OBJECTIVES

• Understand the impact of glycemic control on clinical outcomes for noncritically ill medical and surgical patients
• Review current guidelines and glycemic targets for noncritically ill patients
• Review strategies for safe and effective glycemic control from admission until discharge
• Discuss challenges to glycemic control unique to the hospital setting

HYPERGLYCEMIA*: A COMMON COMORBIDITY IN MEDICAL-SURGICAL PATIENTS IN A COMMUNITY HOSPITAL

HYPERGLYCEMIA IS AN INDEPENDENT MARKER OF INPATIENT MORTALITY IN PATIENTS WITH UNDIAGNOSED DIABETES

CAUSES OF INPATIENT HYPERGLYCEMIA

- Illness related “stress” – counter regulatory hormones and cytokines cause insulin resistance
- Undiagnosed diabetes mellitus
- Medications: steroids, immunosuppressants, sympathomimetics, anesthetic agents, octreotide
- Parenteral and enteral nutrition
- Physical Inactivity
- Inappropriate insulin use e.g. Sliding scale insulin

LINK BETWEEN HYPERGLYCEMIA AND POOR OUTCOMES: POTENTIAL MECHANISMS

Metabolic stress response
- Glucose
- Insulin
- FFAs
- Ketones
- Lactate
- Reactive O2 species
- Transcription factors
- Secondary mediators

Immune dysfunction
- Infection dissemination
- Cellular immune response
- Inflammation
- Cytokines
- Adipokines
- Arachidonic acid
- Nitric oxide

Organ dysfunction
- Protracted hospital stay
- Morbidity
- Mortality


THE IMPACT OF HYPERGLYCEMIA IN NONCRITICALLY ILL PATIENTS

INPATIENT HYPERGLYCEMIA HAS BEEN SHOWN TO BE A MARKER OF POOR OUTCOMES...

- **Critical Illness:** ICU, cardiothoracic surgery, acute myocardial infarction
- **Surgery:** orthopedic, vascular, colorectal, bariatric, trauma
- **Medical:** COPD exacerbation, pneumonia
- **Neurology:** Stroke, Cerebral Aneurysm, Subarachnoid Hemorrhage
- **Obstetrics:** Labor and Delivery
INCREASED WOUND AND NOSOCOMIAL INFECTIONS

Perioperative Glycemic Control and the Risk of Infectious Complications in a Cohort of Adults with Diabetes*

<table>
<thead>
<tr>
<th>Glucose (mg/dL)</th>
<th>Relative Odds of Wound Infection</th>
<th>(P &lt; 0.05 for upward trend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>121-206</td>
<td></td>
<td></td>
</tr>
<tr>
<td>207-229</td>
<td>1.17</td>
<td></td>
</tr>
<tr>
<td>230-252</td>
<td>1.86</td>
<td></td>
</tr>
<tr>
<td>253-353</td>
<td>1.78</td>
<td></td>
</tr>
</tbody>
</table>

Early postoperative glucose control predicts nosocomial infections rate in diabetic patients

Relative risk for “serious” post-op infections increased to 5.7 when glucose >220 mg/dL


IN-HOSPITAL COMPLICATIONS WITH AND WITHOUT DIABETES IN NONCARDIAC SURGERY

Thirty-day mortality and in-hospital complication rates in patients with and without diabetes: blood infection (combined bacteremia and sepsis); urinary tract infection (UTI), acute myocardial infarction (AMI), and ARF. *P < 0.001; †NS; ‡P < 0.017.


IMMEDIATE PRE-OP GLUCOSE AND MORTALITY

- Case controlled study of 2,151 patients who underwent elective non-cardiac surgery
- Pre-op random glucose measurements defined as:
  - Normal: < 110 mg/dL
  - Pre-DM: 110-200 mg/dL
  - DM: > 200 mg/dL
- Prediabetes: 1.7 fold increased mortality compared to normal
- Diabetes: 2.1 fold increased mortality

ASSOCIATION OF MEAN GLUCOSE BEFORE AND AFTER SURGERY

Patients WITHOUT diabetes had higher odds ratio of 30 day mortality with higher mean glucloses

- All patients
- Patients with Diabetes
- Patients without Diabetes

Frisch, A et al. Dia Care 2010;33:1763-1765

PRE-OP GLYCEMIC CONTROL - ORTHOPEDICS

- 115 patients with Type 2 DM s/p TKA*
  - Preoperative HgA1c ≥ 8% was an independent risk factor of wound complications (OR 6.07)
- Duke Study**: >1 million patients who underwent joint replacement surgery from 1968-2005
  - Uncontrolled diabetes had higher adjusted odds ratio of:
    - Stroke (OR 3.42)
    - UTI (OR 1.97)
    - Postop hemorrhage (OR 1.99)
    - Wound infection (OR 2.28)
    - Ileus (OR 1.99)
    - Death (OR 3.23)


COLORECTAL AND BARIATRIC SURGERY WITH POSTOPERATIVE GLUCOSE >180 MG/DL

N=11,633

Outcomes stratified by postoperative hyperglycemia (>180 mg/dl, at any point on the day of surgery, postoperative day 1, or postoperative day 2) for diabetic patients (A) and nondiabetic patients (B). *P < 0.05; \( \odot \) P < 0.005.

EARLY (48H) POSTOPERATIVE GLUCOSE LEVELS AND SSI AFTER VASCULAR SURGERY

P for trend=0.003; **P=0.006; ***P=0.28; ****P=0.69

Adapted from Vriesendorp. Eur J Vasc Endovasc Surg 2004; 28:520-5

HYPERGLYCEMIA AND STROKE

A: Predicted probability of in-hospital adjusted mortality
B: Predicted probability of adjusted symptomatic intracranial hemorrhage

Shihab Masur et al. J Am Heart Assoc 2015;4:e002193

GUIDELINES FOR HYPERGLYCEMIA MANAGEMENT OF NONCRITICALLY PATIENTS
DANGERS OF SLIDING-SCALE INSULIN REGIMENS

- Reactive therapy → provides supplemental insulin after hyperglycemia occurs
- No basal (long term) insulin coverage:
  - Will cause DKA in patients with Type 1 diabetes
- Does not consider nutritional changes or diurnal insulin requirements
- Non physiologic dosing that results in:
  - Increased incidence of hyperglycemic and hypoglycemic episodes


ROLLER COASTER EFFECT OF SLIDING-SCALE INSULIN

RABBIT-2 TRIALS: BASAL/BOLUS SUBCUTANEOUS INSULIN THERAPY IN MEDICAL PATIENTS

- 130 insulin naive patients with Type 2 diabetes
- Discontinued all oral antidiabetic drugs on admission
- Randomized to:
  - Basal-Bolus Arm: glargine and glulisine
  - Standard Arm: Sliding Scale Insulin alone
- Starting Total Daily Dose (TDD):
  - 0.4 units/kg/d x BG between 140-200 mg/dL
  - 0.5 units/kg/d x BG between 201-400 mg/dL
  - Half as glargine and half as glulisine divided daily with meals

**RABBIT-2 TRIAL: BASAL - BOLUS INSULIN**

**THERAPY HAS BETTER GLYCEMIC CONTROL IN NON ICU MEDICAL PATIENTS**

![Graph showing blood glucose levels under different treatment regimens.](image)

- Days of Therapy: 1, 2, 3, 4, 5, 6, 7
- Blood Glucose Level: 100, 120, 140, 160, 180, 200, 220, 240 (mg/dL)

- Basal bolus: Sliding scale
- *P<0.05

Sliding scale regular insulin (SSRI) given 4 times daily.
Basal bolus regimen: glucose once daily; gluclone before meals.
0.4 U/kg x 1 kg between 140-200 mg/dL.
0.5 U/kg x 1 kg between 201-240 mg/dL.

Umpierrez GE et al. Diabetes Care. 2007;30:2181–2186

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**BLOOD GLUCOSE LEVELS IN PATIENTS WHO FAILED SSRI: TRANSITION TO BASAL BOLUS INSULIN**

![Graph showing blood glucose levels under different treatment regimens.](image)

- Days of Therapy: 1, 2, 3, 4, 5, 6, 7
- Blood Glucose Level: 100, 120, 140, 160, 180, 200, 220, 240 (mg/dL)

- SSRI
- Lantus plus Gluline

Failure was defined as 3 consecutive BG values > 240 mg/dL during SSRI

Umpierrez GE et al. Diabetes Care. 2007;30:2181–2186

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**RABBIT-2 SURGERY: BASAL - BOLUS INSULIN THERAPY HAS LOWER POSTOPERATIVE COMPLICATIONS**

- Results:
  - Daily blood glucose (BG):
    - Lower mean fasting, lower mean daily glucose more glucose readings < 140 mg/dL
  - Reduced composite endpoints of postoperative complications:
    - Reduced at 8.6 % vs. 24.3% (P=0.003)
    - Wound infection: 2.9 vs. 10.3% (P=0.247)
    - Pneumonia: 0 vs. 2.8% (P=0.247)
    - Acute renal failure: 3.8 vs. 10.3% (P=0.106)

DPP4-INHIBITORS IN THE HOSPITAL SETTING

- Randomized, open-label pilot study of general medical and surgical patients (n=50)
- T2D on diet, any orals, low dose insulin (<0.4 units/kg/day)
- 3 Arms: sitagliptin alone, sitagliptin + glargine, or basal + bolus insulin

RESULTS
- No difference in mean daily glucose
- No difference in number of target glucose readings
- No difference in hypoglycemia
- Less total daily insulin dose and number of injections in the sitagliptin group


CHALLENGES TO ORAL DIABETES THERAPIES IN THE HOSPITAL

Many restrictions to use of orals in the hospital:
- **Renal or hepatic impairment** (e.g. metformin, sulfonylureas, TZD)
- **Volume overload** (TZD)
- **Changing nutritional status or malnutrition** (insulin secretagogues)
- **Contrast dye** for imaging or procedures (metformin)
- **Slow pharmacokinetic profiles** of oral agents inflective for rapid changes in glucose and insulin requirements
- **Risk of hypoglycemia** is unclear in the hospital setting

CURRENT GUIDELINES FOR GLUCOSE TARGETS

- **Non-ICU Patients:**
  - Premeal glucose targets <140 mg/dL
  - Random blood glucose (BG) <180 mg/dL
  - To avoid hypoglycemia, reassess insulin regimen if BG levels fall below 100 mg/dL
  - Some patients may be maintained with a glucose range below and/or above these cut-points

Hypoglycemia = BG <70 mg/dL
Severe hypoglycemia = BG <40 mg/dL

ADMISSION #1: HIP FRACTURE

- 66 year old female with osteoporosis admitted with a hip fracture
- History of T2DM for 12 years, Hypothyroidism, CAD, CKD 3-4
- DM Meds: metformin 1000mg BID, glyburide 5 mg bid, sitagliptin 100 mg QD
- Admission Labs: Glucose 220 mg/dL, Cr= 1.6, A1c = 9.2%
- Underwent ORIF and postoperative glucose is now 330 mg/dL

How should we treat her diabetes?
- Continue metformin and pioglitazone but increase glyburide dose
- Discontinue all oral agents and start Sliding Scale insulin therapy Q 4-6 hours
- Start a basal (intermediate or long acting) + bolus (rapid acting) insulin regimen

USE INSULIN TO...

Be Proactive, Not Reactive
KEY CONCEPTS OF EFFECTIVE INSULIN THERAPY

- **Basal** insulin
  - Controls hepatic glucose production

- **Food (prandial)** insulin
  - Based on meal carbohydrate content

- **Correction (supplemental)** insulin
  - Treats acute elevation in blood glucose

INSULIN REVIEW

<table>
<thead>
<tr>
<th>Generic</th>
<th>Brand</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
<th>Administration Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin Regular</td>
<td>NovoRapid®</td>
<td>0-1 hr</td>
<td>40-60 min</td>
<td>0-10 min before meals</td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>Humulin N®</td>
<td>0-1 hr</td>
<td>6-10 hr</td>
<td>1-2 hr before meals</td>
<td></td>
</tr>
<tr>
<td>Long</td>
<td>Lantus®</td>
<td>0-1 hr</td>
<td>24 hr</td>
<td>1-2 hr before meals</td>
<td></td>
</tr>
</tbody>
</table>

INITIATING A BASAL BOLUS INSULIN REGIMEN

No clue where to start???
A COMPREHENSIVE DIABETES/HYPERGLYCEMIA MANAGEMENT ORDER SET

Step 1: Order glucose monitoring

Glucose monitoring is QAC and QHS for patients on a diet or Q4 for patients who are NPO, on tube feeds or TPN.

Step 2: Order basal insulin type and dose

Default frequencies are present but can be changed to other options in drop down menus.

A WEIGHT BASED DOSING TABLE IS INCLUDED IN THE ORDER SET

INITIAL DOSING FOR BASAL + BOLUS INSULIN REGIMEN

Choose patients level of insulin resistance (sensitive/average/resistant) and match to patient's weight in kg to find the dose of Lantus and Lispro with meals.
NUTRITIONAL (PRANDIAL) INSULIN

Step 3: Order a mealtime insulin dose for breakfast, lunch and dinner

<table>
<thead>
<tr>
<th>Time</th>
<th>Mealtime</th>
<th>Dose</th>
<th>Insulin</th>
<th>Frequency</th>
<th>Dose</th>
<th>PPD, 2U/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30 AM</td>
<td>Breakfast</td>
<td>1/2 Lente</td>
<td>1 unit</td>
<td>1 T/U</td>
<td>1 unit</td>
<td>2 U/mL</td>
</tr>
<tr>
<td>12:30 PM</td>
<td>Lunch</td>
<td>1/2 Lente</td>
<td>1 unit</td>
<td>1 T/U</td>
<td>1 unit</td>
<td>2 U/mL</td>
</tr>
<tr>
<td>6:30 PM</td>
<td>Dinner</td>
<td>1/2 Lente</td>
<td>1 unit</td>
<td>1 T/U</td>
<td>1 unit</td>
<td>2 U/mL</td>
</tr>
</tbody>
</table>

Nursing Instructions: If patient is NPO or premeal glucose is less than 80, hold the mealtime insulin. May be given up to 10 minutes before meal or immediately after meal if oral intake is uncertain. If corrective dose is needed, add to mealtime dose.

CORRECTION SCALE

Step 4: Order a low, medium or high dose correction scale

<table>
<thead>
<tr>
<th>Patient Status</th>
<th>Premeal Dose</th>
<th>Mealtime Dose</th>
<th>Postmeal Dose</th>
<th>Needle Size</th>
<th>Insulin PPD, 2U/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPO or not eating</td>
<td>0 units</td>
<td>1/2 unit</td>
<td>1 unit</td>
<td>25 gauge</td>
<td>2 U/mL</td>
</tr>
<tr>
<td>Premeal glucose 80-100</td>
<td>1/2 unit</td>
<td>1 unit</td>
<td>2 units</td>
<td>25 gauge</td>
<td>2 U/mL</td>
</tr>
<tr>
<td>Premeal glucose &lt; 80</td>
<td>0 units</td>
<td>1 unit</td>
<td>2 units</td>
<td>25 gauge</td>
<td>2 U/mL</td>
</tr>
</tbody>
</table>

Nurse may change the dosing to premeal if patient is eating or Q 4 hours if patient is NPO, or on Tube feeds or TPN.

HYPOGLYCEMIA TREATMENT, LABS, CONSULTS

Hypoglycemia treatment is included in the order set

Optional orders for labs: hemoglobin A1c and lipid panel

Optional orders for consultations: Endocrinology, Diabetes Education, and Nutrition
ADMISSION #1 – READY FOR DISCHARGE

- Patient has been treated with basal bolus insulin regimen
- Glucose has been between 100-180 mg/dl
- Uncomplicated postop recovery
- Cr is 1.8

What should the discharge regimen be?

Reassess pre-admission regimen:

- Outpatient DM Meds: metformin 1000mg bid, glyburide 5mg bid, sitagliptin 100mg daily
- Labs: Admission glucose 220 mg/dL, HgbA1c 9.2%, creatinine 1.6

CONSIDERATIONS WITH NON-INSULIN DIABETES MEDICATIONS

- Renal Insufficiency:
  - Metformin: Cr > 1.5 (eGFR < 60 cc/min) in men and > 1.4 in women for metformin
  - Sulfonylureas (exception of glipizide)
  - Reduce doses for DPP4 inhibitors, GLP1-RA agonists and SGLT-2 inhibitors

- Hepatic Insufficiency:
  - Metformin and TZDs: LFT’s > 2.5x upper normal

- Volume Overload:
  - TZDs: Renal failure, liver failure, heart failure

DISCHARGE REGIMENS

What is the A1c?

<table>
<thead>
<tr>
<th>A1c</th>
<th>Regimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;7%</td>
<td>Continue previous regimen</td>
</tr>
<tr>
<td>7-8%</td>
<td>Increase doses of previous agents or add additional oral on non-insulin agent. If already on max dose of ≥ 2 oral agents, consider basal insulin</td>
</tr>
<tr>
<td>8-9%</td>
<td>Add basal insulin to previous oral or non-insulin regimen or if already on basal insulin, change to multiple daily injections</td>
</tr>
<tr>
<td>&gt;9%</td>
<td>Multiple daily injections</td>
</tr>
</tbody>
</table>

Other Considerations for Patient centered Approach:
- Costs
- Patient compliance
- Risks of hypoglycemia
- Weight management
- Follow up as outpatient
ADMISSION #2: SOB

- 56 year old male admitted to the floor with pneumonia and COPD exacerbation
- History of T2DM for 6 years
- DM Meds: Metformin 1000mg BID, canagliflozin 300mg daily
- Labs: Glucose 190 mg/dL, Cr= 1.0, HgbA1c = 6.7%
- Started on antibiotics and solumedrol 60mg iv daily

How should we treat his diabetes?
1. Continue metformin and canagliflozin
2. Discontinue orals and start sliding scale insulin therapy
3. Start basal + bolus insulin therapy

INSULIN REGIMENS FOR CORTICOSTEROIDS

- Consider NPH with rapid acting regimens
- Dose basal insulin higher during the day than overnight
- Dose prandial insulin higher towards the end of the day
- May need a ratio of higher prandial than basal insulin (60-70% prandial vs. 30-40% basal)

SUGGESTED INSULIN DOSING FOR STEROID TAPER

<table>
<thead>
<tr>
<th>Prednisone Dosage (mg/day)</th>
<th>Insulin Dosage (U/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>0.4</td>
</tr>
<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>

ADMISSION # 3:
TRANSFER FROM ICU

- 72 year old female admitted with fever, SOB and hypotension
- Admitted to medical ICU for urosepsis and SIRS
- No history of Type 2 Diabetes but has HTN, Hyperlipidemia, CAD, Gout.
- Labs: Glucose = 225 mg/dL, repeat was 253 mg/dL
  HbA1c = 5.9%, Creatinine = 1.8, AST/ALT = normal
- Managed with pressors, corticosteroids, antibiotics and ventilator support
- Excellent glycemic control was achieved with intravenous insulin infusion

ADMISSION #3 – CONTINUED

- Over the next few days, the patient improves significantly.
- Pressors are weaned off and steroids are reduced. She is extubated.
- Tube feedings were started and titrated to goal rate
- 24 insulin requirements from insulin infusion while on stable TF rates are 65 units
- Renal and liver function returning to normal
- Ready for transfer to floor on current TF regimen with plans for swallow study in a few days.

What should we do with the insulin regimen?
- D/C insulin gtt and start sliding scale insulin
- Transition to a basal + bolus SC insulin regimen with sliding scale

SUBCUTANEOUS INSULIN REGIMENS FOR NPO, PARENTERAL OR ENTERAL NUTRITION

Options for Insulin Regimen:
1. Glargine/Detemir daily + Rapid Acting Q4 hours
2. NPH Q6-8 hours + Rapid Acting Q 4 hours
3. 70/30 Mixed Insulin BID - TID

Sample calculation of transition from insulin drip:
Prior 24 hours intravenous insulin = 65 units
70% = 46 units
NPH 15 units q8 hours with lispro/aspart correction q4 hours.
• Several days later the patient passes the swallow evaluation.
• Hydrocortisone is tapered off
• The TF are discontinued at 10 am
• Last NPH dose was at 8 am as scheduled
• At 1 pm, she has a hypoglycemia to 45 mg/dl

What happened?

HYPOGLYCEMIA WITH SUDDEN INTERRUPTION IN CALORIES

• Have Dextrose readily available for patients and start at the same rate as the nutritional rate if on TPN or tube feeds
• Continue iv dextrose until tube feeds resumed or effect of long acting insulin is worn off
• ADJUST THE INSULIN THERAPY OR NOTIFY THE PRIMARY PROVIDER

SPECIAL REGIMENS FOR CONTINUOUS TPN OR TUBE FEEDS

For patients on continuous tube feeds or TPN, recommend a special regimen of NPH Q 8 hours with lispro Q 4 hours

<table>
<thead>
<tr>
<th>Time</th>
<th>Insulin</th>
<th>Dextrose</th>
<th>Fat</th>
<th>Protein</th>
<th>High Fat</th>
<th>Total Carbs</th>
<th>Total Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-8 hr</td>
<td>NPH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 hr</td>
<td>Lispro</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Special nursing instructions: Start 10% Dextrose 10% IV during any interruption in tube feeds or TPN up to a max of 40 cc/hr. HOLD next insulin dose and notify prescriber for further orders.
**ADMISSION # 3 – DISCHARGE REGIMEN**

- Blood sugars have been normal without additional insulin on stable oral diet
- Ready for discharge

Does the patient need insulin or oral agents for discharge?

*On admission: HgbA1c = 5.9%*

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**HOSPITAL HYPERGLYCEMIA REQUIRES DISCHARGE FOLLOW UP**

- **In those with previously diagnosed diabetes, newly diagnosed diabetes, or elevated A1c**
  - Initiate therapy or revise preadmission regimen as required
- **In those without previously diagnosed diabetes**
  - Differentiation between hospital-related hyperglycemia and undiagnosed diabetes requires follow-up testing (FBG, 2H OGTT, A1c) once metabolically stable using established criteria

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**DISCHARGE TRANSITION**

- Diabetes Education – Survival Skills
- Nutrition counseling for carbohydrate and calorie restriction
- Reassessment of admission treatment regimen
- Transition to non insulin therapy, if appropriate
- Outpatient follow-up and referrals for ongoing care
- Clear, written medication instructions for patients
ADMISSION #4: HOSPITAL
ACQUIRED CONDITION

• 32 year old male admitted for Left femoral-popliteal bypass
• H/o Type 1 DM for >20 years on Lantus 15 units QHS and Humalog with carb counting. HgbA1c was 6.7% on this regimen
• On admission he was placed NPO after midnight and ordered a sliding scale
• On the morning of surgery, patient was found to be confused, tachypneic with shallow respirations
• Labs: Glucose =426, Potassium = 5.6, pH =7.2
  Bicarb=14, anion gap of 16, positive serum ketones

What happened???

DANGERS OF SLIDING-SCALE
INSULIN REGIMENS

• Reactive therapy → provides supplemental insulin after hyperglycemia occurs
• No basal (long term) insulin coverage:
  ➢ Will cause DKA in patients with Type 1 diabetes
• Does not consider nutritional changes or diurnal insulin requirements
• Non physiologic dosing that results in:
  – Increased incidence of hyperglycemic and hypoglycemic episodes


DKA MANAGEMENT
PROTOCOL

• Insulin Therapy:
  - Initial Bolus dose = 0.1 units/kg
  - Continuous infusion = 0.1 units/kg/hr
  - Continue drip until acidosis is resolved
• Fluid Resuscitation:
  - Normal Saline until BG < 250, the D5%NS
• Electrolyte Repletion
  - Potassium – Add to iv fluids if K < 5.3 mEq/L
  - Bicarb replacement if pH < 7.0
  - Phosphate replacement
CONTINUOUS SUBCUTANEOUS INSULIN PUMPS (CSII)

- Increased utilization of CSII as outpatient in both Type 1 and Type 2 diabetes
- Lack of knowledge by medical personnel in the hospital setting
- No definitive guidelines
- Some small, single center studies have shown that continuing CSII is safe in the hospital
- Standardized hospital protocols, order sets and patient consents are recommended
- Endocrine consultation

CHALLENGES TO GLYCEMIC CONTROL IN THE HOSPITAL SETTING

BARRIERS IN THE HOSPITAL

- Diabetes/hyperglycemia often overlooked on admission and throughout the hospitalization
- Hypoglycemia feared and often over-treated
- Lack of familiarity with the increasing types of diabetes therapies currently available
- Hyperglycemia is not the primary diagnosis and therefore not a priority
- Traditional sliding scale protocols continue to prevail
BARRIERS IN THE HOSPITAL

- Increased workload on nursing
- When insulin used, timing may still be problematic
- Lack of coordination between departments, e.g., nutrition, radiology, nursing, etc.
- Complexity of individualized dosing + need to make daily adjustments

CONDITIONS PREDISPOSING PATIENTS TO HYPOGLYCEMIA

- Advanced age
- Sepsis/shock
- Malnutrition
- Burns
- Gastrointestinal malabsorption
- Cerebrovascular accident
- Hypoglycemia unawareness
- Altered Mental Status
- Congestive heart failure
- Renal insufficiency
- Adrenal/pituitary insufficiency
- Liver disease
- Pregnancy
- Alcoholism
- Polypharmacy (drug interactions)

IATROGENIC CAUSES OF HYPOGLYCEMIA

- Sudden NPO status or reduction in oral intake
- Enteral feeding or TPN discontinued
- Glucose monitoring and insulin administration are not timed appropriately
- Premal insulin given and meal delayed or not ingested
- Unexpected transport from nursing unit after rapid-action insulin given
- Reduction in corticosteroid dose
INPATIENT DIABETES
TEAMS

Multidisciplinary experts in diabetes are needed to form an effective team:
1. Clinician: physician or physician extender
2. Nurse
3. Diabetes Educator
4. Nutritionist
5. Pharmacist

THANK YOU FOR YOUR ATTENTION!