Hospital Diabetes / Glycemic Control: Tools for Improvement

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SGIM Precourse 03

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Essential First Steps
- Gain institutional support, survey previous / ongoing efforts and resources, form team, define reporting structure, general goals, improvement framework

Identify best practices / evidence
- build into a protocol

Analyze care delivery
- Process maps, FMEA, fishbone

Performance Tracking / Metrics
- Then create specific goals

Integrate protocol into work flow, layer interventions and reliability techniques

Continued Improvement / monitoring
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• **Continued Improvement / monitoring**
Quality Improvement
Introduction

SGIM Precourse, 2007
Kevin Larsen, MD
Assistant Professor, Internal Medicine, U of MN
Hennepin County Medical Center
Why Evidence Based Medicine?

What doctors do

Good medical evidence
What is Quality Improvement?

• Quality improvement (QI) is the process of continually evaluating existing processes of care and developing new standards of practice.

• QI is influenced by objective data and focuses on systems change, rather than individual performance, in order to optimize performance and appropriate resource utilization.
Why do we care?
The Institute of Medicine (IOM) Roundtable

• “…Serious and widespread quality problems exist throughout American medicine. These problems….occur in small and large communities alike, in all parts of the country, and with approximately equal frequency in managed care and fee-for-service systems of care. Very large numbers of Americans are harmed as a result….”
The IOM Roundtable

• “…Serious and widespread quality problems exist throughout American medicine. These problems….occur in small and large communities alike, in all parts of the country, and with approximately equal frequency in managed care and fee-for-service systems of care. Very large numbers of Americans are harmed as a result….”
IOM Health Care Safety

• 7% of hospital patients experience a serious medication error

• 44,000-98,000 Americans die in hospitals each year due to injuries from care
How Hazardous Is Health Care?

(Leape)

<table>
<thead>
<tr>
<th>Total lives lost per year</th>
<th>Number of encounters for each fatality</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>1</td>
</tr>
<tr>
<td>10,000</td>
<td>10</td>
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<tr>
<td>1,000</td>
<td>100</td>
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<td>100</td>
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<td>10,000</td>
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<tr>
<td>1</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

DANGEROUS
(>1/1000)

HealthCare

REGULATED

Driving

Chemical Manufacturing
Chartered Flights

ULTRA-SAFE
(<1/100K)

Scheduled Airlines
European Railroads
Nuclear Power

Mountain Climbing
Bungee Jumping
Intro to QI covering

– systems based care
– plan/do/study/act model
– workflow analysis
– interdisciplinary team for your work
– root cause analysis/healthcare failure modes analysis
– measurements to know you are successful
– sustainability
System based care

• In highly reliable systems, the system supports quality
  – E.g computer cords, you can’t plug the wrong cord into the wrong spot, it won’t fit- you can with arterial vs venous central lines

• “Every system is designed to get exactly the outcome it gets.”
System based care

• A “bad outcome” is a fault of the system
• Reliable systems have multiple checks and layers of defense
• Swiss cheese model of error
Some holes due to active failures

Other holes due to latent conditions

SUCCESSIVE LAYERS OF DEFENSES

HAZARDS
Some holes due to active failures

Other holes due to latent conditions

Accident

SUCCESSIVE LAYERS OF DEFENSES

HAZARDS
Plan what you are going to do, after you have gathered some evidence of the nature and size of the problem.

Do it, preferably on a small scale first.

Study the results. Did the plan work?

Act on the results. If the plan was successful, standardize on this new way of working. If it wasn't, try something else
Plan - Do - Study - Act

**Plan** a change or test aimed at improvement

**Do** it (preferably on a small scale)

**Act**
- Adopt the change
- Abandon it
- Test again

**Study** the results.
What did we learn?
Wheels in Motion: Continuous Quality Improvement

Improvement

Changes that result in improvement
Quality Improvement Organizations

• IHI- Institute for Healthcare Improvement
  – Voluntary, National
• UHC- University Health Consortium- group of teaching hospitals that share data to compare and “benchmark”
• SHM- Quality Improvement Resource Rooms
Accrediting and legal requirements

• JCAHO- Joint Commission on Accreditation of Healthcare Organizations
  – National, sets standards, accredits the hospital

• Minnesota Department of Health- adverse event reporting law
  – Hospitals required to report certain conditions and adverse events (e.g. wrong site surgery)
JCAHO – core measure example

AMI-9 Inpatient mortality

Numerator: Inpatient mortality of AMI patients
Denominator: AMI patients
JCAHO core measure- example

**HF-4 Smoking Cessation Counseling**

- **Numerator:** HF patients who receive smoking cessation advice or counseling
- **Denominator:** HF patients with a history of smoking cigarettes during the year prior to arrival

Average Cases Per Month
National n = 211
### MN Adverse Event Report Card for HCMC 2006

<table>
<thead>
<tr>
<th>CATEGORY AND TYPE</th>
<th>NUMBER</th>
<th>BACKGROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURGICAL EVENTS</td>
<td></td>
<td>9,009 surgeries were performed at this facility during this time period</td>
</tr>
<tr>
<td>Wrong surgical procedure performed</td>
<td>1</td>
<td>Deaths: 0; Serious Disability: 0; Neither: 1</td>
</tr>
<tr>
<td>CARE MANAGEMENT</td>
<td></td>
<td>There were 179,501 patient days at this facility during this time period</td>
</tr>
<tr>
<td>Death or serious disability associated with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 3 or 4 pressure ulcers (with or without death or serious disability)</td>
<td>5</td>
<td>Deaths: 0; Serious Disability: 0; Neither: 5</td>
</tr>
<tr>
<td>CRIMINAL EVENTS</td>
<td></td>
<td>There were 179,501 patient days at this facility during this time period</td>
</tr>
<tr>
<td>Sexual assault on a patient</td>
<td>1</td>
<td>Deaths: 0; Serious Disability: 0; Neither: 1</td>
</tr>
<tr>
<td>TOTAL EVENTS FOR THIS FACILITY</td>
<td>7</td>
<td>Deaths: 0; Serious Disability: 0; Neither: 7</td>
</tr>
</tbody>
</table>
Plan- Workflow analysis

• Analyze your system to find how the work is done
• Will likely need input from others involved in the process
• Can be simple or complex
• Different box shapes can indicate different things
Workflow analysis

Sample High-Level Flowchart: Ischemic Heart Disease Patient Flow

- Patient has acute symptoms
  - Triage in ER: Evidence of MI?
    - Yes: Early anti-ischemia/infarction therapy
      - Inpatient evaluation and therapy
        - Invasive evaluation done?
          - Yes: Revascularization procedure
          - No: Ambulatory care: Rehab and follow-up
          - Procedure indicated?
            - Yes: Revascularization procedure
            - No: Ambulatory care: Rehab and follow-up
    - No: Ambulatory care: Initial evaluation
      - Ambulatory care: Follow-up care
Plan- Project team

- Will need multiple team members
- Input from people appropriate to the workflow
- Doctor doesn’t need to be the leader
- All ideas listened to
- Team may only need to exist for the project
Plan- Failure mode analysis

- FMEA includes review of the following:
  - Steps in the process
  - Failure modes (What could go wrong?)
  - Failure causes (Why would the failure happen?)
  - Failure effects (What would be the consequences of each failure?)
FMEA Tool can be used to

• 1. Analyze the current process and evaluate the potential impact of changes under
• 2. Track improvement over time

http://www.ihi.org/ihi/workspace/tools/fmea
Failure mode analysis

Sample High-Level Flowchart: Ischemic Heart Disease Patient Flow

- Long delay in triage
- Long delay to cath lab
- Fail outpatient appointment
Fishbone diagram

Cause and Effect Diagram: “Fishbone”

People
- Secretary
  - Heavy workload
  - Unavailable when lab called
- Lab tech
- Dispatcher
  - Heavy workload
  - No tracking process
- Phlebotomist

Environment
- Clocks
- Inaccurate
- Transcription error
- Don’t agree
- Rounding

Materials
- Specimen vials
  - Unavailable
  - Spoiled
- Lab supplies
  - Unavailable
  - Spoiled

Methods
- Too many people involved
- Handling in lab
- Escort stopped other places before lab

Equipment
- Lab equipment
  - Slow
  - Do-over
  - Capacity
- Pager malfunction
  - Hard to use
  - Inadequate training
- Phone system
  - Capacity
  - Down

Long test results time
Do-Choose an intervention

- Find a weak spot in your failure mode analysis (a big hole in the cheese)
- Identify one that is system based (not personal responsibility)
- Try to find the simplest one with the biggest impact
Use Performance Improvement Principles

- Institutional buy in / support
- Multidisciplinary team
- Find out where you are, and what your goals are
- Metrics that are reliable, practical
- Pay attention to ease of use
- Standardize the process (devise and refine a protocol)
- Layer interventions and methods to enhance reliability
- Fail faster: ongoing feedback and refinement
- Education: necessary but not sufficient
Study- Types of Measurement/metrics

**system measure** – measures capacity, e.g. how many computers on a unit

**process measure** – measures how well you are doing something, e.g. rate of influenza vaccines given before discharge

**outcome measure** - ultimate measure, e.g. rate of in hospital mortality

Much More on this Later
ACT- Sustainability

• Project should be ongoing
• Use data to refine your intervention
• Move to another area or
• Choose another failure mode
• Consider a run chart or dashboard
Run chart

• Run charts are graphs of data over time and are one of the single most important tools in performance improvement.

• Using run charts has a variety of benefits:
  – help improvement teams formulate aims by depicting how well (or poorly) a process is performing.
  – help in determining when changes are truly improvements by displaying a pattern of data that you can observe as you make changes.
  – give direction as you work on improvement and information about the value of particular changes.
Sample Run Chart: Cesarean Section Rate

XYZ Hospital
Anytown, NY, USA

Median Line

GOAL: 12%

Deliveries per month = 350-450
Domains for Quality Improvement

- Inpatient Unit
- Inpatient Service
- Hospital
- Clinic
- Health System
- Health System Consortium
- Community
- Region
The Chain of Effect in Improving Health Care Quality

Patient and Community Experience

Aims (safe, effective, patient-centered, timely, efficient, equitable)

Micro-system Process

Simple rules/Design Concepts (knowledge-based, customized, cooperative)

Organizational Context Facilitator of Processes

Design Concepts (HR, IT, finance, leadership)

Environmental Context Facilitator of Facilitators

Design Concepts (financing, regulation, accreditation, education)
Informed, Activated Patient

Prepared, Proactive Practice Team

Functional and Clinical Outcomes

Health System

Health Care Organization

Delivery System Design

Decision Support

Clinical Information Systems

Community

Resources and Policies

Self-Management Support

Clinical Information Systems

Self-Management Support

Acknowledgements: Improving Chronic Illness Care, a national program of The Robert Wood Johnson Foundation

Chronic Care Model (Wagner)
• Essential First Steps
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Rationale for Inpatient Glycemic Control

and

Overview of Physiologic Insulin Regimens

Greg Maynard MD, MSc

UCSD
Glycemic Control in Hospital
An Important Process

• 25-40% of inpatients have hyperglycemia
• JCAHO certification now available
• RCT level of evidence for good control SICU > MICU
• Wards and Units: Strong associations and cohorts implying poor control leads to poor outcomes
• Physiologic rationale is robust
• Large Gap
• ADEs / Hypoglycemia common
Managing Diabetes in the Hospital Presents Different Challenges than Managing Diabetes in the Outpatient Arena!

The hospital is associated with:

- Nutritional and clinical instability
- The need for changes from the home diabetes medical regimen
- Acute illness, “stress-related” hyperglycemia
- Use of medications that impact glycemic control
Insulin Requirements in Health and Illness

Hyperglycemia: An Independent Marker of In-Hospital Mortality in Patients with OR WITHOUT Established Diabetes

Total In-patient Mortality

- Normoglycemia: 1.7%
- Known Diabetes: 3.0%
- New Hyperglycemia: 16.0% *

* p < 0.01

Intensive Insulin Therapy in Critically Ill Surgical Patients: Morbidity and Mortality Benefits

- Intensive therapy reduced mortality (-34%), sepsis (-46%), dialysis (-41%), blood transfusion (-50%), and polyneuropathy (-44%)

Intensive Insulin Therapy in the Medical ICU

Greet Van den Berghe, M.D., Ph.D., and the Leuven Group

• RCT of insulin infusion to goal of 80-110 mg/dL vs usual therapy (180-200 mg/dL).
• 1,200 patients randomized
• A priori outcome of interest: patients in MICU for > 3 days
• Only 17% were diabetic
Conclusions: MICU study

• Intensive insulin therapy significantly reduced overall morbidity but not mortality.

• Predefined population analysis (ICU > 3 d):
  – In-house mortality reduced (ARR 9.5%)
  – ICU mortality reduced (ARR 7.2%) $p=0.05$
  – Morbidity Reduced

• BUT, More deaths (18.8 vs 26.8%) in patients in ICU < 3 days (NS w/ adjustment)

• More studies needed.
## Other Studies Demonstrating Worse Outcomes with Poor Glycemic Control

<table>
<thead>
<tr>
<th>Setting</th>
<th>Blood Glucose Threshold</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>General medical and surgical (Umpierrez 2002; Pomposelli 1998)</td>
<td>&gt;189*; &gt;230† &gt;220</td>
<td>↑ Mortality;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ LOS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ Infection rates</td>
</tr>
<tr>
<td>Acute MI (Capes 2000; Bolk 2001)</td>
<td>&lt;100.8 vs 199.8 &gt;109.8*; &gt;124†</td>
<td>↑ Mortality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ Mortality, HF shock</td>
</tr>
<tr>
<td>Cardiac surgery (Furnary 2006, 2003, 1999)</td>
<td>&gt;150</td>
<td>↑ Mortality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ Sternal wound infection</td>
</tr>
<tr>
<td>Stroke (Williams 2002; Bruno 2004)</td>
<td>&gt;130 90-180</td>
<td>↑ Mortality (RR 1.87)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ LOS 60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↓ Penumbra salvage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ Infarct size</td>
</tr>
</tbody>
</table>

*No diabetes; †diabetes; LOS = length of stay; HF = heart failure; RR = relative risk*
Even More Conditions Have Better Outcomes With Better Glycemic Control

• Chemotherapy outcomes (remission, survival, and infection rates)¹
• Reduced rates of kidney transplant rejection²
• Better outcomes in community-acquired pneumonia³
Hyperglycemia and Poor Hospital Outcome

Metabolic stress response

↑ Stress hormones and peptides
↓ Insulin

↑ Glucose
↓ FFA
↑ Ketones
↑ Lactate

↑ Reactive O₂ species
↑ Transcription factors
↑ Secondary mediators

Cellular injury/ apoptosis
Inflammation
Tissue damage
Altered tissue wound repair

Immune dysfunction
Infection dissemination

Prolonged hospital stay
Disability / Death

FFA = free fatty acids

Summary: Potential Benefits of Improved Inpatient Glycemic Control

• Improving hyperglycemia may improve or avoid
  – M&M in critically ill perioperative patients
  – Morbidity in critically ill MICU patients
  – Complications of myocardial infarction and stroke
  – Complications of vascular and cardiac surgery
  – Dehydration, VTE, electrolyte disturbances
  – Gastric emptying, nausea, emesis
  – Infection, healing rates
AACE - Consensus Conference
Blood Glucose Targets

• Upper Limit Inpatient Glycemic Targets:
  – ICU: 110 mg/dl (6.1 mmol/L)
  – Non-critical care
    • Pre-prandial: 110 mg/dl (6.1 mM)
      – (90-130 mg/dL)
    • Maximum: 180 mg/dL (10 mM)
Problems with Oral Agents in the Hospital

- Sulfonylureas (e.g., glyburide, glipizide, etc.)
  - Hypoglycemia (long acting), especially if NPO
  - ? CAD

- Metformin
  - Lactic acidosis risk
    - Renal insufficiency, hypotension, heart failure, contrast
  - Gastrointestinal
    - Nausea, abdominal pain, diarrhea

- Thiazolidinediones (TZDs or “glitazones”) (e.g., rosiglitazone)
  - Possible liver toxicity
  - Fluid overload, heart failure

- All - Inability to titrate quickly
Physiologic Insulin Secretion:
Basal-Bolus Concept

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Basal glucose</th>
<th>Nutritional glucose</th>
<th>Nutritional (prandial) insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.M.</td>
<td>150</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>P.M.</td>
<td>100</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>A.M.</td>
<td>50</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>P.M.</td>
<td>25</td>
<td>1</td>
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</tr>
<tr>
<td>A.M.</td>
<td>0</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>P.M.</td>
<td>0</td>
<td>1</td>
<td>0</td>
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</tbody>
</table>

The 50/50 rule
(or maybe 40/60)

Suppresses glucose production between meals and overnight
Current Practice ≠ “Best Practice”

- Dependence on non-physiologic insulin prescribing (as opposed to insulin that mimics physiologic insulin secretion)
- Dependence on reactive strategies (e.g. sliding-scale insulin)
- Overemphasis on simplicity (particularly simplicity from the perspective of the ordering physician)
- Overemphasis on avoidance of hypoglycemia
- Lack of standardization of insulin use in the hospital
- Sliding scale only does NOT WORK
What is the “Best Practice” for Managing Diabetes and Hyperglycemia in the Hospital?

• The answer is anticipatory, physiologic insulin dosing, prescribed as a basal/bolus insulin regimen

• This means giving the right type of insulin, in the right amount, at the right time, to meet the insulin needs of the patient
Subcutaneous Insulin Terminology

• Basal insulin
  – Long-acting, all Type 1 and most Type 2 DM patients should have basal insulin whether they are eating or not (insulin glargine, insulin detemir, or NPH)

• Nutritional or pre-meal insulin
  – Short-acting insulin given with meals in anticipation of carbohydrate load glycemic spike (scheduled insulin aspart, insulin lispro, insulin glulisine, regular insulin)

• Correction or supplemental insulin
  – Short-acting insulin given to cover high glucose; if substantial use, it should drive adjustment of basal and nutritional insulins
Insulin Terminology

• Sliding scale insulin
  – This is a dirty word; we don’t use dirty words at UCSD
  – “Mindless medicine,” “paralysis of thought,” “action without benefit,” “insulin insanity”

• Evidence does not support this technique without basal insulin; unacceptably high rates of
  – Hyperglycemia
  – Hypoglycemia and insulin stacking
  – Iatrogenic DKA in patients with type 1 DM

Which Patients Should be Treated with a Physiologic Insulin Regimen?

During hospitalization
• Any patient with blood glucose levels consistently above the target range

Immediately at the time of admission
• All patients with type 1 diabetes
• Patients with type 2 diabetes if…
  – They are known to be insulin-requiring
  – They are known to be poorly controlled despite treatment with significant doses of oral agents
  – They are known to require high doses of oral agents that will be held in the hospital
Constructing a Profile for Scheduled Subcutaneous Insulin ....

- **6 am**
  - Lispro
  - Aspart
- **12 pm**
  - Regular
- **6 pm**
  - NPH
- **12 am**
  - Glargine
  - Detemir
Algorithmic Approach: Subcutaneous Insulin in Inpatients

• Define glycemic target
• Decision: need for basal insulin?
• Decision: discontinue oral hypoglycemics?
• Estimate total daily dose of insulin
• Divide insulin into appropriate basal and nutritional insulin doses depending on situation
• Adjust, Adjust, Adjust
Selecting a Non-ICU Glycemic Target For Your Practice/Institution

• Examples of target ranges set by some institutions:
  
  – 90-150 mg/dL
  
  – Pre-prandial target 90-130 mg/dL; Random glucose < 180 mg/dL
  
  – Pre-prandial target 80-130 mg/dL for most patients; pre-prandial target 90-150 mg/dL for patients with hypoglycemia risk factors
Using Exogenous Insulin to Imitate Physiologic Insulin Secretion: Summary

- **Basal insulin:** Use non-peaking, longer acting insulins
  - Glargine or detemir are preferred
  - NPH also possible

- **Nutritional insulin:** Depends on the type of nutrition
  - RAA-I are preferred in eating patients
  - Regular insulin also possible

- **Correctional insulin:**
  - same as the nutritional insulin
A Stepwise Approach to Physiologic Insulin Dosing in the Hospital

1. Estimate the amount of insulin the patient would need over one day, if getting adequate nutrition = Total Daily Dose (TDD)

2. Assess the patient’s nutritional situation

3. Decide which components of insulin the patient will require, and which percentage of the TDD each should represent

4. Assess blood glucoses at least daily, adjusting insulin doses as appropriate
STEP 1: Estimate the Amount of Insulin the Patient Would Need Over One Day, If Getting Adequate Nutrition = Total Daily Dose (TDD)

• Insulin drip-based estimate

• Total of all outpatient insulin dosing and adjust

• Weight-based estimate:
  – TDD = 0.4 units x Wt in Kg
  – 0.3 units x Wt in Kg for those with hypoglycemia risk factors, including kidney failure, type 1 diabetes (especially if lean), frail/low body weight/ malnourished elderly, or insulin naïve patients
  – 0.5-0.6 units (or more) x Wt in Kg for overweight, obese, steroids
Conditions Associated with Hypoglycemia in Hospitalized Patients

- Type 1, known sensitivity, lean
- Malnutrition or low body weight
- Renal failure (ESRD), liver disease, malignancy, circulatory failure (shock), adrenal insufficiency, burns, alcoholism
- Prior hypoglycemia or labile blood glucose control
- Medications: sulfonylureas, pentamidine, quinine, or lowering of the doses of glucocorticoids
- Decreases in nutritional intake
- Advanced age
STEP 2: Assess the Patient’s Nutritional Situation

- Eating meals or receiving bolus tube feeds
- Eating meals but with unpredictable intake
- Getting continuous tube feeds
- Getting parenteral nutrition
- NPO
STEP 3: Decide Which Components of Insulin the Patient Will Require, and Which Percentage of the TDD Each Should Represent

- Basal insulin can generally be estimated to be 1/2 of the TDD

- Nutritional insulin makes up the remaining 1/2 of the TDD

- Basal component ideally a little less with TPN / TF
STEP 3: Decide Which Components of Insulin the Patient Will Require, and Which Percentage of the TDD Each Should Represent, Continued…

• In most cases, basal insulin should be provided
• In most cases, well-designed corrective insulin regimens should be provided
• When a patient is not receiving nutrition, nutritional insulin should not be given
• Nutritional insulin needs must be matched to the actual nutritional intake
STEP 4: Assess Blood Glucoses at Least Daily, Adjusting Insulin Doses as Appropriate

- Blood glucose targets can only be achieved via continuous management of the insulin program

- There is no “autopilot” insulin regimen for a hospitalized patient!
Essential References for Best Practice

- **ACE Position Statement and Consensus Conference Reviews**

- **ACE / ADA Inpatient Diabetes and Glycemic Control Consensus Statement**

- **ADA Technical Review**
  Management of diabetes and hyperglycemia in hospitals.

- **ADA Standards for Diabetes**
  American Diabetes Association: Standards of Medical Care in Diabetes. Diabetes Care. 2006”29(Suppl. 1): S4-S42.

- **ASHP Recommendations for Safe Use of Insulin in Hospitals**
  Accessed as a pdf at:
  (November 13, 2006).
Why Should You Act?

- Hyperglycemia is associated with poor outcomes in a broad range of hospitalized patients, and several studies demonstrate improved outcomes with improved glycemic control.\(^1\)
- 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.\(^2, 4\)
- Despite authoritative guidelines and effective methods to achieve good glycemic control safely, poor glycemic control, suboptimal medication regimens, incomplete patient education, and uneven communication with outpatient care providers are prevalent problems in medical centers.\(^3, 4\)

The Role of the Hospitalist

Provide excellent care for the individual inpatient with hyperglycemia and diabetes, including the expert use of insulin for patients in all nutritional situations.

Lead, coordinate, or participate in initiatives to improve the care of the patient population with hyperglycemia and diabetes in the hospital setting. This may include participation in multidisciplinary teams, which may include nursing and social services, nutrition, pharmacy, and endocrinology, to facilitate patient education, implement order sets, algorithms, and policies to achieve improved glycemic control and reduce iatrogenic hypoglycemia, to improve patient function and outcomes, and advocate patient outreach post discharge. More Like This.

Fundamental Principle for Glycemic Control

Insulin infusion or physiologic subcutaneous insulin regimens that are tailored to the patient's nutritional status and other factors are the best ways to control hyperglycemia in the hospital. The implementation of such regimens can only be safe and effective in improving glycemic control when achieved with a multidisciplinary team.
Workbook for Improvement

Improving Glycemic Control
Preventing Hypoglycemia
AND
Optimizing Care of the Inpatient with Hyperglycemia and Diabetes

SHM Glycemic Control Task Force
Table Top Exercise #1

• Identify current efforts, barriers, and level of institutional support
• Process Map / Fishbone subcutaneous insulin orders on admission
• Identify leverage points
• Identify general goals / aims
• Identify team members
• Review Team Rules
• Essential First Steps
  – Gain institutional support, survey previous / ongoing efforts and resources, form team, define reporting structure, general goals, improvement framework

• Identify best practices / evidence
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• Analyze care delivery
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How Will You Know You’re Making a Difference?
Collecting Data and Devising Metrics

Jeffrey L. Schnipper, MD, MPH
Director of Clinical Research
BWH Hospitalist Service
Brigham and Women’s Hospital
• Data Collection
• Measuring quality of glucose control: “glucometrics”
• Measuring safety: hypoglycemia and extreme hyperglycemia
• Measuring processes of care: insulin ordering, etc.
• Discussion
Data Collection

• Ideal
  – Automated download of glucose meter data into central database
  – Link to hospital database with patient, unit, and service information
  – Automatically generated, customizable reports
  – Statistician available when needed
• Reality
  – No stream of data
    • Don’t wait, start sampling!
  – No link to hospital data:
    • Create link vs. use all available data
  – No reports:
    • Start with simple analyses (“first pass”)
    • Use Yale’s glucometrics web site
  – No statistician:
    • Borrow one vs. do without
• First pass
  – All patients with POC glucose testing
  – Exclude DKA, HHS, pregnancy if possible
• Second pass
  – All patients with billing codes for diabetes (250.xx) or inpatient hyperglycemia (e.g., 2 or more glucose readings > 180 mg/dL)
  – Sensitivity analysis: exclude patients with fewer than 5 evaluable readings
• First pass: all POC readings
• Second pass:
  – Sensitivity analysis: exclude readings on hospital day 1 and hospital days beyond day 10
  – Sensitivity analysis: exclude readings taken within 1 hour of a previous reading
What unit of analysis?

- **Glucose reading**
  - Pros: easy to calculate, most statistical power
  - Cons: least clinically relevant, skewed data

- **Patient Stay**
  - Pros: most clinically relevant
  - Cons: skewed data by LOS, uneven testing

- **Patient-Day**
  - Pros: least biased, good balance of other two
  - Cons: difficult to calculate and interpret
• What measures of control?
  – Rates of hyper- or hypo-glycemia
  – Percent readings within range
  – Mean glucose value (+/- exclusion of low values)
  – Percent of mean values within range
  – Rates of being “in control” (all values within range)
• Establishing definitions
  – Hypoglycemia
  – Extreme hypoglycemia
  – Hyperglycemia
  – Extreme hyperglycemia
  – Ideal glucose range (mean vs. all values)
• First Pass
  – Percent patient-days with mean glucose 80-140 mg/dL
  – Percent patient-days with all values 70-180 mg/dL
  – Percent patient stays with mean glucose 80-140 mg/dL
• Second pass: all first-pass analyses plus
  – Patient-Day weighted mean glucose
  – Mean percent glucose readings per patient that are 70-180 mg/dL
  – Percent patients with mean glucose 80-140 mg/dL by Hospital Day (days 1-7)
Patient Safety

- Percent patient-days with any value
  - < 40 mg/dL (extreme hypoglycemia)
  - < 70 mg/dL (hypoglycemia)
  - > 300 mg/dL (extreme hyperglycemia)
Processes of Care: Insulin Ordering

• More sensitive to change than outcomes
• First pass
  – Among all patients on insulin, percent on basal
• Second pass
  – Among patients with hyperglycemia (e.g., 2 readings > 180 mg/dL), percent on basal
  – Among patients with hyperglycemia and eating, percent on basal and nutritional
  – Percent patient days when changes made to insulin regimen if hypo- or hyperglycemia the day before
Processes of Care: Other Measures

- Use of sliding scale insulin alone
- Use of diabetes order sets
- Use of oral diabetic agents (esp. if contraindicated)
- Coordination of POC glucose testing, insulin administration, and food delivery
- Patient, physician, and nurse attitudes, education, and satisfaction
Analyses

• Before-After analysis
  – Pros: easy to interpret and publish results
  – Cons: doesn’t account for CQI methods
• Run charts
  – Pros: best for CQI
  – Cons: statistics harder to interpret
• Run charts with SPC
  – Best of both worlds when using CQI
Minnesota Glycemic Control Consortium Example Run Chart
Minnesota Glycemic Control Consortium Example Run Chart
Percent of patients with a glucose average <=180

1st order set
Baseline
Order set
Algorithm

Oct-02 / n=30 / N=50
Dec-02 / n=74 / N=126
Feb-03 / n=62 / N=104
Apr-03 / n=75 / N=100
Jun-03 / n=75 / N=117
Aug-03 / n=104 / N=124
Oct-03 / n=93 / N=140
Feb-04 / n=78 / N=117
Apr-04 / n=119 / N=169
Jun-04 / n=105 / N=154
Aug-04 / n=121 / N=158
Oct-04 / n=118 / N=171
Dec-04 / n=91 / N=131
Feb-05 / n=114 / N=161
Apr-05 / n=126 / N=180
Jun-05 / n=130 / N=187
Aug-05 / n=145 / N=184
Oct-05 / n=157 / N=203
Dec-05 / n=157 / N=203
Discussion

• Experiences at your institutions
• Questions
• Concerns
• Comments
Table Top #2

• Choose metrics for ward
  – Glycemic Control
  – Hypoglycemia / Safety
  – Insulin Use Patterns

• Discuss methods of collection and reporting

• Create specific aims for these metrics
• **Essential First Steps**
  – Gain institutional support, survey previous / ongoing efforts and resources, form team, define reporting structure, general goals, improvement framework

• **Identify best practices / evidence**
  – build into a protocol

• **Analyze care delivery**
  – Process maps, FMEA, fishbone

• **Performance Tracking / Metrics**
  – Then create specific goals

• **Integrate protocol into work flow, layer interventions and reliability techniques**

• **Continued Improvement / monitoring**
## Hierarchy of Reliability

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Predicted Success rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em><em>No protocol</em> (&quot;State of Nature&quot;)</em>*</td>
<td>40%</td>
</tr>
<tr>
<td>2</td>
<td>Decision support exists but not linked to order writing, or prompts within orders but no decision support</td>
<td>50%</td>
</tr>
<tr>
<td>3</td>
<td><strong>Protocol well-integrated (into orders at point-of-care)</strong></td>
<td>65-85%</td>
</tr>
<tr>
<td>4</td>
<td><strong>Protocol enhanced (by other QI and high reliability strategies)</strong></td>
<td>90%</td>
</tr>
<tr>
<td>5</td>
<td><strong>Oversights identified and addressed in real time</strong></td>
<td>95+%</td>
</tr>
</tbody>
</table>

* Protocol = standardized decision support, nested within an order set, i.e. what/when
Key Principles
(for effective QI interventions)

#1. Keep it simple to access and use
#2. Don’t interrupt the workflow
#3. Design reliability into the new process
#4. Monitor use of your protocol
#5. Allow for variation from the protocol based on patient characteristics (not providers) and improve protocol based on feedback and justifiable variation
#6. Fail faster (pilot small scale w/ongoing feedback & refinement before wider implementation)
High Reliability Design Solutions (as applied to Insulin Protocol)

- Standardize insulin choices for common situations
- MD must “opt out” of default choices (not opt in)
- Prompts for basal insulin if over glycemic target, prompts for HgA1c, etc.
- Scheduled assessments of glycemic control / insulin regimen
- Redundant responsibility to maintain glycemic target
Table Top Exercise #3

• Create your own insulin management protocol
  – Glycemic Target
  – A1c Prompt
  – Dosing / Adjustment
  – Preferred regimen for:
    • Eating patient
    • NPO patient
    • Continuous enteral feeding / TPN
  – Minimal monitoring criteria
  – Hypoglycemia / Call MD criteria
Table Top #3 continued

• Integrate protocol into order set
  – Critique example
• How will you maximize use of order set?
• Can you identify outliers or high risk patients for closer scrutiny?
• How much standardization vs flexibility?
• Educational Program and other interventions