

Improving Glycemic Control in Hospitals

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Objectives

- State the target fasting and peak blood glucose levels for non-ICU hospitalized patients
- State two components of a comprehensive in-hospital glucose control program
- State one common nutrition issue affecting glycemic control for inpatients

Outline

- Prevalence of Diabetes and Hyperglycemia in Hospitals
- Blood Glucose Control Targets and Recommendations
- Evidence of MNT Efficacy and MNT Goals
- Addressing Special Nutrition Needs
- Integrating Insulin Prescription with Nutrition and Blood Glucose Monitoring
- Components of a Comprehensive Glucose Control Program
- Case Studies

Diabetes Related Hospitalizations

- In 2004, nearly 6.3 million hospital stays occurred among patients with diabetes (diabetes as primary reason for hospitalization or as a coexisting condition).
- Hospital costs 2004
 - Primary diagnosis of diabetes \$3.9 billion
 - Any mention of diabetes \$57.8 billion
 - 20% of hospital costs in the United States involved diabetes

What is the Prevalence of Diabetes and Hyperglycemia?

- Known diabetes in hospitalized patients is reported to be from 12.4% to 25%
- Additionally patients often have undiagnosed diabetes, illness-induced hyperglycemia, or medications that lead to hyperglycemia (e.g. steroids), which combined may impact as many as 30% of hospitalized adults

Hyperglycemia In Hospitalized Patients

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graph TD; A[Hyperglycemia In Hospitalized Patients] --> B[Known/Diagnosed Diabetes]; A --> C[Previously Undiagnosed Diabetes]; A --> D[Transient/Stress Hyperglycemia]; B --> E[Opportunity to address efficacy of existing diabetes control regimen]; C --> F[Diabetes or pre-diabetes Unrecognized diabetes confirm at discharge & monitor later]; D --> G[May revert to normal after discharge];
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Known/Diagnosed Diabetes

Opportunity to address efficacy of existing diabetes control regimen

Previously Undiagnosed Diabetes

Diabetes or pre-diabetes Unrecognized diabetes confirm at discharge & monitor later

Transient/Stress Hyperglycemia

May revert to normal after discharge

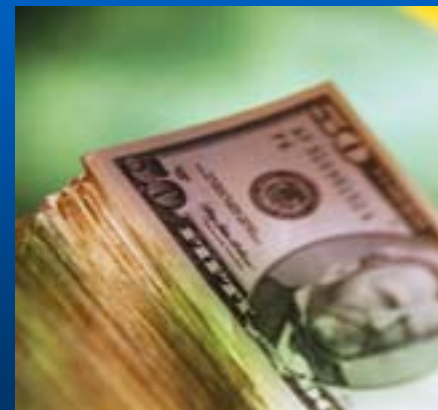
Hyperglycemia Should Be Treated

General Medical and Surgical Patients

- Patients with blood glucose values >220 mg/dl have higher infection rates
- Known diabetes or new hyperglycemia
 - Significantly increased in hospital mortality
 - More likely to require care in an intensive care unit (ICU)
 - More likely to require transitional or nursing home care
- Length of stay higher in new hyperglycemia group than with known diabetes

Potential Benefits of Improving In-Hospital Blood Glucose Control

- Reduced mortality
- Reduced morbidity
- Reduced cost of care by:
 - Shorter length of stay
 - Lower cost of inpatient complications
 - Fewer re-hospitalizations
 - Reduced extended care



Recommendations for Inpatient Glucose Targets

American Diabetes Assoc

Intensive Care Units:

- Close to 110 mg/dL as possible; generally < 180 mg/dL

Non-Critical Care Units:

- Pre-meal close to 90-130 (midpoint 110 mg/dL) as possible given the clinical situation and a postprandial blood glucose level < 180 mg/dL.

American College of Endocrinology

Intensive Care Units:

- Maintain blood glucose ≤ 110 mg/dL.

Non-Critical Care Units:

- Maintain pre-meal blood glucose ≤ 110 mg/dL and peak postprandial blood glucose ≤ 180 mg/dL.

Factors Affecting In-Hospital Glycemic Control

- Stress and illness
- Infection
- Medical procedures
- Decreased activity
- Nothing by mouth (NPO) status
- Meals differing from home

Barriers to Good Glycemic Control

- Reliance on sliding scale insulin regimens
- Health-care professionals (and patients) fear of hypoglycemia
- Lack of understanding of treatment of hyperglycemia and diabetes
- Lack of integrated systems to effectively monitor and trend hypoglycemia and glycemic control
- Majority of patients are admitted for reasons other than hyperglycemia

Definition of Medical Nutrition Therapy (MNT)

MNT includes an assessment of nutritional status and the provision of diet modification, counseling, or specialized nutrition therapy.

MNT in the Outpatient Setting: Type 2 Diabetes

Randomized controlled trials and outcome studies of MNT have reported decreases in A1C of ~1% to 2%, depending on the duration of diabetes.

- MNT provided by dietitians as MNT alone or in combination with diabetes self-management training (DSMT).
- Interventions included reduced energy intake, and/or reduced carbohydrate/fat intake, basic nutrition and healthy food choices for improved glycemia
- Outcomes of interventions were known by 3 months.

Evidence for MNT Type 2 Diabetes

Study (MNT only)	A1C Decrease	Intervention
UKPDS, 1990	1.9% (new diagnosis)	Reduced energy/fat
Franz, 1995	.9% (4-y) 1.7% (new)	Reduced energy/fat
Goldhaber-Fiebert, 2003	1.8%	Portion control and healthier food substitutes
Ziemer, 2003	1.9%	Healthy food choices
Lemon, 2004	1.7%	Carbohydrate counting and simplified meal plans

Evidence for MNT Type 2 Diabetes

Study (MNT in DSMT)	A1C Decrease	Intervention
Sadur, 1999	1.3%	Healthy food choices for improved glycemia
Rickheim, 2002	2% (new)	Carbohydrate counting
Polonsky, 2003	2.3% intensive DSMT 1.7% standard DSMT	Reduced carbohydrate/fat
Banister, 2004	1.5%	Basic nutrition concepts/individualized meal planning strategies

MNT in the Outpatient Setting: Type 1 Diabetes

Randomized controlled trials and outcome studies of diabetes MNT have reported decreases in A1C of ~1%.

- MNT in these studies was provided by dietitians as MNT alone or as MNT in combination with DSMT.
- Interventions include matching insulin doses to desired carbohydrate intake and carbohydrate counting.

Evidence for MNT Type 1 Diabetes

Study	A1C Decrease	Intervention
Delahanty/Halford, 1993	.9%	Carbohydrate counting or exchanges
Kulkarni, 1998	1%	Carbohydrate counting or exchanges
DAFNE, 2002	1%	Matching insulin to carbohydrate
Pieber, 1995; Bott, 1997	1.5%	Matching insulin to carbohydrate

Diabetes MNT Goals: Hospitalized Patients

- Attain and maintain optimal metabolic control of blood glucose, lipids, and blood pressure to enhance recovery from illness and disease
- Incorporate nutrition therapies to treat the complications of diabetes, including hypertension, cardiovascular disease, dyslipidemia, and nephropathy

MNT Goals Continued

- Provide adequate calories for illness and recovery
- Improve health through use of nutritious foods
- Address individual needs based on personal, cultural, religious, and ethnic food preferences
- Provide a discharge plan for continuing self-management training and follow-up care

Screening Criteria

- Screening criteria may include:
 - Insulin or oral diabetes medications
 - Modified diet
 - NPO status
 - Specific admitting diagnoses (such as DKA)
 - Laboratory measures (including blood glucose)

Nutrition Assessment

- Pertinent diagnoses and medications
- Laboratory measures, including blood glucose values, and anthropometrics
- Nutritional adequacy of dietary intake
- Nutrition-related consequences of disease
- Psychosocial, functional and behavioral factors related to food and nutrition intake

Nutrition Assessment Continued

- Diabetes knowledge and self-management skills
- Readiness-to-learn and potential for behavior change
- Lifestyle/cultural influences and literacy skills
- Support systems
- Assessment of mobility, vision, hearing and dexterity
- Previous education and future educational needs for discharge planning

Clement S, et al. (Technical review). *Diabetes Care*. 2004;27:553-591

Lacey K, Pritchett E. *J Am Diet Assoc*. 2003;103:1061-1072

Nutrition Intervention

- Diets continue to be inappropriately ordered by specific calorie levels or “ADA Diet”
- Consistent Carbohydrate
 - Meal planning system developed for hospitals to provide a practical way of serving food to diabetes patients while improving glycemic control

Consistent Carbohydrate

- Carbohydrate is consistent from meal to meal and day to day
 - Emphasis on total carbohydrate content at each meal, not specific calorie amounts
- One carbohydrate serving provides approximately 15 grams of carbohydrate
- Average menu contains 1800 to 2000 calories, with 12 –15 carbohydrate servings, divided between meals and snacks

Consistent Carbohydrate During Diet Progression

- Non-caloric, sugar-free liquid diets are not appropriate for patients with diabetes
 - 200 gms CHO evenly distributed throughout the day
- If the patient is unable to tolerate advancement of the diet, enteral or parenteral nutrition may be required

Insulin Dosing Terminology

- **Basal Insulin**
 - Amount of insulin necessary to maintain blood glucose between meals and when not eating
- **Nutritional Insulin**
 - Needed to cover enteral or parenteral nutrition, and/or intravenous dextrose, snacks or oral supplements, not just discreet meals
- **Supplemental or Correctional Insulin**
 - Amount of insulin given for *unexpected* hyperglycemia before meals or between meals given in addition to the *scheduled insulin*; prior to bedtime a lower dose is usually provided

Nutrition Issues Affecting Glycemic Control: Potential Interventions

Decreased appetite with poor oral intake

- Allow patients to make food substitutions with similar carbohydrate content.
- Snacks/supplements may need to be included to ensure adequate calorie and protein intake. The need for snacks should be individualized.
- Injecting rapid-acting insulin immediately following a meal may be appropriate to more accurately match actual carbohydrate intake.

Common Nutrition Issues with Potential Interventions Continued

Inconsistent carbohydrate intake

- Patients with poor nutritional intake, insulin may need to be decreased
- Meal coverage insulin should not be withheld for “normal” blood glucose levels.
- Patients, family members, and hospital volunteers should understand the effect of carbohydrate on blood glucose and notify hospital staff if additional food is brought to the patient

Common Nutrition Issues with Potential Interventions Continued

Delayed meals/inconsistent meal timing

- Nutritional insulin may need to be withheld if meal is missed or delayed, however, basal insulin is typically still required (will always be required in type 1)
- Patients on oral diabetes medications that may cause hypoglycemia: consider providing a snack if a meal delay is anticipated.

Common Nutrition Issues with Potential Interventions Continued

- Physical activity level
 - Insulin and meal plan may need adjustment as activity level increases or decreases
- Timing of blood glucose monitoring to meal and insulin delivery
 - When using rapid acting insulin the meal tray should be at the patient's bedside before giving injection

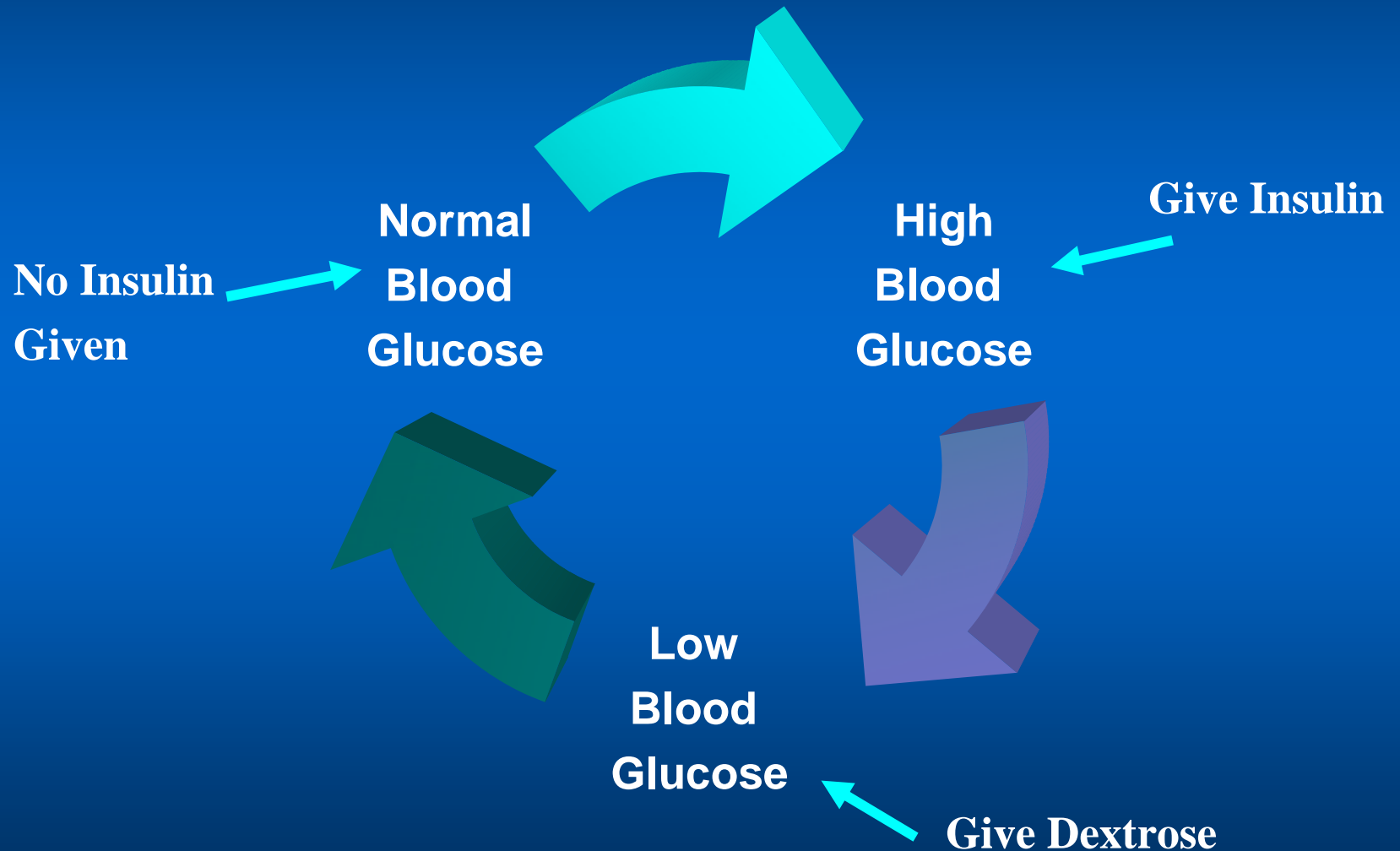
Why Not Use Sliding Scale Insulin?

- Traditional “Sliding Scale” insulin regimens consist of regular insulin without any intermediate or long-acting insulin
- Administered for hyperglycemia without regard to timing or amount of food intake
- Often used throughout the hospital stay with no modification
- “Reactive” approach can lead to rapid changes in blood glucose levels

American Diabetes Association, *Diabetes Care*. 2007;30(Suppl. 1):S4-S41.

Magee MF, Clement S. *Endocrine Practice*.2004;10(Suppl 2):81-88.

Sliding Scale Insulin



Contraindications of Oral Diabetes Medications in the Hospital Setting

Sulfonylureas (and Meglitinides):

- Long action and predisposition to hypoglycemia in patients not consuming their normal nutrition; generally do not allow for rapid dose adjustment.

Metformin:

- Conditions that occur in the hospital setting can potentially lead to lactic acidosis, most commonly congestive heart failure (CHF), renal insufficiency, chronic pulmonary disease.

Oral Diabetes Medications Continued

Insulin Sensitizers (TZDs):

- Delayed onset of effect. Increase intravascular volume potential problem in CHF and with hemodynamic changes related to admitting diagnoses

Alpha Glucosidase Inhibitors:

- Only effective in patients who are eating due to method of action of blunting CHO absorption

Injectable Non-Insulin Glucose Lowering Agents

Pramlintide and Exenatide

- Not appropriate for patients who are not eating (NPO) or with poor appetite
- Nausea is a common side effect
- Better suited to the outpatient setting and initiating when patients are not ill

Glycemic Control Considerations with Nutrition Support

- Additional sources of dextrose include IV fluids as well as dialysates used with peritoneal and continuous renal replacement therapy.
- Sudden interruption of either enteral or parenteral nutrition may lead to hypoglycemia

Charney P, Hertzler SR. *Nutr Clin Pract.* 2004;19:129-136;

Campbell K, Braithwaite S. *Clinical Diabetes.* 2004;22:2:81-88

Insulin During Nutrition Support

Parenteral Nutrition

- Regular insulin can be added to the parenteral nutrition solution, or to allow for more frequent dose adjustments, given through a separate IV insulin infusion
- Continuous scheduled insulin coverage is generally needed to achieve and maintain adequate glycemic control

Parenteral Nutrition

- Goal is to sustain the patient during critical illness and not aggravate metabolic management
- Overfeeding can result in hyperglycemia, abnormal liver function tests, increased oxygen consumption, and increased carbon dioxide production
- Enteral nutrition is the preferred route over parenteral when possible

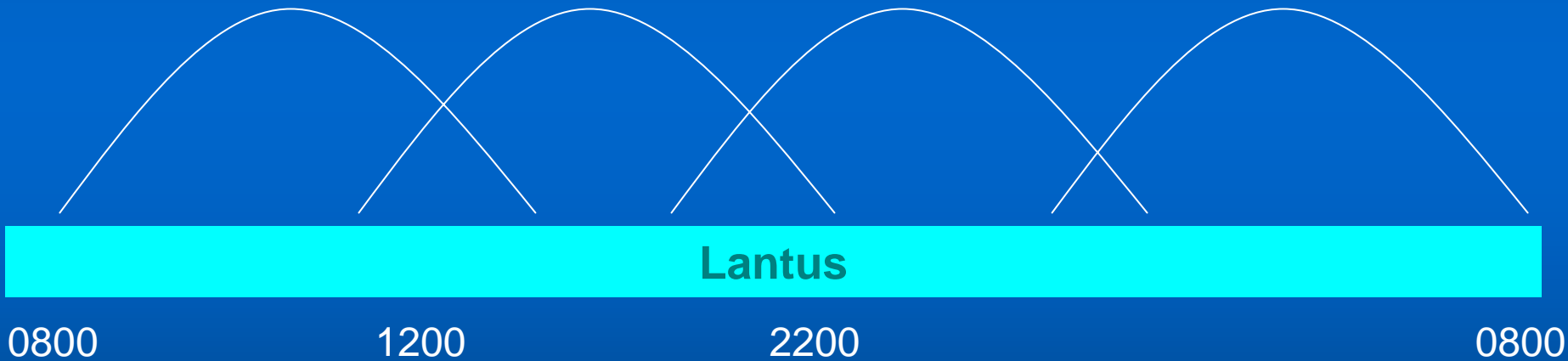
Glycemic Management During Enteral Nutrition:

- Factors influencing glycemic management options during enteral nutrition therapy include:
 - Pre-hospitalization medication/insulin regimen
 - Level of stress
 - Admitting diagnosis
 - Continuous or intermittent enteral feeding
 - The type of enteral formula used

Continuous Enteral Feeding

- Sample Insulin regimen for Continuous Enteral Feeding
 - $\frac{1}{2}$ of total insulin requirement as basal Insulin
 - $\frac{1}{2}$ of total insulin requirement as regular insulin divided into equal doses given every 6 hours
 - Hold regular insulin if BG < 120 mg/dl or if feeding discontinued

Suggested Insulin Regimen for Continuous Enteral Feeding



Intermittent Enteral Feeding

- Sample insulin regimen for intermittent enteral regimen
 - Give regular insulin or rapid-acting insulin analog subcutaneously prior to each feeding bolus
 - Give basal insulin if needed based on blood glucose monitoring results

Blood Glucose (BG) Monitoring Recommendations



- ICU on IV insulin therapy
 - Usually hourly blood glucose testing until stable, then every 2 hrs
- With intermittent enteral feeding
 - Fasting BG pre- and 2 hours post-bolus
- With continuous enteral feeding or NPO
 - BG testing every 4-6 hours
- Eating meals
 - Pre-meal and bedtime

Decreasing Insulin Errors: What Works?

- Eliminate all isolated use of regular insulin sliding scales
- Simplify subcutaneous insulin products; consider eliminating regular insulin except for IV use
- Insulin guideline pocket cards
- Insulin guideline hospital intranet web (or in electronic medical records)
- Specialized CPOE insulin order sets
- Hypoglycemia prevention/treatment order set

Hypoglycemia

- Fear of hypoglycemia is the leading limiting factor for in-hospital glycemic management
- Precipitating factors
 - New NPO status
 - Decrease in IV dextrose
 - Unexpected interruption of enteral or parenteral nutrition
 - Decreased oral intake
 - Emesis
 - Altered nutritional state
 - Heart failure, infection, renal disease, liver disease

Hypoglycemia Prevention

- Understanding that more activity or less carbohydrate intake can lead to hypoglycemia
- Importance of blood glucose monitoring in relation to meal times and insulin delivery
- Know onset and peak time of type of insulin given; e.g. regular insulin may be given 30 minutes before a meal but rapid-acting insulin should not be given more than 15 minutes before a meal

Hypoglycemia Treatment

- Have an established hypoglycemia protocol
- Educate staff on protocol use
- Implement hypoglycemia protocol on all patients with insulin orders
- 15-15 rule; give 15 grams carbohydrate and re-test blood glucose in 15 minutes
 - Glucose tabs
 - Glucose gel
 - 4 oz juice



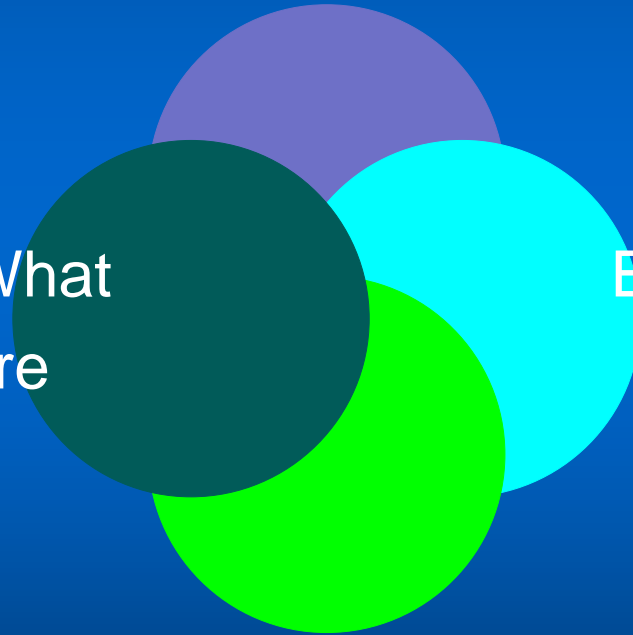
Components of a Comprehensive Inpatient Glucose Control Program

Needs to Be a Hospital Priority

Metrics How and What
You Will Measure

Education About
the Program

Patient Care



Blood Glucose Control Program Implementation

- Physician champion
- Administration support
- Multi-disciplinary team
- Pharmacy & therapeutics committee approval
- Forms
- Education: nursing staff, pharmacists, physicians, dietitians, & patients
- Monitoring/Quality Assurance

Implementation: Medical Treatment Plan

- Method of identifying hyperglycemia
- Guidelines for discontinuation of oral diabetes medications; and use of insulin as appropriate for hyperglycemic patients
- Integration of blood glucose monitoring results with medical treatment plan
- Prevention and treatment of hypo and hyperglycemia
- Standing orders for diabetes/nutrition education and follow up testing and care after discharge as appropriate

Implementation: Nutrition Care Plan

To ensure that the nutrition care plan works with the medical treatment plan:

- Establish screening criteria for appropriate referral to an RD
- Identify nutrition-related issues in clinical pathways and patient care plans
- Standardized diet orders such as consistent carbohydrate menus
- Integrate blood glucose monitoring results with nutrition care plans
- Standardize discharge follow-up orders for medical nutrition therapy and diabetes education

Implementation: Diabetes Education Plan

- DSME is difficult and challenging in the hospital setting
- “Survival skills” teaching is generally a feasible approach.
- The following patients need instruction prior to discharge:
 - new diagnosis of diabetes
 - admitted with diabetes crisis (DKA) or due to poor management at home
 - new to insulin or blood glucose monitoring

Case Study 1:

65 year old woman admitted with pneumonia. She has a 12 year history of type 2 diabetes treated with metformin and glyburide. Her weight is 176 pounds. She has a fever and dehydration but she is not unstable. Blood glucose is 273 mg/dl. She is treated with IV fluids and antibiotics. Her A1C is 8.4%

Discussion Case Study 1

- Medication Treatment Options:
 - Continue oral agents?
 - Continue oral agents with sliding scale insulin?
 - Begin sole therapy with sliding scale insulin?
 - Begin basal bolus insulin therapy?

Discussion Case Study 1

- Medication Treatment Options:
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Discussion Case Study 1

- What are her possible diabetes education needs?
- Should she receive education in the hospital setting before discharge?

Case Study 2

62 year old man with a 9 year history of type 2 diabetes. Admitted with a foot ulcer and surrounding cellulitis. He has been treated with metformin 500 mg BID and glyburide 5 mg BID for the past year and a half. Initial blood glucose is 260 mg/dl. He is treated with IV antibiotics and his wound is debrided. In the hospital is he treated with NPH and lispro insulin dosed BID with blood glucose stabilizing in the 100-150 mg/dl range. After 5 days he is ready for discharge home.

Discussion Case Study 2

- What therapy should this patient be sent home on?
- What additional clinical data would you need to decide?

What is his A1C?

Scenario 1
A1C = 6.6%

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graph TD; A["Scenario 1  
A1C = 6.6%"] --> B["Do Nothing con't  
glyburide 5 BID  
and metformin 500 BID"]; A --> C["Increase metformin  
to 1000 BID  
Continue glyburide 5 BID"]; B --- D["Not Ideal"]; C --- E["Ideal"]
```

Do Nothing con't
glyburide 5 BID
and metformin 500 BID

Not Ideal

Increase metformin
to 1000 BID
Continue glyburide 5 BID

Ideal

Scenario 2
A1C = 9.2%

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graph TD; A["Scenario 2  
A1C = 9.2%"] --> B["Increase metformin  
to 1000 BID  
Continue glyburide 5  
BID and add a TZD"]; A --> C["Start Insulin"]; B --- D["Not Ideal"]; C --- E["Ideal"];
```

Increase metformin
to 1000 BID
Continue glyburide 5
BID and add a TZD

Not Ideal

Start Insulin

Ideal

Case Study 2 Discussion

- What are his possible diabetes education needs?
- Should he receive education in the hospital setting before discharge?

Case Study 3

58 year old woman with history of COPD is admitted to the hospital in acute respiratory distress. She has no previous history of diabetes. Once admitted she is treated with methylprednisolone, antibiotics, bronchodilators and oxygen. Random blood glucose on admission is 180 mg/dl. Due to worsening respiratory distress she is admitted to the ICU for closer monitoring. Four hours after admission her blood glucose is 235 mg/dl

Discussion Case Study 3

- Should the hyperglycemia be treated?
- Should an A1C be ordered to determine if she had pre-existing diabetes? How would that make a difference and why?
- Should insulin be ordered for this patient? Should it be subcutaneous or IV? What factors would you take into consideration to decide?
- How often should her blood glucose be monitored?

Team Approach To Treatment Of The Hospitalized Individual with Diabetes



Physician

Diabetes Educator

Dietitian

Patient

Pharmacist

Endocrinologist

Nurse