REGULATION OF BLOOD SUGAR IN INTENSIVE CARE PATIENTS

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Dysfunctional glucose regulatory mechanisms
Prevalent in critical care (10–65%) [Krinsley, 2003; Umpierrez 2003]
A marker of severity of illness
Associated with increased:
  ◦ Mortality
  ◦ Infection
  ◦ Sepsis and septic shock
  ◦ Myocardial infarction
  ◦ Polyneuropathy
  ◦ Multiple-organ failure

1548 patients (~ cardiac) [Van den Berghe, 2001]
Pitfalls of Insulin Therapy

- No standard protocols, no standard metrics
- Patient conditions and needs evolve over time, sometimes very suddenly (less than 30 mins)
- Education and training of nurses
- Limited resources, infrequent measurement
- Clinical burden → lack of compliance

- Risk of brain damage

Results often unsatisfactory
Model-based Glycemic Control

- Adapts (via a model) to different patient condition and evolution

- Systematic glycemic regulation
  - Advice on insulin and/or nutrition
  - Prediction of outcome of different interventions
  - Scheduling of blood glucose measurements

- Can potentially reduce clinical burden

- Can better insure patient safety, particularly against hypoglycemia
The GlucoSafe model

- A model of insulin and glucose metabolism

Diagram:

- Enteral Nutrition
- Glucose Infusion
- Gut Absorption
- Blood Glucose
- Liver
- Hepatic
- Kidney
- CNS
- Muscle+Fat
- Insulin Sensitivity
- Pancreatic Insulin
- Insulin Infusion
Predictive Validation (safety check)

- Retrospective data from 11 hyperglycaemic patients
  - 5 trauma ICU patients (Aalborg, "DK" cohort)
  - 6 medical ICU patients (Christchurch, "NZ" cohort)

- Prediction accuracy
  - Direct comparison of GlucoSafe (GS) and a clinically tested model (CC)

- Outcome: Prediction errors → Time intervals to predict and act
RMS % Error Prediction

Error is cohort specific – bigger errors for more ill cohorts that are more variable/dynamic.

As error grows over time, so does the need to intervene.
RMS mmol/L Prediction Error

\[ \approx 1.41 \times \text{Meas. Error At intercept} \]
When to measure as a patient or cohort specific metric

- User interface to support clinical control based on RMS errors
Conclusions

- GlucoSafe is expected to be a safe and effective model for glycaemic control in intensive care
- Prediction accuracy and time to act depends on patient cohort (level of critical illness)
- The Future: customization of models to cohort