ADULT Insulin Pump

Clinical Decision Support Tool

Updated: 8/1/2016; Updated by: Erin Corica

Contents

An insulin pump is an external battery-powered device worn by patients 24 hours a day to deliver a continuous subcutaneous (Sub Q) insulin infusion (CSII). The pump uses rapid or short acting insulin to provide basal and bolus amounts to closely mimic normal physiology.

Patients are ideally trained outpatient on all basic pump functions including programming and basic troubleshooting. Patients are NOT necessarily trained in how much to adjust their pump basal and bolus rates for management of inpatient acute issues or glucose fluctuations.

Criteria for continued inpatient pump (CSII) use

1. Patient must be alert, orientated, have no distracting acute medical injury or illness that would make pump use unsafe (such as significant trauma), not be actively or passively suicidal unless deemed safe after a psychiatric evaluation, and not be critically ill.
2. Patient must demonstrate the ability to self-manage their pump. This includes having the physical dexterity and visual acuity to operate the pump.
3. Patient has a suitable infusion site available.
4. If it is determined the patient is unable to operate and manage their insulin pump, a caregiver of the patient may accept the responsibility. In taking this responsibility the designee must demonstrate knowledge and basic competency of the pump and glucose management and must be available around the clock.
5. The clinical care team, including provider and nursing, deems that the patient is appropriate for continued use of the pump.
6. Patient or designee must be able to maintain adequate pump supplies to maintain an uninterrupted insulin pump therapy.
7. Endocrinology consult must be requested.
8. Patient must change the infusion site, reservoir and tubing at a minimum of every 72 hours or more often as clinically indicated.
9. Patient or caregiver designee must sign the Insulin Pump Patient Agreement form.
10. Patient or designee must agree to have all ordered blood glucose tests done by MMC staff using MMC glucometers and understand that dosing and treatment decisions will be made from those results.

Contraindications to continued inpatient pump (CSII) use

1. Patient's level of consciousness becomes impaired, including suicidality, and no designated caregiver is available.
2. Patient cannot provide the pump supplies (insulin cartridge, tubing, infusion set, inserter, batteries, dressings).
3. Patient has or develops diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic state (HHS), critical illness or any of the other conditions outlined in section 1a above.
4. Patient's pump has a mechanical failure.
5. The clinical team no longer deems the patient safe or appropriate for continued pump use during their hospitalization.

Priority points for Inpatient Pump (CSII) Use

An endocrinology consult must be obtained as rates most likely will need to be altered while in the hospital.

1. Providers must use the Insulin Pump Order set for all patients using their insulin pumps while hospitalized
2. Patients (or designee) are responsible for all programming of the pump
3. Any interruption in insulin delivery (due to infusion set clogs, leaks, loss of insulin potency, or pump malfunction) may result in hyperglycemia within 2-to-4 hours and, subsequently, the rapid onset of diabetic ketoacidosis (DKA) within 4-to-10 hours. Unexplained rising blood sugar may be the first clue that there is an issue.
4. If the insulin pump is removed or disconnected the patient is without any insulin. The insulin pump should not be disconnected or suspended for >2 hours without a POC BG check and either pump resumed or an immediate source of subcutaneous basal, prandial (insulin to carb ratio), and correctional insulin therapy or intravenous insulin ordered pending clinical situation.
5. If the patient does not meet criteria for use of CSII, the provider should be notified and will provide an immediate source of Sub Q basal, prandial, and correctional insulin therapy or intravenous insulin pending clinical situation.
6. Basal insulin should be administered prior to the pump being removed.
7. When discontinuing pump therapy, have the patient remove the insertion set from his/her skin, and remove the reservoir from the pump and discard both. The only way to "shut off" a pump is to remove the battery which is NOT recommended as the patient may lose settings if the batteries are out for too long.

How insulin pumps work

1. Insulin pumps are pre-programmed to supply 24-hour subcutaneous continuous insulin delivery using either a rapid acting insulin [Humalog (insulin lispro), NovoLog (insulin aspart), or Apidra (insulin glulisine)], or rarely short acting Regular U100 insulin.*
2. Insulin is delivered by basal and bolus insulin dosing.
3. Dosing is individualized for each patient's specific needs.
4. Patients must check their BG, calculate carbohydrate, and program bolus doses for food or to correct high blood glucose. **This is NOT done automatically.**
5. Patients should be able to access their basal and bolus menus to obtain their settings upon request.

*Some patients will also utilize Regular U-500 concentrated insulin in their pump. If appropriate to continue U-500 with insulin pump therapy, utilize the U-500 insulin pump order set. See page 5 for more information.

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Basic Pump Functions		
Basal	Amount of insulin required over a 24 hour period to maintain normal metabolic state glucose values when not eating	• Delivered in units/hour • Continuously infuses at preset rates (up to 48) determined by out-patient providers • When NPO, rates generally will not need reduction • Rates most likely determined to cover non-stressed metabolic needs so they may need additional basal when in the hospital
Bolus	Amount of insulin delivered "on demand" for prandial and correctional coverage	• Most of the time the pump is "pre-programmed" with insulin to carb ratio (prandial), sensitivity (correctional insulin) and blood sugar targets all individualized to the patient • There can be different ratios, corrections and/or targets for different times of day • Most of the pumps have a calculator built in that will calculate the dose based on input of carbs expected to eat and/or blood sugar at the time of the bolus • The patient can always override what the pump recommends
Suspend	A feature allowing the patient to suspend all insulin delivery	• Patients should have learned to use this safety feature during their initial pump training • The pump should never be suspended for more than 2 hours
Temporary Basal	A feature allowing the patient to temporarily adjust their basal rates up or down	• Used when temporary adjustments need to be made (i.e.: during illness, activity) • The baseline basal rates will not be affected or lost • Can be set in 30 minute increments for up to 24 hours • Not all patients have been trained to use this feature
Filling Reservoir with insulin and Priming Tubing	Pump reservoirs need to be refilled, and tubing changed minimally every 72 hours	• Reservoirs can hold up to 300 units (exact amount varies from pump to pump) • Patients generally fill the reservoir with a three day supply of insulin • The patient may supply their own insulin vial to fill their reservoirs

U-500

U-500 concentrated regular insulin (500 units/ml) is reserved for patients with high dose insulin requirements with severe insulin resistance. Patients receiving >200 units/day of U100 (100 units/ml) insulin are often converted to U-500 concentrated regular insulin in the outpatient setting.

U-500 (500 units/ml) regular insulin is 5 times more concentrated than standard U100 (100 units/ml) regular insulin. Insulin pumps are made for 100 unit/ml insulin concentration.

0.01 ml of U100 = 1 unit of insulin
But 0.01 ml of U-500 = 5 units of insulin

1 "pump unit" of U-500 insulin = 5 units of insulin

Doses displayed on the insulin pump with U500 will need to be multiplied by 5 to determine "true" insulin doses received.

Example U500 Regular insulin displayed pump basal rates:
12mn 0.8 units/hour (shown on pump) => X 5 = 4 units insulin/hour dosing
0600 1.2 units/hour (shown on pump) => X 5 = 6 units insulin/hour dosing
2100 0.6 units/hour (shown on pump) => X 5 = 3 units insulin/hour dosing
Total basal = 24.6 units X 5 = (123 units insulin for conversion off pump)

Example Boluses U500 Regular insulin as displayed on pump
2 units (shown on pump) bolus of insulin => x5 = 10 units of insulin

Converting Insulin to carbohydrate ratio of U500 insulin
Example: 1 unit per 10 grams (shown on pump) => divide by 5 = 1 unit per 2 grams

When transitioning on or off pump when using U-500, see page 11 for further information.

Insulin Supply

If the patient is unable supply their own insulin, the in-patient pharmacy can provide lispro, regular U100 and U-500 regular insulin. Aspart and glulisine are not on formulary but lispro is considered bioequivalent to the other rapid acting insulins and can be substituted in most cases. Refill supply must be ordered via the "insulin pump refill" order panel.

Blood Glucose Monitoring

1. Point of Care (POC) blood glucose (BG) monitoring should be performed with the approved MMC POC monitoring system. Explain to the patient all insulin and medication adjustment will be made based on MMC POC results or via laboratory results prn.
    a) The patient may have a home glucose meter that is "linked" to their pump (using radio frequency it will send the blood sugar result from that meter to the pump to be used in calculations and tracking).
    b) A patient may use their home meter in conjunction with the MMC meter but home meter should not be used for treatment decisions.
    c) Results of the 2 meters should not be compared, they are different systems and patients will need to be reminded insulin should be consistently dosed off MMC meter.
    d) Patients can input BG levels manually in the pump when the result is obtained from the MMC approved meter.
2. NPO, parenteral nutrition (TPN) or continuous enteral tube feeding (ETF) patient: Q6H
    a) Appropriateness of maintaining insulin pump therapy with TPN and ETF should be re-evaluated.
3. POC BG testing should be performed prior to disconnecting a patient's pump for a procedure or surgery, and every two hours if pump disconnected or stopped to ensure safe BG control.

Documentation

1. Using Pump order set, providers document appropriateness of patient to remain on and continue insulin pump therapy as well as document basal rates and bolus settings.
2. Nursing to add Insulin pump LDA to the EMR for documentation of:
    a. Appropriateness to remain on pump at admission and with each shift
    b. Pump/infusion insertion site assessment at admission and with each shift
    c. Observation of reservoir and infusion set change minimally every 72 hours
    d. Assessment of infusion set (tubing) and site with any blood sugar level >300 mg/dl
3. Nursing may provide patients with the Insulin Pump Self-Management Bedside Worksheet and request documentation of BG tests, grams of carbohydrate consumed, any bolus doses and any basal rate changes.
4. All self-administered bolus doses should be entered by nursing into the EMR MAR every shift.
5. The patient's basal rates will be entered into the EMR MAR by nursing every shift.

Pump Troubleshooting

Hyperglycemia

Severe hyperglycemia or DKA can occur if insulin delivery, basal or bolus delivery is obstructed or stopped for more than 2-3 hours. Pump infusion sites can become kinked, dislodged, the adhesive can become loose. Connections to the insertion site or to the pump itself can leak or become disconnected. Occasionally the pump may alarm if there is an issue. Often there is no specific alarm.

Assessment for hyperglycemia:

1. Assist the patient to check pump infusion site and pump function with BG >300mg/dL.
2. Check pump and tubing connections, infusion site for leaks or dislodgement, and insulin cartridge for insulin. Make sure the pump is connected and infusing insulin.
3. Ask the patient if the pump has given any no deliver or other alarms. If so evaluate what the alarm says (all pumps have an alarm history that can be accessed by the patient).

Action for hyperglycemia:

Problem	Fix
Site redness, tenderness, swelling	Change site
Leakage, breakage, or kinked pump tubing –	Change set
Battery failure	Change battery
Empty reservoir or cartridge	Fill and change cartridge
Air in tubing	Disconnect: re-prime/change set
Omitted bolus (observe doses to avoid this)	Check history; discuss problem with patient
Needle not under skin	Change set and site
Blood Sugar >300 mg/dl twice in six hour period (may have a kink in the catheter that is not visualized)	• If none of the above present, contact provider for one time injection of rapid acting insulin (MMC correctional scale guidelines may be used to calculate correctional dose) • Change set and site • Retest blood sugar in 2 hours
Pump problem cannot be corrected, and/or blood sugar remains > 300 mg/dl in spite of all of the above actions	Remove pump. Order another means of delivering insulin: • Basal, prandial (insulin to carb ratio) and correctional insulin • IV insulin infusion

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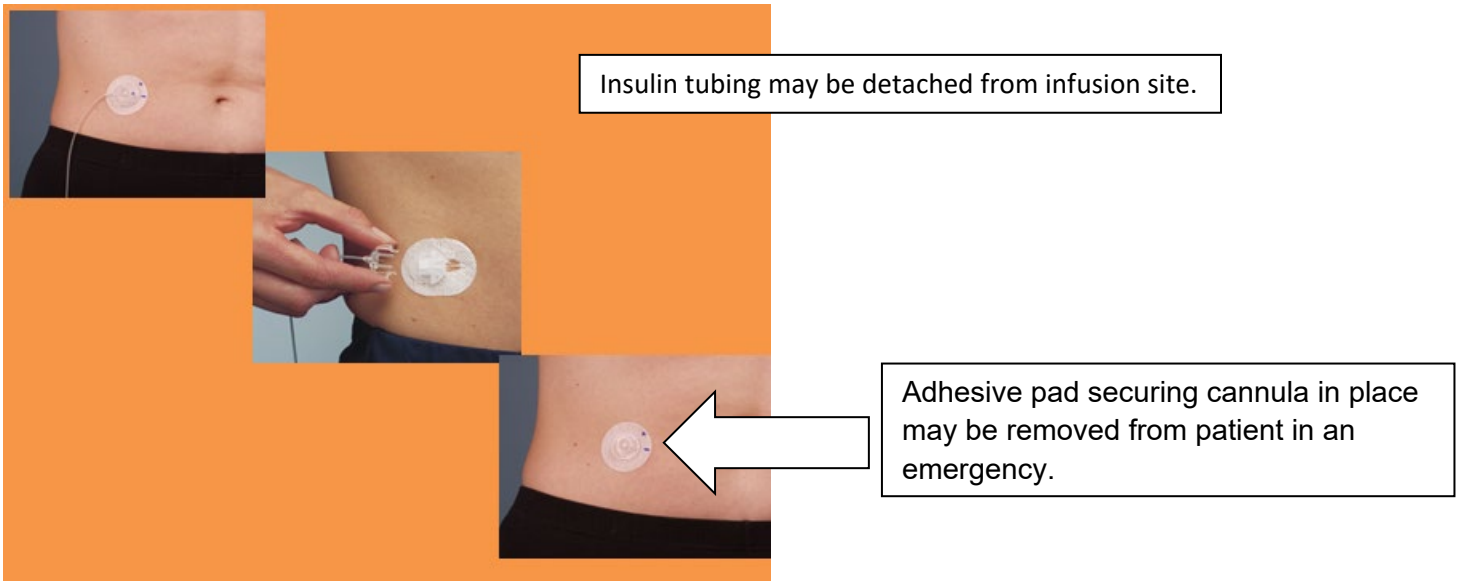
Hypoglycemia

The major risk of insulin therapy is hypoglycemia whether injections or pumps are used. Appropriate dosing and timing of insulin in relation to food intake should minimize this risk.

Action for hypoglycemia:

Blood Sugar Value	Action
If capillary POC BG is between 50-70 mg/dl	Treat the low BG using standard MMC Hypoglycemia protocol
If Capillary POC BG is < 50 mg/dl	• **Direct patient to suspend pump or disconnect pump at the infusion site*** (if patient unable nursing to disconnect pump at infusion site or remove infusion site) • Treat the low BG using standard pre-checked MMC Hypoglycemia guidelines
Once hypoglycemia is resolved (above 70 mg/dl)	• Resume pump if it was suspended or disconnected • Consider reasons for hypoglycemia (if can be determined) • Notify provider for any pump setting adjustments that may be necessary

*** Never SUSPEND or disconnect the pump for over 1-2 hours without BG check or alternative source of insulin.**



External Radiation or Diagnostic Fluoroscopy Imaging Procedures:

1. Patient must temporarily disconnect the insulin pump/pod prior to MRI, X-ray, CT, or for any type of radiological procedure.
2. Exposure to external radiation or magnetic fields may damage insulin pumps and may cause them to malfunction. Therefore, all insulin pump manufactures state to remove the insulin pump/pod prior to procedures where the pump may be exposed to external radiation or MRI.
3. Some examples of tests or procedures where the pump may be exposed include: general x-ray, MRI, PET, CT scans, catherization, angioplasty/stents, mammography, ultra sound, Ba swallow/enemas, UGI, cystogram. Staff or patients may check for specifics on each individual pump website (end of this document) if more information is desired.

Procedure to follow:

1. Have the patient temporarily suspend the pump's operation and disconnect the pump at the insertion site.
2. Ideally, the insulin pump should be temporarily disconnected and removed just outside the procedure room. It is best to have the patient wear the pump for as long as possible.
3. A patient **must NOT be disconnected for more than 2 hours** without a POC BG check and a form of Sub Q insulin delivered. A Sub Q correctional scale can be ordered to cover for procedures.
4. After the procedure the patient should immediately re-connect to the pump and resume insulin delivery.
5. Special considerations**:**
    a) **Stainless steel needle:** if the patient has this type of infusion set, it must be completely removed for MRI
    b) **OMNI Pod Insulin pump:** the patient will need to totally remove the pod from their body and replace with a new pod.

Should direct radiation exposure occur to the pump, the patient should be alerted and should disconnect self from the insulin pump and perform a self-test immediately. The patient should be directed to call the specific pump manufacturer to alert them of the exposure. A provider should be notified and an alternative source of insulin delivery ordered if warranted.

Procedures requiring Sedation

Decision to continue or remove pump should take into consideration the patient's expected degree of cognitive impairment post procedurally. A patient must be alert and oriented and able to independently operate the pump.

Surgeries

General surgery:

1. Insulin pump should be removed and insulin infusion started ideally 2-4 hours prior to transport.
2. The primary team should order the insulin infusion.
3. Once patient is able to meet criteria as listed on page 1 or the designee is available and with the patient, the patient's primary team will need to transition patient back to pump use.
4. Exceptions may be made for C-sections at discretion of the Ob-Gyn surgeon.

General information:

Types of pumps

Below are the brands most likely seen at MMC. All pumps have a 1-800 number listed on the back of the pump for technical assistance (or Omnipod PDM).

- Medtronic/Minimed: http://www.medtronicdiabetes.com/home
- Animas: http://www.animas.com/
- Tandem/T Slim: http://www.tandemdiabetes.com/
- Omnipod: https://www.myomnipod.com/

Components of most pumps:

1. The pump itself, a computer that is programmed to deliver insulin. Pumps are about the size of a cell phone. They can be connected to the patient via infusion tubing and infusion set; or can be directly attached to the skin. The pumps are controlled either on the unit itself (detached versions) or a separate PDM (for those whose pump attaches directly to the skin).
2. A reservoir or cartridge which holds the insulin.
    a. The patient fills the reservoir with insulin as part of the set up process.
    b. Depending on the pump, they can hold up to 300 units.
    c. The patients may use a syringe to fill them, or a filling device supplied with their reservoirs.
3. Infusion sets. Components of the infusion set are:
    a. Tubing that connects the reservoir to the Cannula
        i. The patient can disconnect at the infusion set for short periods of time such as showering.
        ii. There are many different types and lengths to choose from
        iii. Not all pumps have tubing (see Omnipod below)
    b. Cannula: The small part that is inserted into the subcutaneous skin for insulin to infuse through.
        i. Most are plastic but a few are stainless steel.
4. The Omnipod pump is currently the only pump that is "tubeless". The pump itself is attached to the patient (called a pod). The reservoir and insertion cannula are also housed in the pod. The patient carries a separate PDM to control the pump.

5. Sensors: Some pumps have continuous blood glucose sensors that communicate directly with the insulin pump.

a. There is a sensor that is inserted under the skin (similar to an IV) that reads the blood sugar in the interstitial fluid.
b. The sensor transmits results to the pump or to a separate monitoring device
c. There is a continuous feed of blood glucose information to the pump for the patient's review.
d. Sensors are not always 100% accurate so the patient needs to calibrate them on a regular basis, and any insulin dosing decision needs to be done with a finger stick confirmation.
e. All per our policy, all decisions about blood sugar management will be done using our MMC POC meters

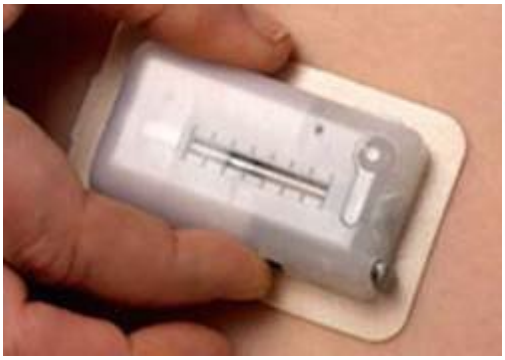
V-Go insulin delivery device

These are mechanical insulin delivery devices, not true programmable electronic pumps. The criteria for patient to continue to use inpatient should be handled similarly to pumps.

The device needs to be filled with insulin by patient. Aspart and lispro are the recommended insulins but U-500 is sometimes being used. This has the same concerns as any other device with U500. The device is only calibrated to recognize U-100 concentrations. The U-500 pump order set should be used for these cases.

Device is replaced every 24 hours. Devices are available in 3 basal doses (see table below)
To fill in the basal rate for the order set, use the corresponding rate from table below ie. Patient says basal rate is 20 units = 20 units/24 hours = 0.83 units/hr.

Patients are able to deliver 2 unit bolus doses up to 18 times a day.
See link if you want more information. http://www.go-vgo.com/hcp



V-Go option	Preset basal rate	+	On-demand bolus dosing	=	Total available insulin
VGO® 20 DISPOSABLE INSULIN DELIVERY	20 Units/24 hr (0.83 U/hr)	+	Up to 36 Units in 2-Unit increments*	=	56 Units
VGO® 30 DISPOSABLE INSULIN DELIVERY	30 Units/24 hr (1.25 U/hr)	+	Up to 36 Units in 2-Unit increments*	=	66 Units
VGO® 40 DISPOSABLE INSULIN DELIVERY	40 Units/24 hr (1.67 U/hr)	+	Up to 36 Units in 2-Unit increments*	=	76 Units

Discontinuing & Transitioning off the Insulin Pump:

If a patient does not wish to continue pump therapy or does not meet criteria to remain on CSII the patient must have basal subcutaneous or intravenous insulin therapy ordered prior to pump removal**.** Most patients should also have prandial and correctional insulin. **Patients in DKA should utilize the DKA order set.**
The following guidelines may be used.

Changing to:	**Order Options:** **If pump using U100 insulin**	**Order options:** **If pump using U-500** **Consult Endocrinology regarding insulin dosing.** **An insulin infusion may be simplest option.**
Subcutaneous insulin: Basal (cont. next page)	1. Review pump basal rate settings Order glargine (Lantus) or detemir (Levemir) insulins to replace basal insulin delivery to replace 24 basal total. Closely evaluate BG over next 24 hours. Patients may need a 10-20% dose increase when transitioning to glargine or detemir. Basal rates below from pump: 2400 0.3 units/hour 0500 0.6 units/hour 1200 0.4 units/hour 2000 0.3 units/hour 24 hour total pump basal insulin = 10.1 units Answer: 10 units basal daily OR	1. Transition total daily basal dose to glargine with or without mealtime boluses. Basal rates below from pump with U-500 2400 0.3 units/hour 0500 0.6 units/hour 1200 0.4 units/hour 2000 0.3 units/hour 24 hour total pump basal insulin = 10.1 units units shown on pump x 5 = 50.5 units Answer: 50 units basal daily
Changing to:	**Order Options:** **If pump using U100 insulin**	**Order options:** **If pump using U-500**
Subcutaneous insulin: Basal	**2.** If basal rates are not available, Order Sub Q basal per standard MMC weight based insulin guidelines <u>Remember</u> • Basal insulin should be administered 2 hours prior to removal of pump Basal insulin should be ordered daily.	2. Transition to U-500 injections 3 times a day **Not appropriate for patient who are NPO**
Prandial and Correctional	1. Review pump prandial (insulin to carb ratio) and correctional (sensitivity) settings	Insulin to carb ratio on pump: 1 unit: 10 grams carb Divide by 5 to convert to U100 Answer 1 unit:2 grams carb

	a. Order lispro (Humalog) using home insulin to carb ratios and correctional(sensitivity) factor. OR 2. Order prandial and correctional per standard MMC insulin guidelines	Correctional on pump: 1 unit: 50 points above target Answer 1 units: every 10 points
IV insulin Non DKA	1. Review Pump basal rate settings Divide the 24 hour total basal by 24 to obtain starting units per hour Basal rates below from pump: 2400 0.3 units/hour 0500 0.6 units/hour 1200 0.4 units/hour 2000 0.3 units/hour 24 hour total pump basal insulin = 10.1 units Answer: 10 units pump basal / 24 hours = Initiate insulin infusion at 0.4 units/hour, then remove insulin pump. OR 2. Initiate standard insulin infusion according to standard insulin infusion order set and protocol using the IIP Calculator.	1. Transition to insulin infusion (at 80% of pump basal rates) with or without meal time boluses Basal rates below from pump with U-500 2400 0.3 units/hour 0500 0.6 units/hour 1200 0.4 units/hour 2000 0.3 units/hour 24 hour total pump basal insulin = 10.1 units units on pump x 5 x 0.8 = 40.4 units Answer: 40 units/24 hours = 1.7 units/hr

Transitioning back onto pump

Pump temporarily suspended/removed (i.e. surgery, procedure)	Restart home pump dosing when patient appropriate to resume pump therapy
Pump due to clinical condition (i.e. critically ill, DKA, altered mental status)	Consult with endocrinology when patient appropriate to resume pump therapy

References:

1. American Association of Clinical Endocrinologists (AACE) Consensus Panel on Insulin Pump Management, (2010), AACE Consensus Statement, Endocrine Practice, 16 (5).

2. Cook et al, (2005), Use of Continuous Subcutaneous Insulin Infusion (Insulin Pump) Therapy in the Hospital Setting: Proposed Guidelines and Outcome Measures, The Diabetes Educator, 31 (6), 849-857.

3. ECRI Institute, (2007), Patient-Supplied Equipment, Health Devices, 3.