Disclosures

Conflict of Interest (COI) and Financial Relationship Disclosures:

–none

Inpatient Glycemic Management: How We Get Others To Follow Our Lead

August 5th, 2015
New Orleans, LA

Objectives

1) State current inpatient glycemic control goals
2) Discuss several strategies to improve insulin safety
3) Describe several ways to decrease clinical inertia in acute care
4) State innovative ways to educate health care professionals in the hospital setting using technology

“Each blind man perceived the elephant as something different: a rope, a wall, tree trunks, a fan, a snake, a spear...”
**Inpatient Diabetes Goals**

- **Who Cares**
  - Just get patient home
- **Sliding Scales are fine**
- **Avoid that scary hypoglycemia**

**Inpatient Diabetes Goals**

- Appropriate Glucose Control Based on physiology and outcome studies

**Inpatient Diabetes Goals**

- Normal glucose for everyone
- A high glucose means failure
- Sliding Scales are banned
- Some hypoglycemia is acceptable

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**Insulin Administration**

- Order Written
- Order Sent to Pharmacy
- Order Entry by Pharmacist
- Drug Preparation by pharmacy
- Insulin delivery to unit
- Medication Administration
- Documentation

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**Target Glucose Levels**

- **Alive**

**Target Glucose Levels**

- No DKA or Hyperosmolar Coma

**Target Glucose Levels**

- No hypo- or hyperglycemia

  - Prevent fluid and electrolyte disturbances
  - Improve WBC function
  - Improve gastric emptying
  - Decrease surgical complications
  - Earlier hospital discharge
Target Glucose Levels

Normal Glucoses

Decreased Morbidity and Mortality

Problems With High Glucoses

Glucose and Post-CABG: Morbidity and Mortality
Diabetes and Coronary Artery Bypass Surgery
An examination of perioperative glycemic control and outcomes
Retrospective review of 291 patients surviving 24 h post-op
40% with retinopathy, nephropathy, or neuropathy

Inpatient complications:
- For each 1 mmol/l (18 mg/dL) increase in post-op day 1 over 6.1 mmol/l (110 mg/dL), a 17% increased risk of complications


High Blood Glucose Levels Associated With Increased Mortality in ICU
- Retrospective review of 259,040 critically ill patients conducted by the Veterans Affairs Inpatient Evaluation Center based in Cincinnati

- Hyperglycemia was an independent predictor of mortality starting at 111 mg/dL
- Effect was greatest with acute myocardial infarction, unstable angina, and stroke
  - Raised MI risk from 1.7 to 6 times
  - Raised stroke risk from 1.8 to 29 times
  - Raised unstable angina from 1.4 to 3 times


- A significant but weaker effect was seen in patients with sepsis, pneumonia, and pulmonary embolism
- Hyperglycemia was not found to be associated with mortality in diseases such as COPD and hepatic failure, hip fractures
- In diabetes patients, the increase in mortality risk was not seen until mean glucose was >146 mg/dL

Intervention Studies

Hyperglycemia-related mortality in critically ill patients varies with admission diagnosis.
**Decreased Infections**

Insulin infusion improves neutrophil function in diabetic cardiac surgery patients

**Perioperative IV insulin infusion**

**Neutrophil phagocytic activity**

<table>
<thead>
<tr>
<th>% baseline</th>
<th>Control</th>
<th>Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>47</td>
<td>75</td>
</tr>
</tbody>
</table>


**Decreased Infections**

Glucose control lowers the risk of wound infection in diabetics after open-heart operations

**Perioperative IV insulin infusion**

**Protocol to maintain glucoses <200 mg/dL**

<table>
<thead>
<tr>
<th>Incidence of Deep Wound Infections (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 1999</td>
</tr>
<tr>
<td>Routine Control 2.4 2.0</td>
</tr>
<tr>
<td>“Tight” Control 1.5 0.8</td>
</tr>
</tbody>
</table>


**Decreased Morbidity and Mortality**

**Intensive Insulin Therapy in Critically Ill Patients**

- Patients (all) on mechanical ventilation in ICU
- Randomly assigned to IV insulin maintaining glucoses between 80-110 mg/dL or conventional treatment (IV insulin if glucose >215 mg/dL then maintain glucose between 180-200)

<table>
<thead>
<tr>
<th>12 month mortality</th>
<th>Intensive 4.0%</th>
<th>Main effect on patients in ICU &gt;5 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional 8.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**NICE-SUGAR**

- 6104 adults who were expected to require treatment in the ICU on 3 or more consecutive days randomized to intensive blood glucose control (target range, 81 to 108 mg/dL) or conventional blood glucose control (<180 mg/dL)
- Primary endpoint death from any cause within 90 days after randomization
- Baseline characteristics similar


**Problems With Low Glucoses**

Data on Blood Glucose Level, According to Treatment Group

Probability of Survival and Odds Ratios for Death, According to Treatment Group

Hypoglycemia and Mortality in Insulin-treated vs on-Insulin-treated AMI Patients

Hypoglycemia was associated with higher mortality in patients not treated with insulin, but not in patients treated with insulin.

2015 Inpatient Glucose Goals

<table>
<thead>
<tr>
<th>Organization</th>
<th>ICU</th>
<th>Non-ICU Pre-Glucose</th>
<th>Non-ICU Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>AACE/ACE</td>
<td>140-180 mg/dL</td>
<td>&lt;140 mg/dL</td>
<td>180 mg/dL</td>
</tr>
<tr>
<td>ADA</td>
<td>140-180 mg/dL</td>
<td>&lt;140 mg/dL</td>
<td>180 mg/dL</td>
</tr>
<tr>
<td>ACP</td>
<td>140-200 mg/dL</td>
<td>Avoid &lt;140 mg/dL</td>
<td>180 mg/dL</td>
</tr>
<tr>
<td>Endocrine Society</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Society of Critical Care Medicine</td>
<td>100-150 mg/dL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UCSF</td>
<td>100-160 mg/dL</td>
<td>100-180 mg/dL</td>
<td></td>
</tr>
</tbody>
</table>

Mean Blood Glucose Levels During Insulin Therapy

How to Obtain “Tight” Control

- Bedside glucose monitoring
- IV insulin drips
- Diabetes Flow sheets
- Discourage the use of traditional Sliding Scale insulin

INSULIN SLIDING SCALE
Mr. And Mrs. XXXXX are admitted for "Giants" fever.

Mr. XXXXX has Type 2 diabetes and takes a total of 75 Units insulin per day (2 shots). Glucose at home are "poorly controlled."

Mrs. XXXXX also has Type 2 diabetes but she has good control taking about 25 units of Lispro premeal and 40 Units glargine at night.
Improving Insulin Safety

Creating and Implementing Comprehensive Insulin Order Sets

Why Computerized Order Sets?

- **Reduces insulin dosing errors:** Auto-calculates safe dose
  
- **Simplifies & promotes weight based dosing:** Auto-populates weight into dosing algorithm

- **Reduces insulin TYPE errors:** basal, prandial and correction insulins are separated

Why Computerized Order Sets (Cont.)?

- **Reduces clinical inertia:** Takes fear out of dosing insulin by automating process

- **Reduces omission of doses and improper timing of BGM & insulin:** e.g. RN gets medication due reminder, Prescriber & RN get reminder of need for basal insulin for Type 1 patients

Secret to Success: Pre-Checked Orders
Step One
Which Order Set Do I Choose?

Why wasn't poor PO intake ordered?

Descriptions Next To Each Order Set

Very Low Dose Aspart-Glargine Order Set

A1c*

Type of Diabetes

Bedside BGM

Diabetes Meal Plan**

* A1c can be used to diagnose diabetes, evaluate glycemic control PTA

** All diabetes and/or hyperglycemia pts placed on Diabetes Meal Plan

Defaults to 6 servings (60gm Carb) per meal
NPO: no auto-basal for type 2
Very Low Dose .10 u/kg
Low Dose .15 u/kg
Med Dose .20 u/kg
High Dose .30 u/kg

Hypoglycemia Treatment

Diabetes Education

Pt Education: Focus on Survival Skills

Diabetes Teaching Resources

Consistent Carbohydrate Menu
Lists Serving Sizes & Grams
Teaching Patients to Use Insulin Pen

Diabetes Education Documentation

Diabetes Champions
- Meets Monthly (1 hr) & Annually (8 hr)
- Email reminders sent to all RNs, NPs, RDs
- Created TEAM WEB with educational resources for pts & professionals

Developing & Implementing Glycemic Control Guidelines

Adult Inpatient Glycemic Management Guideline Pocket Card Page 1

Insulin Titration Algorithm

**WHICH INSULIN NEEDS ADJUSTMENT:**

- If AM fasting BG is too high or low: Adjust Glargine
- If pre-lunch, pre-dinner or bedtime is too high or low: Adjust Aspart

**HOW TO ADJUST:**

<table>
<thead>
<tr>
<th>BG Level</th>
<th>Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50</td>
<td>Deduct 50%</td>
</tr>
<tr>
<td>Less than 70</td>
<td>Deduct 20%</td>
</tr>
<tr>
<td>70-100</td>
<td>Deduct 10%</td>
</tr>
<tr>
<td>180-250</td>
<td>Add 10%</td>
</tr>
<tr>
<td>&gt;250</td>
<td>Add 20%</td>
</tr>
</tbody>
</table>
Inpatient Guideline Pocket Card (P2)

| Inpatient Guideline Pocket Card (P3) |

| Data VIS Pattern Management Tool |

| References |

References (Cont.)


UCSF Inpatient Diabetes

• Infrastructure
  – 1989: Bedside Glucose Monitoring
  – 1990: IV insulin order set
  – Mid 1990s SQ Insulin Order sets
  – 1999: intranet education
  – 2004: Mandatory use of New insulin order sets
  – 2004: New mandatory nursing (online) and Physician education (online and small group case based)
  – 2012: Inpatient EMR for orders (EPIC)

Therapeutic Inertia

• Glucoses Better
• Low rate of hypoglycemia
• Nevertheless, our audits continued to show inappropriate initial insulin orders and therapeutic inertia for both attending staff and housestaff, with required insulin order changes not being made on a daily basis.

Therapeutic Inertia

• Physician Education
• Daily High Glucose Report
  – Nurse to check in on patients with very high glucoses
• Diabetes team for patients with high glucoses
  – Physician
  – Nurse
  – Pharmacist
• Diabetes Team for All Patients
  – Physician
  – Nurse
  – Pharmacist

General Resident Education

• residents may gain confidence about their knowledge and feel more at ease with inpatient glucose management, but significant improvements in management have generally not occurred.
Education by Example

• David Baldwin, et al showed that having an endocrinologist round with a member of the medical team improved both insulin order-writing and glucose levels.

UCSF Intervention limitations

• Physician Education
  – Still not all residents get training
  – Residents not taking care of patients
  – Hospitalists (turnover)

• Nursing
  – NPs managing patients

Order set

<table>
<thead>
<tr>
<th>Adult SQ Insulin – Patient eating - set premeal dose</th>
<th>Premeal Dosing: Premeal Dosing (based on amount consumed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult SQ Insulin – Patient eating - CHO Counting</td>
<td>Premeal Dosing: CHO dependent Premeal Dosing: CHO consumed Premeal Dosing (based on CHO consumed)</td>
</tr>
<tr>
<td>Adult SQ Insulin – NPO, TPN</td>
<td>CHO nutrition and correction Nutrition dose timed to cycle TPN, correction q4h</td>
</tr>
<tr>
<td>Adult SQ Insulin – Tube Feeding</td>
<td>CHO nutrition and correction Nutrition dose timed to cycle feedings, correction q4h</td>
</tr>
<tr>
<td>Adult Insulin Pump</td>
<td>Nutrition dose timed to cycle feedings, correction q4h</td>
</tr>
<tr>
<td>IV Insulin protocol  – ICU</td>
<td>Specific, initial rate for CV/DM/Arter</td>
</tr>
<tr>
<td>IV Insulin protocol  – Medical/surgical units</td>
<td>Specific, initial rate for CV/DM/Arter</td>
</tr>
<tr>
<td>OM/NA</td>
<td>Nutrition dose timed to cycle feedings, correction q4h</td>
</tr>
</tbody>
</table>

Big Brother

• Daily Reports:
  – 2 or more glucose>225
  – Glucose <60
  – On insulin pump
  – Dx type 1 DM

How to communicate with teams

• Impossible to figure out who is actually taking care of patient
• Pager – to tell them to read email (but which pager)
• Email – no one actually reads emails
• Sticky notes
• Endocrine notes (people don’t actually read other notes)
Inpatient Hyperglycemia

The virtual Inpatient Glucose Management Service

![Image of glucose management interface]

![Image of glucose management interface close-up]

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![Image of glucose management interface 2]

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![Image of glucose management interface 3]

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![Image of glucose management interface 4]
10 Day Audits of Patients Per Day with 2 or More Glucoses ≥ 225 mg/dl (for specific units)

% of Patient in Each Glucose Range Among Patients on SQ Insulin Premeal Protocol
10/2012 0 (baseline) 272 20 80 4.06 3.45
5/2013 1 month 257 21 79 3.62 3.07
10/2013 5 months 242 17 83 3.39 2.8
5/2014 1 year 248 31 69 3.25 2.55
4/2015 2 years 220 38 62 3.01 2.13

Criteria Used for No Note

- Following by endocrinology consult team
- Random High:
  - Glucoses were fine before
  - No new meds (e.g., glucocorticoids)
  - No pattern
  - Would be dangerous to change orders based on the two higher numbers

- New Orders Already Written
  - Appear appropriate
  - Shows understanding how to adjust
- On IV insulin infusion
- Change of Medications
  - Single glucocorticoid pulse
  - Glucocorticoid discontinued

- One time issue
  - Received Dextrose with medication (though may put in note to avoid the dextrose)
- Procedure
  - Glucoses before fine and would expect ok after
- New orders written (often day of admit)
  - Cannot yet assess effect
The numbers

- Number of vGMS notes in past 2 years: 3400
- Time to complete task: 30-45 minutes
- Change in number of Formal Endocrinology Consults: none

Community Hospital Training
Annenberg Project

Diabetes Educators

- Carol Manchester, MSN, ACNS, BC-ADM, CDE
  University of Minnesota Medical Center-MetroHealth, Minnesota
- Jane Jefferie Seley, DNP, MPH, BC-ADM, CDE
  New York Presbyterian/Weill Cornell Medical Center
- Mary M. Sullivan, RN, DNP, ANP-BC, CDE
  University of California, San Francisco
- Eric D. Peterson, EdD, FACME
  Annenberg Center for Health Sciences at Eisenhower

Physicians

- Robert J. Rushakoff, MD
  Director, Inpatient Diabetes, UCSF
- Cheryl W. O’Malley, MD
  Program Director, Internal Medicine, Banner Good Samaritan Medical, Phoenix, Arizona
- Kendall M. Rogers, MD
  Chief, Hospital Medicine, University of New Mexico Health Sciences Center, Albuquerque, New Mexico
- Archana Sadhu, MD
  Director, Inpatient Diabetes Program, The Methodist Hospital System Houston, Texas

Pharmacists

- Heidemarie Windham
- Lisa Kroon
- Kethen So
- Thomas Bookwalter
- Anna Seto
- Yali Brennan

Administration

- Rosanne Rappazini
- Jennifer Pacholuk
- Joy Pao
- Janice Hull

Nurses

- Mary Sullivan
- Pauline Chin
- Marlene Bedrich
- Craig Johnson
- Molly Killion
- Jeanne Buchanan
- Noraliza Salazar
- Lynn Dow
- Byanaq Robinson

Dietary

- Marian DeVereaux
- Ami Bhow
Site Visit
- Faculty team visits each site
  - 1 physician (inpatient endocrinologist or hospitalist)
  - 1 nurse with inpatient glycemic control experience
- Team Meeting
  - Review appointment, goals, barriers
  - Hurdle or learn from
  - Discuss the project and their current performance
  - Coaching support so they are likely to wait and manage the care of patients
  - Improvise and measurement, that they may want to consider in advance process and outcome
- Presentation to other stakeholder groups
  - Physician or nursing staff

Web Conferences
- 3 Web conferences planned
  - #1 Sites share their project plans
  - #2 Sites present interim progress and challenges
  - #3 Sites present data generated from their project
- Primarily intended as a tactic to keep sites “on task” and to facilitate interaction between sites

Annenberg Center Diabetes Project
-Hospital B-
- Community, non-teaching; No Endocrinology
- Lots of forms – main was self adjusting SS
- Many MD groups, hospitalist group
- No education, Meal timing

Glucose metrics and glucose measurements
- These hospitals developed a glucose control system for data collection. One site redesigned nursing workflow to capture point of care glucose data at appropriate times.

Formulary simplification
- One site reduced the number of insulin products on their hospital formulary to prevent look alike-round alike insulin errors.

DKA/hyperosmolar coma, Perinitual insulin pump
- Two sites revised their protocols for DKA and hyperosmolar hyperglycemic state; two sites developed inpatient insulin pump order sets; one site developed a perinitual insulin order set

Clinical Practice
- Four sites implemented new clinical practices that included new ways of deploying pharmacists, nurses, and endocrinologists in the care of patients with diabetes, care rounds, and case conferences focused on the management of difficult patients.

Annenberg Center Diabetes Project
-Hospital B-
- Lots of forms – main was self adjusting SS
  - SS form gone; BB mainly used (CHO based post meal for meals on demand)
- Many MD groups, hospitalist group
  - Hospitalist contract dispute
- No education
  - Case studies – CDs, in person for specific populations
- Meals
  - Refreshment centers closed
  - Still get meals on demand
- CDE involvement
  - Assist with insulin orders
  - Call MDs for consistently high numbers

Annenberg Center Diabetes Project

Carbohydrate counting
- Two sites reported adding a carbohydrate controlled meal plan to their diet order sets. One site developed a tool that automated the calculation of carbohydrates in the meal plan to assist providers in reconciliation of the patient insulin dose.

Timely data availability
- Several sites improved laboratory reporting to ensure that clinicians have the data they need to manage glycemia within the protocols.

Physician/Nurse
- Physician/Nurse education/CEEs brought those to the physician offices to assist the physicians with the use of the programs. Nurse champions were identified and trained to provide patient education in survival skills. New training supplies and written materials developed.