# Fine tuning the control of diabetes

## The 0.12 formula for the management of type 1 diabetes

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# Fine tuning the control of diabetes
## **Today's workshop**

- 2 Case scenarios
- I will review the current formulae available to fine tune the management of type 1 diabetes
- Identify the 3 important factors that help us to manage type 1 diabetes
- **The 0.12 formula and its potential role in managing type 1 diabetes.**
- Discussion around the management of diabetes using the two case scenarios

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## Case scenario 1

- Sebastian, newly diagnosed type 1 diabetic, presented at the age of 22 months with osmotic symptoms, BS of 24.6 mmol/L and blood ketones of 2 mmol/L
- Weight 13kgs, Clinically very well. Normal BP, normal perfusion, Normal electrolyte, and Normal blood gases.

**How would you manage him?**

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## Case scenario 2

- Suleman, aged 11, diagnosed in Pakistan with type 1 diabetes at the age of 2 and coeliac in September last year in the UK.
- On the basal bolus regimen of Lantus 26 units and Novorapid 7, 7, 7. No carb. counting, non compliant.
- Presented January 2014 with severe DKA. Previous similar episode in Sept. 2013 .
- Ph: 7.0, BE -29, Bic: 4.5, BS 44mmol/L BK: 5.9 mmol/L. U&Es, Cr Normal, Agitated, but alert, not vomiting. BP and perfusion are normal. not significantly dehydrated. Weight 29 kgs

**How would you manage him?**

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## **Why better control!!**

DCCT (Diabetes Control and Complications Trial) Study Findings:

- Intensive blood glucose control reduces risk of
    - Eye disease, by 76%
    - Kidney disease by 50%
    - Nerve disease by 60%

EDIC (Epidemiology of Diabetes Interventions and Complications) Study Findings

- Intensive blood glucose control reduces risk of
    - Any cardiovascular disease event by 42%
    - Nonfatal heart attack, stroke, or death from cardiovascular causes by 57%

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## **Why better control!!**

- The Good control of diabetes is essential to minimise the risk of complications

- For each 1% reduction in HbA1c there is 20-25% reduction in the risk of the long term complications

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## Background

- **Formulae Calculating Insulin Sensitivity / Correction Factor (CF)**
  - the 1500 rule pioneered by Paul Davidson:
    - » 1500/TDD - 83/TDD (total daily dose of insulin)
  - 1500 became 1800 from which the 100 rule was derived.
  - Subsequently further adjustment made (1076 – 2200)

- **Formulae calculating Carbohydrate to Insulin Ratio (CIR)**
  - Walsh and Roberts' 450 rule was introduced in 1994 and later modified to the 500 rule, and the 300 rule for paed
  - CIR = 450/TDD

  In 1998 Steed developed the rule-of-3 for the carbohydrate insulin ratio
  - CIR = 3 x **body weight (lb)**/TDD

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## Clinical studies

**Davidson and Colleagues 2003 (167 pump patients)**

- Correlated the 1500 rule and the rule-of-3 and looked at insulin pump settings
- Retrospective study that calculated the TDD as a mean of 6 days prior to their visit of best HbA1c (<7%) with a mean basal rate of 48% of TDD
- They derived modification of both formulae
- **Insulin sensitivity = 1717/TDD**
- **CIR = 2.8 x weight (lbs) / TDD.**
- Neither of which has been subsequently validated
- Glucose control was not intensely established. It relied on low HbA1 as a reflection of good control

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## Clinical studies

**Kings and Armstrong** (2007http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2769604/)

- 30 pump patients on CGM were studied to calculate CIR and CF with a mean basal rate of 38% of TDD
- The CIR was determined from the amount of rapid acting insulin needed to return the glucose to +/- 20% of premeal level within 4 hours.
- **CIR = 217/TDD + 3**
- To determine the CF, the premeal insulin bolus was reduced by 25% to cause hyperglycaemia by 4 hours later. Then the CF was calculated by the amount of rapid acting insulin required to return the glucose to 80-120 mg/ dl within four hours of the bolus.
- **Insulin sensitivity = 1076/TDD**

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## Clinical studies

**Walsh and colleagues** (2010http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2956816/)

- They analysed the data of 1020 pump patients selecting 396.:
  - 85% of glucose data were entered directly from a meter
  - **At least 28 days of consecutive data (average 74) with at least 20 glucose readings (average 316)**
- The pumps then were divided into tertiles 132 each based on mean glucose and the lowest mean of 8mmol/L then was used to derive the formulae
- Their mean basal rate was 48% of the TDD
- **Insulin sensitivity = 1960/TDD or 109/TDD**
- **CIR = 2.6 x weight (lb) / TDD or 5.7 x weight (kg) / TDD**

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## Available formulae

### Formulae calculating Insulin Sensitivity Factor

- Insulin sensitivity = 1500/**TDD** (Davidson)
- Insulin sensitivity = 1717/**TDD** (Davidson and colleagues)
- Insulin sensitivity = 1076/**TDD** (King and Armstrong)
- Insulin sensitivity = 1960/**TDD** (Walsh and Colleagues)

### Formulae calculating Carb/Insulin Ratio (CIR)

- CIR = 450/**TDD** (Walsh and Roberts)
- CIR = 3 x body wt (lb) /**TDD** (Steed)
- CIR = 2.8 x body wt (lb) / **TDD.** (Davidson and Colleagues)
- CIR = 2.6 x body wt (lb) / **TDD** (Walsh and Colleagues)
- CIR = 217/**TDD** + 3 (King and Armstrong)

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## How reliable !!!

- **Currently all formulae rely on the Total Daily Dose of Insulin which is 3 times inaccurate:**
  - rarely would an individual use the same daily dose of insulin
  - The TDD includes the basal insulin while the carb insulin ratio is concerned with bolused insulin only.
  - In any diabetic with HbA1c of more than 8% the TDD cannot be accepted as a true body need

- **All formulae have no physiological background.**
  - **For the insulin sensitivity figures between 1076 and 1960 (60 -109) have been suggested**
  - **For CIR the proposed figures are not practical**

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## Case scenarios

### Case 1

- Sebastian newly diagnosed type 1 diabetic, presented at the age of 22 months with osmotic symptoms and BS of 24.6 mmol/L and blood ketones of 2 mmol/L
- Weight 13kgs, Clinically very well. Normal BP, normal perfusion, Normal electrolyte, and Normal blood gases.

**How would you manage him?**

### Case 2

- Suleman aged 11, diagnosed in Pakistan with type 1 diabetes at the age of 2 and coeliac in the UK 4 months ago.
- On the basal bolus regimen of Lantus 26 units and Novorapid 7, 7, 7. No carb. counting, non compliant.
- Presented January 2014 with severe DKA. Previous similar episode in Sept. 2013 .
- Ph: 7.0, BE -29, Bic: 4.5, BS 44mmol/L BK: 5.9 mmol/L. U&Es, Cr Normal, Agitated, but alert, not vomiting. BP and perfusion are normal. not significantly dehydrated. Weight 29 kgs

**How would you manage him?**

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# OUR APPROACH

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## Important factors

- **Insulin Sensitivity Factor:**

  Is the effect of 1 unit of insulin on the blood sugar of the diabetic over the duration of its effect.

  **Helpful for the correction of high blood sugar**

- **Carbohydrate Insulin Ratio**:

  Is the amount of carbohydrate that is metabolised by 1 unit of insulin injected S/C over the duration of its effect.

  **Helpful in giving freedom and flexibility to patients**

- **Glucose Sensitivity Factor: (0.12 formula)**

  Is the amount of carbohydrate in grams needed to raise the blood sugar in diabetics by 1 mmol/L without the effect of insulin.

  **Helpful to calculate the carbohydrate dose of hypoglycaemia**

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## Important features

**GSF x ISF = CIR**

**ISF = CIR/GS**

**GS = CIR/ISF**

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# The 0.12 Formula

## Glucose sensitivity (the origin of the 0.12 formula)

- Glucose is in all body fluid which form 65% of body weight
- 1mmol/L = 18mgs/dl
- 1mmol/L = 180mgs/L = 0.18gram/L so

To raise the blood sugar by 1 mmol/L (in type 1 diabetic) we need to give 0.18 gram of sugar for every litre of body fluid

- 0.18 x Body weight x 0.65 = **0.12 x body weight (Kg)**

**0.12 is the amount of carb. in grams needed for each 1 kg body weight to raise the blood sugar by 1 mmol/L**

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## The 0.12 Formula

### Example: 20 kg. child with CIR ratio of 1:10

- His glucose sensitivity according to the formula is:

  0.12 x 20 = **2.4** grams (Say **2.5**)

  If we know 2.5 gram carb raise his blood sugar by 1 mmol/L then 10 gram (his carb ratio) will raise it by (10 / 2.5) = 4 mmol/L.

- what is the Insulin sensitivity?

  If 1 unit of insulin is needed for 10 grams of carb and we know that 10 grams of carb will increase BS by 4 mmol/L then 1 unit given without 10 gram of carb should drop blood sugar by 4 mmol/L

- Insulin sensitivity: **10/2.5 = 4 mmol/L**

**GSF (4) x ISF (2.5) = carb ratio (10)**

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## Case scenario 1

## Our management of Sebastian

- **Given 2 units of S/C insulin (0.05x13x4) BS:**
    - Baseline: 24.6 mmol/L
    - 1 hour: 18.3 mmol/L
    - 2 hours: 11.8 mmol/L
    - 3 hours: 7.6 mmol/l
    - 4 hours: 3.2 mmol/l
- **His insulin sensitivity is calculated therefore to be 10 -12 mmol/L (21/2)**
- **His glucose sensitivity 13x0.12=1.5**
- **His carb ratio is 1: 18**

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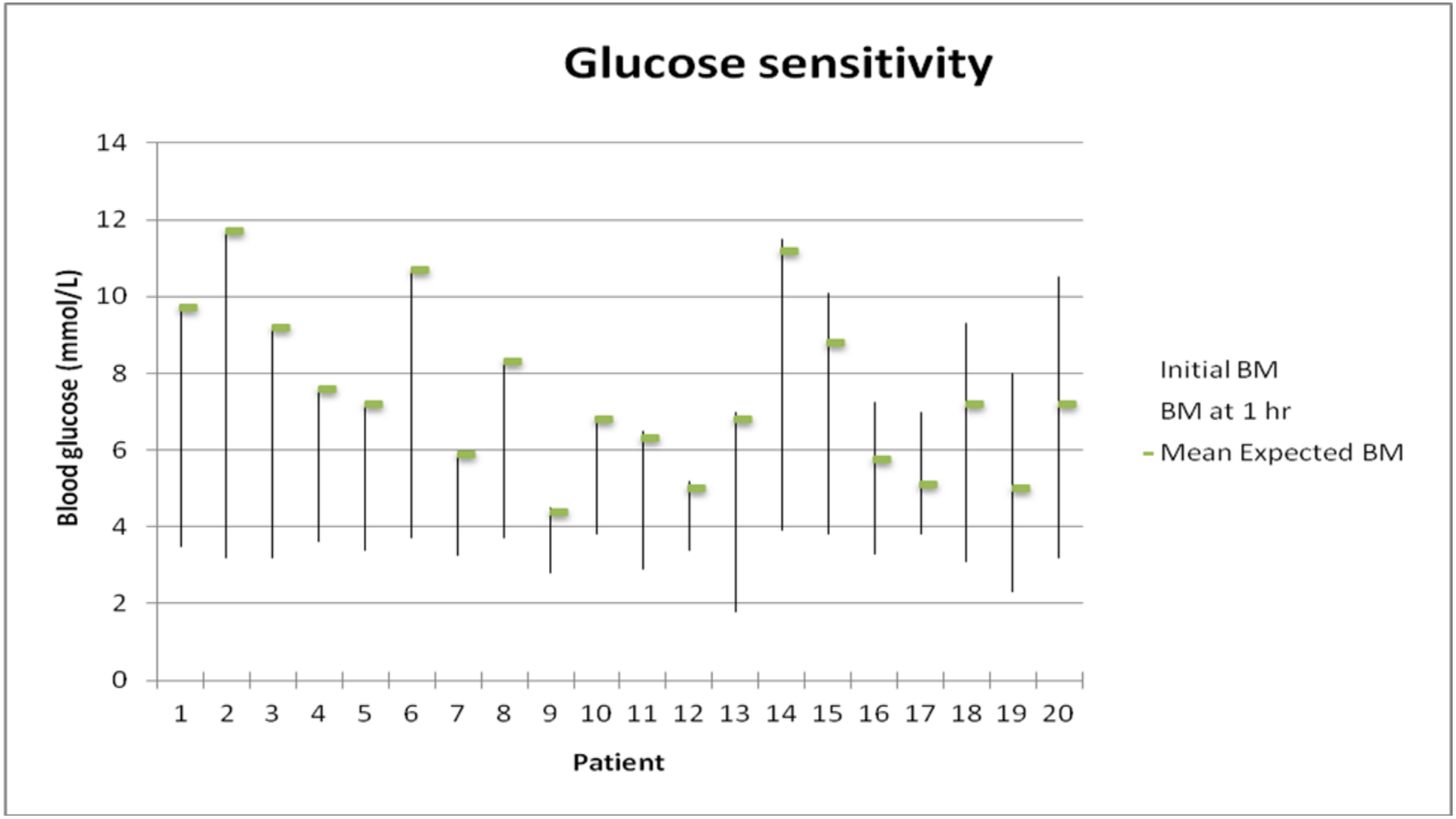
## Case scenario 2

## Our management of Suleman

- **Given IV Normal saline maintenance fluid and given 6 units of S/C Insulin (0.05x29x4). Blood sugar dropped**
    - Baseline: 44 mmol/L
    - 1h: 38mmol/L
    - 2h: 34mmol/L
    - 3h: 31mmol/L
    - 4h: 26mmol/L
- **Insulin Sensitivity: 18/6 = 3**
- **Glucose sensitivity 0.12 x 29 = 3.5**
- **Carbohydrate Insulin ratio 3 x 3.5 = 10.5**

# Testing the 0.12 formula



# Testing the 0.12 formula