**Purpose**

To provide physicians and nurses at CCAD with a protocol for using intravenous insulin infusion to treat adult critically ill patients with hyperglycemia after cardiac surgery. **For non-cardiac surgery patients, use Insulin Infusion Protocol for Glycemic Control.** **For patients with diabetic ketoacidosis or hyperglycemic hyperosmolar state, use Insulin Diabetic Ketoacidosis or Hyperglycemic Hyperosmolar State Protocol, respectively.**

**Protocol**

1. Ordering
   1. This protocol will be initiated by a provider order.
   2. Subsequent orders specified by the protocol will be entered by a nurse as ‘per protocol’.
   3. Subsequent orders not specified in the protocol will require a provider order.
2. Insulin protocol
   1. Initiate intravenous regular insulin infusion if blood glucose is greater than 8.5 mmol/L (153 mg/dL)
      1. Check blood glucose within 30 minutes post ICU admission
   2. Goal blood glucose is 6.5-8.5 mmol/L (117-153 mg/dL).
      1. Blood glucose should never exceed 10 mmol/L (180 mg/dL), especially during the first 12-25 hrs after ICU admission
   3. Patients on insulin infusion should avoid carbohydrate containing food.
      1. Patients with a blood glucose < 8.5 mmol/L (153 mg/dL) or on a very low dose insulin infusion may be given a meal if they request one.
   4. If enteral or parenteral nutrition is stopped, decrease insulin infusion by 50% and monitor blood glucose every 1 hour until blood glucose is > 4.4 mmol/L (> 80 mg/dL) for 3 consecutive levels, then check blood glucose every 2 hours.
   5. Monitor patient's blood glucose every 2 hours.
      1. Increase monitoring to every 1 hour if blood glucose >9 mmol/L (162 mmol/L)
      2. Sampling site and lab analysis should remain consistent. Arterial sampling is the preferred method for the first 25 hours after ICU admission.
   6. Calculate the initial bolus using the patient's weight, 0.05 units/kg, to a maximum of 5 units. Do not bolus if glucose < 8.5 mmol/L.
   7. Calculate initial infusion rate using the patient’s weight, 0.05 unit/kg/hour, to a maximum of 5 units/hour.
   8. Adjust the infusion rate based on the previous blood glucose, current blood glucose and current infusion rate per adjustment table.
   9. If blood glucose <3.8mmol/L (<70 mg/dL)
      1. Stop the insulin infusion
      2. Give 50 mL of 50% Dextrose or 120 mL juice orally or via PEG/NG tube
      3. Notify provider
      4. Obtain blood glucose every 15 minutes until blood glucose >3.8mmol/L (>70 mg/dL) for three consecutive measurements and then check blood glucose every 2 hours.
   10. If blood glucose decreases ≥ 1.6 mmol/L (≥ 30 mg/dL) and blood glucose is 3.8-4.3 mmol/L (70-79 mg/dL)
       1. Stop the insulin infusion
       2. Give 25 mL of 50% Dextrose or 120 mL juice orally or via PEG/NG tube
       3. Notify provider
       4. Obtain blood glucose every 30 minutes until blood glucose >4.4 mmol/L (>80 mg/dL) for three consecutive measurements and then check blood glucose every 2 hours.
       5. If blood glucose increases to > 7.5 mmol/L (>135 mg/dL) restart insulin infusion at half the previous rate without a bolus, and recheck blood glucose every 2 hours.
   11. Notify provider if insulin infusion is >15 units/h or if blood glucose is > 9 mmol/L (162 mg/dL)
       1. If the patient is on epinephrine, call provider to consider weaning epinephrine and changing to dobutamine. Expect a rapid decrease in blood glucose.
       2. If the combination of all D5W based solutions exceed 50 mL/h, call provider to consider changing base solutions to 0.9% sodium chloride so that D5W based solutions do not exceed 50 mL/h.
       3. Treat hyperkalemia with caution. Contact provider with current blood glucose value. Order to treat should use minimum safe amount of 50% Dextrose
   12. If insulin infusion is ≤ 1 units/h, contact provider for alternative insulin therapy and blood glucose monitoring orders.
   13. Criteria for transition to subcutaneous insulin:
       1. Insulin infusion has been off and blood glucose < 7.5 mmol/L (135 mg/dL) for > 6 consecutive hours
       2. Insulin infusion rate ≤ 2 units/h and blood glucose has remained < 7.5 mmol/L for > 6 consecutive hours
   14. Transition to subcutaneous insulin:
       1. Give short-acting insulin (regular insulin, insulin lispro) 60 minutes PRIOR to stopping the insulin infusion
       2. Give long-acting insulin (insulin glargine) 90 minutes PRIOR to stopping the insulin infusion.
       3. Most patients will require long-acting insulin in addition to supplemental short-acting insulin. Please contact provider for orders.
   15. After stopping the insulin infusion, monitor blood glucose every 1 hour times 2.
       1. If blood glucose is < 7.5 mmol/L (<135 mg/dL), monitor blood glucose as ordered by prescriber.
       2. If insulin infusion has been stopped ≤ 24 hours, restart insulin infusion when the first blood glucose value is ≥ 7.5 mmol/L (≥ 135 mg/dL). Do not bolus. Restart insulin infusion at half the previous rate. Check blood glucose every 2 hours.
3. Adjustment table

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| --- | --- | --- | --- |
| **Blood Glucose** | **If blood glucose decreases ≥1.1 mmol/L (≥20 mg/dL) since previous level** | **If blood glucose is stable since previous level change <1.1 mmol/L (< 20 mg/dL)** | **If blood glucose increases ≥1.1 mmol/L (≥20 mg/dL) since previous level** |
| <3.8 mmol/L (≤70 mg/dL) | Stop insulin infusion and start hypoglycemic protocol. Notify provider. | Stop insulin infusion and start hypoglycemic protocol. Notify provider. | Stop insulin infusion and start hypoglycemic protocol. Notify provider. |
| 3.8-4.3 mmol/L (70-79 mg/dL) | Stop insulin infusion. Give 25 mL of 50% Dextrose or 120 mL juice orally or via PEG/NG tube  Obtain blood glucose every 30 minutes until blood glucose >4.4 mmol/L for 3 consecutive measurements and then check blood glucose every 2 hours. Notify provider. | Hold insulin infusion and recheck glucose every 2 hours. If glucose ≥ 7.5 mmol/L, restart insulin infusion at half the previous rate without a bolus. | Hold insulin infusion and recheck glucose every 2 hours. If glucose ≥ 7.5 mmol/L, restart insulin infusion at half the previous rate without a bolus. |
| 4.4-5.4 mmol/L (80-98 mg/dL) | Hold insulin infusion and recheck glucose every 2 hours. If glucose ≥ 7.5 mmol/L, restart insulin infusion at half the previous rate without a bolus. | Hold insulin infusion and recheck glucose every 2 hours. If glucose ≥ 7.5 mmol/L, restart insulin infusion at half the previous rate without a bolus. | Hold insulin infusion and recheck glucose every 2 hours. If glucose ≥ 7.5 mmol/L, restart insulin infusion at half the previous rate without a bolus. |
| 5.5-6.4 mmol/L (99-116 mg/dL) | Hold insulin infusion and recheck glucose every 2 hours. If glucose ≥ 7.5 mmol/L, restart insulin infusion at half the previous rate without a bolus. | Decrease rate by 75% | Continue current rate |
| 6.5-8.5 mmol/L (117-153 mg/dL) | Decrease rate by 50% | Continue current rate | Increase rate by 50% |
| 8.6-9.0 mmol/L (154-162 mg/dL) | Decrease rate by 25% | Increase rate by 25%  (if glucose decreasing: no bolus  if glucose increasing: bolus 2 units) | Bolus 2 units and increase rate by 50% |
| 9.1-10 mmol/L (163-180 mg/dL) | Continue current rate and check glucose every 1 hour. | Increase rate by 25% and check glucose every 1 hour.  (if glucose decreasing: bolus 2 units  if glucose increasing: bolus 3 units) | Bolus 3 units and increase rate by 50%. Check glucose every 1 hour. |
| 10.1-11.0 mmol/L (181-199 mg/dL) | Continue current rate and check glucose every 1 hour. | Increase rate by 50% and check glucose every 1 hour.  (if glucose decreasing: bolus 3 units  if glucose increasing: bolus 4 units) | Bolus 4 units and increase rate by 75%. Check glucose every 1 hour. |
| 11.1-13 mmol/L (200-234 mg/dL) | Continue current rate and check glucose every 1 hour. | Increase rate by 50% and check glucose every 1 hour.  (if glucose decreasing: bolus 4 units  if glucose increasing: bolus 6 units) | Bolus 5 units and double the rate. Check glucose every 1 hour. |
| Blood glucose | **If blood glucose decreases ≥2.2 mmol/L (≥40 mg/dL) since previous level** | **If blood glucose is stable since previous level change <2.2 mmol/L (< 40 mg/dL)** | **If blood glucose increases ≥2.2 mmol/L (≥40 mg/dL) since previous level** |
| 13.1-15 mmol/L (235-270mg/dL) | Continue current rate and check glucose every 1 hour. | Increase rate by 50% and check glucose every 1 hour.  (if glucose decreasing: bolus 3 units  if glucose increasing: bolus 6 units) | Bolus 6 units and double the rate. Check glucose every 1 hour. |
| 15.1-17 mmol/L (271-306mg/dL) | Bolus 2 units and increase rate by 25%. Check glucose every 1 hour. | Double the rate and check glucose every 1 hour.  (if glucose decreasing: bolus 3 units  if glucose increasing: bolus 6 units) | Bolus 6 units and double the rate. Check glucose every 1 hour. |
| 17.1-19 mmol/L (307-342mg/dL) | Bolus 4 units and increase rate by 50%. Check glucose every 1 hour. | Double the rate and check glucose every 1 hour.  (if glucose decreasing: bolus 3 units  if glucose increasing: bolus 6 units) | Bolus 6 units and double the rate. Check glucose every 1 hour. |
| >19 mmol/L (>342 mg/dL) | Notify provider | Notify provider | Notify provider |

**Oversight and Responsibility**

1. Respiratory & Critical Care Institute
2. Department of Pharmacy
3. Department of Endocrinology, Diabetes, and Metabolism
4. Quality & Patient Safety Institute

**Definitions**

1. None

**References**

1. Cleveland Clinic Intensive Care Unit Insulin Protocol

**Institute / Department / Committee Involved in Procedure Development / Revision**

1. Respiratory & Critical Care Institute
2. Department of Pharmacy
3. Quality & Patient Safety Institute

**Contact for Questions / Clarifications**

1. Janise Phillips, PharmD
2. Jeffrey Chapman, MD
3. Maurice Hogan, MD

**Related or Supporting Documents**

1. None