

# **Quantifying Diabetes**

**Lessons learned from 100,000+ blood glucose readings**

Jana E. Beck

May 8, 2012

# Type 1 Diabetes

- an auto-immune disease
  - = the body's immune system attacks and kills the insulin-producing  $\beta$ -cells in the pancreas
- very little to no endogenous insulin production
  - = dependent on synthetic insulin
- insulin dosing **is not easy!**
  - basal insulin
  - bolus insulin
    - = matched to carbohydrates consumed, roughly

# Continuous Glucose Monitoring



the

Dexcom Continuous Glucose Monitor  
(Seven+ generation, now on G4 Platinum)

# About the Dexcom

The Dexcom provides:

- an (approximate) blood glucose reading every five minutes
- an arrow indicating
  - trend (= up, down, or steady)
  - rate-of-change
- audible and/or vibrating alerts when blood glucose is
  - too high
  - too low
  - or changing *very* rapidly
- ability to download data!

# Blood Glucose Management

- non-diabetics blood glucose: between 70-130 mg/dL
- my goals:
  - as many readings in the “target” non-diabetic range as possible
  - keep the % of readings *below* 65 mg/dL to a minimum
  - reduce standard deviation (as measured on a day’s worth of readings)
  - reduce mean

# My Experiment

- first experience with Dexcom= *shock*
- next= **frustration**

# My Experiment, Cont'd

## Hypothesis

*Carbohydrate restriction is an effective way to improve blood glucose outcomes.*

# Inspiration

*Good Calories, Bad Calories* by Gary Taubes

*When I hear a physician saying to a type 1 diabetes patient, "Go ahead and eat whatever you want, just make sure you cover your glucose with insulin," it's like telling a firefighter, "Just go ahead and pour as much gasoline as you like on that fire you're trying to put out, as long as you cover it with enough water."*

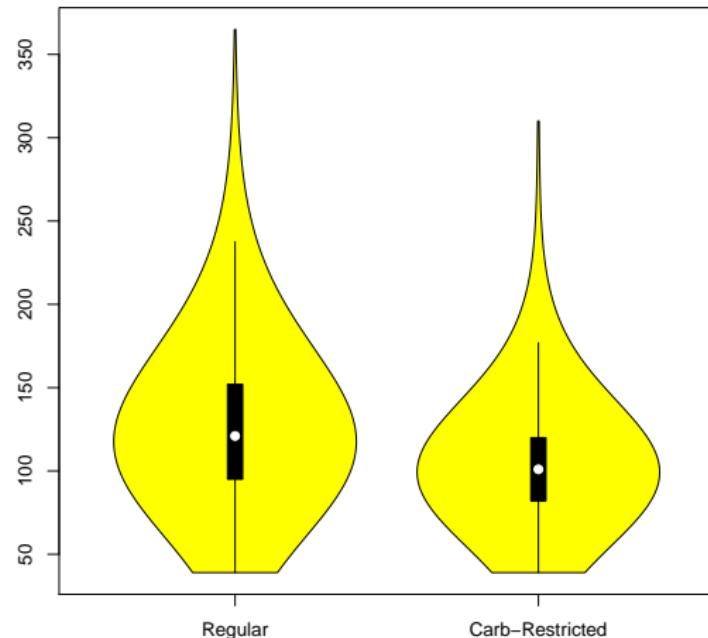
— Dr. Peter Attia

# Tools

- Dexcom data export formats:
  - XML files, useful for manipulating in Python with [BeautifulSoup](#)
  - tab-delimited .csv files, useful for direct importing into R
- in R:
  - built-in non-parametric statistical functions
  - built-in plotting functions: `boxplot()`, etc.
  - [ggplot2](#)

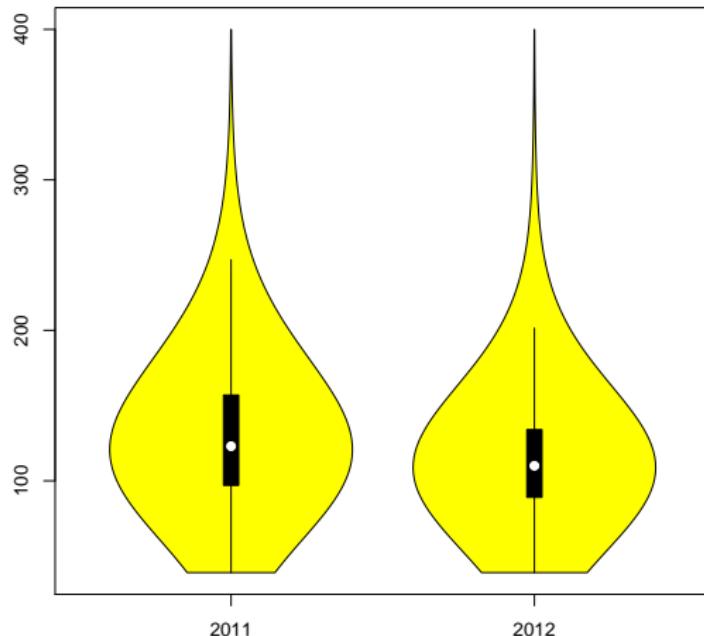
# Visualizing Change: Violin Plot

2-month data samples from 2011 and carb-restriction experiment in 2012.

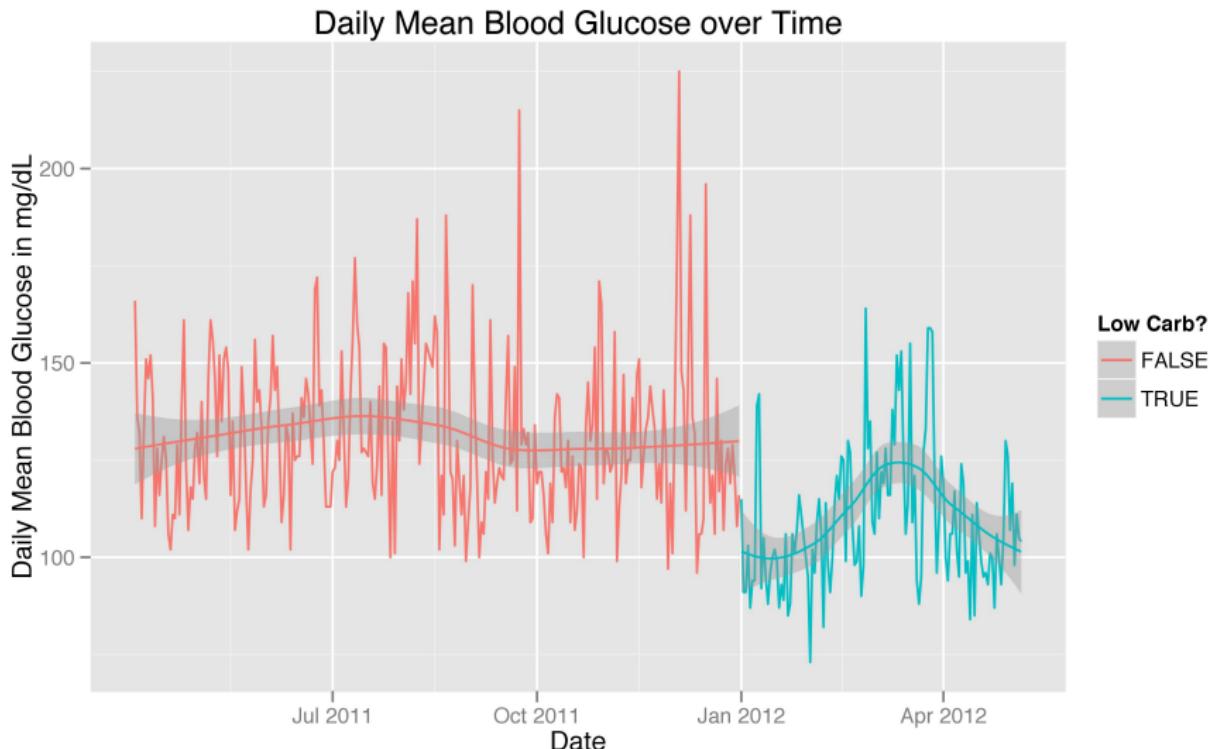


# Comparing Years: Violin Plot

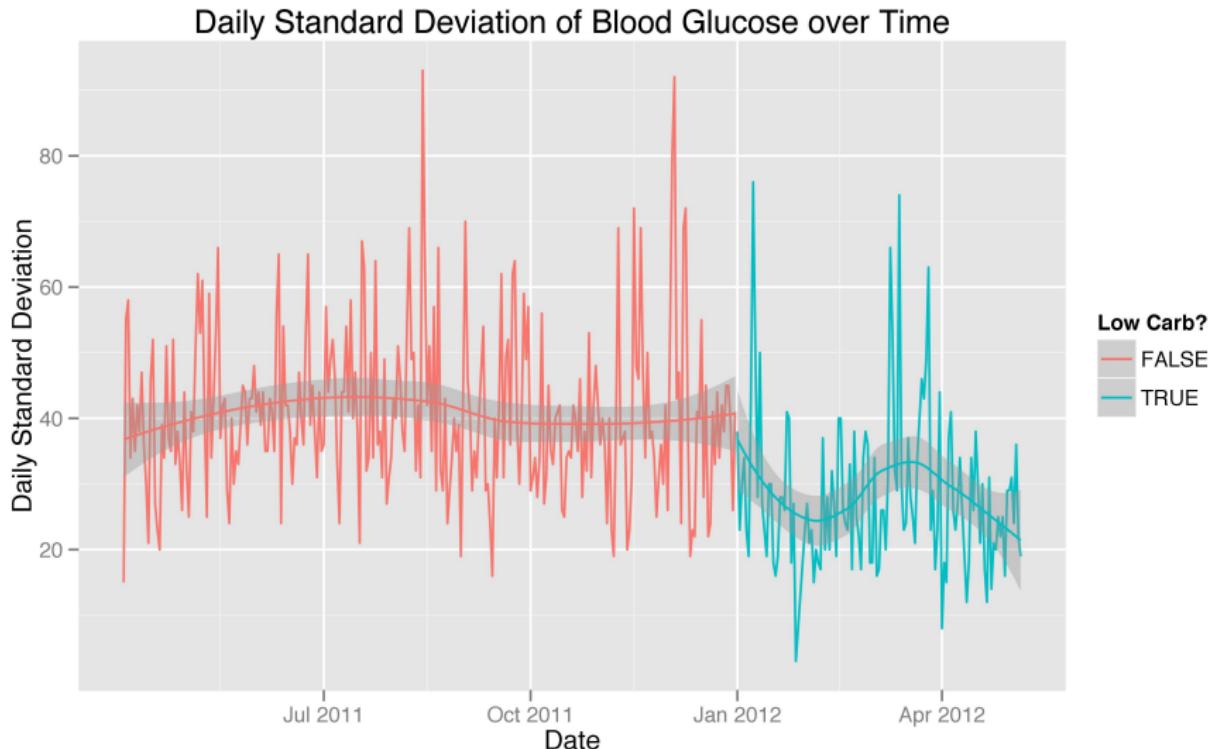
All of 2011 compared with all of 2012.



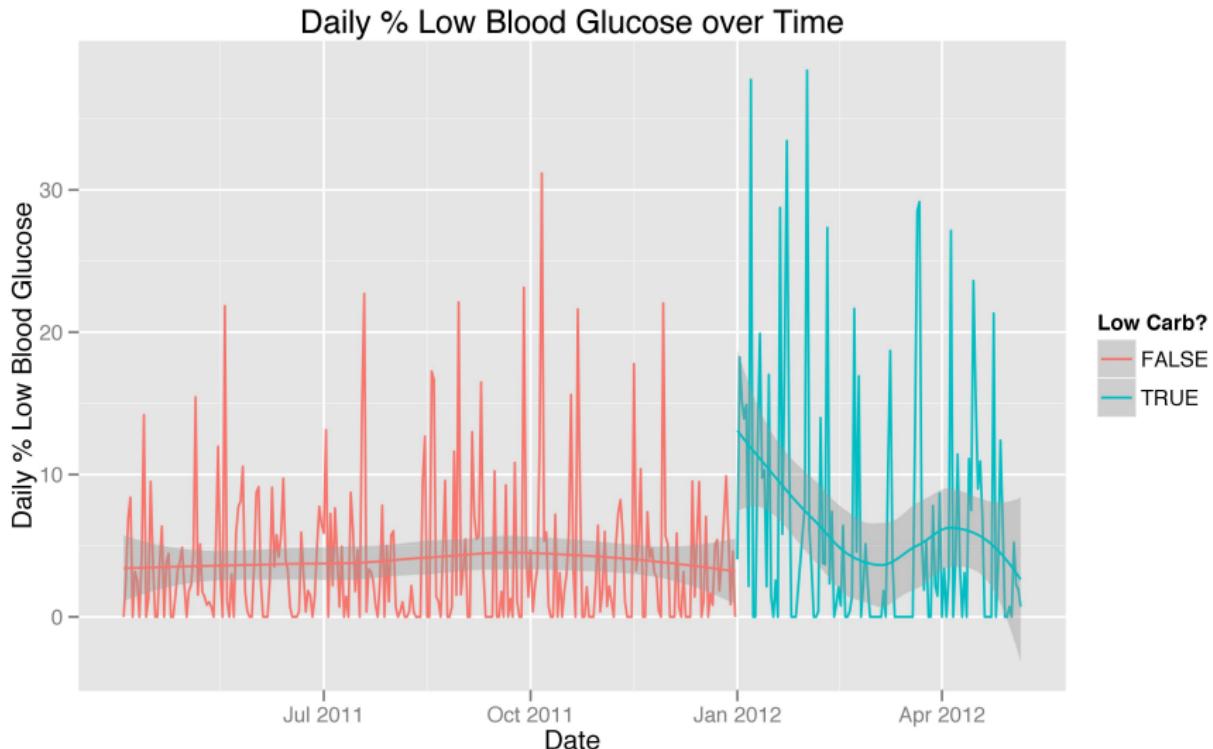
# Visualizing Change: Daily Mean over Time



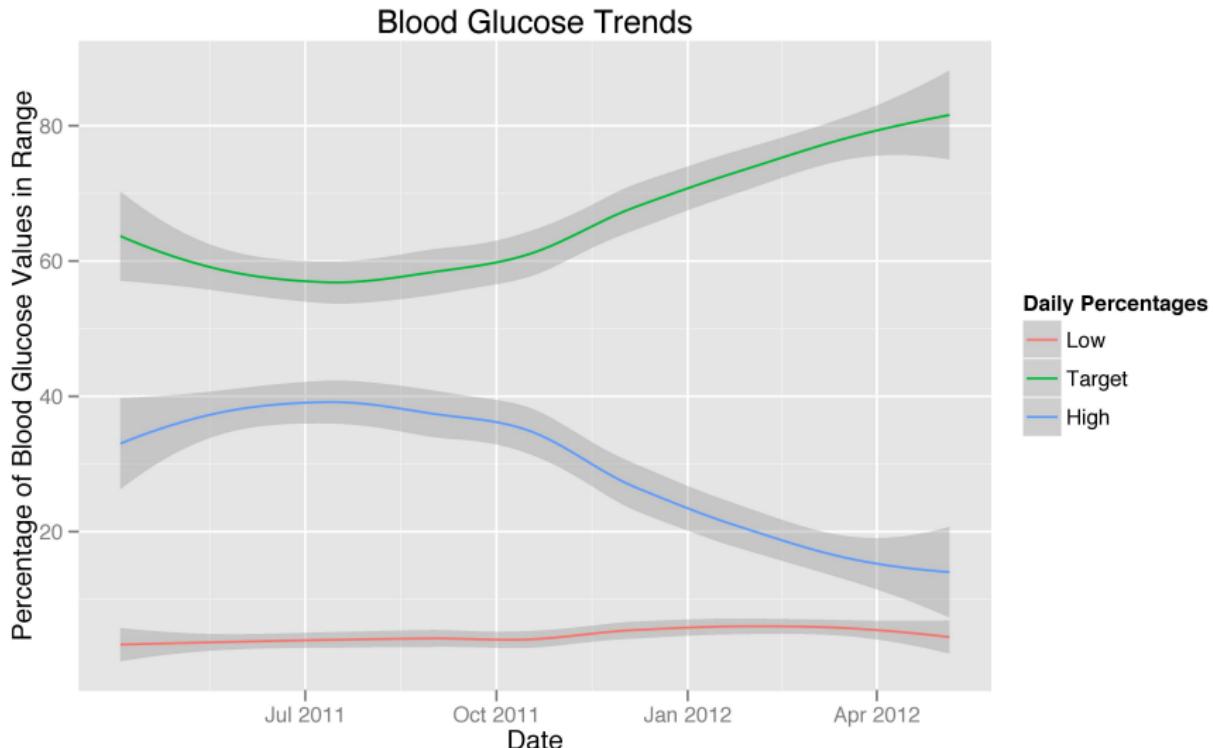
# Visualizing Change: Daily Std. Deviation over Time



# Visualizing Change: Daily % Low over Time



# Visualizing Change: Daily Percentages over Time



# Statistical Significance

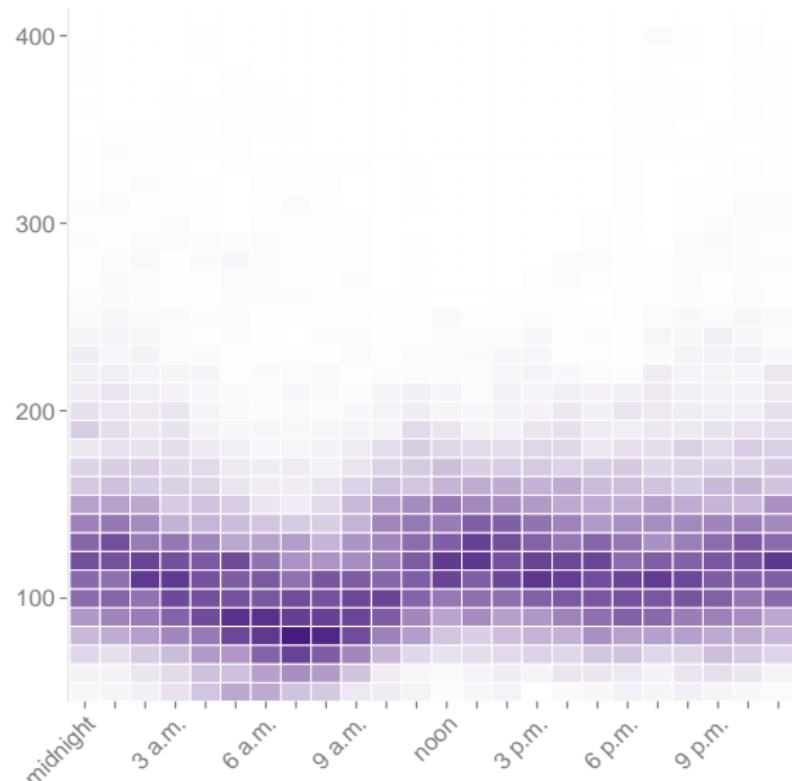
## Question

*Did adopting a carbohydrate-restricted diet starting January 1st, 2012 result in a statistically significant difference in blood glucose?*

Wilcoxon rank-sum test:

- similar to the Student's t-test, but for non-parametric (= non-normally-distributed) data
- p-value < 2.2e-16
- **Conclusion:** change in diet resulted in significant (negative) change in blood glucose values
- estimate of the median of the difference between a sample from regular diet blood glucose data and a sample from low-carb diet data is **about -19 mg/dL**

# Patterns: Time of Day



# Thanks!

Contact: [jana.eliz.beck@gmail.com](mailto:jana.eliz.beck@gmail.com)

Upcoming Project: <https://github.com/jbeck/iPancreas>  
(Description here: <http://jbeck.github.com/iPancreas/>)