PURPOSE

To provide a standard procedure for optimizing care of the inpatient with hyperglycemia and/or diabetes. Substantially provide safe and effective glucose control for all adult inpatients. Reduce the incidence of hypoglycemic events. Increase the percentage of patients receiving evidence-based, rational insulin regimens. Improve the knowledge and education of health care providers on diabetes and hyperglycemia management.

POLICY

The Glycemic control pharmacist will use the Pharmacy and Therapeutics approved protocol to clinically manage glycemic drug therapy. All pharmacists participating in this protocol will be certified by the inpatient pharmacy. This includes initiating, adjusting, monitoring of medications and labs to optimize control of blood glucose.

GOALS

Hyperglycemia is associated with poor outcomes in a broad range of hospitalized patients, and several studies demonstrate improved outcomes with improved glycemic control. Hospitalization presents a frequently missed opportunity to diagnose diabetes, identify those at risk for diabetes, and to optimize the care of patients with diabetes via education and medical therapy.

PROCEDURES

Staff Responsibilities

A. Physician/Licensed Independent Practitioner
   1. Initiate the Glycemic Control Protocol by ordering “Glucose management per pharmacy Protocol”

B. Inpatient Pharmacist
   1. Order HbA1c if a result is not available within the last 30 days
      a. Document “uncontrolled” Type 1 or Type 2 DM in the progress note if HbA1c > 7% or if there are 2 CBGs > 180 mg/dL. See Attachment #6 if it is not clear what type of diabetes the patient has.
   2. Order serum creatinine as needed.
   3. Will assess patient according to the following parameters and write orders to optimize blood glucose control.

Glycemic Targets and Frequency of Glucose Testing

a. Target blood glucose:
   90-150 mg/dL pre-meal, <180 mg/dL with at other times (and a general goal for all pre-op pts)

b. CBGs recommended at least before every meal and at every bedtime (every 6 hours if NPO/tube feeds/TPN). 2 a.m. CBG recommended if on NPH QPM (vs QHS), evening insulin has been adjusted, there is increased risk of hypoglycemia, or Type 1 DM.
General Insulin Dosing Recommendations

1. Type 1 DM: basal insulin needed at ALL times to prevent ketosis (even when NPO), but mealtime insulin should be held when NPO (basal insulin can be in form of long-acting SQ or continuous drip).

2. Type 2 DM: recommend holding oral agents upon admission
   a. Sulfonylureas (Glipizide, Glyburide): HOLD if NPO, risk of hypoglycemia if NPO or paired with basal insulin.
   b. Metformin (Glucophage); increased risk of lactic acidosis with renal failure and CHF – hold for 48h before and 48h after contrast administration (CT, cardiac cath, etc), consider doing the same for surgery if at risk for fluid shifts.
   c. Glitazones (Avandia and Actos): risk of volume overload and CHF exacerbation

3. Transitioning off Insulin Drip:
   a. Two options for Glargine (Lantus): This is assuming the TDD was mainly basal insulin and included nutritional insulin requirements (i.e. Patients NPO and not receiving a significant dextrose source by oral intake or IV fluids).
      1) When using Glargine (Lantus) average current stable (minimal rate changes for 6-8hrs) rate x 24 = Total Daily Dose (TDD) divide 100% of the TDD by 2 and give twice a day.
      2) When using Glargine (Lantus) average current stable (minimal rate changes for 6-8hrs) rate x 24 = Total Daily Dose (TDD) and multiply by 0.8 (TDD = 80% of 24 hour insulin requirements) and give this preferably at HS

   Determine if this is the TDD or basal dose based on current nutrition.
   - If the insulin drip was serving as basal and nutritional needs (such as on continuous TF or TPN), this will be the TDD. Half of the TDD should be given as basal insulin and half should be given as nutritional insulin
     Example – insulin drip at 3 units/hour over the last 6 hours. Estimated TDD = 72 units x 0.8 = 58 units. Give 29 units of Glargine (Lantus). DC insulin drip in 2 hours. Nutritional insulin 9 units three times a day.
   - If the insulin infusion was not covering significant nutrition (such as NPO or not eating), this could be the basal insulin dose. In addition, the same amount should be given as nutritional insulin.
     Example – insulin drip at 3 units/hour over the last 6 hours. Estimated TDD = 72 units x 0.8 = 58 units. Give 58 units of Glargine (Lantus). DC insulin drip in 2 hours. Nutritional insulin 19 units three times a day (only if you definitely know patient will eat).

4. When using NPH average current stable (minimal rate changes for 6-8hrs) rate x 24 = Total Daily Dose (TDD) and multiply by 0.8 (TDD = 80% of 24 hour insulin requirements) and divide TDD by 2 and give NPH ACB and HS.
How to calculate Nutritional Insulin when Transitioning off Insulin Drip:

1. Give 1/3rd of 50% TDD with each meal (if you are confident patient will eat well). OR
2. Use weight based dosing. OR
3. Can count number of carbohydrates patient will eat
   
   If you are not confident patient will eat well, you can also choose to order just the basal insulin and a correctional scale, and then calculate your bolus doses of insulin the next day or order nutritional insulin with admin instructions to give 50% of dose if patient eats 50% or less of meal.
   
   a. Weight based dosing
      
      1) Type 1 DM: 0.2-0.5 unit/kg TDD
         a) If above seems like too much due to being unsure of how much the patient is eating or if patient is at risk for hypoglycemia (advanced age, renal insufficiency, or liver failure):
            i. Basal dose of 0.15units/kg at bedtime (e.g. 10 units glargine at every bedtime or 5 units NPH twice a day for 70 kg person).
            ii. Pick prandial dose based upon grams of carbohydrate per meal for a 1800-2000 calorie diabetic diet at KSMC (60 grams carbohydrate per meal). Starting ratio: 1 unit prandial insulin per 10 grams carbohydrate (e.g. 6 units aspart or regular three times a day before meals). The other option is to give prandial dose based upon home regimen.
            iii. Prandial insulin can be initiated if patient is taking at least a full liquid diet and should not be initiated if patient is on a clear liquid diet.
      2) Type 2 DM: 0.4-0.7 unit/kg TDD
         a) If above seems like too much due to being unsure of how much the patient is eating or if patient is at risk for hypoglycemia (advanced age, renal insufficiency, or liver failure):
            i. Basal dose of 0.15units/kg at bedtime (e.g. 10 units glargine at every bedtime or 5 units NPH twice a day for 70 kg person).
            ii. Pick prandial dose based upon grams of carbohydrate per meal for a 1800-2000 calorie diabetic diet at KSMC (60 grams carbohydrate per meal). Starting ratio: 1 unit prandial insulin per 10 grams carbohydrate (e.g. 6 units aspart or regular three times a day before meals).
            iii. Prandial insulin can be initiated if patient is taking at least a full liquid diet and should not be initiated if patient is on a clear liquid diet.
4. Patients Already on Insulin: use outpatient dose for baseline and increase (infection, steroids) or decrease (fewer calories ingested than at home) as needed.
5. ADJUST INSULIN: Evaluate insulin dose DAILY to prevent hyper- and hypoglycemia. Hospitalized patients have varying insulin needs due to illness, recovery, surgery, steroids, etc. (consider decreasing overall insulin requirements by 20-50% daily especially in post-operative cardiac surgery patients).

   a. Glucose above goal:

<table>
<thead>
<tr>
<th>AM fasting CBG</th>
<th>Lunchtime CBG</th>
<th>Dinnertime CBG</th>
<th>Bedtime CBG</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 150 &amp; &lt; 180</td>
<td>&gt; 150 &amp; &lt; 180</td>
<td>&gt; 150 &amp; &lt; 180</td>
<td>&gt; 150 &amp; &lt; 180</td>
</tr>
<tr>
<td>Increase lantus by 10% or increase evening NPH by 10%</td>
<td>Increase lantus by 20% or increase evening NPH by 20%</td>
<td>Increase lantus by 30% or increase evening NPH by 30%</td>
<td>Increase lantus by 40% or increase evening NPH by 40%</td>
</tr>
<tr>
<td>If AM fasting CBG</td>
<td>If AM fasting CBG</td>
<td>If AM fasting CBG</td>
<td>If AM fasting CBG</td>
</tr>
<tr>
<td>&gt; 180 &amp; &lt; 230</td>
<td>&gt; 180 &amp; &lt; 230</td>
<td>&gt; 180 &amp; &lt; 230</td>
<td>&gt; 180 &amp; &lt; 230</td>
</tr>
<tr>
<td>Increase lantus by 10% or increase evening NPH by 10%</td>
<td>Increase lantus by 20% or increase evening NPH by 20%</td>
<td>Increase lantus by 30% or increase evening NPH by 30%</td>
<td>Increase lantus by 40% or increase evening NPH by 40%</td>
</tr>
<tr>
<td>If AM fasting CBG</td>
<td>If AM fasting CBG</td>
<td>If AM fasting CBG</td>
<td>If AM fasting CBG</td>
</tr>
<tr>
<td>&gt; 230 &amp; &lt; 280</td>
<td>&gt; 230 &amp; &lt; 280</td>
<td>&gt; 230 &amp; &lt; 280</td>
<td>&gt; 230 &amp; &lt; 280</td>
</tr>
<tr>
<td>Increase lantus by 10% or increase evening NPH by 10%</td>
<td>Increase lantus by 20% or increase evening NPH by 20%</td>
<td>Increase lantus by 30% or increase evening NPH by 30%</td>
<td>Increase lantus by 40% or increase evening NPH by 40%</td>
</tr>
<tr>
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<tr>
<td>&gt; 280</td>
<td>&gt; 280</td>
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<td>&gt; 280</td>
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<tr>
<td>Increase lantus by 10% or increase evening NPH by 10%</td>
<td>Increase lantus by 20% or increase evening NPH by 20%</td>
<td>Increase lantus by 30% or increase evening NPH by 30%</td>
<td>Increase lantus by 40% or increase evening NPH by 40%</td>
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</table>

   b. Glucose below goal:

<table>
<thead>
<tr>
<th>AM fasting CBG</th>
<th>Lunchtime CBG</th>
<th>Dinnertime CBG</th>
<th>Bedtime CBG</th>
</tr>
</thead>
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<tr>
<td>&lt; 90 &amp; &gt; 70</td>
<td>&lt; 70 &amp; &gt; 50</td>
<td>&lt; 90 &amp; &gt; 70</td>
<td>&lt; 70 &amp; &gt; 50</td>
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<tr>
<td>Basal Insulin</td>
<td>(lantus/NPH)</td>
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<td>Basal Insulin</td>
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<tr>
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<td>Decrease by 20%</td>
<td>Decrease lantus by 10% or decreasing evening NPH by 10%</td>
<td>Decrease lantus by 20% or decreasing evening NPH by 20%</td>
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<tr>
<td>Mealtime insulin</td>
<td>Mealtime insulin</td>
<td>Mealtime insulin</td>
<td>Mealtime insulin</td>
</tr>
<tr>
<td>Decrease by 10%</td>
<td>Decrease by 20%</td>
<td>Decrease by 10%</td>
<td>Decrease by 20%</td>
</tr>
</tbody>
</table>

   c. If CBGs < 40-50, consider decreasing appropriate insulin up to 50%.
Correction Dose Insulin (basal insulin must be ordered)

1. Always use same type of insulin for correction and bolus.
2. Correctional scales are designed to correct hyperglycemia to fine tune control
3. Select scale based on patient characteristics (see exhibit 1)
4. ‘1700 Rule’ (some people will use 1500 or 1600)
   a. 1700 divided by TDD to determine a correction factor (ie: 1700 divided by 60 units total daily insulin dose is 28, rounding to 30 is okay)
   b. Subtract TARGET glucose from CURRENT glucose (ie: 280mg/dL current minus 120mg/dL goal = 160mg/dL above goal) and divide by ‘correction factor’ (160mg/dL above goal divided by 30mg/dL per unit = 5 units)

Insulin Infusions

1. Patients with type 1 DM must have a dextrose-containing IV fluid (or TPN, TF) ordered. This can be administered as low as 30 mL/hr if desired.
2. Patients with type 2 DM with insulin infusion rates ≥ 5 units/hr do not need dextrose-containing IV fluids
3. Transition to SQ insulin (see exhibit 2)
4. Troubleshooting:
   a. Hypoglycemia (< 70 mg/dL)
      1) Type 1 DM: increase dextrose IV fluid and continue drip until transitioned
      2) Non-Type 1 DM patients: then consider discontinuing drip
   b. Hyperglycemia
      1) Make sure drip is functioning properly & changes are appropriate, ie: changing columns to right, insulin drip is not infiltrated.
      2) Consider decreasing dextrose-containing IV fluid rate or changing to a non-dextrose containing IV fluid

Peri-Operative and Peri-Procedure Orders (NPO patient)

1. Type 1 DM: must have basal insulin (see above), hold nutritional insulin
2. Type 2 DM, controlled on oral agents: simply keep NPO (see above)
3. Day of procedure:
   a. Oral medications: Hold
   b. Nutritional insulin: Hold
   c. Correctional insulin: continue as needed
   d. Basal insulin:
      1) Glargine (Lantus): continue usual dose
      2) NPH: administer only ½ or 2/3 the usual dose in AM, HS dose is usual dose.
      3) 70/30: should be avoided, but if used, give only ½ the usual a.m. dose or consider changing to NPH for peri-op.
e. Consider Insulin infusion if:
   Type 1 DM and NPO > 8 hrs
   Type 2 DM and NPO > 24 hrs
   Major surgery
   Poorly controlled glucose levels (glucose > 150mg/dL x 2 within 24 hours post-op)
   Critically ill or unstable
f. Avoid dextrose-containing IV fluids (unless on insulin drip).
g. If diet is advanced within 24 hours of surgery, remove dextrose from IV fluid (exception: Type 1 DM)

Special Situations:
1. Steroid related hyperglycemia:
   a. Determine insulin starting dose by weight based estimate.
      1) Patients with diabetes, starting TDD = 0.5-0.6 units/kg/day
      2) Patients without diabetes, starting TDD = 0.3-0.4 units/kg/day
   b. Once daily steroids – NPH/regular is the preferred regimen because morning NPH dose mimics glucose rise in response to prednisone. TDD basal 40% / prandial 60%. Prandial dose may need to be progressively increased from breakfast to lunch to dinner. A 2nd option is to divide the TDD for NPH equally by three and administer each dose at breakfast, lunch, and bedtime with the remaining 60% prandial dosing using aspart. If regular insulin is utilized instead of aspart insulin, it may also be administered TID before meals

For non diabetic patients receiving high dose steroids (prednisone) who develop post-prandial hyperglycemia, order a prandial correction scale and consider starting an AM dose of NPH insulin in a dose adjusted for patient weight and the steroid dose. For an example of one suggested dosing strategy see table from “Suggested Dosages of NPH Insulin for Tapering Doses of Glucocorticoids” (from Clore & Thorby-Hay. Glucocorticoid-induced Hyperglycemia. Endocrine Practice 2009; 15:469-474)

<table>
<thead>
<tr>
<th>Prednisone Dose</th>
<th>Insulin dose</th>
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<tbody>
<tr>
<td>Mg/day</td>
<td>Units/kg</td>
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<tr>
<td>&gt;= 40</td>
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<tr>
<td>30</td>
<td>0.3</td>
</tr>
<tr>
<td>20</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>0.1</td>
</tr>
</tbody>
</table>

c. Twice a day, three times a day, four times a day steroids – TDD Basal 50% / prandial 50%. Can use glargine/aspart
d. Sulfonylureas are ineffective for steroid induced hyperglycemia.
e. CBG 2 hours after lunch is the best measure of control for steroid induced hyperglycemia

Usual problem is post-prandial hyperglycemia (usually peaking between lunch and dinner) due to fact that primary effect of glucocorticoids on glucose metabolism is decreased glucose uptake into muscle.
2. Tube Feeding
   a. If there is a history of diabetes, recommended regimen of every 12 hours glargine (Lantus) for basal coverage if stable (approx 40% of TDD) versus Regular insulin q 6 hours (at 15% of TDD for each dose) or aspart (Novolog) every 4 hours (at 10% of TDD for each dose). The regular insulin regimen is preferred over the glargine regimen, some people prefer NPH every 6, but beware of hypoglycemia if tube feeding held given longer duration of action. Avoid using 100% of TDD of insulin as glargine (Lantus), if TF are held or decreased, this will result in hypoglycemia.
   b. If no history of diabetes and coverage is for tube feeding only, recommended regimen is Regular insulin every 6 hours.
   c. If TF are interrupted and insulin has already been given, check CBGs every 2 hours and start D10 if CBGs < 120mg/dL, order D10 at the same rate as the TF and adjust rate based on glucose trend to avoid hyper- or hypoglycemia.
   d. For cyclical TF, the timing of the insulin dose and CBGs is important. CBGs should be checked every 6 hours while on TF (beginning at the start of the TF). Depending on the length of the cycle, may also need to check 1-2 CBGs while off TF. Can give NPH at the beginning of the cycle +/- regular insulin Q6hrs during the cycle if needed + correctional scale every 6 hours.

3. Total Parenteral Nutrition
   a. 2 options
      1) If patient is on insulin drip and the drip is to be continued while on TPN - Calculate the estimated TDD based on the insulin drip rate. It is important to have at least 8 hours of overlap time with the TPN and insulin drip. Add 1/3-1/2 of the estimated TDD to the TPN in the form of regular insulin. Continue the insulin drip. The following day, more regular insulin can be added to the TPN based on the insulin drip rate.
      2) If patient is on insulin drip and the drip is to be discontinued – Calculate the estimated TDD based on the insulin drip rate. It is important to have at least 8 hours of overlap time with the TPN and insulin drip. Add 1/3-1/2 of the estimated TDD to the TPN in the form of regular insulin. Provide a dose of basal insulin to transition the insulin drip off. This is especially important in diabetic patients. Discontinue the insulin drip 2 hours after the new TPN is started. Start regular correctional scale every 6 hours. The following day, more regular insulin can be added to the TPN based on the insulin drip rate. The basal insulin can also be increased if needed.
   b. If the dextrose is being increased in the TPN, consider increasing the amount of insulin in the TPN.

4. Cardiac Surgery
   a. Recommend starting insulin drip the night prior to surgery in known diabetic patients (when NPO at midnight). Can consider starting earlier for urgent, non-scheduled cases.
   b. For known diabetic patients, continue the insulin drip for at least 48 hours post-op. May need to consider doing same for other patients, depending on glucose control and insulin drip rate.
   c. For patients on the 90-140 insulin drip protocol, may consider administering regular insulin IV boluses for CBGs greater than or equal to 250. This requires a provider’s order (either the physician or the physician’s assistant). The recommended dose is 0.1 units/kg regular insulin intravenous bolus X 1 dose. Must recheck POCT within 30 minutes. If the glucose is still greater than or equal to 250, may consider repeating same dose. Must recheck POCT within 30 minutes. Once the glucose is less than 249, continue with the 90-140 insulin drip protocol. If the patient requires more than 2 bolus doses, reassess and ensure the drip concentration is correct, the infusion rate is correct, and the IV access site looks good before ordering more doses.
   d. Consider allowing patients to eat meals while on insulin drip. These patients will need to be given nutritional insulin subcutaneously for meal coverage (using Insulin Infusion CVS orderset).
e. These patients tend to have lower insulin requirements immediately post-op (secondary to sedation, etc), but the requirements can increase rapidly within hours of surgery (including non-diabetics). Recommend keeping these patients on an insulin drip. If the drip is initially held for hypoglycemia, it may need to be restarted once the sedation wears off.

f. Epinephrine increases insulin resistance, increases glycogen breakdown, and to a small extent decreases the production of insulin. These patients may require more insulin. When the epinephrine drip is decreased or discontinued, the insulin requirements may decrease.

g. In post-op patients, if the patient is recovering well and the CBGs are improving, consider decreasing insulin 20-50% daily as stress induced hyperglycemia resolves. More aggressive daily reductions may be considered in patients without diabetes.

Hypoglycemia Management:

1. Hypoglycemia defined at KSMC at CBG < 70 mg/dL.
2. ‘15/15 rule’ for treatment: give 15 gm glucose (approximately 4 oz juice = 3 glucose tabs), then repeat CBG in 15 minutes. Repeat 15 gm glucose PO if still < 70 and/or feed meal. Give half amp of D50 ONLY if mental status changes or unsafe to swallow. May give glucagon 1 mg IM if no IV access and unable to take PO.
3. Recurrent hypoglycemia :D5 or D10 at 50 mL/hr and adjust rate as needed based on glucose.
4. ADJUST the insulin or other medication that CAUSED the hypoglycemia (see Insulin adjustment recommendations above). DO NOT hold the next dose of insulin since this was unlikely to have caused the hypoglycemia and holding the dose will result in rebound hyperglycemia.

Signing-Off Protocol

Can consider signing-off in non-cardiovascular patients once stable for 48 hours (CBGs in goal range and no insulin required) or if patient is comfort care. Check with primary team before signing-off.

Patient Education pharmacist:

1. Hypoglycemia Recognition, Definition and Management.
2. Insulin Action Times (Attachment #4).

Insulin Pumps:

1. Insulin pumps are not an approved medical device to use in the hospital. Can discuss special situations with Endocrinologist (Attachment #7).
2. Refer to MD to initiate protocol.

Discharge Planning and Transition to Outpatient

The transition process from inpatient to outpatient can be initiated as early as the day of admission and as late as the day of discharge. It is ideal to begin this process as soon as possible, optimally a few days prior to discharge. Oral medications should be restarted when appropriate, ideally closer to discharge or at discharge. Patients home insulin types should be reinstated prior to discharge to facilitate a smooth transition to outpatient.

A. Assess

1. Current and previous medication history
2. Medical history
3. Lab results
4. Patient and/or caregiver instruction on SMBG and insulin administration
5. Patient preference
B. Factors affecting medication selection include, but are not limited to:

1. HgbA1c
2. Adherence
3. Patient’s ability to pay
4. Medical status
5. Social issues

C. Restart oral agents while inpatient

1. Pharmacist may discontinue sulfonylureas and manage with subcutaneous insulin while in hospital if clinically appropriate.
2. Consider restarting Metformin when:
   a. Taking PO well (At least 50% regular diet)
   b. Stable kidney function (Male SCr < 1.5 and Female SCr < 1.4)
   c. Low risk for lactic acidosis (hypoxemia, CV collapse, respiratory failure, acute MI, acute CHF, septicemia) or metabolic acidosis
   d. No hepatic dysfunction (ALT < 3x ULN in the last 3 months)
   e. CHF should be stable and not requiring titration of medication
   f. No hypoxemia or dehydration
   g. No excessive alcohol intake (acute or chronic)
   h. > 48 hours since IV iodinated contrast media with stable kidney function, or unlikely to require same
3. Consider restarting glipizide when:
   a. Taking PO well (At least 50% of regular diet)
   b. May restart at half dose if taking at least full liquids well. Then advance to full dose when taking regular diet
   c. CrCl should be > 10 mL/minute
   d. No hepatic dysfunction (ALT < 3x ULN in the last 3 months)

D. Discharge Recommendations

1. If A1c < 7%
   Return to previous therapy
   Consider adding short-term basal insulin for stress-induced hyperglycemia or steroid-induced hyperglycemia (if requiring > 15 units of day of basal insulin)
2. If A1c 7-8%
   Increase dose of orals OR
   Add second or third oral agent OR
   Add basal insulin at HS
   Consider adding short-term basal insulin for stress-induced hyperglycemia or steroid-induced hyperglycemia (if requiring > 15 units of day of basal insulin)
3. If A1c > 8%
   If already on 2 orals, add once daily basal insulin at HS
Consider adding short-term basal insulin for stress-induced hyperglycemia or steroid-induced hyperglycemia (if requiring > 15 units of day of basal insulin)

4. If A1c > 9%
   Consider discharging on basal/nutritional insulin regimen

E. Discharge Insulins (See Attachment #8)

Type 1 DM – Glargine is standard basal insulin. Insulin Aspart is the standard nutritional insulin.

Type 2 DM – In most cases, NPH will be the standard basal insulin. Insulin regular is the standard nutritional insulin. Glargine/Aspart are acceptable insulins based on different patient categories:

Insulin Pens are acceptable if one of the following is present:

   Unable to draw up insulin accurately from a vial with a syringe due to young age, visual impairment, physical disabilities (i.e. amputations, tremors/Parkinson’s disease, rheumatoid arthritis, etc.) OR requires small doses of insulin, <5 units/dose.

F. Insulin Algorithms (How to convert insulin types)

1. Converting Lantus to NPH for discharge:
   Decrease Lantus dose by 40% (safety factor) and covert to NPH
   Example: Lantus 20 units at every bedtime = NPH 12 units at every bedtime

2. Converting Novolog to Regular insulin for discharge:
   Decrease total dose of Novolog by 20% (safety factor) and convert to Regular insulin
   Example: Novolog 10 units three times a day = Regular insulin 12 units twice a day before meals

ATTACHMENTS

1. Insulin drip infusion adjustment chart, Form No. 19142
2. Correctional insulin
3. Transition to SQ insulin
4. Insulin pharmacokinetics & glycemic management strategy
5. Steroid Comparison
6. Does this patient have Type 1 or Type 2 Diabetes?
7. Insulin Infusion Pumps, Personal, Use of the Hospital, KSMC Clinical Interdisciplinary Manual
8. Choosing the Best Insulin for Your Patient at Hospital Discharge

REFERENCES

Standards of Medical Care in Diabetes—2009. DIABETES CARE, VOLUME 32, SUPPLEMENT 1, JANUARY 2009
## Correctional Insulin

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<thead>
<tr>
<th>Blood Glucose</th>
<th>Mild Scale</th>
<th>Moderate Scale</th>
<th>Aggressive Scale</th>
<th>Custom</th>
<th>Bedtime or NPO</th>
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<tr>
<td></td>
<td>DM1, thin, elderly, kidney disease, TDD less than 40 units of insulin/day, BMI less than 25</td>
<td>Most Patients TDD 40-80 units of insulin/day BMI 25-35</td>
<td>Steroids, infection/sepsis, high insulin resistance, TDD more than 80 units of insulin/day BMI greater than 35</td>
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<td>(unless on continuous tube feeds or TPN)</td>
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<tr>
<td>151-200</td>
<td>1 unit</td>
<td>2 units</td>
<td>3 units</td>
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<tr>
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<td>2 units</td>
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<td>6 units</td>
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Glycemic Control Protocol
01/12 • (ksmc_website/documents/policies_procedures/clinical/inpatient_pharmacy)
Transition From Insulin Infusion to Subcutaneous Insulin

The target glucose is 90-150 mg/dL before meals (less than 180 mg/dL other times).
To transition from intravenous to subcutaneous insulin, first calculate the today daily dose of insulin (TDD).

Total Daily Dose (TDD) = average rate of insulin infusion over last 6 hours ____ units/hours x 24 hours
(Simple calculation is to multiply column # by 10 (insulin infusion algorithm), i.e., patient in column 4 needs approximately 40 units TDD.)

Next, select either glargine/aspart or NPH/Regular regimen.

Glargine / Aspart
For conversion from insulin infusion to insulin glargine (Lantus)/insulin aspart (NovoLog) regimen:

a. TDD ____ units/day x 0.5 = ____ units insulin glargine daily (usually dosed every morning or at bedtime)
b. Nutritional (bolus) insulin = TDD ____ units/day x 0.17 = ____ units insulin aspart SQ at meals three times a day. Nutritional insulin can be initiated if patient is taking at least a full liquid diet.

NPH / REGULAR
For conversion from insulin infusion to NPH insulin (Novolin NPH)/regular insulin (Novolin Regular) regimen. (Recommended for patients getting prednisone three times a day.)

a. Morning basal insulin = TDD ____ units/day x 0.33 = ____ units NPH SQ at breakfast (NPH peak also covers lunch)
b. Evening basal insulin = TDD ____ units/day x 0.33 = ____ units NPH SQ at bedtime
c. Nutritional (bolus) insulin = TDD ____ units/day x 0.17 = ____ units regular insulin before meals twice a day (lunch dose not needed because of morning NPH peak). Nutritional insulin can be initiated if patient is taking at least a full liquid diet

TUBE FEEDING
For continuous tube feeds and history of diabetes mellitus:

a. Basal insulin = TDD ____ units/day x 0.4 = ____ units insulin glargine daily (divided every 12 hours)
b. Nutritional insulin = TDD ____ units/day x 0.15 = ____ units regular insulin SQ every 6 hours. Hold when TF held.
c. The regular insulin regimen is preferred over the glargine regimen

For continuous tube feeds without history of diabetes mellitus:

TDD ____ units/day divided by 4 = ____ units regular insulin SQ every 6 hours. Hold when TF held.

OTHER INFORMATION
1. Patients recovering from surgery, infection, sepsis, steroids, etc., will have decreasing insulin requirements. Insulin needs may decrease by 15% to 33% per day so insulin doses will need DAILY ADJUSTMENT AND ATTENTION.
2. Estimating insulin doses without insulin infusion can be done based on weight:
   Type 1 DM (or if known type) 0.2 to 0.5 Units/kg/day = TDD
   Type 2 DM 0.4 to 0.7 Units/kg/day = TDD

Use calculations above to divide total daily dose into basal and nutritional (bolus) insulin.
Pharmacokinetics of most commonly used insulin preparations:

<table>
<thead>
<tr>
<th>Insulin Type</th>
<th>Onset of action</th>
<th>Time to Peak effect</th>
<th>Duration of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>aspart (NovoLog), lispro (Humalog), glulisine (Apidra) (all are non-formulary, but aspart is the preferred option)</td>
<td>5-15 min</td>
<td>45-75 min</td>
<td>2-4 hr</td>
</tr>
<tr>
<td>regular (Humulin R, Novolin R)</td>
<td>About 30 min</td>
<td>2.5-5 hr</td>
<td>5-8 hr</td>
</tr>
<tr>
<td>NPH (Humulin N, Novolin N)</td>
<td>About 1-2 hr</td>
<td>6-10 hr</td>
<td>12-18 hr (or less)</td>
</tr>
<tr>
<td>glargine (Lantus)</td>
<td>About 3-4 hr</td>
<td>No peak</td>
<td>18-24 hr</td>
</tr>
<tr>
<td>determir (Levemir) (non-formulary)</td>
<td>About 3-4 hr</td>
<td>NI No peak (3-14 hrs)</td>
<td>6-24 hr (dose dependent)</td>
</tr>
<tr>
<td>Humulin Regular U-500</td>
<td>1-3 hr</td>
<td>6-12 hr</td>
<td>12-24 hr</td>
</tr>
<tr>
<td>1 unit = 5 units regular insulin (non-formulary)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Glycemia Management Strategies to consider:

1. Most patients need BOTH basal and nutritional insulin. High doses of basal insulin without mealtime insulin lead to increased risk of hypoglycemia between meals and more post-mealtime hyperglycemia.

2. Any combination of basal and nutritional insulin can be used, but pharmacokinetics (above) must be considered for timing of administration.

3. Below are some commonly used regimens, but there are no ‘rules’

<table>
<thead>
<tr>
<th>STRATEGY</th>
<th>INJECTION TIMES</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>metformin &amp; Every Bedtime Insulin (NPH or Glargine)</td>
<td>Every Bedtime</td>
<td>Fewer injections</td>
<td>Patients with borderline control may benefit from adding every bedtime insulin, others may need a regimen below. NOTE: increased hypoglycemia if insulin is added to sulfonylureas</td>
</tr>
<tr>
<td>NPH &amp; Regular</td>
<td>Breakfast Dinner (or at every bedtime)</td>
<td>Fewer injections since am NPH ‘peak’ often covers lunch needs.</td>
<td>May not offer tightest control, Best for daily steroids since morning NPH will cover rise related to prednisone</td>
</tr>
<tr>
<td>glargine (Lantus) &amp; aspart (Novolog)</td>
<td>Breakfast Lunch Dinner, and usually at every bedtime</td>
<td>Offers tightest control options and is more physiologic.</td>
<td>4 injections per day. Glargine (Lantus) cannot be mixed in a syringe with other insulin. It can be given any time of day but am or at every bedtime are preferred. Rarely, some patients will need it twice a day.</td>
</tr>
</tbody>
</table>
## Steroid Comparison

Comparison of commonly used glucocorticoid preparations

<table>
<thead>
<tr>
<th></th>
<th>Approximate equivalent dose, mg</th>
<th>Relative potency</th>
<th>Mineralocorticoid activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortisol</td>
<td>20</td>
<td>1.0</td>
<td>Yes</td>
</tr>
<tr>
<td>Cortisone</td>
<td>25</td>
<td>0.8</td>
<td>Yes</td>
</tr>
<tr>
<td>Prednisone</td>
<td>5</td>
<td>4.0</td>
<td>No</td>
</tr>
<tr>
<td>Prednisolone</td>
<td>5</td>
<td>4.0</td>
<td>No</td>
</tr>
<tr>
<td>Dexamethasone</td>
<td>0.75</td>
<td>30-150</td>
<td>No</td>
</tr>
</tbody>
</table>

*(Reference: Up-to-Date) – Note: methylprednisolone is similar to prednisone (approximate equivalent dose in 5 mg and relative potency is 5)*