Making Sense of Glucose Monitoring

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Disclosure to Participants

• Conflict of Interest (COI) and Financial Relationship Disclosures:
  – Clinical Advisory Board: Senseonics

Program Goals

• Describe how you can evaluate glucose data from glucose meter and continuous glucose monitoring (CGM) reports
• Participants will be able to state pros and cons of use of personal or professional CGM
• Given a case scenario, participants will utilize patient data to evaluate glucose levels to make treatment recommendations

My Journey with Glucose Monitoring – Over the Last 37 Years

What I’m Not Going to Cover

Greenwood DA, et al. J Diabetes Technol. Published online June 2017

Current Tools for Understanding Glucose Dynamics

A1c: “Gold” Standard Worldwide:
• Provides 90-day average
• Healthcare provider uses in decision-making

SMBG: Important Tool for People with Diabetes (PwD):
• Helps with daily decision making
  • Assists healthcare provider with adjustments

CGM: Provides significant amount of glucose data
• Healthcare provider and PwD learning to interpret and use this data

Limitations of Current Glucose Monitoring Methods

A1C
What Does it Really Tell Us?

Complexities of Glucose Fluctuations
- Relying on only one testing method to reveal information about variability is suboptimal
- Both the person with diabetes (PWD) and healthcare providers need comprehensive, accurate, and actionable information about glucose levels and variability to achieve management goals

Self Monitoring Blood Glucose (SMBG)

Did You Bring Your Meter to Your Appointment Today?

Evidence-Based Recommendations
- Frequency blood glucose checks per day
  - May depend on insurance coverage and/or financial resources
  - "Most patients using intensive insulin regimens (multiple-dose insulin or insulin pump therapy) should perform self-monitoring of blood glucose (SMBG) prior to meals and snacks, at bedtime, occasionally postprandially, prior to exercise, or when they suspect low blood glucose"
  - "When prescribed as part of a broad educational program, SMBG may help to guide treatment decisions and/or self management for patients taking less frequent insulin injections or noninsulin therapies"

What’s the Evidence – Integrating Nutrition Therapy - SMBG & CGM?
- Glucose monitoring is a valuable tool for assessing food, activity, and medications when data used for decision-making
- Glucose monitoring can provide insights into the influence of macronutrients on prandial glucose response.

SMBG Data Sharing - Handwritten Records

Real-life challenges
- Typically no direction for organization of data
- No advice on times to check
- Lack of targets
- Inadequate time to detect patterns
- Hypo- and hyperglycemia often missed & overnight

Harris MI. Diabetes Care. 24(6):979-982, 2001

Practice Pearl: “Journal of Self-Discovery”

YOU CAN:
- Provide guidance & direction
- Set expectation – YOU will look at data every visit
- Food records + BG data:
  - Document episodes of food and beverage intake
  - Household measurements
  - If applicable: insulin injections – how much for food & how much for BG correction

BG Monitoring 101:

- Glucose average (mean):
  - Overall
  - Time period
- Standard Deviation:
  - How much the glucose is above and below the average glucose level
- Drastic Variations = Glycemic Variability


Average Mean & Standard Deviation

- Standard Deviation = SD
- Twice the standard deviation should be less than the average blood glucose level (SD × 2 < average)
- Example:
  - Average: 164 mg/dL
  - SD: 50
  - Average: 164 mg/dL
  - SD: 119

Person with T1D

- New patient to our practice
- 35 year old male, father of 4 young children
- A1c = 6.3%
- Lives in rural Washington state
- Job requires that he drive a lot during the day
- Wife trying to lose her “baby” weight
- Family eating healthier & recently started working out – has lost 10 lbs

Blood Glucose Download
Settings on Insulin Pump

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Stamp</td>
<td>12:04PM</td>
</tr>
<tr>
<td>BG Readings</td>
<td>114</td>
</tr>
<tr>
<td>Readings Above Target</td>
<td>100</td>
</tr>
<tr>
<td>Readings Below Target</td>
<td>50</td>
</tr>
<tr>
<td>Average BG (mg/dL)</td>
<td>94</td>
</tr>
<tr>
<td>Average A1c (%)</td>
<td>7.2</td>
</tr>
<tr>
<td>Average Hba1c (%)</td>
<td>7.2</td>
</tr>
<tr>
<td>Average % of Time Below Target</td>
<td>95</td>
</tr>
<tr>
<td>Average % of Time Above Target</td>
<td>95</td>
</tr>
<tr>
<td>Average % of Time in Range</td>
<td>95</td>
</tr>
</tbody>
</table>

Adherence Reports:

- Practice Pearl – SMBG
  - Set expectation that BG results will be evaluated at EVERY appointment
  - BG Targets - 2017 American Diabetes Association Recommendations Glucose Goals
    - Fasting or Pre-meal: 80-130 mg/dL
    - Post-Prandial (peak 1-2 hours) after meal: <180 mg/dL
    - Or adjust based on the needs of the individual PWD

- Continuous Glucose Monitoring (CGM):
  “Food Choices In Living Color”
  aka as job security for RDN & diabetes educator
Professional CGM in US

- Dexcom G4
- Medtronic i-Pro2
- Freestyle Libre Pro

Personal CGM in US

- Hybrid closed loop pump:
  - Medtronic 670G
- CGM enabled pump:
  - Medtronic 530G + Revel
  - Animas Vibe + Dexcom G4
  - Tandem t:slim + Dexcom G4
- Stand Alone:
  - DexCom G5 + G4

Rationale for Use? Professional vs. Personal

- Professional
  - Identification of glucose patterns
  - Hypo or hyperglycemia
  - Adjustment of medication
  - New patient/client to your clinic to obtain baseline data
  - Have no idea what is going on
- Personal
  - Ability to see glucose trends
  - Prevention of severe hypoglycemia and reduction of prolonged hyperglycemia
  - Dexcom - use as an adjunctive device to complement, not replace, information obtained from SMBG
  - Medtronic - hybrid closed loop technology

CGM Reports

- Although each CGM company has different generated reports, the information is generally the same and includes:
  - Statistics/Summaries
  - Birds Eye View
  - Daily View

Statistics/Summary Reports

- Provides valuable information
  - Time in target range compared to time high or low
  - Accuracy of the sensor data
  - Quantitative analysis of glucose excursions
Birds Eye View

- Glucose trend reports
- Identify glycemic patterns (or lack of patterns)
  - Identifies glycemic patterns by overlaying the sensor readings of each day into one graph
  - Can assist in pattern and trend recognition.
  - Examples of 2 different reporting types

Everyone knows what an EKG tracing report looks like

Unfortunately until recently data output for different CGM devices was NOT standardized.
**Ambulatory Glucose Profile (AGP) Graph Review**


**AGP Graph Review**

- Median, middle of all the data points
- 25th Percentile, 10th Percentile
- Interquartile Range (IQR), 50% of all the data
- 75th Percentile, 90th Percentile

**AGP Graph Review: “Time In Range”**


**Unknown Daily Glucose Fluctuations**

**Glucose Fluctuations of Four T1D Patients**

- A1c: 7.6 to 7.7%

**Birds Eye & Daily Views**

- Tim - T1D, Aspergers Syndrome, age 47, BMI: 28
  - 80+ year old parents, safety of living independently?
  - Mdi: glargine 35 BID, lispro 20 units per meal
- A1c: 13%
- SMBG:
  - Average: 183 mg/dL
  - SD: 67
  - Frequency SMBG: < 1 x/day
Pete

- T2D x 28 yrs
  - Recently dx CKD stage 3, neuropathic pain in his feet and hands
  - BMI: 38
  - A1C 9.7%
- "Wake-up" call after learning of decline in renal function
- First appointment ever with RDN/CDE after Libre
- MDI:
  - Basaglar 25 units BID
  - Aspart - 10-20 units per meal based on “WAG” method
Practice Pearls: An Actionable "Surprise" For All Users

- Breakfast bump – Refined/processed foods/smoothies
- Post-activity – glucose response
- Observe glucose response to different types of food – “Pizza” effect – prolonged postprandial hyperglycemia
- Nocturnal hypoglycemia
- Hypoglycemia unawareness
- Over-correction for hyperglycemia

Practice Pearl: Timing of insulin dose “lag-time”

- Ask patients about insulin action:
  - onset
  - peak
  - duration
- Difficult to be under 200 mg/dL “peak” after eating unless injecting/bolusing 15-20 minutes before start of meal
- However – use of ”lag-time” must be balanced with safety
- Viewing real-time glucose data can increase risk of ”STACKING”

Visual Reinforcement of “Stacking” Concept

“Lag Times” Based on Degree of Pre-prandial Hyperglycemia

<table>
<thead>
<tr>
<th>Pre-Meal Blood Glucose (mg/dL)</th>
<th>Lag Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-99</td>
<td>0</td>
</tr>
<tr>
<td>100-199</td>
<td>10-20</td>
</tr>
<tr>
<td>200-299</td>
<td>20-30</td>
</tr>
<tr>
<td>&gt;300</td>
<td>30-40</td>
</tr>
</tbody>
</table>

Practice Pearl: Timing of Prandial Insulin
Practice Pearls: Maximizing Education Sessions

• Encourage use of portals and BG software to upload data!
• Data analysis helps to make adjustments with pump settings for "activities of daily living":
  - Physical activity
  - Stress/Illness
  - Restaurant meals
  - Travel
  - Menses

Practice Pearl: Look for Cheat Sheets
Most companies provide a "cheat" sheet with computer generated strategies recognized by patterns

Practice Pearl: Organizational Support
• Endocrine Society Clinical Practice Guideline – Diabetes Technology
• Co-sponsored by AACE

Support for Role of CDE in CGM

Summary
"Research shows the glucose data need to be used for decision-making; otherwise, value in reducing A1c and complications is questionable."

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