U |
| <i>Situation Dependent: Current Blood Glucose</i> | 13 mmol/L |
| <i>Situation Dependent: Carbs Consumed</i> | 10 g |

1. Correction Dose for Potential DKA

| Type | Formula | Calculation | Units Rapid |
|----------------------|---|---|-------------|
| Correction Dose: | $(81 * (\text{Glucose}) * \text{TDD} * ((\text{Glucose}) - 7)) / 69425$ | $(81 * (13 \text{ mmol/L}) * 25 * (13 \text{ mmol/L} - 7)) / 69425$ | 2.3 |
| Total Rapid Insulin: | | | = 2.3 |

2a. Less than 12 hrs off pump

| Type | Formula | Calculation | Units Rapid |
|--|--|---|-------------|
| Basal Dose: | TDB / 8 | 15 U / 8 | 1.9 |
| Correction Dose: | $(\text{Glucose} - 7 \text{ mmol/L}) / \text{ISF}$ | $(13 \text{ mmol/L} - 7 \text{ mmol/L}) / 2 \text{ mmol/L/U}$ | + 3 |
| Meal Dose: | Carbs / ICR | 10 g / 10 g/U | + 1 |
| Total Rapid Insulin (every three hours): | | | = 5.9 |

2b. Greater than 12 hrs off pump

| Type | Formula | Calculation | Units Long |
|---|---------|-------------|------------|
| Long acting: | TBD | 15 U | 15 |
| Total Long Acting Insulin (once a day): | | | = 15 |

| Type | Formula | Calculation | Units Rapid |
|---|--|---|-------------|
| Correction Dose: | $(\text{Glucose} - 7 \text{ mmol/L}) / \text{ISF}$ | $(13 \text{ mmol/L} - 7 \text{ mmol/L}) / 2 \text{ mmol/L/U}$ | 3 |
| Meal Dose: | Carbs / ICR | 10 g / 10 g/U | + 1 |
| Total Rapid Insulin (for every meal and/or correction event): | | | = 4 |