Glucometrics

Assessing Quality in Inpatient Glycemic Management
The 4 Spheres of a Quality Inpatient Glucose Management Program

- Recognition as a hospital priority
- Education
- Patient care
- Metrics
Glycemic Management:
Why Should This Be a Hospital Priority?

- Enhance quality and patient safety
- Competitive advantage
- Cost savings
- Indirect educational impact on our trainees
- The Joint Commission
Institution-Wide Educational Efforts

- Physicians
- Nursing staff
- Pharmacists
- Dietitians
- Medical assistants
Patient Care

- Identification (and proper coding) of patients
- Policies and procedures
  - Point-of-care blood glucose (BG) testing
  - Institutional glycemic targets (ICU, wards)
  - ICU IV insulin protocols
  - Standardized SC insulin order sets
  - Hypoglycemia protocol
  - Patient education tools
- Inpatient diabetes management team/service
- Transition to outpatient care (access)
Metrics Frequently Used in the Inpatient Glucose Literature

- Raw blood glucose (BG) average
- % of BGs within a prespecified range (80-110, 100-150, <180, <200 mg/dL)
- % of patients with a certain % of BGs within a prespecified range
- Hypoglycemia rates (<40, <50, <60, <70 mg/dL)
  - % of BGs
  - % of patients
- Hyperglycemic excursions (>180, >200, >300 mg/dL)
  - % of BGs
  - % of patients
Generation of Inpatient Glucometrics

POC testing

POC meter docking interface

Computer data repository

Glucometric reports

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Measuring Inpatient Glycemic Control: Special Issues

- Sample site (finger sticks, lab plasma glucose)
- Multiple measures during hypoglycemic or hyperglycemic events
- Varying time intervals of measurement
- Timing in relationship to meals
- Effects of IV fluids (dextrose)
- How to collect glucose measurements
- How to analyze them
- How to present data to clinicians/administrators
Example of Graphic Display of Glucometrics Data

MICU/CCU Avg BG Level By Year

- **Diabetic**
- **All Patients**
- **Nondiabetic**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Diabetic</th>
<th>All Patients</th>
<th>Nondiabetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>159.9</td>
<td>149.6</td>
<td>141.2</td>
</tr>
<tr>
<td>2005</td>
<td>158</td>
<td>144.9</td>
<td>133.6</td>
</tr>
<tr>
<td>2006</td>
<td>152.3</td>
<td>141.6</td>
<td>130.8</td>
</tr>
<tr>
<td>2007-Q1</td>
<td>150.3</td>
<td>141.8</td>
<td>133.9</td>
</tr>
</tbody>
</table>
Example of Graphic Display of Glucometrics Data

Diabetic Patients

Nondiabetic Patients

All Patients
### Glucometrics Project: Methods

#### Sample
- Yale-New Haven Hospital blood glucose (BG) data downloaded into relational database for analysis
  - BG values
  - Date/time
  - Patient ID
  - Hospital ward
- Sample: One general medical ward’s March 2004 BG results (n=1552)

#### Metrics Tested
- Mean/median BG
- % BG in “favorable” range (80-139 mg/dL)
- % Hyperglycemia (>300 mg/dL)
- % Hypoglycemia (<60 mg/dL)


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Glucometrics Project: Units of Analysis

- **Ward**
  - n = 1552

- **Patient Stay**
  - n = 118
  - [13.2 BGs/stay]

- **Patient Day**
  - n = 467
  - [3.3 BGs/day]


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Blood Glucose (mg/dL)

SUN  MON  TUE  WED  THU  FRI  SAT

Patient 2
Patient 1
Patient 3
Patient 4
Glucometrics Project: Mean and Median Blood Glucose

Glucometrics Project: Blood Glucose Within Target Range

Blood Glucose 80-139 mg/dL

- Ward: 33.9%
- Patient Stay: 32.2%
- Patient-Day: 35.8%

Glucometrics Project: Hyperglycemic Events

Blood Glucose >300 mg/dL

- Ward: 12.8%
- Patient Stay: 39.0%
- Patient-Day: 21.8%

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Glucometrics Project: Hypoglycemic Events

Blood Glucose <60 mg/dL

- Ward: 1.5%
- Patient Stay: 7.6%
- Patient-Day: 4.5%

Glucometrics Project: Summary

- Metrics for mean blood glucose (BG), median BG, and the percentage in target range are similar for all 3 analytical models.

- There were substantial differences between the models for percent hyperglycemia and percent hypoglycemia:
  - Ward model had lowest percentage
  - Patient stay model had highest percentage
  - Patient day model was intermediate
Glucometrics Project: Other Findings

- Addition of venous plasma lab glucose measurements to finger stick data
  - Slight reduction in mean glucose values but not clinically meaningful
- Deletion of 1st hospital day of blood glucose
  - Slight reduction in mean glucose values but not clinically meaningful
- Applying glucometrics to the ICU (with IV insulin infusion), the realistic maximum percentage of patient days within target range is probably ~80%

Glucometrics Project: Conclusions

• Glucometrics are useful intermediate outcomes measures of inpatient hyperglycemia management
• Perception of performance and quality may depend upon the unit of analysis
• All 3 units of analysis provide useful information
  – Ward model is the simplest; may be most useful in operational analyses
  – Patient stay model perhaps most useful to consumers (and risk management)
  – Patient day model may be the most actionable by providers

## Inpatient Diabetes Management Team: Impact on Glucometrics (Before vs After)

<table>
<thead>
<tr>
<th>Patient Day Metric</th>
<th>Before Consult</th>
<th>After Consult</th>
<th>Absolute Change</th>
<th>Relative Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean BG</td>
<td>225.1 mg/dL</td>
<td>182.7 mg/dL</td>
<td>-42.4 mg/dL</td>
<td>-18.8%</td>
</tr>
<tr>
<td>% in target range (70-149 mg/dL)</td>
<td>16.7%</td>
<td>35.3%</td>
<td>+18.6%</td>
<td>+111.4%</td>
</tr>
<tr>
<td>% Hyperglycemia (&gt;299)</td>
<td>46.7%</td>
<td>22.8%</td>
<td>-23.9%</td>
<td>-51.2%</td>
</tr>
<tr>
<td>% Hypoglycemia (&lt;70)</td>
<td>12.9%</td>
<td>13.0%</td>
<td>+0.1%</td>
<td>+0.8%</td>
</tr>
</tbody>
</table>

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## Inpatient Diabetes Management Team: Example of Impact on Glucometrics

<table>
<thead>
<tr>
<th></th>
<th>IDMT</th>
<th>Non-IDMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean BG reduction</td>
<td>-49.5 mg/dL</td>
<td>-16.4 mg/dL</td>
</tr>
<tr>
<td></td>
<td>*P&lt;0.01</td>
<td>*P=NS</td>
</tr>
<tr>
<td>Increased cases in target range (70-149 mg/dL)</td>
<td><em>P=0.03</em></td>
<td>*P=NS</td>
</tr>
<tr>
<td>Reduction in hyperglycemia (&gt;299)</td>
<td>*P&lt;0.01</td>
<td>*P=NS</td>
</tr>
<tr>
<td>Increase in hypoglycemia (&lt;70)</td>
<td>*P=NS</td>
<td>*P=NS</td>
</tr>
</tbody>
</table>

* McNemar’s Test

Summary

• “Quality” in inpatient glucose management needs to be better defined
• Achieving it requires efforts in 4 spheres: prioritization, education, patient care, and metrics
• Measures of inpatient glucose management are dependent on the analytical methods employed
• It is important for the diabetes community, hospitals, clinical investigators, and QI experts to work together to better define and validate standardized glucometrics which are meaningful, fair, and actionable