ANALYSIS AND DEVELOPMENT OF A MEAL DETECTION ALGORITHM FOR THE ARTIFICIAL PANCREAS

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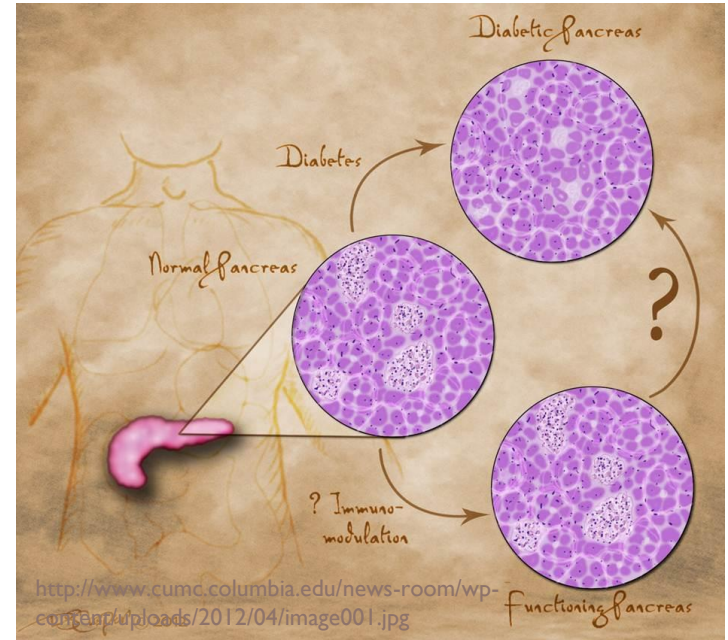
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EUREKA   **August 23, 2012**

Type 1 Diabetes

▸ Cause and Effects of Type 1

  ▸ Autoimmune destruction of pancreatic beta cells
  ▸ No control of blood glucose
  ▸ Exogenous insulin required
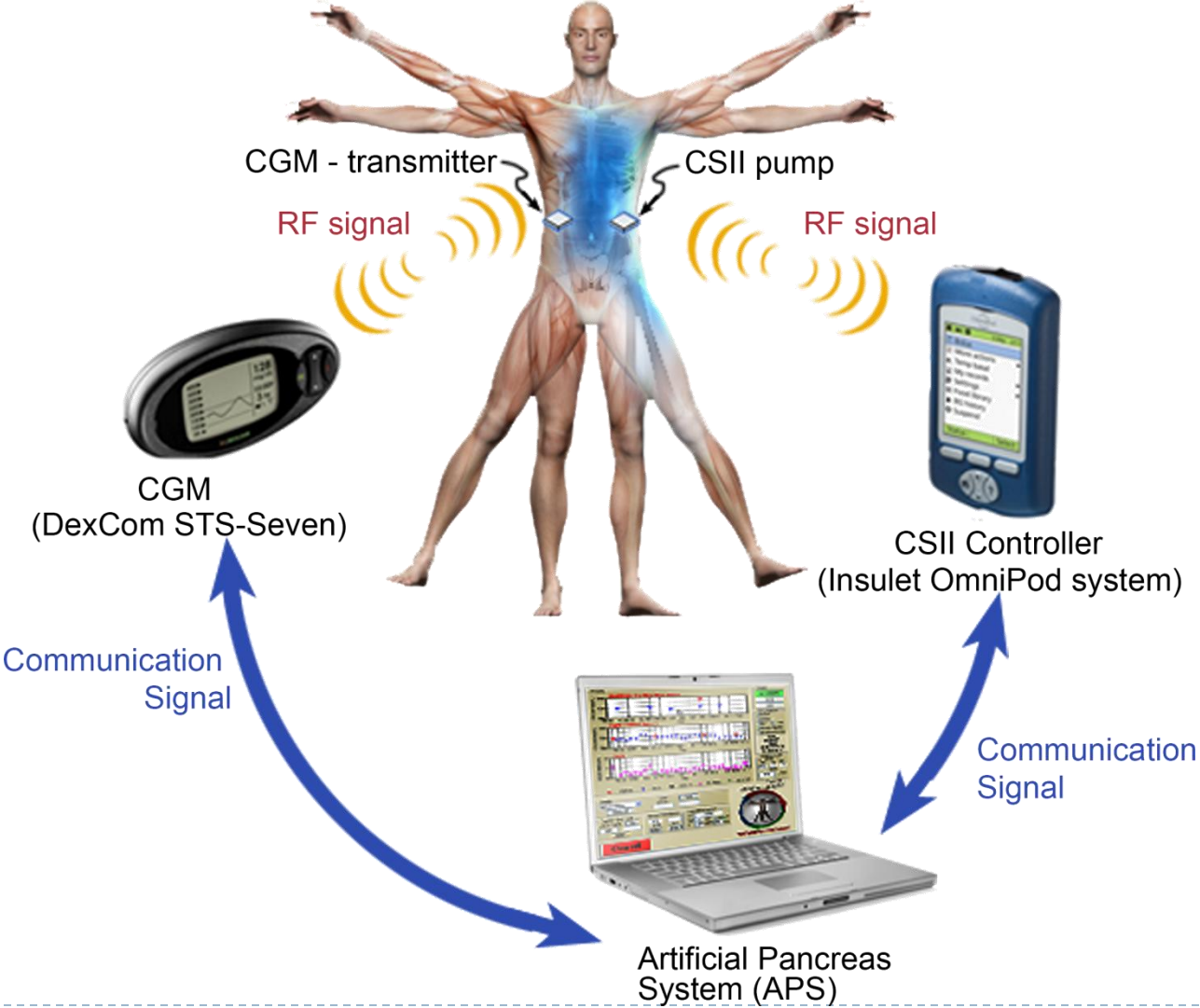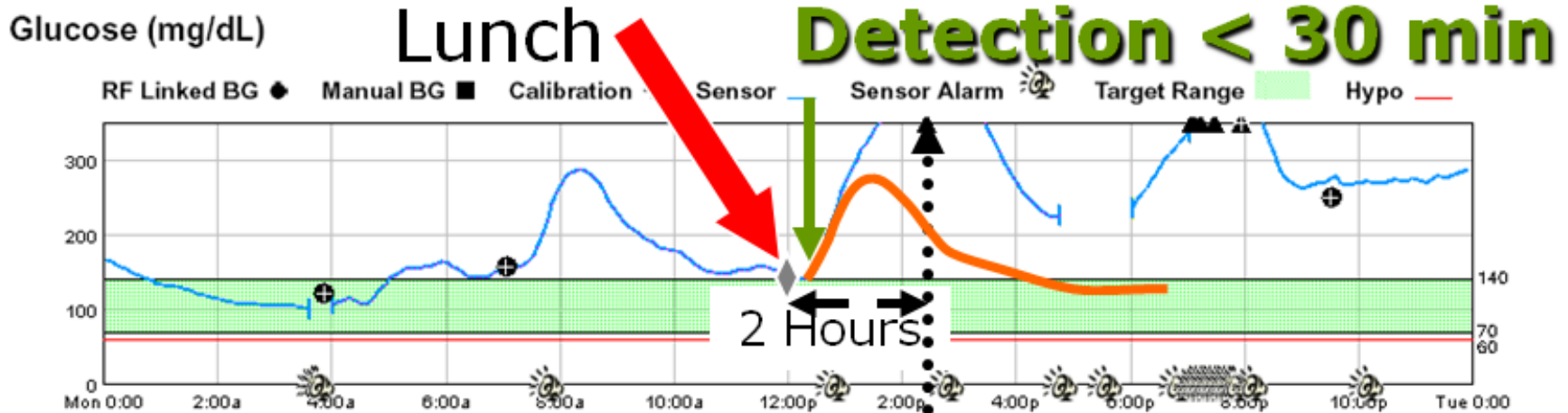
▸ Current disease therapy

  ▸ Self monitoring
  ▸ Multiple daily insulin injections
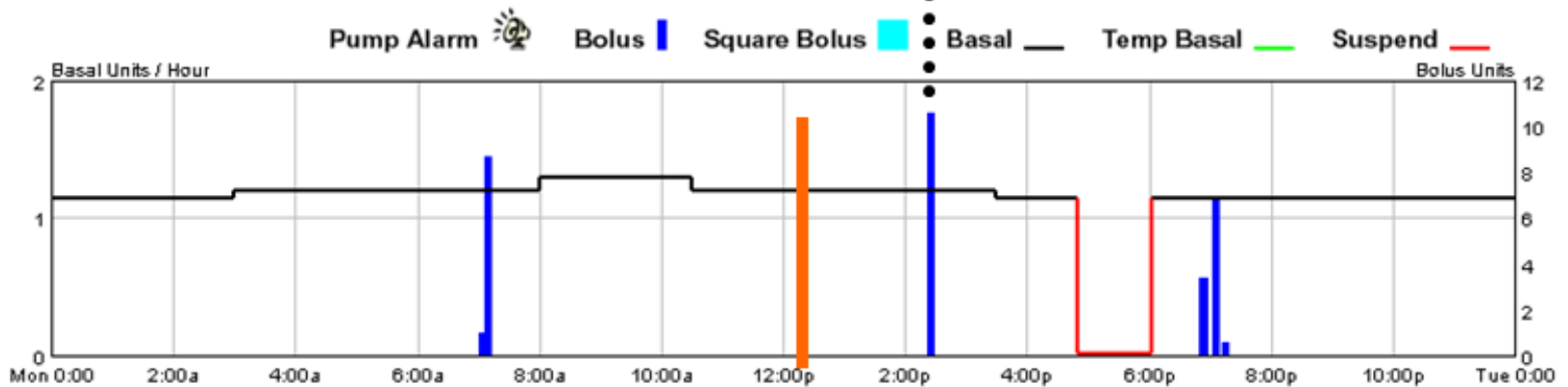
Future of Disease Therapy: Artificial Pancreas

CGM - transmitter   CSII pump

RF signal   RF signal

CGM
(DexCom STS-Seven)

CSII Controller
(Insulet OmniPod system)

Communication
Signal

Communication
Signal

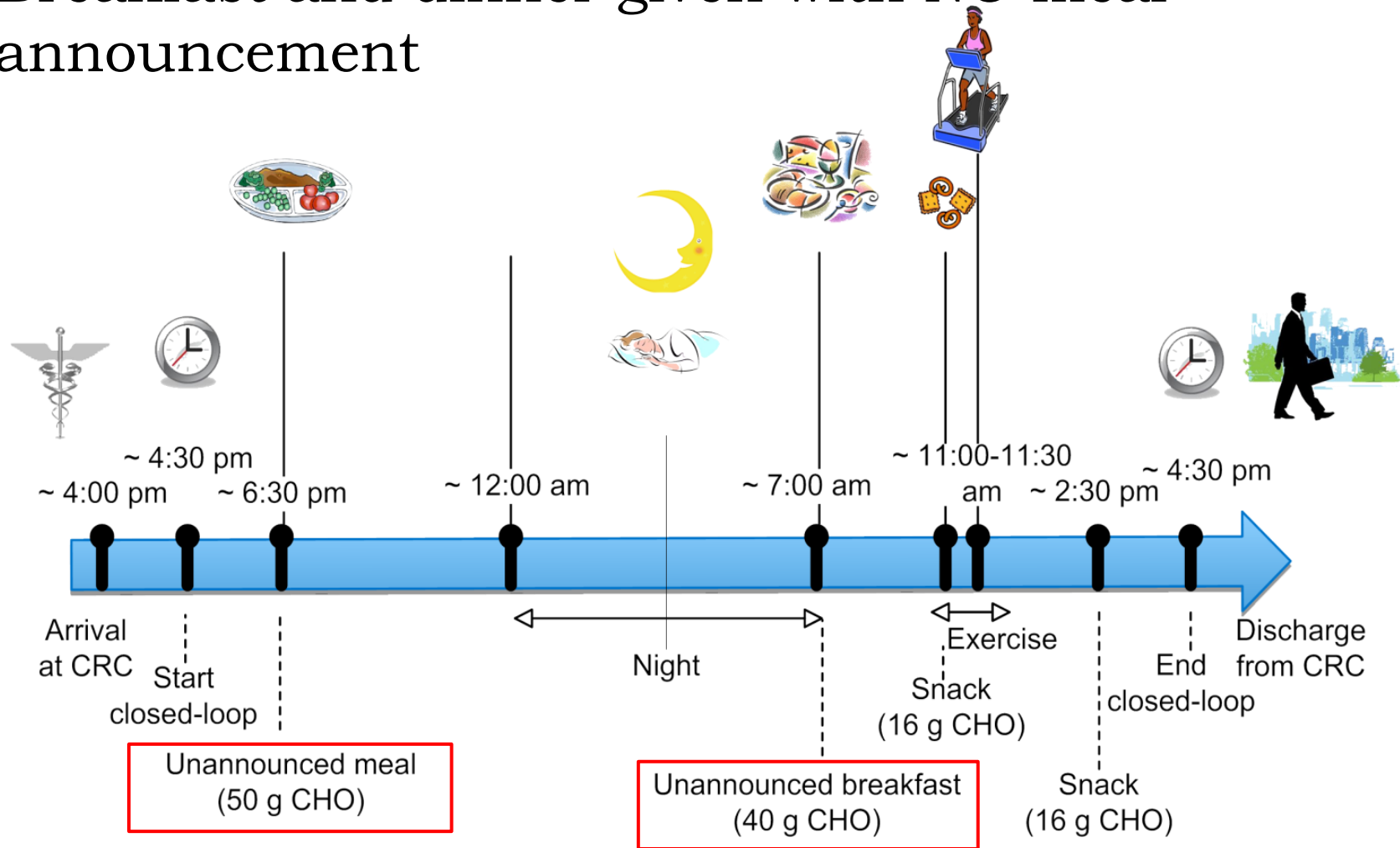Artificial Pancreas
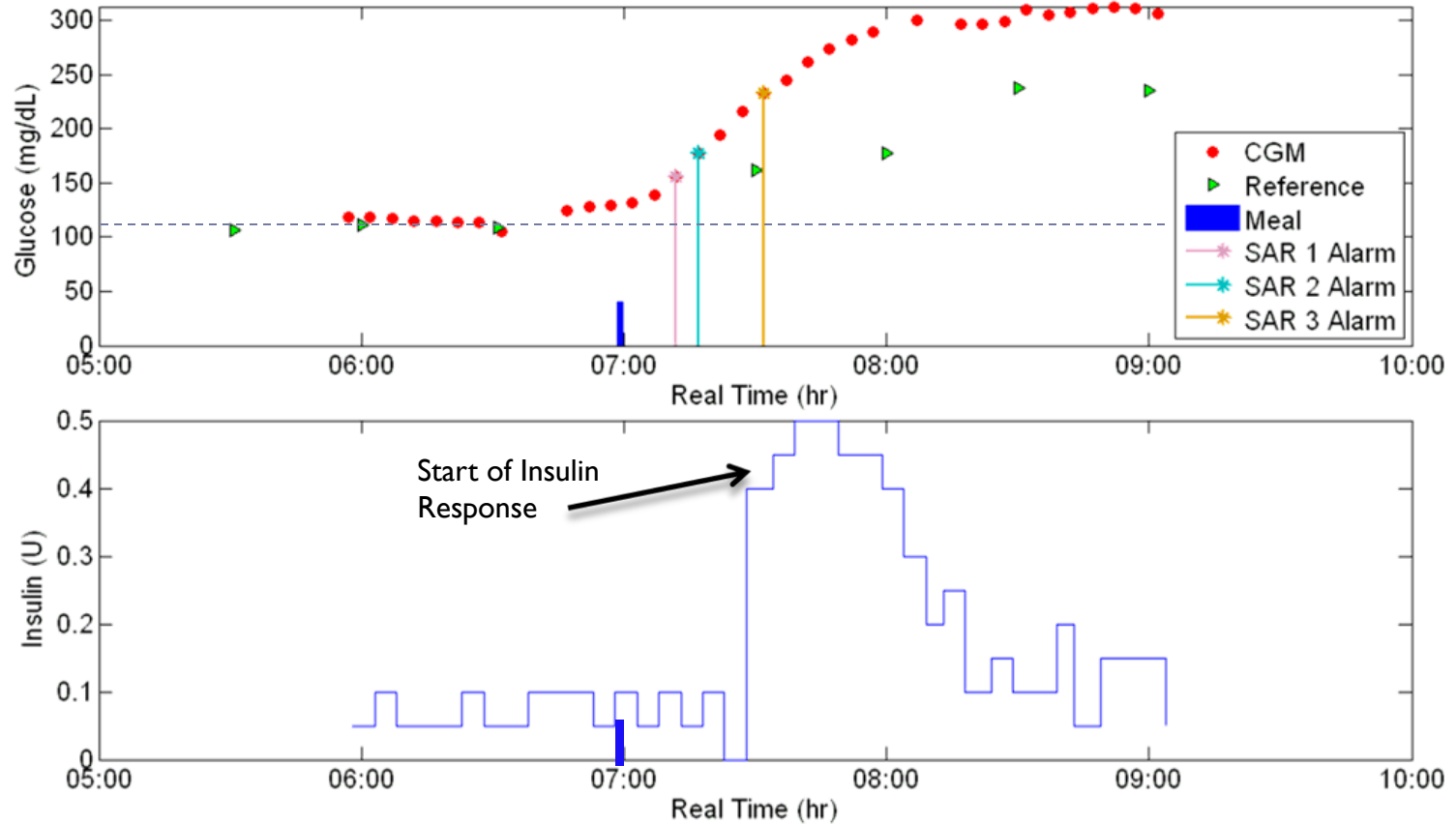System (APS)

Effect of a Meal on Glucose

Project Goals

▸ Implementing basic meal detection algorithm

▸ Establish metrics that represent desired qualities
  ▸ Alarms faster than current controller response
  ▸ Very few false alarms
  ▸ True positive alarms

Data from Clinical Trials (12 subjects)

- Breakfast and dinner given with NO meal announcement

Timeline:
- ~ 4:00 pm — Arrival at CRC
- ~ 4:30 pm — Start closed-loop
- ~ 6:30 pm — Unannounced meal (50 g CHO)
- ~ 12:00 am
- Night
- ~ 7:00 am — Unannounced breakfast (40 g CHO)
- ~ 11:00-11:30 am — Snack (16 g CHO), Exercise
- ~ 2:30 pm — Snack (16 g CHO)
- ~ 4:30 pm — End closed-loop, Discharge from CRC

Algorithm and System Alarming

- ▸ **Slope predicted at each point**
  - ▸ Threshold
  - ▸ Max and min slope
- ▸ **Algorithm Parameters**
  - ▸ Subsequent Alarms Required (SAR)

Hypotheses

▸ **Hypothesis 1**: with SAR 1, the reaction time for detecting a meal will be the fastest, however there will be more false positive alarms

▸ **Hypothesis 2**: by using SAR 3, we anticipate a longer reaction time with a greater number of false negative alarms, but less false positive alarms present

Determining the Best Parameter Settings: SAR
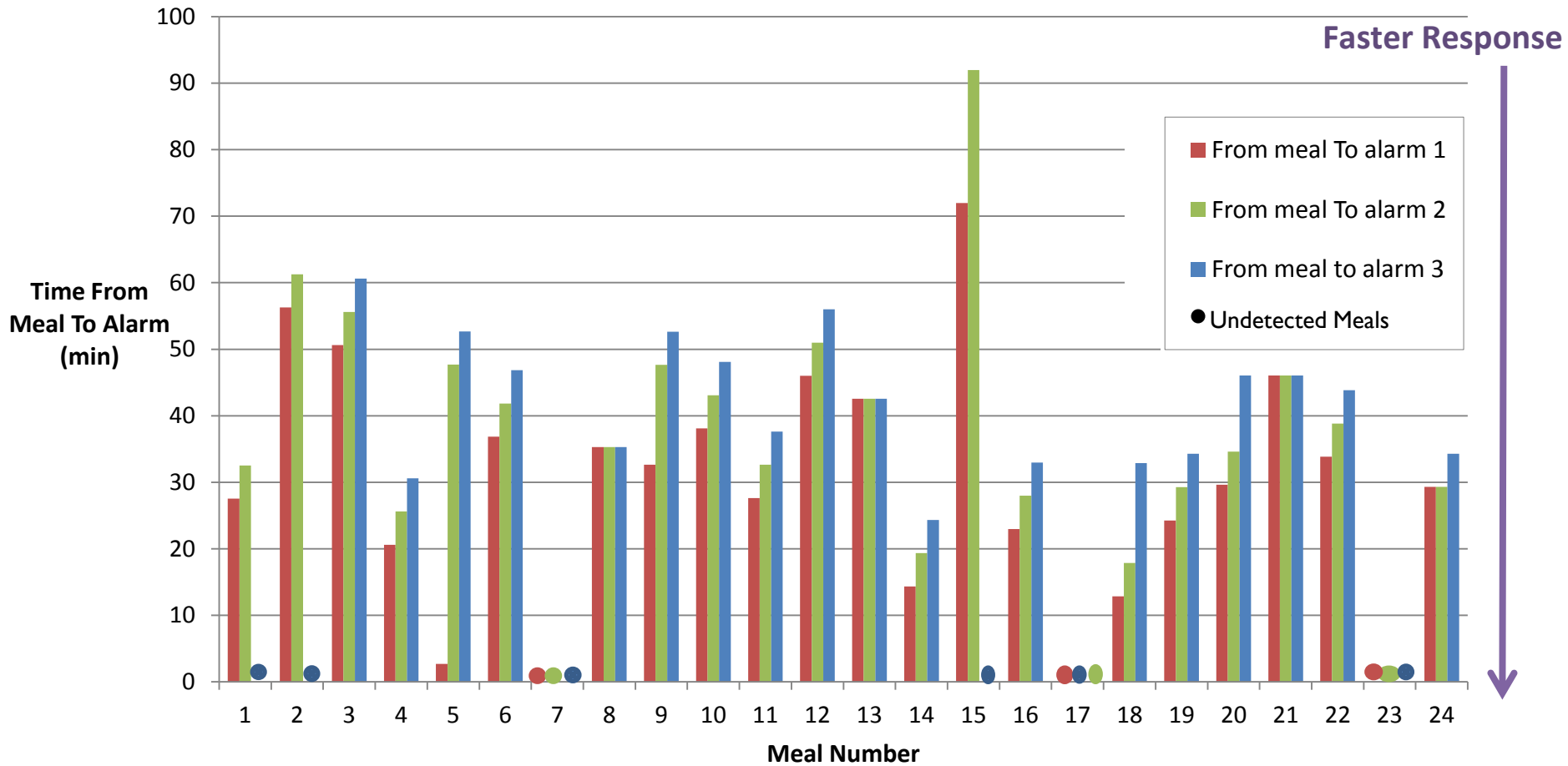
Results: The Better Detector

Number of Alarms Required	1	2	3
True Positive Ratio	21/24	21/24	19/24
# of False Positives	1/24	1/24	1/24
Average Time Difference from Alarm to Insulin Delivery	-11 ± 1 min	-6 ±17 min	3 ± 14 min

Conclusions & Future Work

▸ Hypothesis 1 unconfirmed: SAR 1 should have had more false positive alarms

▸ Hypothesis 2 confirmed: SAR 3 had more false negative alarms

▸ Future Work: Using the basic algorithm as a benchmark for an advanced system

Acknowledgements
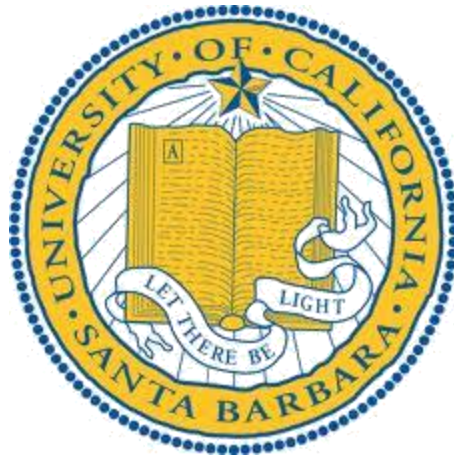
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Questions?