Type 1 Diabetes; how does it happen, how do we manage it?
Outline

• Normal physiology
• Types of diabetes
• Type 1 diabetes
• Autoimmunity
• Management: insulin and devices
Normal physiology
Glucose metabolism

Intake:
- Starch
- Glycogen
- Disaccharides
- Monosaccharides (glucose, fructose, galactose)

Storage:
- Glycogen

Distribution and utilization:
- Free glucose
Sugar
Glucose Metabolism

Normal cell

Glucose

GLUT1

Glycolysis

Pyruvate

+ O₂

Mitochondria

C₀₂ + energy
Insulin
Insulin
Insulin

An islet
Diabetes

• Glucose cannot enter the cells
  - No insulin = Type 1 Diabetes
  - Insulin not working = Type 2 Diabetes

• Other types, less common
Diabetes

- Glucose accumulates in the blood

- Spills over in the urine (when level is >180)
  (Normal is 70-110, up to 140)

  - Takes water with it

  - Increased urine and thirst
Type 2 Diabetes

*Insulin not working*

- Overweight and lack of physical activity lead to insulin resistance
- We make more insulin to compensate
- Eventually, islet cells burn out, cannot make enough
Type 2 Diabetes

Treatment

• Eliminate the cause:
  
  Decrease weight, increase activity

• Drugs
  
  Help make more insulin
  Help insulin work better
  Lower blood sugar (in other ways)

• Insulin
Type 1 Diabetes

No Insulin

• Trauma – Infection - Surgery
• Cystic Fibrosis
• Autoimmune (true T1D)
Autoimmunity
Autoimmunity

Normal

Autoimmune Disorder

immune response against bacteria

antibodies attaching body tissues

body tissues
The immune system (very simplified)

Look! Intruder!
Get 'em!
bacteria

You're history!

virus-infected cell

killer T cell
cancer cell
bacterium-infected cell

The killer T cells terminate cancer cells and cells infected by a virus or bacterium.
Autoimmunity against Beta cells
Autoimmunity

- Genetic predisposition
- Immune system
- Autoimmunity
- Environmental factors
- Hormonal factors
Type 1 Diabetes

No Insulin

• Treatment: Take insulin!
Type 1 Diabetes; Management

In normal physiology, glucose metabolism is exquisitely controlled;

- Blood Glucose (BG) has a tight range
- BG levels are sensed continuously
- Instantaneous response in the β-cells
- Almost immediate and quick effect of insulin
- Short lived effect
Type 1 Diabetes; Management

We’re not even close

• We check BG every few hours
• We deliver insulin every few hours
• Insulin action is still too slow
• Deliver insulin in subcutaneous space (it takes a while to reach the blood)
Insulin
1922
Insulin

Frederick Banting & Charles Best
Insulin

1990
Type 1 Diabetes; Management

We need insulin all the time

- Long acting insulin, 1 or 2 doses/day
- Short acting insulin, for every meal
Type 1 Diabetes; Management

Insulin pump, continuous infusion of short acting insulin

[Diagram showing insulin regimen with an insulin pump (CSII) and examples of different meal bolus profiles with an insulin pump.]
Type 1 Diabetes; Management

Daily tasks, before each meal

- Check BG
- Count the carbohydrates in the meal
- Calculate dose of insulin
- Deliver insulin, by injection or insulin pump
Insulin pumps
Insulin pumps
Insulin pumps
Glucose sensors
(Continuous Glucose Monitors)
Glucose sensors
(Continuous Glucose Monitors)

A: pump
B: infusion set
C: sensor
D: transmitter
Type 1 Diabetes; Management

Lots of cool tools, but they don’t think for us

• What kind of food (fat, fiber, protein)
• Activity (before and after)
• Time of day
• Time of month
• Constantly making adjustments
# Diabetes logs

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Diabetes logs
Closing the loop
Closing the loop
The Artificial Pancreas