Technology

How to adjust insulin settings during pregnancy and childhood

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There is an increasing body of literature regarding the optimal ratios of basal and bolus insulin in pump users for targeted glycaemic control. In general it has been suggested that a basal–bolus ratio of around 50:50 is probably an accurate reflection of the relative needs for optimising glycaemic control. One study showed that those pump users with the best control had a basal–bolus ratio of just under 50% basal, whilst there was a small but significant increase in the basal component in those with worse control (Wilkinson et al, 2010).

Two recent studies have considered whether these apparently optimal basal–bolus insulin ratios apply generally or whether there may be exceptions for specific user groups: Mathiesen et al (2013) and Cemeroglu et al (2013), summarised alongside and on the next page respectively.

Mathiesen et al looked at changes in pump settings in pregnant women. Unsurprisingly, as widely recognised in clinical practice, the greatest increase in insulin requirement as pregnancy progressed was in the insulin bolus requirement at breakfast; with a four-fold increase in the insulin to carbohydrate ratio by late gestation. Corresponding increases in lunch and dinner insulin to carbohydrate ratios were two- and three-fold, respectively. In contrast, changes in the basal insulin component were much less marked. After an initial fall in basal requirements in the latter first trimester, there was an approximate 50% increase in basal insulin dose by the third trimester when compared with early pregnancy. Given a total daily insulin dose of 0.56 IU/kg/day at 8 weeks' gestation and 0.95 IU/kg/day at 33 weeks' gestation, this would indicate the optimal basal–bolus ratio during pregnancy moves from 50:50 in early pregnancy to about 45:55 by late pregnancy. This is in keeping with Murphy et al's findings (2011) from closed loop studies in pregnancy, although, if anything, the increase in bolus versus basal requirements in later pregnancy appeared even greater from that data. Helpfully, Mathiesen et al have provided a practical guide to insulin pump setting adjustment in pregnancy.

Cemeroglu et al (2013) report on pump settings throughout childhood, considering basal–bolus ratios and formulae for predicting insulin sensitivity factors and insulin to carbohydrate ratios in various age groups. They selected 154 children with well-controlled T1D and divided them into eight age groups. They derived a table of guidance as to the ratios and formulae they would recommend for different age groups. The main difference across the age groups is seen in children under 7 years of age whose recommended basal insulin component is 30–35%, compared to 40–45% in peri- and post-pubertal children. Children under 7 years of age have a correspondingly greater predicted insulin to carbohydrate ratio, and this increased demand is particularly great with breakfast. However, correction boluses in children aged under 7 years were significantly smaller than those in peri- and post-pubertal children. Interestingly, despite the increase in insulin requirements seen in puberty as a result of the insulin resistance associated with the other hormonal changes at this time, the pump settings in puberty are no different to those post-puberty. These are presumed similar to what would be seen in an adult population, although it is worth noting that insulin requirements in this post-pubertal group were still high at 0.9 IU/kg/day.

In conclusion, these papers provide useful information as to how insulin pump settings change during pregnancy and childhood, and provide recommendations to guide adjustment within these settings in routine practice. ■

Murphy HR et al (2011) *Diabetes Care* **34**: 2527–9
Wilkinson J et al (2010) *Diabet Med* **27**: 1174–7

J Matern Fetal Neonatal Med

Basal–bolus changes throughout pregnancy in T1D

Readability	✓✓✓✓
Applicability to practice	✓✓✓✓
WOW! Factor	✓✓✓

1 This Danish trial focused on variation in basal–bolus insulin requirements during pregnancy through the analysis of insulin pump settings in 27 women with T1D who used a bolus calculator. The settings used and resulting HbA_{1c} levels were recorded at discrete timepoints throughout gestation. Pregnancy outcomes were compared between active participants and 96 similar women on multiple daily injections.

2 Among those receiving pump therapy, the carbohydrate–insulin ratio was largest at breakfast and decreased at each of the three main meals. Between early and late pregnancy, median carbohydrate–insulin ratio decreased by a factor of four, from 12 (range 4–20) at 8 weeks to 3 (range 2–10) at 33 weeks (P=0.001).

3 Basal insulin delivery at 05.00 decreased significantly (P=0.005) from 8 to 12 weeks and thereafter increased by about 50%, from an average of 0.8 (0.5–2.2) to 1.2 (0.6–2.5) IU/h at 05.00 and from 1.0 (0.6–1.5) to 1.3 (0.2–2.3) IU/h at 17.00.

4 Glycaemic control (in terms of HbA_{1c}), rates of severe hypoglycaemia and pregnancy outcome were comparable in women on bolus-calculated insulin pump therapy and those treated with injections.

5 In pregnant women with T1D using a bolus-calculated insulin pump, the carbohydrate–insulin ratio declined four-fold from early to late gestation, while basal changes were smaller.

Mathiesen JM, Secher AM, Ringholm L et al (2013) Changes in basal rates and bolus calculator settings in insulin pumps during pregnancy in women with type 1 diabetes. *J Matern Fetal Neonatal Med* 27 Sept [Epub ahead of print]

> "In a specialist experienced insulin pump centre, continuous glucose monitoring reduced severe hypoglycaemia and improved HbA_{1c} in selected individuals, although it failed to restore awareness."

Endocrine Practice

Insulin requirement increases with age and pubertal status

Readability ✓✓✓✓
Applicability to practice ✓✓✓✓
WOW! Factor ✓✓✓

1 The authors aimed to establish continuous subcutaneous insulin infusion (CSII) settings appropriate for children with T1D. They reviewed data for 154 young people aged 3–21 years who had well-controlled T1D, according to American Diabetes Association guidelines. Children enrolled in the study were classified into eight groups, according to age, gender and pubertal stage.

2 Insulin requirements increased during puberty in both genders. Average insulin requirements in pre-pubertal boys and girls were 0.70 U/kg/day, which rose to the peak requirement of 0.97 U/kg/day in midpubertal girls before menarche and 0.90 U/kg/day in late-pubertal boys.

3 The basal percentage of total daily insulin dose was consistently lower in children than that published for adults. Indeed, the lowest basal percentage was recorded in the youngest group: prepubertal boys and girls less than 7 years of age – at an average of 34.3 ± 7.7% (P<0.01).

4 Pubertal girls required significantly more basal insulin than pubertal boys (P<0.05), but still less than the standard amount of basal insulin required by adults.

5 Basal and bolus insulin requirements of children with T1D differ considerably from those of adults. Dose calculation for CSII varies by age and pubertal status. These differences will need consideration when calculating CSII dosing, especially for younger children.

Cemeroglu AP, Thomas JP, Zande LT et al (2013) Basal and bolus insulin requirements in children, adolescents and young adults with type 1 diabetes mellitus on continuous subcutaneous insulin infusion: Effects of age and puberty. *Endocr Pract* **19**: 805–11

JAMA

Sensor-driven insulin delivery cuts events

Readability ✓✓✓✓
Applicability to practice ✓✓✓✓✓
WOW! Factor ✓✓✓✓

1 This randomised clinical trial measured the potential of a sensor-augmented insulin pump with automated low-glucose insulin suspension to reduce the incidence of severe or moderate hypoglycaemia events in 46 people with T1D, compared with 49 people with T1D who were randomised to the insulin pump only.

2 After 6 months of therapy, the event rate in the pump-only group decreased from 28 to 16 events per 100 patient-months, compared with a reduction of 175 to 35 events per 100 patient-months in the low-glucose suspension group.

3 The incidence rate ratio per 100 patient-months for hypoglycaemic events was 3.6 (95% confidence intervals, 1.7–7.5; P<0.001) favouring the low-glucose suspension group.

Ly TT, Nicholas JA, Retterath A et al (2013) Effect of sensor-augmented insulin pump therapy and automated insulin suspension vs standard insulin pump therapy on hypoglycemia in patients with type 1 diabetes. *JAMA* **310**: 1240–7

Diabetes Technol Ther

Glucose monitoring in critically ill adults

Readability ✓✓✓✓
Applicability to practice ✓✓✓✓
WOW! Factor ✓✓✓

1 The authors examined the accuracy of FreeStyle® Navigator® (Abbott Diabetes Care, Alamanda, CA, USA) subcutaneous continuous glucose monitoring device in critically ill adults using two methods of calibration: enhanced calibration at variable intervals at 1–6 hours using arterial blood glucose (ABG) and standard calibration according to the manufacturer's instructions using arterial blood and the built-in point-of-care glucometer.

2 Twenty-four consenting adults admitted to a neuroscience critical care unit in the UK were randomised in a 1:1 ratio to each calibration method.

3 More calibrations occurred during the enhanced calibration method than the standard method. The numerical and clinical accuracy was significantly improved using the enhanced calibration protocol compared to the standard protocol.

Leelarathna L, English SW, Thabit H et al (2014) Accuracy of subcutaneous continuous glucose monitoring in critically ill adults: improved sensor performance with enhanced calibrations. *Diabetes Technol Ther* **16**: 97–101

Clinical Endocrinology

Infusion pump reduces glycaemic variability

Readability ✓✓✓
Applicability to practice ✓✓✓✓
WOW! Factor ✓✓✓✓

1 This cross-sectional observational cohort study of 48 children and adolescents with T1D investigated whether glycaemic variability was lower in those that were administered insulin by continuous subcutaneous insulin infusion ([CSII]; a pump) or multiple daily injections (MDI).

2 Insulin requirement, HDL-cholesterol, the mean of glycaemic excursions (P<0.01) and the standard deviation of mean glucose concentration were significantly lower among individuals given CSII than those given MDI.

3 Children and adolescents with T1D who use an insulin pump show lower glycaemic variability and a concomitantly lower glycaemic risk parameter than those using MDI.

Schreiver C, Jacoby U, Watzer B et al (2013) Glycaemic variability in paediatric patients with type 1 diabetes on continuous subcutaneous insulin infusion (CSII) or multiple daily injections (MDI). *Clin Endocrinol* **79**: 641–7