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Patient Care + Research + Clinical Trials

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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:

- **copy of 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 (Admelog or Humalog), aspart (Fiasp, Trurapi or NovoRapid), or glulisine (Apidra)** (less preferred: regular insulin)
- **blood glucose meter with teststrips and a poker**
- **ketone testing supplies inc. ketone strips and meter** (urine ketostix are not recommended)
- **sugar/rapid carb source and glucagon**

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

- **long-acting insulin pen such as glargine (Basaglar or Lantus) degludec (Tresiba), detemir (Levemir)** (less preferred: NPH because it requires bi-daily injection)

Treatment

One of the below is TRUE - - - - - - - - - - - - - - - **Sugar >= 15 mmol/L** **Ketones >= 0.7 mmol/L** **You feel unwell**	**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. You need to follow sick day management closely. 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. Repeat corrections every hour till you meet the blood sugar target and your symptoms subside
ALL the below are TRUE - - - - - - - - - - - - - - - **Sugar < 15 mmol/L** **Ketones < 0.7 mmol/L** **You feel okay**	**Fix your pump. If you anticipate being off your pump for some time, you will switch to MDI as follows:** **< 12 hrs off pump:** 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. **> 12 hrs off pump:** 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.

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Formulas used for calculations

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. See the FAQ below if you do not have access to your settings.

1. Initial Correction Dose for Potential DKA (use only if you are sick, sugar high or you have ketones)

Values needed: TDD

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

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

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

2b. Greater than 12 hrs before pump working (use until pump working correctly)

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

Calculation for Long Acting: TDB

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

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Glossary

- Insulin Sensitivity Factor OR Correction Factor (ISF/CF)
  - 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 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 = (Patient Weight in kg) * 0.5 U/kg = 100 kg * 0.5 U/kg = 50 U
   - TDB = TDD / 2 = 50 U / 2 = 25 U
   - ICR = 500 / TDD = 500 / 50 U = 10 g/U
   - ISF = 100 / TDD = 100 / 50 U = 2 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.

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My Pump Values Notebook

Please Save a Copy for Your Records

Online Calculator

Insulin Sensitivity Factor/Correction Factor (ISF/CF)	_____ 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 * (Glucose) * TDD * ((Glucose) - 7))/69425	(81 * (____ mmol/L) * ____ U * (____ 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:	(Glucose - 7 mmol/L) / ISF	(____ mmol/L - 7 mmol/L) / ____ 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:	(Glucose - 7 mmol/L) / ISF	(____ mmol/L - 7 mmol/L) / ____ mmol/L/U	_____ U
Meal Dose:	Carbs / ICR	____ g / ____ g/U	+ _____ U
Total Rapid Insulin (for every meal and/or correction event):			**_____ U**

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Example Notebook

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

1. Correction Dose for Potential DKA

Type	**Formula**	**Calculation**	**Units Rapid**
Correction Dose:	(81 * (Glucose) * TDD * ((Glucose) - 7))/69425	(81 * (13 mmol/L) * 25 * (13 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:	(Glucose - 7 mmol/L) / ISF	(13 mmol/L - 7 mmol/L) / 2 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:	(Glucose - 7 mmol/L) / ISF	(13 mmol/L - 7 mmol/L) / 2 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

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