

**University of Virginia Medical Center
GUIDELINE FOR INSULIN INFUSION IN ADULT ACUTE CARE ¹**

A. PURPOSE

This guideline contains recommendations for the medical and nursing management of hyperglycemia by insulin infusion in adult patients on acute care units at the University of Virginia Medical Center.¹ Key elements of the guideline are replicated in MIS physician orders as a protocol that allows the Registered Nurse to titrate insulin infusions and treat hypoglycemia (refer to Appendix A). A physician's order must be present before the nurse may manage an insulin infusion using the recommendations contained in this guideline.

The goals of the guideline are to:

1. Decrease the prevalence of hyperglycemia
2. Decrease the complications associated with hyperglycemia
3. Achieve and maintain steady-state glucose control within target glucose range
4. Prevent hypoglycemic episodes

This guideline is NOT intended for treatment of diabetic ketoacidosis (DKA) or hyperosmolar hyperglycemic state (HHS). It is strongly recommended that every attempt be made to admit adult patients requiring insulin infusion for the management of DKA to one of the following units: adult critical care units, 3 WEST, 3 CENTRAL, 4 EAST, 4 CENTRAL, 5 WEST, 5 CENTRAL, and the Emergency Department. In these patients the nurse will report hourly bedside glucose results to the physician for insulin rate change orders. Refer to Appendix B for DKA/HHS management guidelines.

Continuous intravenous infusion of insulin is appropriate in specific circumstances. Not all patients will require insulin infusion for hyperglycemic control. Patient selection criteria for the use of insulin infusion include:

1. Failure of current insulin regimen to achieve stable glucose control (e.g., blood glucose > 300 mg/dl for more than four hours uncontrolled by subcutaneous sliding scale insulin)
2. High dose glucocorticoid therapy resulting in hyperglycemia
3. Poor diabetes control with dehydration and/or volume depletion
4. Severe generalized edema leading to poor absorption of subcutaneous insulin
5. Erratic oral intake leading to poor glucose control

The Diabetes Consult Team is available to offer management recommendations for patients with persistent glucose control problems (e.g., those in whom it is difficult to achieve or maintain target glucose while on insulin infusion or those who do not meet insulin infusion selection criteria).

B. DEFINITIONS

1. **Target glucose range in the acute care setting is 125 to 175 mg/dl.**
2. A standard insulin infusion concentration of 250 units Regular Insulin in 250 mL 0.9% NaCl (1 unit : 1 ml concentration) is to be used consistently in all adult acute care and critical care units. Only pharmacy-prepared insulin infusions are to be used.
3. Hypoglycemia is defined as blood glucose less than 80 mg/dl.
4. UVA Medical Center-approved symbols used in this document include:

↑ increase	↓ decrease
> greater than	< less than
≥ greater than or equal to	≤ less than or equal to

¹ Refer to Appendix D for a list of units approved for use of insulin infusion.


C. ASSESSMENT

1. Physician Assessment
 - a. Determine if patient meets selection criteria.
 - b. Obtain patient's current weight.
 - c. In patients with a history of diabetes, ascertain patient's current management regimen – e.g., diet controlled, oral diabetes agents, insulin type and total daily dosage.
 - d. Consider patient's diagnosis. Is patient under severe stress – e.g., sepsis, stroke? Is patient receiving high-dose steroids? Is patient insulin resistant – i.e., use of more than 75 units of insulin per day?
 - e. Evaluation of the continued need for insulin infusion (a minimum of every eight hours) should include trend of glucose levels – is glucose target range achieved and maintained? Were there hypoglycemic events? Was hyperglycemia (> 250 mg/dl) experienced for longer than three hours before controlled? How did medication timing (e.g. steroid doses) and diet (e.g. tube feeding interruptions) affect glucose control? Adequate hydration, avoidance of hypoglycemia, and measures to deal with underlying stress and infection are key to minimizing unstable glucose patterns.
2. Nursing Assessment
 - a. Obtain initial blood glucose (BG) level by bedside meter immediately before starting infusion.
 - b. **Test BG by bedside meter every hour. During hypoglycemic episodes, test blood glucose 15 minutes after hypoglycemia treatment, and then every 15 minutes until glucose greater than 100 mg/dl.**
 - c. Check blood glucose if signs & symptoms of hypoglycemia occur: e.g. diaphoresis, trembling, tachycardia, confusion, lethargy, decreased mental status, mood change or irritability, headache.

D. INITIATION OF INSULIN INFUSION THERAPY

1. Physician (refer to Appendix C)
 - a. Begin orders on MIS Insulin Index screen.
 - b. Click on Acute Care Insulin Infusion and progress through order screens.
 - c. **Discontinue previous insulin orders.** Note: All insulin should be discontinued initially. Subcutaneous insulin can be added after steady-state glucose control is achieved using conversion guidelines (refer to Section K).
 - d. **Discontinue oral diabetes agents.**
 - e. **Order maintenance IV fluids. Fluids should contain dextrose and be delivered via a dedicated IV line.**
 - f. **Order Insulin Infusion titrated per Acute Care Insulin Protocol. Order starting rate for insulin infusion:**
 - (1) Begin infusion at 0.5 unit per hour for all patients under 70 kg and for patients 70 kg or over who were previously diet controlled, taking oral diabetes agents, or taking ≤ 30 units insulin per day.
 - (2) Begin infusion at 1 unit per hour for patients 70 kg or over and for patients under 70 kg who were previously taking > 30 units insulin per day.
 - (3) Consider initial dosing at 3 to 5 units per hour for patients with: severe stress (e.g., sepsis, stroke), insulin resistance (e.g., use of more than 75 units per day), or high dose steroid use.
 - g. **Order Hypoglycemia Treatment Protocol.**
 - h. Note: **Transfer of the patient between an acute care unit and an intensive care unit requires discontinuation of the current insulin infusion protocol and reordering of an appropriate insulin infusion protocol if still indicated** (e.g., transfer of patient on ICU Insulin Infusion Protocol from MICU to 3 West requires new order for Acute Care Insulin Infusion Protocol and order to discontinue ICU Protocol).

2. Nurse

- a. Ensure that the MIS order includes a starting rate and orders for the treatment of hypoglycemia. Transfer of the patient between an acute care unit and an intensive care unit requires discontinuation of the current insulin infusion protocol and reordering of an appropriate insulin infusion protocol if still indicated (e.g., transfer of patient on ICU Insulin Infusion Protocol from MICU to 3 West requires new order for Acute Care Insulin Infusion Protocol and order to discontinue ICU Protocol). Check the Patient Treatment Plan to ensure that appropriate orders are present and that previous insulin and oral diabetes agents have been discontinued. Contact the physician, if needed, for appropriate orders before beginning the infusion.
- b. Schedule insulin infusion bag to be prepared and delivered by pharmacy.
- c. Attach IV tubing to insulin infusion bag and flush IV line with 25 mL insulin solution before connecting infusion to patient. Piggyback insulin infusion into the Y-site of a dedicated maintenance IV closest to the insertion site. Maintenance IV fluids should contain dextrose. Administer only via infusion pump.
- d. Place Insulin Infusion Flow Sheet in bedside chart. A new flow sheet is required every 24 hours.
- e. Begin infusion at initial rate ordered by physician.
- f. Note: Do not flush insulin line or bolus fluid through insulin line.
- g. Use of the Panel Lock  feature on the infusion pump is recommended to prevent unauthorized changes in pump settings.
- h. Discuss staffing implications with the charge nurse/unit manager as needed to ensure that appropriate care can be provided.
- i. Promptly notify the patient's physician if the patient's response to the infusion is unusual, unexpected, or if any situation develops that is not addressed in the protocol.

E. INSULIN INFUSION TITRATION PROTOCOL

The Nurse will adjust insulin rate hourly using the bedside BG result to achieve *target glucose range of 125 – 175 mg/dl* according to this titration protocol:

- > (greater than) < (less than)
 ≥ (greater than or equal to) ≤ (less than or equal to)
 ↑ (increase) ↓ (decrease)

MINIMAL CHANGE in BG BG has changed less than 50 mg/dl in the previous hour		BG has DECREASED BG has decreased 50 mg/dl or more in the previous hour		BG has INCREASED BG has increased 50 mg/dl or more in the previous hour	
≤ 80*	Stop infusion; Hypoglycemia protocol	≤ 80*	Stop infusion; Hypoglycemia protocol	≤ 80*	Stop infusion; Hypoglycemia protocol
81 - 124	↓ 1 unit/hr	81 - 124	↓ rate 50%	81 - 124	↓ 0.5 unit/hr
125 - 175	No change	125 - 175	↓ rate 50%	125 - 175	No change
176 - 200	↑ 0.5 unit/hr	176 - 200	No change	176 - 200	↑ 0.5 unit/hr
201 - 250	↑ 1 unit/hr	201 - 250	↑ 0.5 unit/hr	201 - 250	↑ 1 unit/hr
> 250 *	↑ 2 units/hr *Notify MD if BG > 250 mg/dl for 3 consecutive readings	> 250 *	↑ 1.5 units/hr *Notify MD if BG > 250 mg/dl for 3 consecutive readings	> 250 *	↑ 2 units/hr *Notify MD if BG > 250 mg/dl for 3 consecutive readings

* Glucose < 40 mg/dl should be repeated to ensure accuracy, *without* delaying treatment for hypoglycemia. Values < 40 mg/dl and > 400 mg/dl should be repeated on another machine to ensure accuracy and reported to the physician. The physician should order a STAT venous sample for glucose testing to be sent to the Core Lab.

Notes:

1. Notify physician when insulin infusion rate reaches 15 units per hour.
2. Titration of insulin infusion rate (upward or downward) must be per protocol or covered by a physician's order. Adjustments based on nursing clinical judgment are off-protocol and are not covered by a physician's order. Concerns about the efficacy or safety of the protocol for an individual patient should be communicated to the patient's physician and documented in the medical record.

F. HYPOGLYCEMIA TREATMENT PROTOCOL

1. Stop the insulin infusion if hypoglycemia occurs (blood glucose less than 80 mg/dl).
2. If the patient is:
 - conscious and able to eat or drink, give 15 Gm of carbohydrate (CHO) such as 3 or 4 glucose tablets (*preferred treatment, if available without delay*), 4 oz fruit juice or regular soda, or one cup skim milk
 - conscious and on tube feedings, give 4 oz apple juice or soda via feeding tube
 - unconscious or unable to eat or drink, give 25 mL ($\frac{1}{2}$ amp) of Dextrose 50% slow IV push STAT or 1 mg Glucagon IM STAT if there is no secure IV access. After administration of Glucagon, anticipate the occurrence of nausea and vomiting, and institute aspiration precautions.
3. Retest the blood glucose level after 15 minutes. Repeat 15 Gm CHO treatment and repeat BG test every 15 minutes until glucose reaches greater than 100 mg/dl; then resume regular schedule for hourly BG test.
4. After initial treatment of hypoglycemia, notify the physician about the hypoglycemic episode. The physician should evaluate the cause of each hypoglycemic episode and adjust management as indicated.
5. When blood glucose reaches ≥ 150 mg/dl, restart the infusion at 50% of the infusion rate prior to the hypoglycemic episode and continue schedule of hourly BG tests.
6. Note: It is important to administer hypoglycemic treatment in the ordered dosages and to measure amounts in order to prevent rebound hyperglycemia. Treatment repeated at 15-minute intervals will safely reverse hypoglycemia.

G. PROLONGED HYPERGLYCEMIA PROTOCOL

1. Call the patient's physician if the blood glucose remains above 250 mg/dl for three consecutive readings. Failure to notify the physician while continuing to increase the infusion rate by 2 units/hour can result in delay in achieving target glucose and BG control.
2. The physician should evaluate the etiology and may choose to order an increase in infusion rate beyond protocol parameters to achieve glucose control. This requires placement of a MIS order that can be accessed from the Insulin Index screen.
3. If the physician orders an increase in infusion rate beyond protocol parameters, nursing will resume hourly blood glucose tests at the next hour, and resume infusion adjustments per protocol when the glucose is < 250 mg/dl. If glucose remains above 250 mg/dl, the physician should again be contacted for additional orders.

I. NUTRITION

1. Reduce the insulin infusion rate by 50% and notify the physician for any significant changes in nutrition delivery (i.e., tube feeding interrupted or discontinued, NPO status, prolonged vomiting).
2. A nocturnal tube feeding schedule should be avoided for a patient receiving insulin infusion.
3. Insulin infusion is not useful in the management of post-meal hyperglycemia (e.g., bolus tube feeding, hyperglycemia following nutritional supplements). In this situation, consider the use of a short-acting subcutaneous insulin in addition to the insulin infusion.

J. OFF-UNIT TRANSPORT

Patients receiving insulin infusion may travel off the unit *only* if accompanied by a registered nurse who has been trained in the use of the insulin infusion protocol. The physician and nurse should consider an alternative glucose management regimen (e.g., subcutaneous insulin coverage) during transport. If the infusion is held during transport, test a BG immediately before the patient leaves the unit. Since insulin administered by the IV route has a short half-life, the patient should do well if BG is >100 mg/dl before traveling. If the infusion cannot be temporarily stopped, the patient must be accompanied by a registered nurse.

A travel kit will be maintained on each unit and will accompany the patient during transport. Contents will include glucose tablets and Dextrose 50% injection. Before transport, the nurse will obtain a glucose meter from the unit and add it to the transport kit.

K. CONVERSION FROM INFUSION TO SUBCUTANEOUS INSULIN

1. The physician should evaluate the continued need for insulin infusion:
 - a. every 8 hours
 - b. when glucose remains within target range for 3 hours
 - c. when the patient is tolerating solid food or enteral feeding
2. Subcutaneous intermediate-acting or long-acting insulin (e.g. NPH, Glargine, or Ultralente) should be given at least 4 hours prior to stopping the infusion. This is necessary to prevent deterioration in metabolic glucose control. A longer overlap may be needed for patients with gastroparesis.
3. During the transition to subcutaneous insulin, meal coverage with Regular insulin is required.
4. The Diabetes Consult Team is available to assist with the conversion from infusion to subcutaneous insulin.
5. Physician orders:
 - Discontinue order for Acute Care Insulin Infusion
 - Order intermediate or long-acting insulin, oral diabetes agent(s), and/or short-acting insulin
 - Order bedside meter BG test schedule
 - Continue order for Hypoglycemia Treatment Protocol
6. Nursing instructions:
 - If intermediate or long-acting insulin has been ordered, administer at the next scheduled time, and discontinue the insulin infusion four hours later. In the four-hour interval, continue to titrate insulin infusion according to protocol.

L. DOCUMENTATION

1. The Insulin Infusion Flow Sheet has been designed to guide the documentation of care for this patient population. The nurse will document BG results, infusion rate adjustments, comments (including protocol variations and notification of physician), and two-RN safety checks on the Insulin Infusion Flow Sheet. The Flow Sheet is to be kept in the bedside chart. It is not necessary to duplicate any documentation that is done on the Insulin Infusion Flow Sheet.
2. A second Registered Nurse will verify and document the correct medication, ordered dose and dose programmed into the pump at:
 - a. *initiation of therapy* – for accuracy of the medication label, concentration, ordered dose, and dose programmed into the pump.
 - b. *all bag changes* – for label accuracy compared to the physician’s order, including concentration.
 - c. *change of direct nursing care provider* – for accuracy of ordered dose on the protocol

- compared to the dose and concentration programmed into the pump.
3. Document hypoglycemia treatment and its effect.

M. QUALITY MONITORS

1. Guideline compliance.
2. Guideline efficacy - incidence (percentage) of patients on insulin infusion therapy who have documented hyperglycemia defined as blood glucose > 200 mg/dl.
3. Guideline safety -incidence (percentage) of patients on insulin infusion therapy who have documented hypoglycemia defined as < 80 mg/dl

CONTACT INFORMATION

Resources are available 24 / 7 to discuss treatment options and to answer questions about the insulin infusion protocol.

**Diabetes Nurse Educators available Monday through Friday 8AM – 5PM
PIC 9767/ Phone 243-9767**

Endocrine Fellow on-call available 24 / 7 through PIC 1676 or the Hospital Page Operator

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1. Brown G, Dodeck P. Intravenous insulin nomogram improves blood glucose control in the critically ill. *Critical Care Medicine* 2001;29(9):1714-1719.
2. Finney SJ, Zekveld C, Elia A, Evans TW. Glucose control and mortality in critically ill patients. *JAMA* 2003;290(15):2041-2047.
3. Furnary AP, Zerr KJ, Grunkemeier GL, Starr A. Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. *Ann Thorac Surg* 1999;67:352-362.
4. Krinsley JS. Effect of an intensive glucose management protocol on the mortality of critically ill adult patients. *Mayo Clin Proc* 2004;79(8):992-1000.
5. Levetan CS, Magee MF. Hospital management of diabetes. *Endocrinology & Metabolism Clinics of North America* 2000;29(4):745-770.
6. McCowen KC, Malhotra A, & Bistrrian BR. Stress-induced hyperglycemia. *Critical Care Clinics* 2001;17(1):107-124.
7. Van den Berghe G, Wouters P, Weekers F, et al. Intensive insulin therapy in critically ill patients. *N Engl J Med* 2001;345:1359-1367.
8. Zerr KJ, Furnary AP, Grunkemeier SB, et al. Glucose control lowers the risk of wound infection in diabetics after open heart operations. *Ann Thorac Surg* 1997;63:356-361.
9. 63rd ADA Scientific Sessions. Abstract #444-P; *Diabetes* 52(S1):A104., New Orleans, 2003.
10. Insulin Infusion Protocols from:
 - University of Virginia TCVPO unit
 - University of Virginia STICU
 - Yale Diabetes Center
 - Massachusetts General Hospital
 - Johns Hopkins Hospital
 - St. Mary's Medical Center, San Francisco
 - Stanford Hospital and Clinics
 - University Medical Center, Tucson

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Guidelines are general and cannot take into account all of the circumstances of a particular patient. Judgment regarding the propriety of using any specific procedure or guideline with a particular patient remains with that patient's physician, nurse or other health care professional, taking into account the individual circumstances presented by the patient.

Appendix A

Nursing Protocol for Insulin Infusion in Acute Care – Quick Reference

(Use protocol only when physician's order is in place. NOT FOR USE IN INITIAL TREATMENT OF DKA)

Target Blood Glucose (BG) Range = 125 to 175 mg/dl

Bedside BG test frequency

Perform bedside BG test every hour

- Exception – Hypoglycemia (glucose < 80 mg/dl) Check glucose every 15 minutes until > 100 mg/dl (then resume hourly BG test schedule)

Symbol Key: ↑ (increase); ↓ (decrease); > (greater than); < (less than); ≥ (greater than or equal to); ≤ (less than or equal to)

Minimal Change in BG BG has changed less than 50 mg/dl in the previous hour		BG has DECREASED BG has decreased 50 mg/dl or more in the previous hour		BG has INCREASED BG has increased 50 mg/dl or more in the previous hour	
≤ 80*	STOP INFUSION Hypoglycemia protocol	≤ 80*	STOP INFUSION Hypoglycemia protocol	≤ 80*	STOP INFUSION Hypoglycemia protocol
81 – 124	↓ 1 unit/hr	81 – 124	↓ rate 50%	81 – 124	↓ by 0.5 unit/hr
125 – 175	no change	125 – 175	↓ rate 50%	125 – 175	no change
176 – 200	↑ by 0.5 unit/hr	176 – 200	no change	176 – 200	↑ by 0.5 unit/hr
201 – 250	↑ 1 unit/hr	201 – 250	↑ 0.5 unit/hr	201 – 250	↑ 1 unit/hr
> 250*	↑ 2 units/hr	> 250*	↑ 1.5 units/hr	> 250*	↑ 2 units/hr
<ul style="list-style-type: none"> ➤ Notify physician if BG is > 250 mg/dl for three consecutive readings. Physician may order one-time off-protocol increase in infusion rate. In that case, resume hourly blood glucose checks at the next hour <i>and</i> resume infusion adjustments per protocol when the glucose is < 250 mg/dl. If glucose remains above 250 mg/dl, notify physician. ➤ Notify physician when insulin infusion rate reaches 15 units/hr <p>* Glucose < 40 mg/dl should be repeated to ensure accuracy, <i>without</i> delaying treatment for hypoglycemia. Values < 40 mg/dl and > 400 mg/dl should be repeated on another machine to ensure accuracy and reported to the physician. The physician should order a STAT venous sample for glucose testing to be sent to the Core Lab.</p>					

Nutrition

Reduce insulin infusion rate by 50% and notify physician for significant changes in delivery of nutrition (i.e., tube feeding interrupted or discontinued, NPO status, prolonged vomiting).

Glucose ≤ 80 mg/dl	Hypoglycemia Protocol
If patient is conscious and able to eat or drink	<ul style="list-style-type: none"> • Stop insulin infusion • Give 15 Gm of carbohydrate (CHO) <ul style="list-style-type: none"> ○ 3 – 4 glucose tablets (preferred treatment if available without delay) <i>or</i> ○ 4 oz juice or regular soda or 1 cup skim milk • Give 4 oz apple juice or soda via feeding tube • Give 25 mL (½ amp) of Dextrose 50% slow IV push STAT <i>or</i> 1mg Glucagon IM STAT if no IV access. • Repeat treatment every 15 minutes if needed until glucose is >100 mg/dl (then resume schedule for hourly BG checks). • Notify MD • When glucose is ≥ 150 mg/dl • At 50% previous rate • Continue hourly BG checks.
If patient is conscious and on tube feedings	
If patient is unconscious or unable to eat or drink	
Recheck BG in 15 min	
Restart insulin infusion	

Conversion to Subcutaneous Insulin

1. The physician should evaluate the continued need for insulin infusion:
 - a. Every 8 hours
 - b. When glucose remains within target range for 3 hours
 - c. When patient is tolerating solid food or enteral feeding
2. Stop insulin infusion and begin subcutaneous insulin administration per physician order. **Note: Stop the infusion 4 hours after administration of subcutaneous intermediate acting or long-acting insulin (e.g. NPH, Glargine, or Ultralente). In the 4-hour interval, continue to titrate insulin infusion according to protocol.** (During the transition to subcutaneous insulin, meals require coverage with Regular insulin.)

Transport of Patient during Insulin Infusion

The physician and nurse should consider an alternative glucose management regimen during transport (e.g. subcutaneous insulin coverage). If the infusion cannot be temporarily stopped during transport, the patient must be accompanied by an insulin infusion-trained nurse. Take the Insulin Infusion Travel Kit during transport after adding a glucose meter.

Appendix B

Guidelines for the Management of Diabetic Ketoacidosis (DKA) or Hyperosmolar Hyperglycemic States (HHS) in the Adult Patient

This guideline for the management of DKA/HHS is a stand-alone treatment regimen and is not used in conjunction with the Acute Care Insulin Infusion Guidelines or titration protocol. **The nurse will not titrate insulin infusion rate based on a protocol. The nurse will report hourly bedside blood glucose (BG) results to the physician for rate change orders. All changes in insulin infusion rate must be ordered in MIS.**

It is strongly recommended that every attempt be made to admit adult patients requiring insulin infusion for the management of DKA to one of the following units: adult critical care units, 3 WEST, 3 CENTRAL, 4 EAST, 4 CENTRAL, 5 WEST, 5 CENTRAL, and the Emergency Department.

The DKA/HHS guideline is intended for use up to the first 24 hours of treatment. After 24 hours, or sooner if DKA or HHS is resolved, the physician should convert to a subcutaneous insulin regimen or to the Acute Care Insulin Infusion Protocol.

Place MIS orders for the DKA/HHS Insulin Infusion and for Hypoglycemia Treatment Protocol.

Physician Responsibilities

1. Target glucose range is 175 to 200 mg/dl for the first 24 hours of treatment. Thereafter, target glucose range is 125 to 175 mg/dl.
2. Assessment: Evaluate the underlying cause of DKA/HHS. Treatment for the underlying cause should be initiated as soon as possible. During DKA/HHS treatment, assessment of progress should be repeated every 1 to 4 hours until the metabolic abnormalities are corrected.
3. IV solutions:
 - a. Give two liters (2000 mL) 0.9% sodium chloride IV during the first hour of treatment.
 - b. After the first hour, give 250 to 1000 mL/hour saline IV depending on the patient's state of hydration, serum electrolyte levels, and urinary output.
 - c. When blood glucose decreases to 250 mg/dl, change IV solution to include 5% dextrose and infuse at a minimum of 100 mL/hour.
 - d. DKA only – If blood glucose levels should drop below 150 mg/dl during the first 24 hours of treatment and acidosis/acidemia are largely resolved ($\text{pH} > 7.32$, $\text{HCO}_3^- > 19$ mEq/L); consider conversion to a subcutaneous insulin regimen or to the Acute Care Insulin Infusion Protocol. If blood glucose levels are less than 150 mg/dl but acidosis/acidemia have not resolved, increase the rate of dextrose infusion and look for other components of acidosis (e.g., lactate, etc.).
4. Insulin dosing:
 - a. Give initial dose of Regular insulin 10 to 15 units IV bolus.
 - b. Immediately begin insulin infusion at 5 units/hour for patients under 70 kg, or previously diet controlled or on oral agents, or taking less than 30 units of insulin daily
 - c. Begin insulin infusion at 10 units/hour for patients 70 kg or over or previously taking more than 30 units of insulin daily.
 - d. If glucose does not decrease by 150 mg/dl in the first two hours of treatment, double the rate of the insulin infusion.
 - e. If hyperglycemia is not resolving at the rate expected by the physician, the patient's hydration status and / or underlying DKA/HHS etiology (i.e. infection, stress) should be reevaluated.
5. Electrolyte replacement
 - a. Once renal function is assured, the IV solution should include potassium 20 to 40 mEq/L.
 - b. If serum potassium is above 5 mEq/L, do not give supplemental potassium.
 - c. Check serum potassium every 2 hours. Electrocardiographic monitoring is recommended to evaluate hyperkalemia / hypokalemia.
 - d. Phosphate infusion is usually not used unless severe hypophosphatemia is present. If


serum phosphate is less than 1 mg/dl, replace one-third of the potassium deficit as potassium phosphate. (Note: Some authorities suggest infusion of 30 mmol of potassium phosphate [44 mEq potassium] in one of the IV fluid bags. *If given, this is a one-time dose.*) If phosphate is infused, monitor for the development of hypocalcemia.

6. Use of bicarbonate to treat severe acidosis/acidemia (*DKA only*)
 - a. Sodium bicarbonate is usually not required for the treatment of DKA. Bicarbonate treatment is not intended to fully correct acidosis, but is given only if necessary to raise pH above immediately dangerous levels.
 - b. When pH is 6.9 to 7, infuse 44 mEq of sodium bicarbonate (usually added to one liter of 0.45% sodium chloride and infused over 4 hours). When the pH is < 6.9, increase the dose to 88 mEq of sodium bicarbonate/L.
 - c. Hypokalemia is usually exacerbated by bicarbonate infusion. Check potassium every hour and replace with IV potassium as needed.
 - d. Consider admission to ICU. EKG monitoring is recommended.
7. At 24 hours, or sooner, while ensuring continued administration of adequate dextrose, discontinue the order for DKA/HHS insulin infusion and enter orders for subcutaneous insulin administration or the Acute Care Insulin Infusion Protocol.
9. The Diabetes Consult Team is available for advice regarding problems or complications encountered in the management of DKA/HHS, particularly if DKA/HHS persists after 24 hours.
10. Diabetes patient education is recommended for all patients with DKA/HHS. Diabetes education can be requested with a MIS order or by calling the Diabetes Education Office at 243-9767.

Nurse Responsibilities

1. Obtain initial BG test result by bedside meter immediately before starting the insulin infusion.
2. **Test BG by bedside meter every hour. Notify the physician hourly with BG results.**
3. BG values greater than 400 mg/dl should be repeated on another machine to ensure accuracy and reported to the physician. The physician should order a STAT venous sample for glucose testing to be sent to the Core Lab. During hypoglycemic episodes, test BG 15 minutes after hypoglycemia treatment, and then every 15 minutes until glucose reaches > 100 mg/dl.
3. Check BG if signs / & symptoms of hypoglycemia occur: e.g. diaphoresis, trembling, tachycardia, confusion, lethargy, decreased mental status, mood change or irritability, headache.
4. Ensure that MIS orders are placed for the DKA/HHS insulin infusion and the Hypoglycemia Treatment Protocol. Contact the physician, if needed, for appropriate orders prior to beginning infusion.
5. Schedule the insulin infusion solution to be prepared and delivered by pharmacy.
6. Flush IV line with 25 mL insulin solution before connecting infusion to patient. Piggyback insulin infusion into the Y-site of a dedicated maintenance IV closest to the insertion site. Administer only via IV pump.
7. Obtain an Insulin Infusion Flow Sheet from the nurses' station and place in bedside chart. Document hourly glucose results, insulin rate changes, and required two-RN checks.
8. Give insulin bolus and begin infusion at rate ordered by physician. The physician will order subsequent changes in insulin infusion rate. Notify the physician hourly with BG results.
9. Anticipate the following physician interventions:
 - a. An order to add dextrose to IV fluids when the BG reaches 250 mg/dl
 - b. An order to convert to subcutaneous insulin regimen or to begin titration of insulin infusion using the Acute Care Insulin Infusion Protocol when the BG reaches 175 mg/dl or after initial 24 hours of DKA treatment.

Note: *Do not titrate insulin infusion rate as you would when using the titration protocol in the Acute Care Insulin Infusion Protocol. The physician must order every change in insulin infusion rate.*

9. Note: Do not flush insulin line or bolus fluid through insulin line.
10. Use of the Panel Lock  feature on the IV pump is recommended to prevent unauthorized changes in pump settings.
11. Discuss staffing implications with the charge nurse/unit manager as needed to ensure that appropriate care can be provided.

Appendix C

Physician Guide to Insulin Infusion in Acute Care

(Nurse can titrate per protocol only when physician's order is in place)

Target Blood Glucose (BG) Range = 125 to 175 mg/dl

Step 1	<p style="text-align: center;"><u>Determine if Patient Meets Criteria for Insulin Infusion*</u></p> <ul style="list-style-type: none">• Failure of current insulin regimen to achieve stable glucose control (e.g., blood glucose > 300 mg/dl for more than four hours uncontrolled by subcutaneous sliding scale insulin)• High dose glucocorticoid therapy resulting in hyperglycemia• Poor diabetes control with dehydration and/or volume depletion• Severe generalized edema leading to poor absorption of subcutaneous insulin• Erratic oral intake leading to poor glucose control <p><i>Note: The insulin infusion protocol is NOT intended for treatment of diabetic ketoacidosis (DKA) or hyperosmolar hyperglycemic states (HHS). DKA/HHS treatment guidelines and MIS orders are available.</i></p> <p>* Call the Diabetes Consult Team for management recommendations in those patients in whom it is difficult to achieve or maintain target glucose while on insulin infusion or those who do not meet insulin infusion selection criteria).</p>
Step 2	<p style="text-align: center;"><u>Place Insulin Infusion Orders in MIS</u></p> <ul style="list-style-type: none">• In MIS go to INSULIN INDEX• Pick ACUTE CARE INFUSION and progress through order screens to order infusion and starting rate.• Discontinue previous insulin orders and oral diabetes agents• Order maintenance IV fluids – should contain dextrose• Order Hypoglycemia Treatment Protocol which includes automatic infusion restart at 50% previous rate when blood glucose reaches \geq 150 mg/dl• <i>NOTE:</i> Transfer of the patient between acute care and intensive care units requires discontinuation of current insulin infusion protocol and reorder of appropriate insulin infusion protocol if still indicated.
Step 3	<p style="text-align: center;"><u>Conversion from Infusion to Subcutaneous Insulin</u></p> <ol style="list-style-type: none">1. Evaluate the continued need for insulin infusion:<ul style="list-style-type: none">• Every 8 hours• When glucose remains within target range for 3 hours• When patient is tolerating solid food or enteral feeding2. Subcutaneous intermediate acting or long-acting insulin (e.g. NPH, Glargine, or Ultralente) should be given at least 4 hours prior to stopping the infusion. During the transition to subcutaneous insulin, meals require coverage with Regular insulin. Place the following orders:<ul style="list-style-type: none">- Discontinue order for Acute Care Insulin Infusion. Continue order for Hypoglycemia Treatment Protocol- Order intermediate or long-acting insulin, oral diabetes agent(s), and/or short-acting insulin- Order bedside BG test schedule<p style="text-align: center;"><i>Call the Diabetes Consult Team for assistance with the conversion from infusion to subcutaneous insulin.</i></p>
You will be notified	<ul style="list-style-type: none">• Every hypoglycemic episode. Evaluate the cause of each hypoglycemic episode and adjust management as needed.• If insulin infusion rate reaches 15 units/hour• If blood glucose remains above 250 mg/dl for three consecutive hours. Evaluate the etiology; you may choose to order an increase in infusion rate beyond protocol parameters to achieve glucose control. One-time order for off-protocol rate adjustment must be ordered in MIS. (If you order an increase in infusion rate beyond protocol parameters, the nurse will resume hourly glucose tests at the next hour, and will resume infusion adjustments per protocol when the glucose is < 250 mg/dl. If glucose remains above 250 mg/dl, the nurse will notify you again.)• For significant changes in nutrition status (e.g., tube feeding interrupted or discontinued, NPO status) after nurse has reduced the insulin infusion rate by 50%.
Off-unit transport	<p>Work with nursing staff to consider an alternative glucose management regimen during transport (e.g. subcutaneous insulin coverage). If the infusion cannot be temporarily stopped during transport, the patient must be accompanied by an insulin infusion-trained nurse.</p>

Appendix D

- ❖ Pediatric insulin infusion is under the domain of the pediatric critical care and endocrinology services.
- ❖ Adult units approved for Adult Acute Care Insulin Infusion:

Unit	Comments
ABMTU	
3E	
3C	
3W	
4E	
4C	
4W	
5C	
5W	
6E	
6C	
6W	
8C (Gynecology/Oncology)	8C (Obstetrics/Maternity) uses ICU protocol
8W	
Inpatient renal unit	
PACU boarder area	Acute care protocol used for ICU boarders; switch to ICU protocol after patient admitted to ICU bed
Surgical Admission Suite	
Emergency Department	Acute care protocol used for ICU boarders; switch to ICU protocol after patient admitted to ICU bed
PTU	Acute care protocol only; DKA will not be managed

- ❖ Insulin infusion for the treatment of DKA in acute care: It is strongly recommended that every attempt be made to admit adult patients requiring insulin infusion for the management of DKA to one of the following units:
 - adult critical care units
 - 3 WEST
 - 3 CENTRAL
 - 4 EAST
 - 4 CENTRAL
 - 5 WEST
 - 5 CENTRAL
 - Emergency Department.