HOW TO GET YOUR INSULIN DOSE RIGHT

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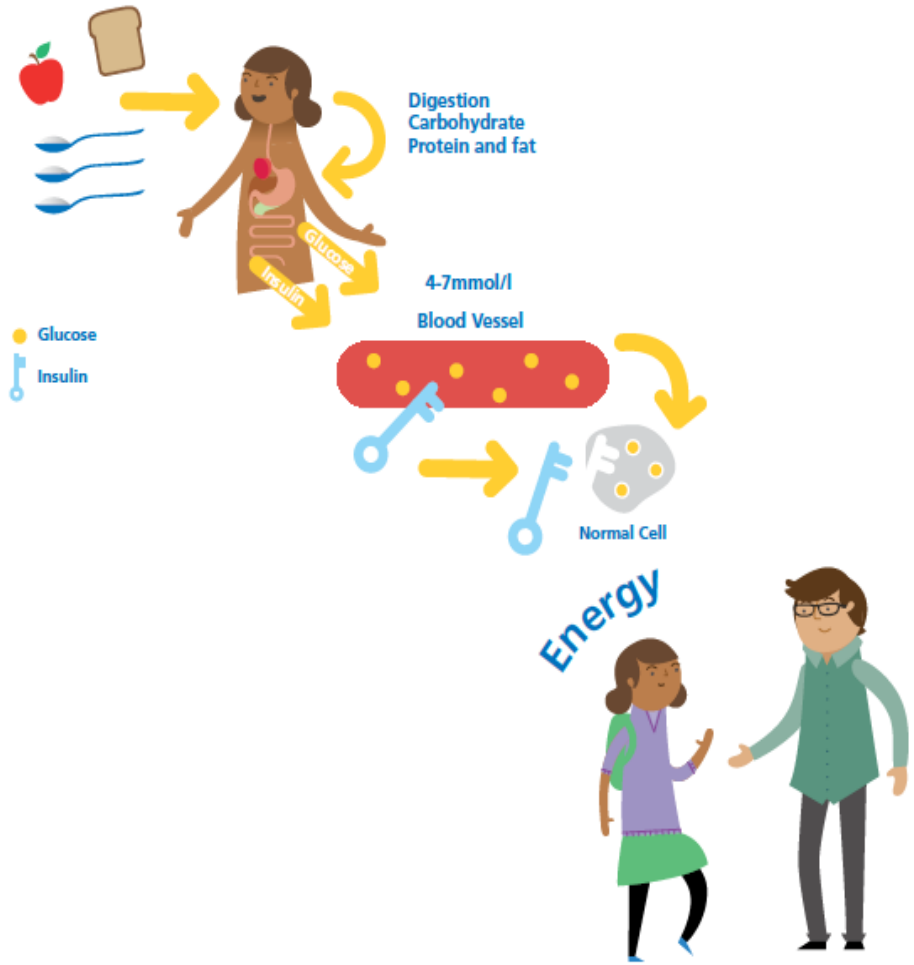
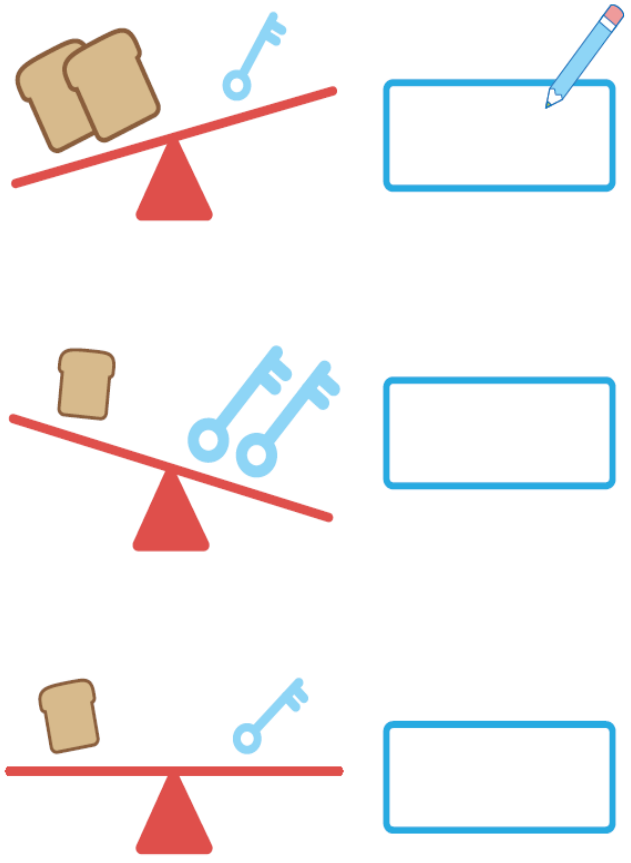
WHAT WE WILL COVER

- How accurate does carb counting need to be?
- When carb counting works, when need to think differently?
- Extra insulin for high fat and protein - KISS
- Top tips to get great after meal glucose levels:
  - BIFF
  - Super bolus


Digestion
Carbohydrate
Protein and fat
Glucose
Insulin
4-7mmol/l
Blood Vessel
Glucose
Insulin
Normal Cell
Energy

Balancing Insulin - Effect on Blood glucose

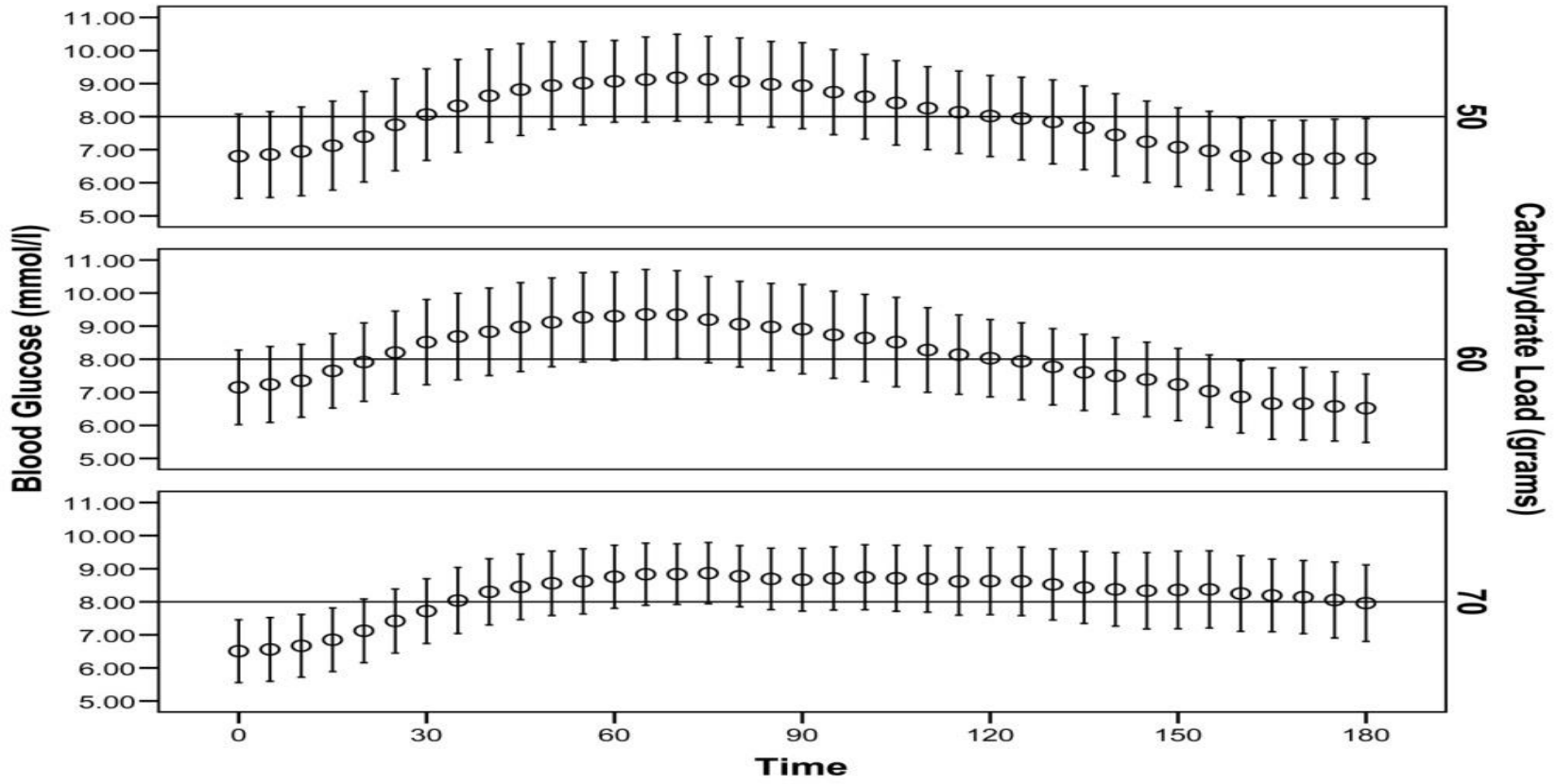


HOW ACCURATE DOES CARB COUNTING NEED TO BE?

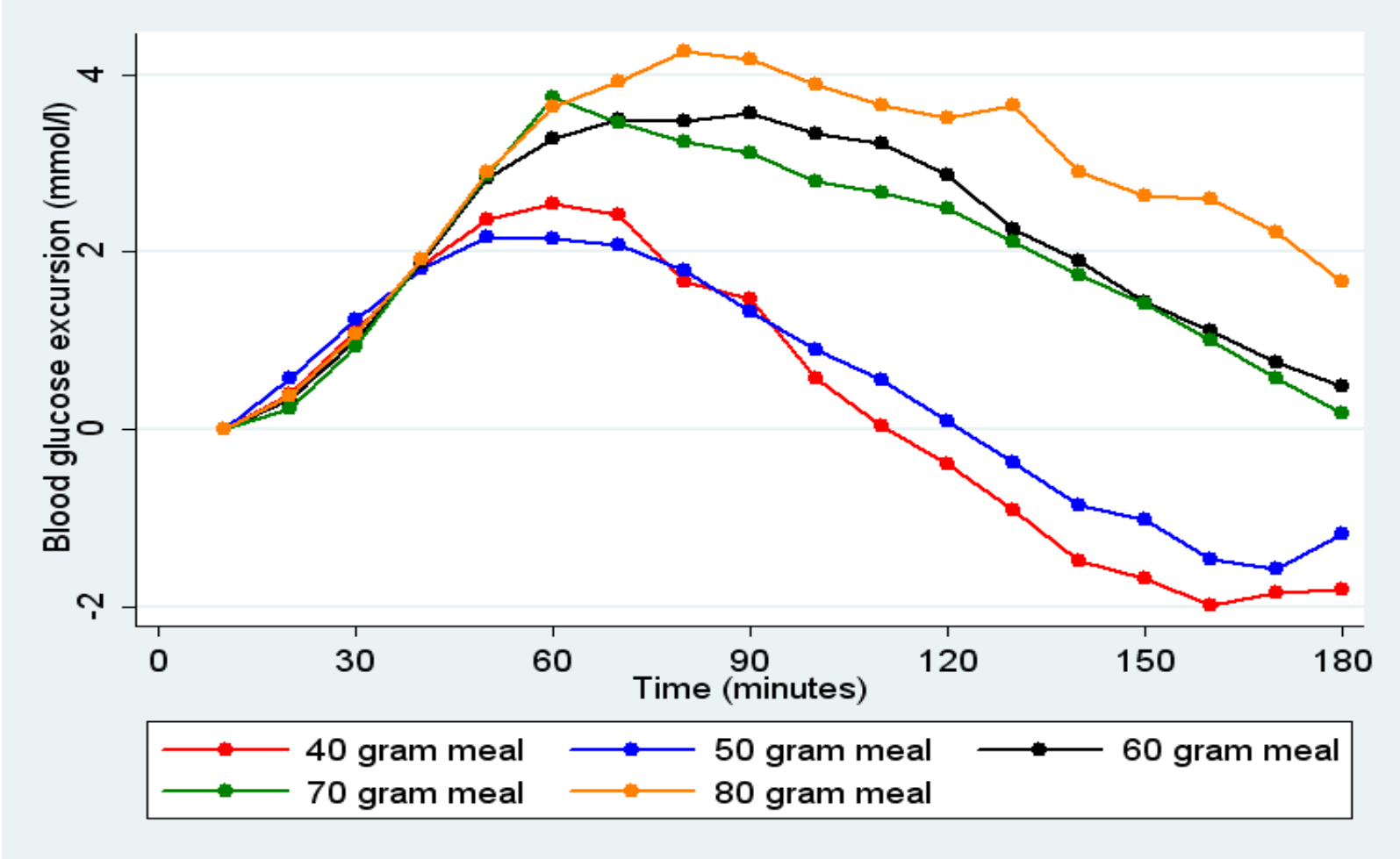
- If the meal contains 60g carbs, how accurate would the persons carb counting need to be to get an insulin that works?

A. 55-65g
B. 52 – 68g
C. 50 - 60g
D. 45 – 65g

SMART ET AL 2009: CHILDREN AND ADOLESCENTS ON INTENSIVE INSULIN THERAPY MAINTAIN POSTPRANDIAL GLYCAEMIC CONTROL WITHOUT PRECISE CARBOHYDRATE COUNTING.



SMART ET AL 2012: A 20-G VARIATION IN CARBOHYDRATE AMOUNT SIGNIFICANTLY IMPACTS ON POSTPRANDIAL GLYCAEMIA



IS IT ONLY CARBOHYDRATE THE CAUSES GLUCOSE LEVELS TO GO HIGH?

BOTH FAT AND PROTEIN INCREASE POSTPRANDIAL GLUCOSE EXCURSIONS IN CHILDREN WITH TYPE 1 DIABETES AND THE EFFECT IS ADDITIVE

Smart et al (2013)

Recruitment Period

Run-in Period

Monday Insert CGM Sensor

Tues/Wed/Thurs/Fri Mornings A, B, C, D

1. Fasting BGL → 2. Insulin bolus or injection → 3. Test meal A,B,C or D

4. No snacks/activity (5 hrs)

Lunch → Usual activities and insulin

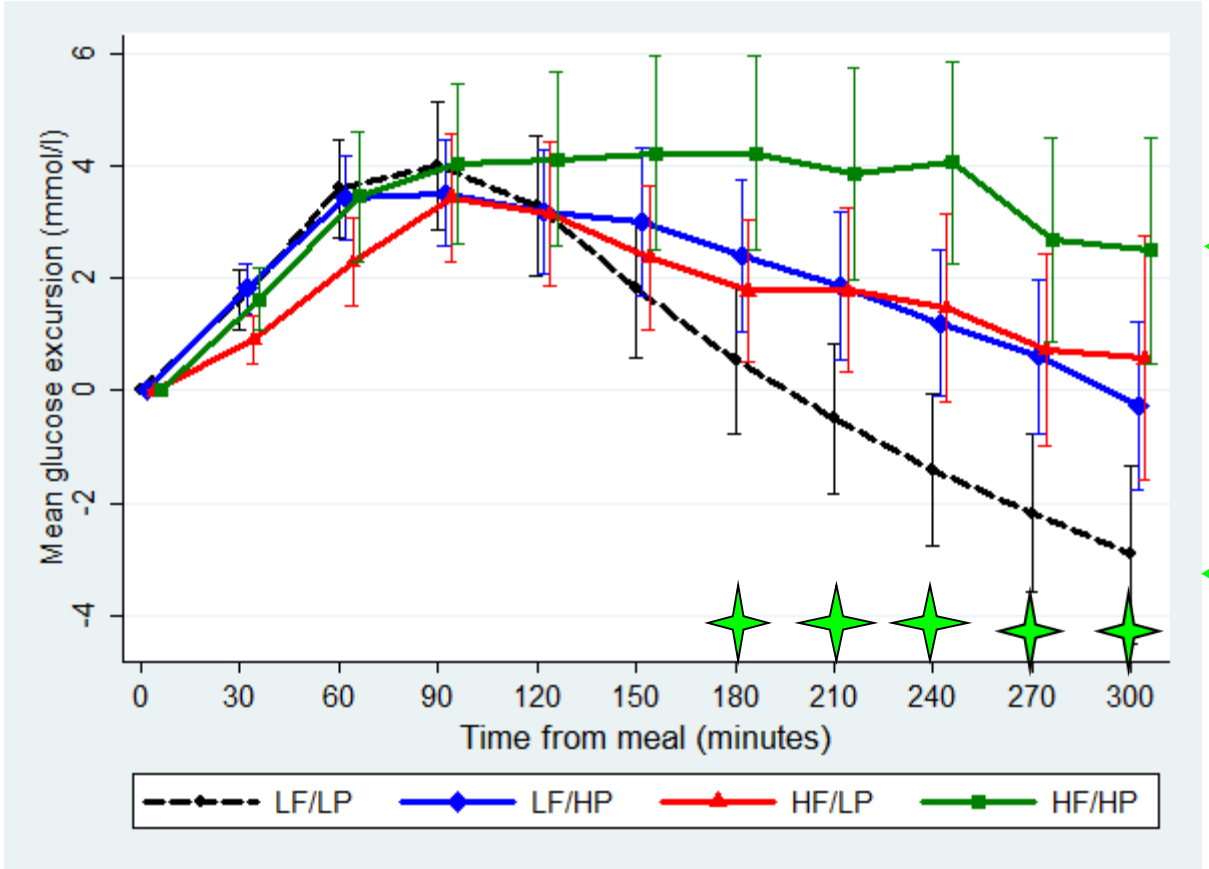
Meal A
Standard CHO
Low Fat
Low Protein

Meal B
Standard CHO
High Fat
Low Protein

Meal C
Standard CHO
Low Fat
High Protein

Meal D
Standard CHO
High Fat
High Protein

MEAN POSTPRANDIAL GLUCOSE EXCURSIONS FOR ALL MEAL TYPES



5.4mmol/l (97.2mg/dl)

CONCLUSIONS

- The insulin to carbohydrate ratio covers the glucose raising effect of usual fat and protein amounts in meals.
- Meals very high in protein or fat cause hyperglycaemia
- Protein and fat have an additive impact
- Protein may have protective effect on hypoglycaemia
- Protein and fat should be considered in prandial insulin dose and distribution if much higher than usual

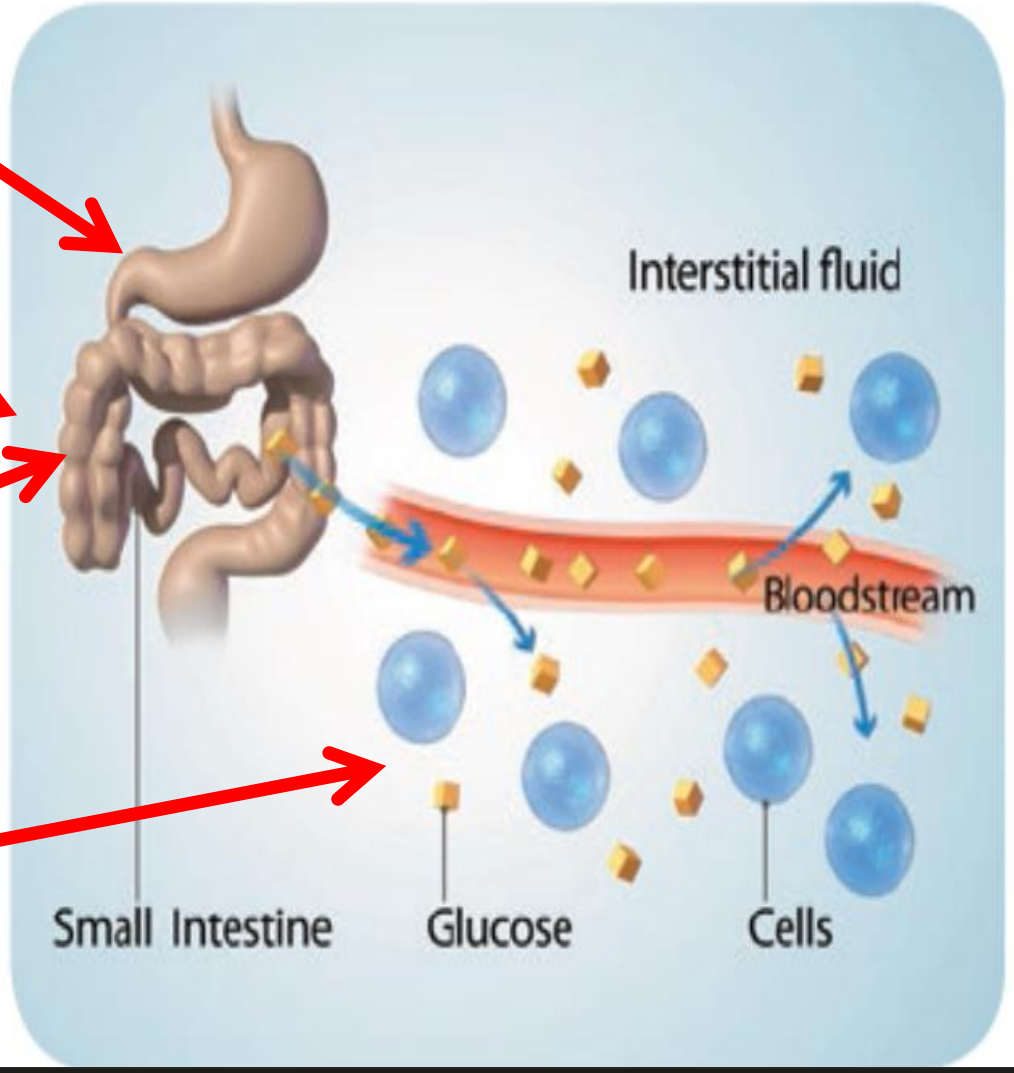
WHY?

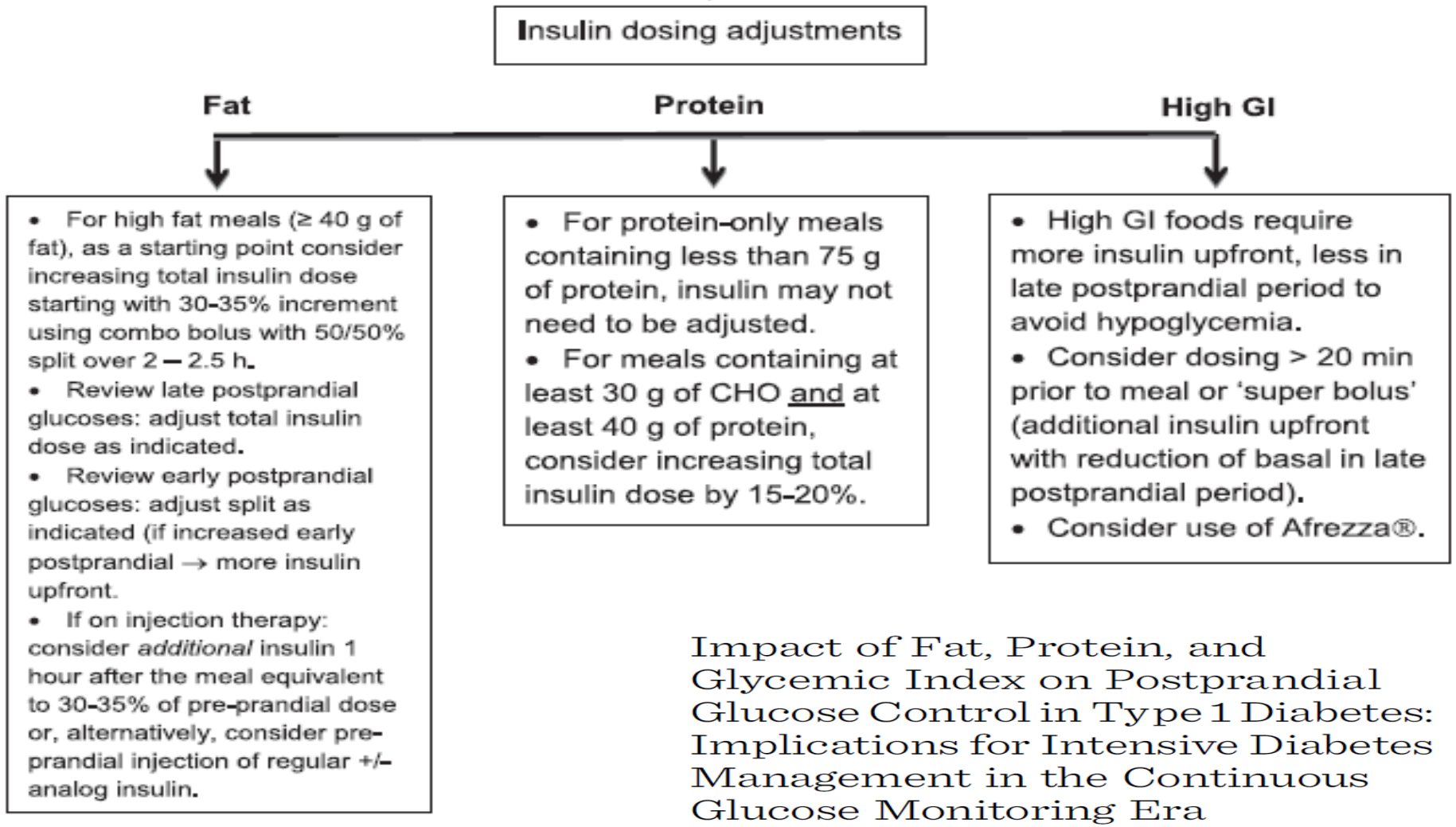
High fat foods slows down how quickly glucose enters the blood stream, making them low GI. Pyloric vale tightens
(1point)

Excess protein increases Glucagon in the first 120minutes (1 point).

Excess protein increases new glucose creation after 180 minutes – Gluconeogenesis
(1 point)

High fat can cause insulin resistance, increasing the need for even more insulin.
(1 point)





Impact of Fat, Protein, and Glycemic Index on Postprandial Glucose Control in Type 1 Diabetes: Implications for Intensive Diabetes Management in the Continuous Glucose Monitoring Era

Diabetes Care 2015;38:1008–1015 | DOI: 10.2337/dc15-0100

BELL ET AL (2016) – THE PIZZA STUDY

1. 10 T1D received LFLP & HFHP Pizza (70g)
2. Repeated the HFHP meal with an adaptive model-predictive insulin bolus

How much extra insulin in % was needed for HFHP?

A. 35%
B. 50%
C. 65%
D. 80%

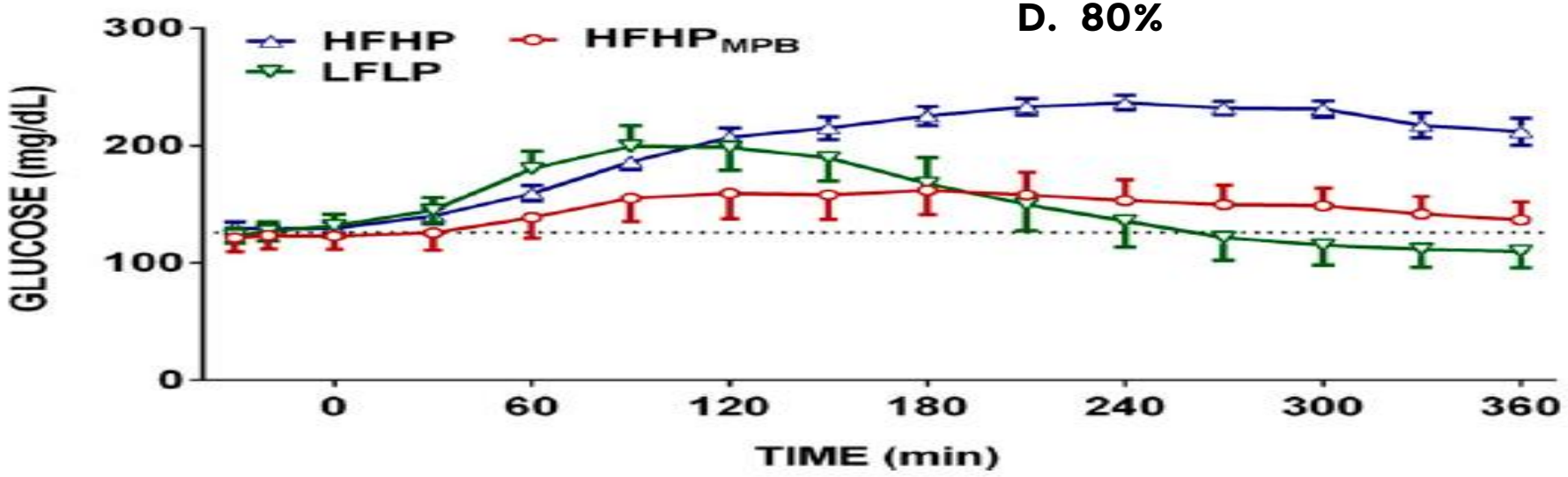


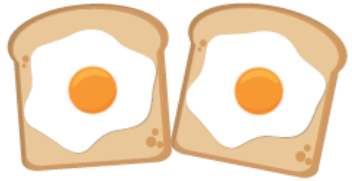
Figure 1—Postprandial plasma glucose response following LFLP and HFHP meals with identical carbohydrate content and insulin dose and an HFHP meal with optimal MPB (HFHP$_{MPB}$).

Normal meal

High Fat and Protein Meal

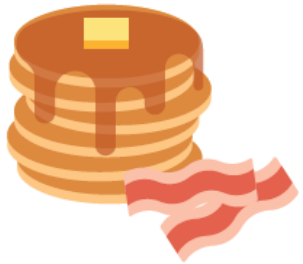
When Carbohydrate Counting Works

Well-balanced breakfast



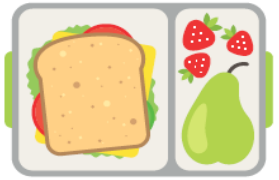
When more insulin is needed

High fat and protein breakfast



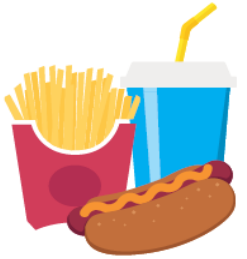
When Carbohydrate Counting Works

Well-balanced lunch



When more insulin is needed

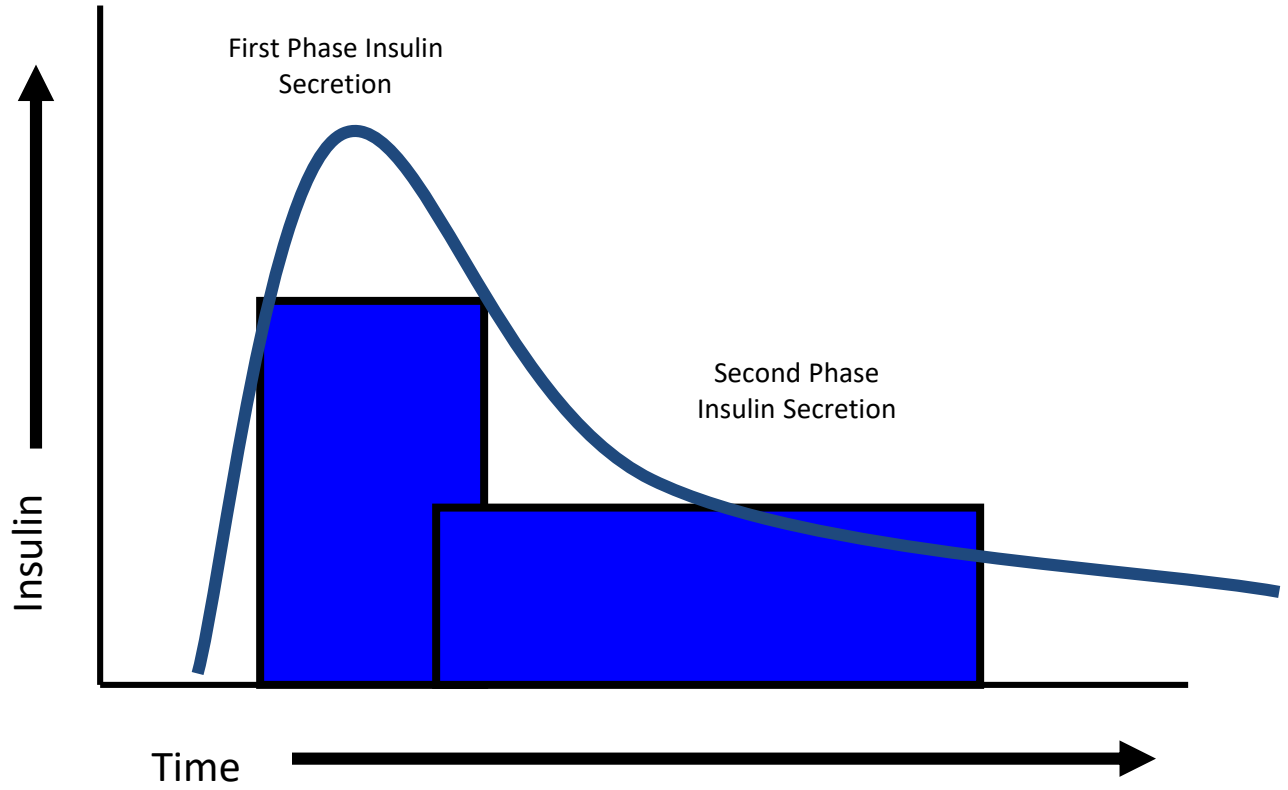
High fat and protein lunch



GLYCAEMIC INDEX

High GI	Medium GI	Low GI
To treat hypos	Absorbed in 2-4 hours	High Fat and Protein
Absorbed in 30mins	Normal Insulin	Absorbed 4-10hrs
		Extra Insulin & split
Lucozade	Breakfast cereal	Pizza
Glucose tablets	Sandwiches	Creamy pasta
Sweets	Fruit	Fish and chips
	Potato meals	Chinese takeaway
	Most meals	Fast food takeaway

MULTIWAVE BOLUS OR SPLIT INJECTION



KISS APPROACH – BIRMINGHAM CHILDREN'S HOSPITAL
EXTRA INSULIN AND SPLIT INSULIN

Meal	Extra Insulin	Multiwave wave Split
Fish and Chips	25%	50% now 50% over 2.5 hours 50% 15min before & 50% 60min after
Indian Takeaway	25%	50% now 50% over 2.5 hours 50% 15min before & 50% 60min after
Pizza	25%	50% now 50% over 2.5 hours 50% 15min before & 50% 60min after
Chines Takeaway	25%	50% now 50% over 2.5 hours 50% 15min before & 50% 60min after
Pasta with creamy sauce e.g macaroni cheese	25%	50% now 50% over 2.5 hours 50% 15min before & 50% 60min after
Fast Food meals e.g McDonalds, KFC	25%	50% now 50% over 2.5 hours 50% 15min before & 50% 60min after

EXAMPLE

- Jim is having Pepperoni Pizza with garlic bread which is 80g carbohydrate

- He knows the pizza has high fat and protein and therefore needs 25% extra insulin

- He can do this by:
  - Carb amount x 1.25 = 80 x 1.25 = 100g
  - 100g with 1u:10g ratio = 10untis
  - How to split?
    - Pump 50% now, 50% over 2.5 hours
    - Injections: 5units 15min before and 5 units 60 minutes after eating

GUIDANCE ON ADAPTING – 2.5 HOURS TEST

- **Monitoring:**
  - Test blood glucose before meal
  - Test blood glucose two half hours after
  - Test blood glucose after six hours

- **Two half hour test – does the first percentage need adjusting?**
  - If blood glucose more than 4mmol.l higher than before meal:
    - Increase the initial % by 20%
    - e.g. 50% + 50% **to** 70% + 30%

  - If blood glucose lower than before meal blood glucose:
    - Reduce the initial % by 20%
    - e.g. 50% + 50% **to** 30% + 70%

CASE STUDY

- multiwave 50% Now 50% Square 2.5 hours
  - What to change multiwave wave to?

Meal	Pre-meal blood glucose	2.5 hour after meal blood glucose
Pizza	6.2	12.2

Increased by > 4mmol.l

Change to 70% Now 30% Square 2.5 hours

GUIDANCE ON ADAPTING – 6 HOUR TEST

- **Monitoring:**
  - Test blood glucose before meal
  - Test blood glucose two & half hours after
  - Test blood glucose after six hours

- **Six hour test –do you need more insulin?**

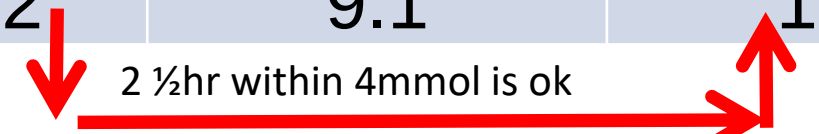
  - If blood glucose at six hours is 2 - 6mmol.l higher than before meal:
    - Increase the additional carbs by 10% so from 25% extra to 35% extra.
      - Carbohydrate to be eaten x 1.35
      - E.g. 100 x 1.35

  - If blood glucose at six hours is more than 6mmol.l higher than before meal:
    - Increase the additional carbs by 20% so from 25% extra to 45% extra.
      - Carbohydrate to be eaten x 1.45
      - E.g. 100 x 1.45 = 145g

CASE STUDY

- multiwave 50% Now 50% Square 2.5 hours for 100g carbs eaten but 125g entered for extra 25% or **customised 1.**
  - How much extra insulin for next time?

Meal	Pre-meal blood glucose	2.5 hour after meal blood glucose	6 hour after meal blood glucose
Pizza	6.2	9.1	13.3



2 ½hr within 4mmol is ok

but 6hr Increased by >6mmol/l so insulin needs increasing

Increase by 45% next time: 100 x 1.45 = 145g

Review Article

Optimal prandial timing of bolus insulin in diabetes management: a review

D. Slattery, S. A. Amiel and P. Choudhary

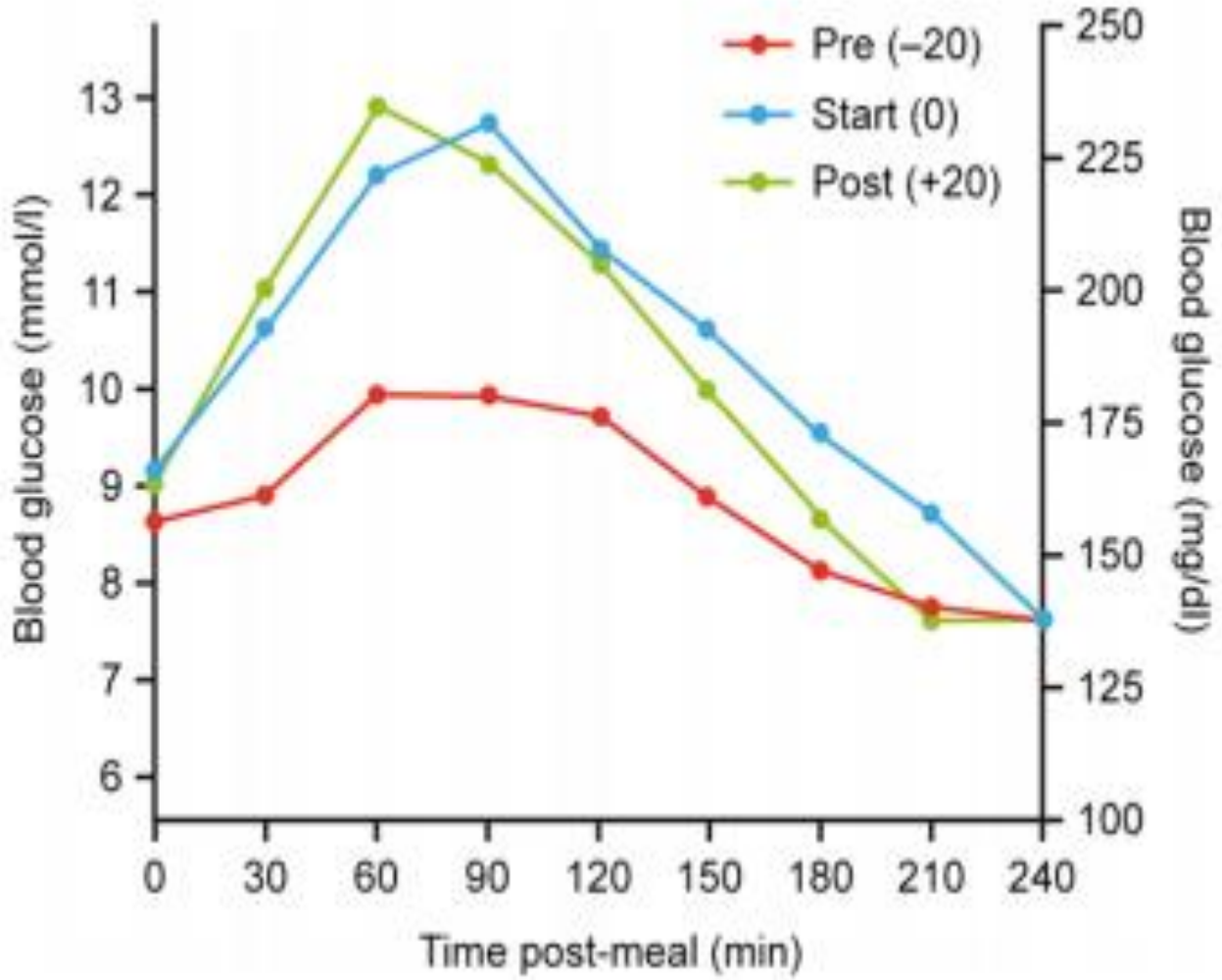
Kings College London, Weston Education Centre, London, UK

Accepted 12 October 2017

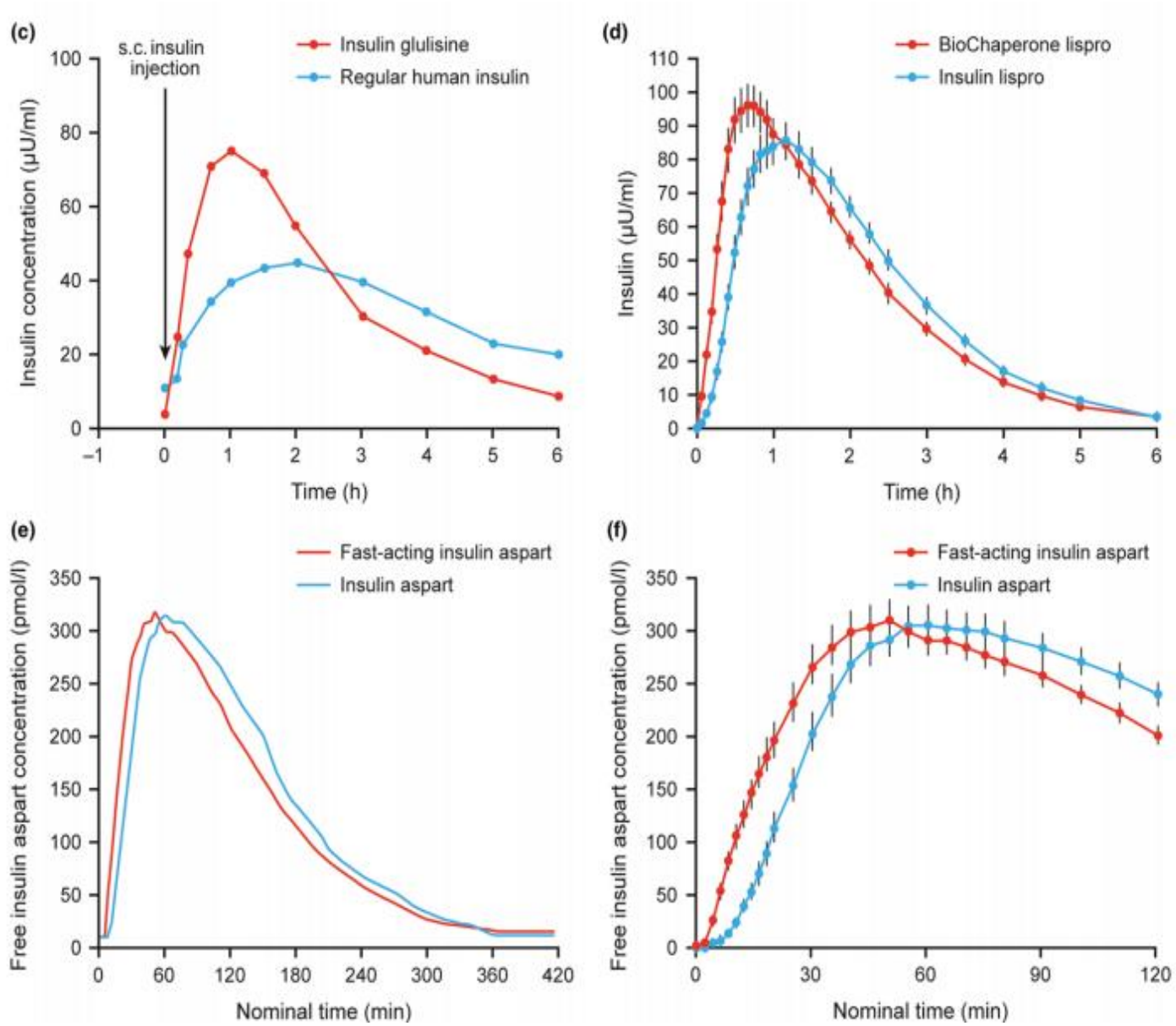
Abstract

The inability to achieve optimal diabetes glucose control in people with diabetes is multifactorial, but one contributor may be inadequate control of postprandial glucose. In patients treated with multiple daily injections of insulin, both the dose and timing of meal-related rapid-acting insulin are key factors in this. There are conflicting opinions and evidence on the optimal time to administer mealtime insulin. We performed a comprehensive literature search to review the published data, focusing on the use of rapid-acting insulin analogues in patients with Type 1 diabetes. Pharmacokinetic and pharmacodynamic studies of rapid-acting insulin analogues, together with postprandial glucose excursion data, suggest that administering these 15–20 min before food would provide optimal postprandial glucose control. Data from clinical studies involving people with Type 1 diabetes receiving structured meals and rapid-acting insulin analogues support this, showing a reduction in post-meal glucose levels of ~30% and less hypoglycaemia when meal insulin was taken 15–20 min before a meal compared with immediately before the meal. Importantly, there was also a greater risk of postprandial hypoglycaemia when patients took rapid-acting analogues after eating compared with before eating.

Diabet. Med. 35, 306–316 (2018)



Corby et al. (2010)



SLATTERY ET AL (2018)

B.I.F.F

B = Blood
I = Insulin
F = Fifteen
F = Food

CONSIDER YOUR GLUCOSE LEVEL

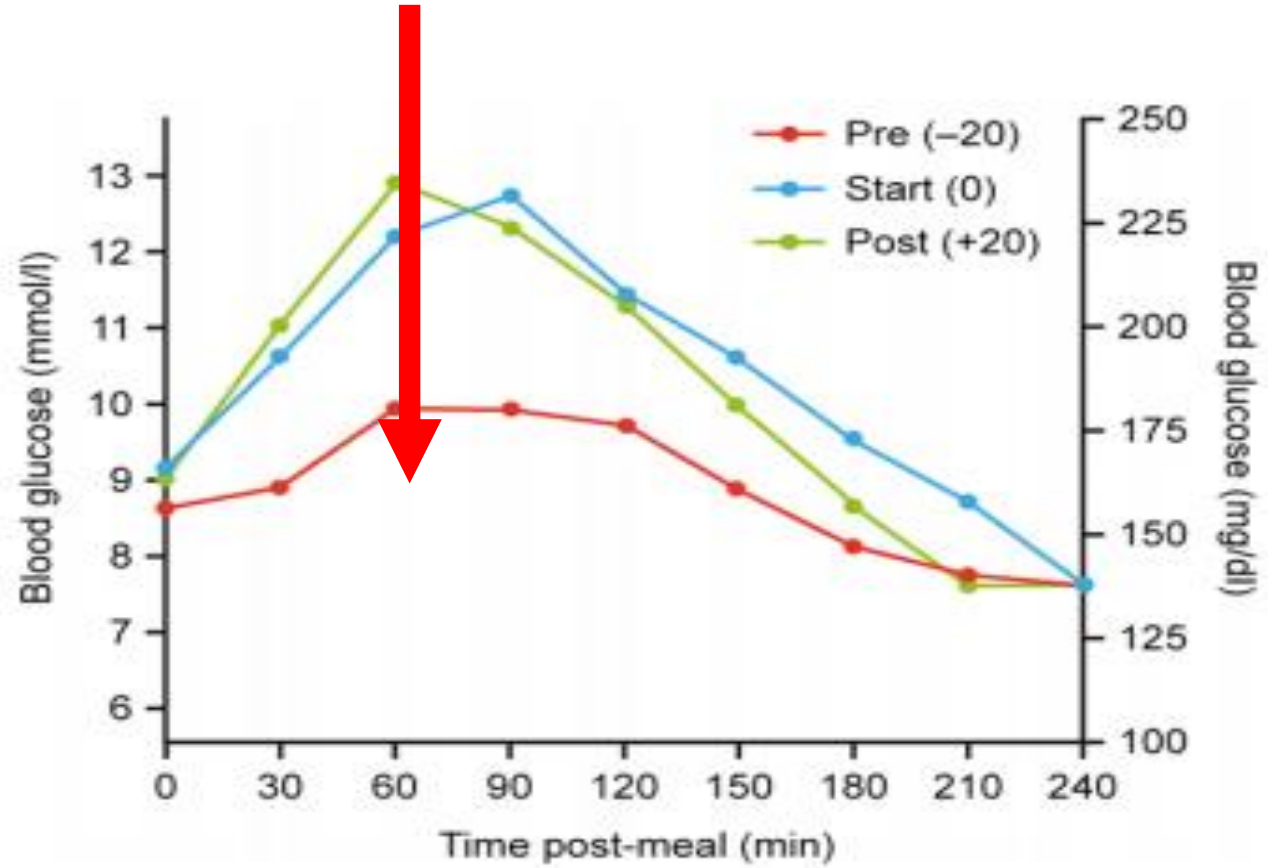
Glucose level mmol/l	Glucose level mg/dl	Minutes to bolus before meal
4 – 6	70 – 100	5 - 15 minutes
6 – 10	100 – 180	15 – 30minutes
10 – 14	180 – 250	30 – 40 minutes
More than 14	More than 250	40 – 60 minutes

WHEN TO BE CAREFUL WITH 15-20 MINUTE PRE-BOLUS?

- Fussy eaters
- Slow eaters (45-60 minutes)
- Gastroparesis
- High fat meals – Not low GI!
- Glucose 3.5-4.5mmol/l pre-meal

SUPER BOLUS

Trying to mimic people without diabetes



- When useful?
  - For high GI meals
  - 1 hour pregnancy BG target (<7.8mmol),
  - Post-prandial hyperglycaemia Adults 2hr <9mmol Children 2hr <10mmol

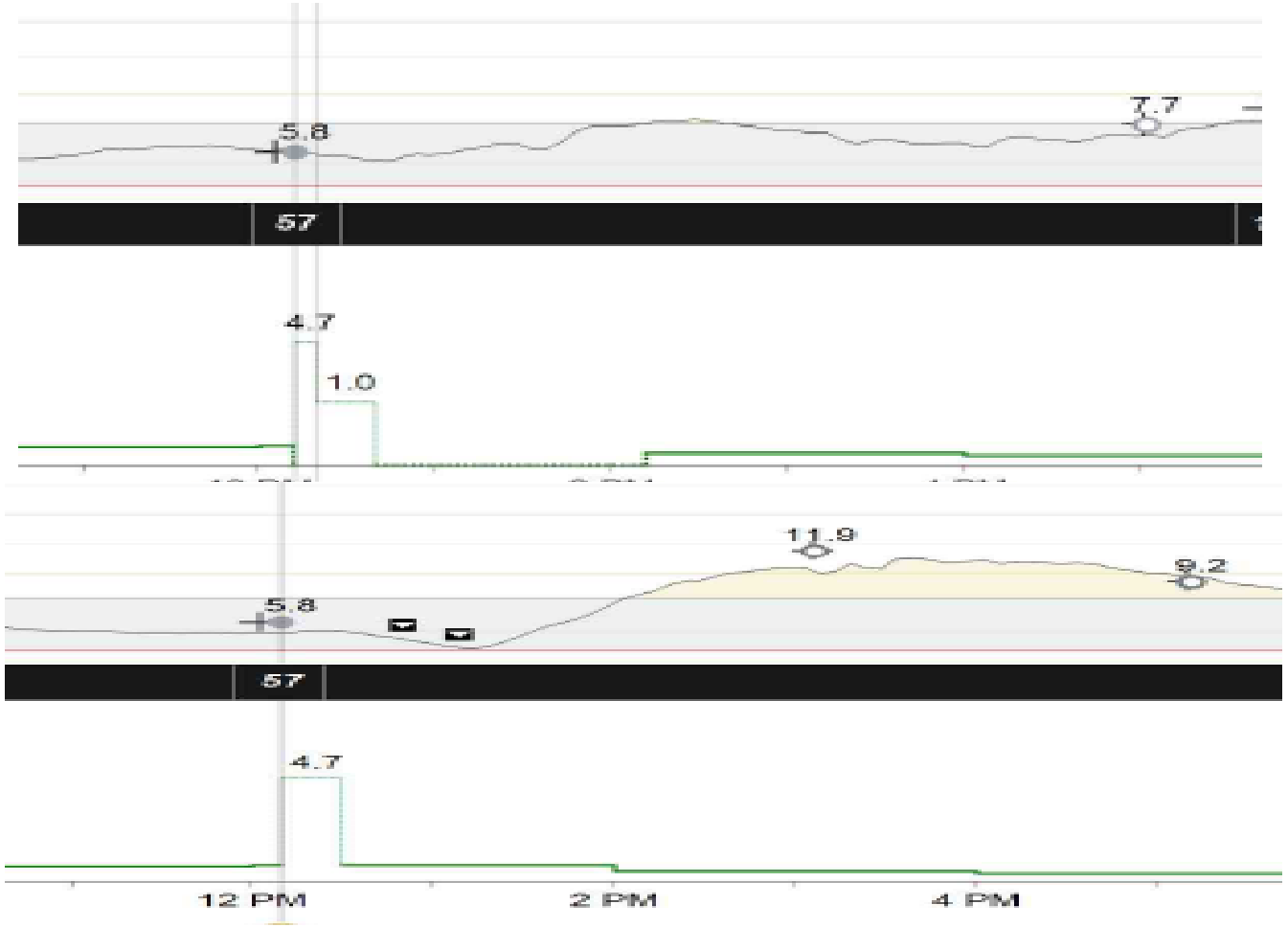
- Two steps for more insulin action early but not more insulin in total:

  - 1. Temporary basal rate of 0% for 2-3 hours when bolus for food

  - 2. Add missed basal onto food bolus

  - Example.
  - 1. 1unit/hr = 2-3units of missed basal – Start temp basal before bolus
  - 2. 100g carb with 1unit:10g =10units
  - Total 10 + 2 or 3 = 12 or 13 units bolused

SUPER VS NORMAL BOLUS : LUNCH



SUPER BOLUS PRACTICE

- Mrs X is having 4 slices of white medium cut toast:
  - Her insulin to carbohydrate ratio is 1u:15g
  - Her basal rate is 0.75unit per hour, temps for 2 hours

- How would you do the Super bolus?
  - 60g Carbohydrate = 4 units
  - 0.75 x 2 = 1.5 units

SUMMARY

- Carb counting accuracy within 10g
- Keep fat and protein as consistent as possible
  - **Macro-consistency**
- Think about adding 25% extra insulin and splitting if very high fat and protein meal
- Deliver insulin 15-20 mins pre-meal as a default, maybe more, maybe less
  - BIFF
  - Super bolus

REFERENCES

- Bell, et al (2015) Impact of Fat, Protein, and Glycemic Index on Postprandial Glucose Control in Type 1Diabetes: Implications for Intensive Diabetes Management in the Continuous Glucose Monitoring Era. *Diabetes Care 2015;38:1008–1015*
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- Smart CEM, Evans M, O'Connell SM, et al. (2013) Both dietary protein and fat increase postprandial glucose excursions in children with type 1diabetes, and the effect is additive. *Diabetes Care ;36:3897–3902*
- *Slattery et al (2018)* **Optimal prandial timing of bolus insulin in diabetes management: a review.** Diabet Med. 2018 Mar;35(3):306-316