Inpatient Glycemic Management 101

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University of Toronto Ontario Canada

Summer 1921



thestar.com

Discovery of Insulin - 1921









James Dexter Havens (1900–1960) First American to Receive Insulin



Rochester, NY

Printmaker

Died of Cancer



Fine Arts Museum of San Francisco

https://beachmetro.com/

Elizabeth Evans Hughes Gossett August 19, 1907 – April 21, 1981 (74 years)



- Born in NYS executive mansion (father was governor)
- Dxed with DM1 age 11 (1918)
- Moved to Toronto with mother to start receiving insulin (August 15, 1922)
 - lived 63 years with DM1
 - on insulin for 59 years







Insulin

Powerful Life-Saving

Patient JL, 15 pounds

December 15, 1922

Patient JL, 29 pounds

February 15, 1923







Inpatient Glycemic Management 101

Learning Objectives

- 1. Describe the normal daily excursions of serum insulin levels in someone without diabetes
- 2. Describe the role of basal insulin replacement
- 3. Describe the process to determine the insulin to carbohydrate ratio of an individual
- 4. State the glycemic targets for acceptable diabetes control



<u>History</u>

- L foot osteomyelitis (MRSA), TMA
- R foot necrotizing fasciitis, BKA
- HTN
- Tobacco Abuse Disorder
- CC: bilateral arm weakness
 Cervical Spine MRI



Diabetes History

- Metformin \rightarrow diarrhea
- Insulin replacement: last 15 yrs
 - Glargine 60 a.m. & 60 p.m.
 - -Aspart \rightarrow does not take b/c hypogly
- If no bedtime snack \rightarrow hypogly
- Symptoms if FSBG is <80



In Hospital

- Glargine 40 h.s.
- Aspart 30 with meals
- 2000 Cal Constant-CHO diet

| | FSBG | | | | |
|----------|--------------------------------|-----|-----------|-----|--|
| | Breakfast Lunch Dinner Bedtime | | | | |
| 2 Jan 22 | 228 | 141 | 85 | 221 | |
| 3 Jan 22 | 55 (symp) | 206 | 56 (symp) | 283 | |
| 4 Jan 22 | 355 | 178 | 138 | 186 | |



Insulin Levels in People without Diabetes



Basal Insulin Secretion in People without Diabetes

Table 1 Characteristics of the motionty studied

| | Table 1. Ch | Table 1. Characteristics of the patients studied | | | |
|--|------------------|--|----------------|----------------|----------------|
| | Subject (no.) | Sex (M/F) | Age (years) | Weight (kg) | BMI (kg/m²) |
| iabetologia (1987) 30: 16-21 Diabetol | ogia 1 | F | 24 | 68 | 27 |
| © Springer-Verlag | 2 | Μ | 25 | 82 | 25 |
| | 3 | М | 20 | 70 | 21 |
| | 4 | М | 20 | 93 | 27 |
| | 5 | Μ | 27 | 67 | 21 |
| | 6 | F | 33 | 51 | 19 |
| asal and 24-h C-peptide and insulin secretion rate in normal man | 7 | F | 31 | 55 | 22 |
| T. Kruszynska, P. D. Home, I. Hanning and K. G. M. M. Alberti | 8 | F | 19 | 51 | 21 |
| partment of Medicine, University of Newcastle-upon-Tyne, Newcastle-upon-Tyne, UK | 9 | Μ | 32 | 68 | 21 |
| | 10 | F | 27 | 57 | 23 |
| | Mean \pm SD | | 26 ± 5 | 66 ± 14 | 23 ± 3 |



Basal Insulin Secretion in People without Diabetes

| Table 3. Insulin and C-peptide secretion rates and urinary C-peptide excretion rate in normal man | | | | | |
|---|-------------------|----------------------|----------------|-------------------|--|
| Subject (no.) | C-peptide secr | C-peptide secretion | | cretion | |
| | Basal (nmol/h) | Total (nmol/24 h) | Basal (U/h) | Total (U/24 h) | |
| 1 | 7.0 | 288 | 1.2 | 48.3 | |
| 2 | 11.2 | 487 | 1.9 | 81.7 | |
| 3 | 7.5 | 335 | 1.3 | 56.2 | |
| 4 | 14.0 | 548 | 2.3 | 92.0 | |
| 5 | 5.4 | 242 | 0.9 | 40.6 | |
| 6 | 5.1 | 345 | 0.8 | 57.9 | |
| 7 | 6.7 | 351 | 1.1 | 58.9 | |
| 8 | 6.4 | 402 | 1.1 | 67.5 | |
| 9 | 7.2 | 376 | 1.2 | 63.1 | |
| 10 | 7.8 | 386 | 1.3 | 64.8 | |
| $Mean \pm SD$ | 7.8 ± 2.7 | 376 ± 89 | 1.3 ± 0.4 | 63 ± 15 | |

Basal and 24-h C-peptide and insulin secretion rate in normal man

Y. T. Kruszynska, P. D. Home, I. Hanning and K. G. M. M. Alberti Department of Medicine, University of Newcastle-upon-Tyne, Newcastle-upon-Tyne, UK



Basal Insulin Secretion in People without Diabetes

~1 unit/hr

Basal and 24-h C-peptide and insulin secretion rate in normal man

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In Hospital

- Glargine 40 h.s.
- Aspart 30 with meals
- 2000 Cal Constant-CHO diet

| | FSBG | | | | | |
|----------|--------------------------------|-----|-----------|-----|--|--|
| | Breakfast Lunch Dinner Bedtime | | | | | |
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In Hospital

- Glargine 40 h.s. \rightarrow 24 h.s.
- 2000 Cal Constant-CHO diet

| | FSBG | | | |
|----------|-----------|-------|--------|---------|
| | Breakfast | Lunch | Dinner | Bedtime |
| 6 Jan 22 | | Stat | ole? | 229 |
| 7 Jan 22 | 169 | | | 215 |
| 8 Jan 22 | 201 | | | 199 |
| 9 Jan 22 | 136 | | | |

The Role of Basal Insulin Replacement

Keep the blood glucose constant when not receiving nutrition.



66 yo Delivery Man w/ DM2 for 24 years In Hospital

- Glargine 24 h.s., 2000 Cal Constant-CHO diet
- Need prandial insulin replacement

| | FSBG | | | |
|----------|-----------|-------|--------|---------|
| | Breakfast | Lunch | Dinner | Bedtime |
| 6 Jan 22 | | | | 229 |
| 7 Jan 22 | 169 | | | 215 |
| 8 Jan 22 | 201 | | | 199 |
| 9 Jan 22 | 136 | | | |

Insulin Levels in People without Diabetes



Prandial Insulin Replacement

* Peak Insulin Level is proportional to CHO in meal



Prandial Insulin Replacement

* Peak Insulin Level is proportional to CHO in meal

Insulin:CHO Ratio

I:CHO Ratio I:C Ratio



Prandial Insulin Replacement

Insulin:CHO Ratio

default value

1:10





Carbohydrate Counting



Carbohydrate Counting

Nutrition Facts

About 6 servings per container Serving size 1¹/₄ Cup (58g)

| Amount per serving | 00 | |
|--|-------------------|-------------|
| | | |
| % Daily | value* | |
| Saturated Eat Og | 0% | |
| Trans Eat Og | 0 70 | |
| Polyupsaturated Eat 1g | | |
| Monourposturated Fat 1g | | |
| | 0.9/ | |
| Cholesterol unig | <u> </u> | |
| Sodium 140mg | 6% | |
| Total Carbohydrate 43g | 16% | |
| Dietary Fiber 12g | 44% | |
| Soluble Fiber 1g | | |
| Insoluble Fiber 10g | | |
| Total Sugars 8g | | |
| Includes 7g Added Sugars | 14% | |
| Protein 11g | 18% | |
| | | |
| Vitamin D 0mcg | 0% | |
| Calcium 90mg | 6% | |
| Iron 2.8mg | 15% | |
| Potassium 200mg | 4% | |
| Phosphorus | 15% | |
| Magnesium | 15% | |
| Zinc | 10% | |
| * The % Daily Value (DV) tells you how much a nutrient of food contributes to a daily diet. 2,000 calories a day general putrition advice. | in a se is use | Kashi cerea |

general nutrition advice

| Whole Serving Size Servings Pe | Milk 8 fl oz r Conta | (240mL iner 2 | .) |
|---|---|---|--|
| Amount Per Se | rving | | |
| Calories 150 |) Calor | ies from | Fat 70 |
| | | % Dail | y Value' |
| Total Fat 8g |) | | 12% |
| Saturated | Fat 5g | | 25% |
| Cholestero | 35mg | | 12% |
| Sodium 125 | ōmg | | 5% |
| Total Carbo | hydrate | e 12g | 4% |
| Dietary Fi | ber 0g | | 0% |
| Sugars 11 | g | | |
| Protein 8g | | | |
| | | | |
| Vitamin A 6% | • | Vitam | in C 4% |
| Calcium 30% • | Iron 0% | Vitamir | n D 25% |
| Percent Daily V calorie diet. You or lower dependence | alues are b ir daily valu ding on you Calories: | vased on a ves may be vr calorie n 2,000 | 2,000 higher eeds. 2,500 |
| Total Fat Sat Fat Cholesterol Sodium Total Carbohydrat Dietary Fiber | Less than Less than Less than Less than le | 65g 20g 300mg 2,400mg 300g 25g | 80g 25g 300mg 2,400mg 375g 30g |
| | Whole Serving Size Servings Pe Amount Per Se Calories 150 Total Fat 8g Saturated Cholesterol Sodium 125 Total Carbo Dietary Fi Sugars 11 Protein 8g Vitamin A 6% Calcium 30% • * Percent Daily Vicalorie diet, Yo calorie diet, Yo calorie diet, Yo calorie diet, Yo calorier Jata Sat Fat Cholesterol Sodium Total Carbohydra Dietary Fiber | Whole Milk Serving Size 8 fl oz Servings Per Contal Amount Per Serving Calories 150 Calor Total Fat 8g Saturated Fat 5g Cholesterol 35mg Sodium 125mg Total Carbohydrate Dietary Fiber 0g Sugars 11g Protein 8g Vitamin A 6% Calcium 30% • Iron 0% * Percent Daily Values are b calorie diet. Your daily values or lower depending on you Calories: Total Fat Less than Sat Fat Less than Sodium Less than | Whole Milk Serving Size 8 fl oz (240mL Servings Per Container 2 Amount Per Serving Calories 150 Calories from % Dail Total Fat 8g Saturated Fat 5g Cholesterol 35mg Sodium 125mg Total Carbohydrate 12g Dietary Fiber 0g Sugars 11g Protein 8g Vitamin A 6% • Vitami * Percent Daily Values are based on a calorie diet. Your daily values may be or lower depending on your calorie n Calories: 2,000 Total Fat Less than 65g Sat Fat Less than 65g Sat Fat Less than 300mg Cholesterol Less than 300mg Sodium Less than 2,400mg Total Carbohydrate 300g Dietary Fiber 25g |

CHO: **56 gms**



Carbohydrate Counting Constant CHO Diet

| | Grams of Carbohydrate | | | | |
|----------|-----------------------|--------|----|--|--|
| | Breakfast | Dinner | | | |
| 1600 Cal | 65 | 65 | 65 | | |
| 1800 Cal | 75 | 75 | 75 | | |
| 2000 Cal | 85 | 85 | 85 | | |
| 2200 Cal | 95 | 95 | 95 | | |

66 yo Delivery Man w/ DM2 for 24 years <u>In Hospital</u>

Glargine 24 h.s., 2000 Cal Constant-CHO diet

| | Grams of Carbohydrate | | | | | |
|----------|------------------------|----|----|--|--|--|
| | Breakfast Lunch Dinner | | | | | |
| 1600 Cal | 65 | 65 | 65 | | | |
| 1800 Cal | 75 | 75 | 75 | | | |
| 2000 Cal | 85 | 85 | 85 | | | |
| 2200 Cal | 95 | 95 | 95 | | | |

Insulin:CHO Ratio

default value









66 yo Delivery Man w/ DM2 for 24 years <u>In Hospital</u>

- Glargine 24 h.s., 2000 Cal Constant-CHO diet (85 gm CHO @ meal)
- Lispro 8 with meals

| | FSBG | | | | | | |
|----------|-----------|-------------------------------|-----|-----|--|--|--|
| | Breakfast | Breakfast Lunch Dinner Bedtim | | | | | |
| 6 Jan 22 | | | | 229 | | | |
| 7 Jan 22 | 169 | 198 | 211 | 215 | | | |
| 8 Jan 22 | 201 | 239 | 175 | 199 | | | |
| 9 Jan 22 | 136 | 111 | 207 | 242 | | | |

TREATMENT MODALITIES





A Visit to the Kitchen





A Visit to the Kitchen



A Visit to the Kitchen





66 yo Delivery Man w/ DM2 for 24 years <u>In Hospital</u>

- Glargine 24 h.s., 2000 Cal Constant-CHO diet (85 gm CHO @ meal)
- Lispro 8 with meals

| | FSBG | | | | | | |
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66 yo Delivery Man w/ DM2 for 24 years In Hospital

- Glargine 24 h.s., 2000 Cal Constant-CHO diet (85 gm CHO @ meal)
- Lispro 8 with meals
- Appetite decreased
- Became depressed

.....dropped to eating only $\frac{1}{2}$ of his tray

<u>History</u>

- L foot osteomyelitis (MRSA), TMA
- R foot necrotizing fasciitis, BKA
- HTN
- Tobacco Abuse Disorder
- CC: bilateral arm weakness
 Cervical Spine MRI







In Hospital

- Glargine 24 h.s.
- 2000 Cal Constant-CHO diet
 85 gm CHO each meal
- Lispro 8 with meals

I:CHO ≠ 1:10



If the I:CHO Ratio is Too Low (i.e., FSBG is consistently >180)

1:10 1:7 185



How did Sliding Scale Insulin Get Started?



l don't know.



Death to the Sliding Scale!

Belinda P. Childs, ARNP, MN, CDE, Editor

Diabetes Spectrum Volume 16, Number 2, 2003

ORIGINAL INVESTIGATION

Glycemic Control and Sliding Scale Insulin Use in Medical Inpatients With Diabetes Mellitus

William S. Queale, MD, MS; Alexander J. Seidler, PhD; Frederick L. Brancati, MD, MHS

Queale WS, Seidler AJ, Brancati FL: Arch Int Med 157:545-552, 1997



Glycemic Control and Sliding Scale Insulin Use

- Prospective Cohort Study
- 171 consecutive adult admissions
- FSBG measurements were followed over the first four full hospital days or until the day of discharge
- Sliding scales:
 - conservative (coverage if >200)
 - aggressive (coverage if >150)



Relative Risk of Hyperglycemia (BG>300 mg/dl)

Johns Hopkins Medical Institutions, 1994

| | Sliding Scale Regular Insulin Regimen Adjusted RR (95% CI) | | |
|--------------------------------|---|-----------------------------|-----------------------------|
| Standing Regimen | No Sliding Scale | Conservative (BG>200) | Aggressive (BG>150) |
| None | 1.00 (Reference) | 2.85* (1.07-7.59) | 3.25* (1.23-8.60) |
| Oral Hypoglycemic Agents | 0.25 (0.05-1.33) | 0.93 (0.29-2.98) | 0.48 (0.10-2.36) |
| Intermediate-Acting Insulin | 1.38 (0.42-4.59) | 1.82 (0.69-4.81) | 0.90 (0.19-1.81) |

Queale WS, Seidler AJ, Brancati FL: Arch Int Med 157:545-552, 1997



*p<0.05

Observations on the Use of Sliding Scale Insulin In the Hospital

> By looking at the blood sugar results alone, it is difficult to tell who is on "SSI" and who is not.



Observations on the Use of Sliding Scale Insulin In the Hospital

 Depends on the busy nurse being able to give the coverage insulin on time.



Description of the Automatic Regular Insulin Sliding Scale Genuth S. *Clinical Diabetes* 12:40, 1994

- 1. Anti-intellectual
- 2. Contrary to our knowledge of physiology and experience with diabetes
- 3. Does not take into account severity of illness





Description of the Automatic Regular Insulin Sliding Scale

Genuth S. Clinical Diabetes 12:40, 1994

- 4. Does not account for whether the patient is eating or being sustained intravenously
- 5. Does not account for the time of day
- 6. Takes no account of prehospitalization metabolic control or responsiveness to insulin





Description of the Automatic Regular Insulin Sliding Scale Genuth S. Clinical Diabetes 12:40, 1994

- 7. Used unthinkingly in patients who do not need it
- 8. Reactive rather than proactive
- 9. Produces paralysis of thought
 - If it doesn't work, it's not the physician's fault
 - Self-perpetuating: sliding scales rarely change during a hospitalization





Inpatient Glycemic Management 101 What to Remember **1. Basal Estimate** 1 unit per hour 2. I:CHO Estimate • 1:10 3. Target 100 - 180



Inpatient Glycemic Management 101

Learning Objectives

- 1. Describe the normal daily excursions of serum insulin levels in someone without diabetes
- 2. Describe the role of basal insulin replacement
- 3. Describe the process to determine the insulin to carbohydrate ratio of an individual
- 4. State the glycemic targets for acceptable diabetes control



Basal – Bolus Therapy

It's not easy, and it takes teamwork.

Do you believe the return is worth the investment?

James Desemone MD, FACP, CPE desemoj@amc.edu



What we missed

- Correction
- How to write a good lispro order
- IV insulinization (why better than sq?)
- Transition from IV to SQ
- Insulin pumps in the hospital
- CGM in the hospital
- Engaging leadership to avoid sliding scales
- Transition to home

