

Table 2 HYPERGLYCEMIA (for diabetic ketoacidosis see table 3)				
TREATMENT IN EMERGENCY DEPARTMENT				
Type 1 New Stable	Type 1 Established Stable	Type 1 New or Established Unstable	Type 2 New Stable	Type 2 New or Established Unstable
<ul style="list-style-type: none"> Administer rapid-acting insulin stat (e.g., 10 units or 0.1 unit/kg body wt, subcut) Consider IV fluids* Re-assess clinical condition in 2-4 hours Consider admission for observation and continuation of IV fluids and subcutaneous insulin, or if complicating psychosocial or medical problems, or daily follow up outpatient treatment cannot be arranged Obtain consultation from diabetologist/endocrinologist Arrange for discharge once management plan is confirmed Provide written instructions 	<ul style="list-style-type: none"> Consider rapid-acting insulin stat (e.g., 10 units or 0.1 unit/kg body wt, subcut) Consider IV fluids* Re-assess clinical condition in 2-4 hours Contact PCP or primary endocrinologist Arrange for discharge once management plan is confirmed Provide written instructions 	<ul style="list-style-type: none"> Refer to DKA guideline (table 3) and admit 	<ul style="list-style-type: none"> Consider rapid-acting insulin stat (e.g., 10 units or 0.1 unit/kg body wt, subcut) Consider IV fluids* Re-assess clinical condition in 2-4 hours Contact PCP re: discharge plans Provide written instructions 	<ul style="list-style-type: none"> Administer rapid-acting insulin stat (e.g., 10 units or 0.1 unit/kg body wt, subcut) Start IV fluids* Re-assess clinical condition in 2-4 hours Consider admission for continuation of IV fluids and insulin; measure intake and output Consider that, in the hyperosmolar state, the patient may need more fluid and less insulin than indicated in the DKA guideline (pg. 3)
ADMISSION STRATEGY				
Consider admission if:				
<ul style="list-style-type: none"> Hemodynamically unstable Unable to maintain oral intake Unable and/or unlikely to initiate/attain self-management skills within 24 hours BG > 400 mg/dl Newly diagnosed type 1 in special circumstances Very low pH, low HCO₃ Other apparent medical/surgical reasons Pregnancy 				
SUBSEQUENT INSULIN MANAGEMENT FOR TYPE 1 & INSULIN-REQUIRING TYPE 2				
Stable Patients				
<i>(Call provider if BG < 60 mg/dl, if there are symptoms of hypoglycemia, or if BG > 400 mg/dl)</i>				
For Patients Taking P.O.			If Patient N.P.O.	
<ul style="list-style-type: none"> Return to prior insulin regimen or re-evaluate dose if prior regimen inadequate (for patients previously receiving insulin) If patient becomes hypoglycemic (BG < 70 mg/dl), administer 15 g carbohydrate (3-4 glucose tablets, 4 oz. juice, 1 tube glucose gel) and repeat BG 15 min. later 			<ul style="list-style-type: none"> Give ½ usual dose intermediate (NPH) or full dose long-acting (glargine or detemir) insulin; no rapid or short-acting insulin; no change in basal rate for insulin pump patients Pre-mixed insulin: may be less than half of usual dose 	
*SUGGESTIONS for FLUID MANAGEMENT				
<p>Infuse normal saline as indicated to maintain euvoolemia. If the patient is normotensive, hypotonic saline (1/2 NS) may also be necessary if the patient has a high normal serum sodium and will be required if hypernatremic initially. Assessment of initial and follow-up volume status is an important parameter in deciding rates of fluid administration. One may need to adjust type and rate of fluid administration (e.g., use ½ NS) in the elderly and in patients with CHF or renal failure.</p>				
DIABETES SELF-MANAGEMENT EDUCATION				
Educational Assessment			Skills/Knowledge Needed	
<ul style="list-style-type: none"> If admitted, refer for inpatient teaching as early as possible Assess short-term learning needs/skills re: diabetes self-management Refer for outpatient ongoing diabetes self-management education: <ul style="list-style-type: none"> within 1 week for newly diagnosed patients within 2-3 weeks for established patients 			<ul style="list-style-type: none"> Self-monitoring blood glucose (SMBG): actual frequency individualized, but recommend minimum of 2-4x/day Insulin administration if indicated Basic meal planning skills Sick day guidelines and hypoglycemia treatment strategies Emergency indicators and reasons to call M.D. 	
DISCHARGE PLANNING				
<ul style="list-style-type: none"> Assess ongoing and future medical and educational needs Arrange for home care as appropriate for patient Coordinate discharge follow-up with PCP or endocrinologist within 1-2 weeks 				

Table 3		DIABETIC KETOACIDOSIS (DKA)																	
DEFINITION: Blood glucose (>200 mg/dl) with metabolic acidosis (arterial pH <7.3) and an elevated anion gap (>12) with positive ketones** **Ketoacidosis with blood glucose <200 mg/dl may occur, but consider other causes of metabolic acidosis.																			
SPECIMENS/TESTS: Acute Inpatient Management		TREATMENT																	
<ul style="list-style-type: none"> Fingerstick glucose every hour Electrolytes every 2 hours until sustained improvement x 4 hours Follow anion gap Recommend checking phosphate every 4 hrs; calcium and magnesium level at initiation Check urine ketones; DO NOT REPEAT if anion gap and bicarb are returning to normal Check EKG if K⁺ > 6.0 mEq/l 		<ul style="list-style-type: none"> If diagnosis confirmed as DKA and insulin drip required, consider admission Contact PCP re: plan Obtain consultation from diabetologist/endocrinologist; refer to diabetes consult team if available Initiate patient education 																	
<u>SUGGESTED FLUID AMOUNTS</u>																			
<p>May need to adjust type & rate of fluid administration in the elderly, in patients with CHF or renal failure, or in patients with HHS (see table 4). KCL should be added to IV fluids once urination is established. If patient is severely hypovolemic or in shock, initiate fluid resuscitation before commencing insulin.</p> <p style="text-align: center;">Administer NS as indicated to maintain volume status, then follow general guidelines:</p> <ul style="list-style-type: none"> Administer NS for first 4 hours Then consider ½ NS x 4 hours When plasma glucose <250 mg/dl, switch from ½ NS to D5 ½ NS <table border="0" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: left;">Hour</th> <th style="text-align: left;">Volume</th> </tr> </thead> <tbody> <tr> <td>1st ½ -1</td> <td>1 Liter</td> </tr> <tr> <td>2nd hour</td> <td>1 Liter</td> </tr> <tr> <td>3rd hour</td> <td>500 ml-1Liter</td> </tr> <tr> <td>4th hour</td> <td>500 ml-1Liter</td> </tr> <tr> <td>5th hour</td> <td>500 ml-1Liter</td> </tr> <tr> <td>Total 1st 5 hours</td> <td>3.5-5 Liters</td> </tr> <tr> <td>6-12th hours</td> <td>250-500 ml/hr</td> </tr> </tbody> </table>				Hour	Volume	1 st ½ -1	1 Liter	2 nd hour	1 Liter	3 rd hour	500 ml-1Liter	4 th hour	500 ml-1Liter	5 th hour	500 ml-1Liter	Total 1 st 5 hours	3.5-5 Liters	6-12 th hours	250-500 ml/hr
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<u>INSULIN MANAGEMENT</u>																			
<ul style="list-style-type: none"> Aim for target plasma glucose between 100-200 mg/dl Administer Regular insulin 10 units IV STAT (may not apply in pregnancy or to pediatrics) Start Regular insulin infusion at 5 units/hour or 0.1units/kg/hour Assess possible causes for lack of adequate decrease in plasma glucose (e.g., sepsis, glucocorticoids, severe insulin resistance, IV access problems) Increase Regular insulin by 1 unit/hr q 1-2 hours if < 10% drop in glucose or no improvement in acid-base status Decrease insulin by 1-2 units/hr when glucose ≤ 250 mg/dl and/or progressive improvement and anion gap closing DO NOT decrease insulin infusion to < 1 unit/hour If plasma glucose initially drops to < 100 mg/dl on insulin infusion, add glucose to IV as D5 or D10 at sufficient rate Check plasma glucose every 30 minutes if plasma glucose drops to < 100 mg/dl If plasma glucose continues to drop consistently on IV D5 consider change to IV D10 to maintain glucose at 100-200 mg/dl, while on insulin infusion Once patient can eat and anion gap is resolving, consider change to subcut insulin (continue IV insulin infusion for 1 hour after starting subcut insulin) <ul style="list-style-type: none"> For patients previously managed on insulin: re-evaluate insulin regimen before returning to prior dose For patients new to insulin: consider a regimen including a mixture of rapid- and long-acting insulin 																			
*** POTASSIUM (use KCL)																			
<i>Do not administer K⁺ if K⁺ > 5.5 or if patient is anuric. Once patient voids, add K⁺ to each liter of IV fluids and administer as above.</i>																			
<u>Serum K[±] (mEq/l)</u>		<u>Additional K[±] required (at infusion rates listed above)</u>																	
<3.5		40 mEq/L																	
3.5-4.4		20 mEq/L																	
4.5-5.5		10 mEq/L																	
>5.5		Stop infusion																	
<p>*** If there is persistent acidosis due to hyperchloremia, consider using K⁺ phosphate or K⁺ acetate instead of KCL as replacement. Can consider oral K⁺ replacement, as needed, once able to tolerate oral intake</p>																			
<u>BICARBONATE</u>																			
<ul style="list-style-type: none"> If arterial pH < 7.0, consider giving 50 mEq NaHCO₃ over 45 minutes Check acid-base 30 min. later & repeat if pH < 7.0 Bicarbonate should not be administered if K⁺ is ≤ 3.5mEq 																			
<u>PHOSPHATE</u>																			
Consider K ⁺ phosphate if patient is hypophosphatemic. Oral replacement is preferred.																			
<u>GENERAL MEASURES</u>																			
<ul style="list-style-type: none"> Consider Foley catheter Adequate IV access recommended for appropriate hydration/insulin administration. Rec. # 18 catheter or larger. 		<ul style="list-style-type: none"> Consider nasogastric tube (NGT) for gastric atony Consider anti-emetics if no concerns about mental status 																	
<u>DIABETES SELF-MANAGEMENT EDUCATION AND DISCHARGE PLAN</u>																			
(refer to pg. 2 Hyperglycemia Management)																			

Table 4 HYPEROSMOLAR HYPERGLYCEMIC STATE (HHS)

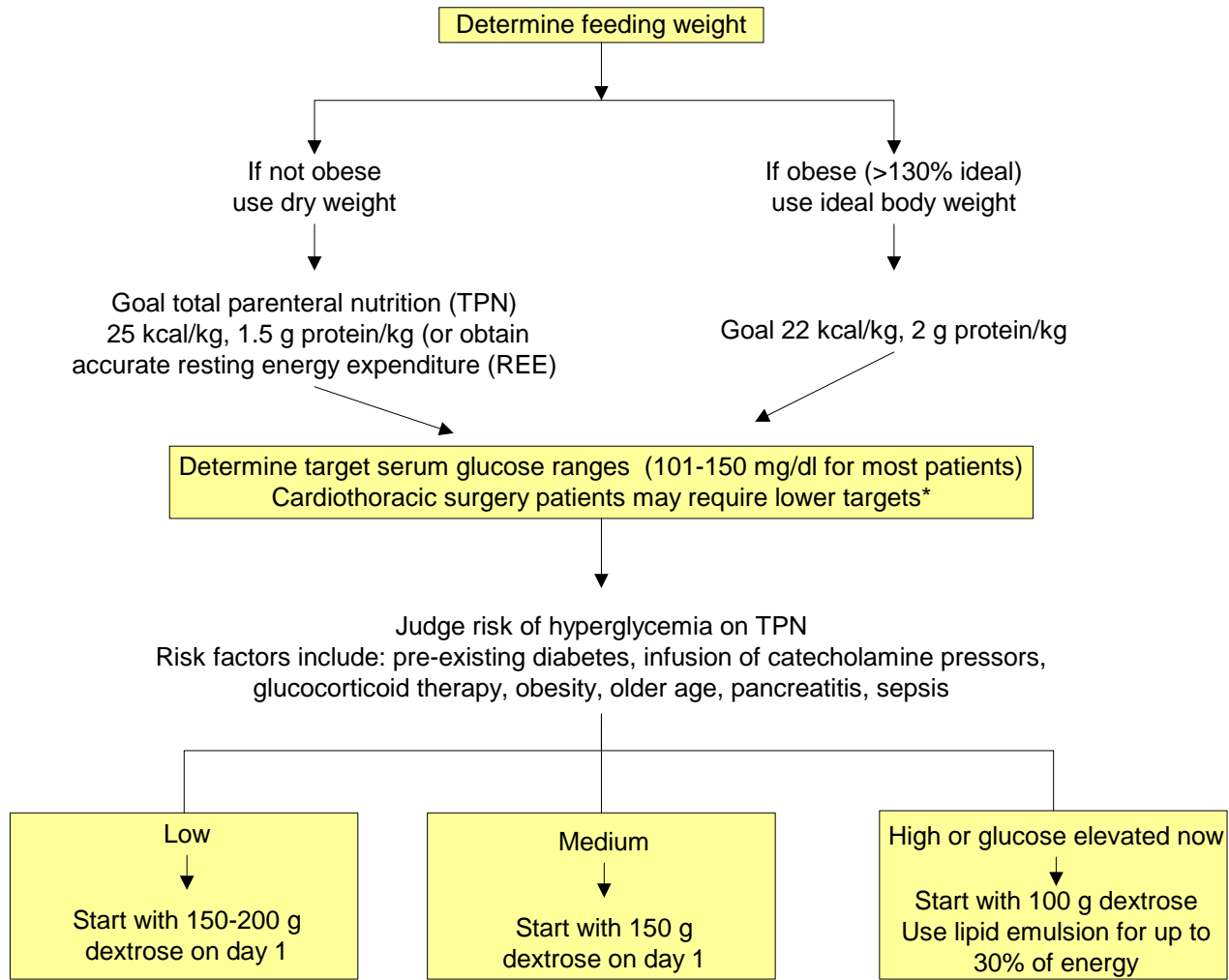
DEFINITION: Blood glucose >600mg/dl and osmolarity >320 mOsm/kg

- These states require similar management to the above, with the following exceptions:
- Acidosis, if present, may be due to other causes; consider checking lactic acid, toxicology screen, etc.
 - More fluids, as listed in table 3, may be required as patients may be more dehydrated
 - Lower doses of insulin may be required as patients may be sensitive to insulin
 - Monitoring of the cardiovascular status in elderly is required especially if at risk for CHF and fluid overload

Table 5 TREATMENT OF HYPERGLYCEMIA for PATIENTS RECEIVING NUTRITION SUPPORT

For patients requiring total parenteral nutrition (TPN) support at any point during their hospital stay, it is important to avoid hyperglycemia. Once TPN is initiated, fingerstick monitoring of glucose should be performed every 6 hours or more frequently, if necessary.

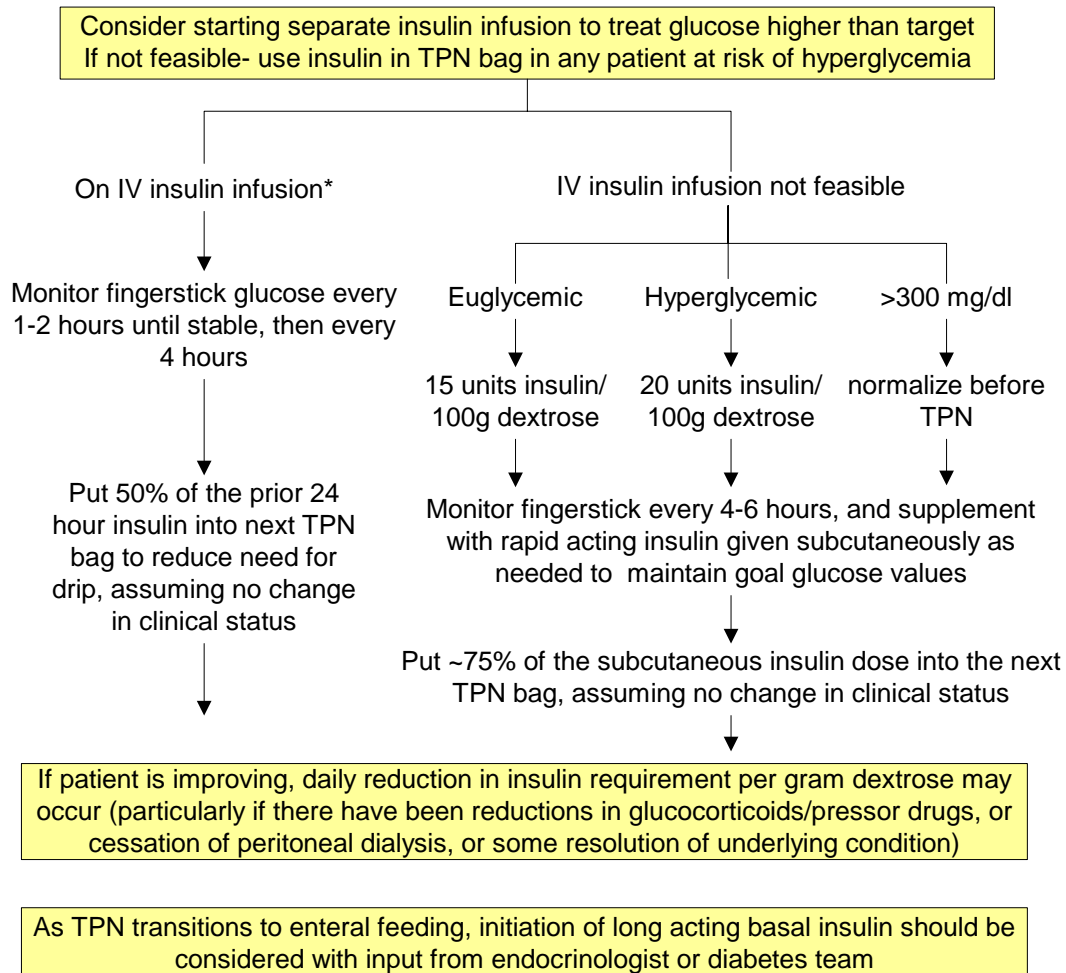
Guideline algorithm for initiation of total parenteral nutrition (TPN) in hospitalized patients, emphasizing avoidance and treatment of hyperglycemia



*Refer to Joslin's Guideline for Inpatient Management of Surgical and ICU Patients

(Continued on next page)

Guideline algorithm for initiation of total parenteral nutrition in hospitalized patients, emphasizing avoidance and treatment of hyperglycemia (*continued*)



**Refer to Joslin's Guideline for Inpatient Management of Surgical and ICU Patients*

Adapted from McCowen KC and Bistran BR. See reference 6.

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Glossary	
ABGs: arterial blood gasses	K⁺: potassium
BG: blood glucose	NGT: nasogastric tube
CHF: congestive heart failure	P.O.: orally
CNS: central nervous system	NS: normal saline
β-OHB: beta-hydroxybutyrate	REE: resting energy expenditure
DKA: diabetic ketoacidosis	SMBG: self-monitoring of blood glucose
Dry weight: body weight when total body water makes the normal contribution to body weight.	Subcut: subcutaneously
HCO₃: bicarbonate	TPN: total parenteral nutrition
HHS: hyperosmolar hyperglycemic state	UTI: urinary tract infection
	VBGs: venous blood gasses

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References:

1. American Diabetes Association. Hyperglycemic crises in diabetes. *Diabetes Care* 27:S94-S102, 2004.
2. American Diabetes Association. Standards of medical care in diabetes – 2007. *Diabetes Care* 30:S5-S41, 2007.
3. Clement S, Braithwaite SS, Magee MF et al. Management of diabetes and hyperglycemia in hospitals. *Diabetes Care* 27:553-591, 2004.
4. DeFronzo R, Matsuda M, Barrett E. Diabetic ketoacidosis: a combined metabolic-nephrologic approach to therapy. *Diabetes Review* 2:209-238, 1994.
5. Genuth, S. Diabetic Ketoacidosis and hyperosmolar hyperglycemic state in adults. In: Lebovitz HE, ed. Therapy for diabetes mellitus and related disorders. 4th ed. Alexandria: American Diabetes Association, 2004:93.
6. Kitabchi AE, Umpierrez GE, Murphy MB, Kreisberg RA. Hyperglycemic crises in adult patients with diabetes: a consensus statement from the American Diabetes Association. *Diabetes Care* 29:2739-48, 2006.
7. McCowen KC, Bistrian BR. Hyperglycemia and nutrition support: theory and practice. *Nutr Clin Pract* 19:235-244, 2004.
8. Porte, D, Sherwin, R, Ellenberg, M, Rifkin, H. Diabetic ketoacidosis. In: Porte D, Sherwin R, eds. *Ellenberg and Rifkin's diabetes mellitus*. 5th ed. Stamford: Appleton & Lange, 1997.
9. Wyckoff J, Abrahamson MJ. Diabetic ketoacidosis and hyperosmolar state. In: Kahn CR, Weir GC, King GL, et al, eds. *Joslin's diabetes mellitus*. 14th ed. Philadelphia: Lippincott Williams & Wilkins, 2005:887-899.

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