1. What's the point of a network – the case for research?
2. How to use CSII effectively

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What should an insulin pump network do?

- Improve quality of care - support, education, training, collaboration, sharing best practice, developing policies and guidelines, advocacy

- Research – using surveys and sharing data about diabetes technology to answer outstanding clinical and scientific questions

Some examples: recent research based on local or national surveys of diabetes technology

- Technical problems with CSII
- Patient responses to CGM
- Long-term clinical outcomes on CSII
- Long-term glycaemic control on CSII

Research question 1

Is modern CSII associated with less technical complications than early insulin pump therapy?

Survey of non-metabolic complications of CSII
Pickup JC et al. Diabet Technol Therapeut 2014; 16: 1-5

- Self-report questionnaire completed by all type 1 DM patients on CSII for 6 mo at Guy's Hospital, London

- Duration of CSII: 0.5-32 years

- Data included:
  - Infusion set type and duration, pump model, pump insulin
  - Frequency of complications
    - Infusion set
    - Infusion site
    - Pump malfunctions
    - Open responses to other problems

Infusion set problems are common

- Infusion site lipohypertrophy is frequent:
  - Reported by 26% of patients
  - Commoner in those with long duration of CSII

- Infusion set blockage/kinking at some time occurred in 64% of patients
  - Strongest risk factor for blockage was infusion set use for >3 days + use of lispro insulin (RR 1.71)

Pickup JC et al. Diabet Technol Therapeut 2014; 16: 1-5

Pump malfunction is common
(per cent reporting)

- Any type of malfunction at any time   48%
  (Mostly occurring in 1st year of CSII)

- Pump stop/no delivery   26%
- Key pad/button malfunction   12%
- Rewind malfunction   12%
- Battery compartment problem   11%
- Other, e.g. display, continuous alarm, unknown

Pickup JC et al. Diabet Technol Therapeut 2014; 16: 1-5

Conclusion

Insulin pump malfunctions, and
infusion set and site problems are still
common with contemporary CSII

Research question 2

What are patient and caregivers experiences and perceptions of real-time CGM, when given in their own words?

Survey of patient narratives about using CGM

- On-line survey of UK patients' experiences with RT-CGM of all types - with MDI, CSII and LGS pumps

- First 100 responses analysed at Guy's Hospital using qualitative framework analysis

Pickup JC, Ford-Holloway M, Samsi K. Diabetes Care 2015; 38: 544-550

Four themes identified

- **Metabolic control**
  - Reduced HbA1c, BG variability and hypoglycaemia

- **Living with CGM**
  - Improved work and school life, sleep, control during exercise, nutrition, reduced SMBG frequency

- **Psychological issues**
  - Mostly reduced stress, more confidence, improved QoL, but notable negatives like stress of knowing control is poor

- **Barriers to CGM use**
  - Technical (e.g. perceived inaccuracy), financial, often negative HCP attitudes

Example narrative - patient

- 'The low suspend is a life-saving piece of equipment and I would never be without that. It is a no brainer really that this is superior to anything else at the moment on the market - it saves lives'

Example narrative - parent

'She feels more safe and confident, doesn't want to have the embarrassing low hypos that make her look 'silly' and she hasn't had one like this since using sensors. She said it is like having a mummy in her pocket!'

Research question 3

Little is known about long-term clinical outcomes on CSII: is CVD and mortality reduced on CSII?

Reduction in mortality with CSII

- Data from Swedish National Diabetes Registry
- 2,441 type 1 DM on CSII
- 15,727 type 1 DM on MDI
- Followed up for 7 years

- All cause mortality reduced by 27% on CSII
- CHD mortality reduced by 45%
- CVD (stroke and CHD) mortality reduced by 42% on CSII

Steineck I et al. BMJ 2015; 350: h3234

Research question 4

Is improved glycaemic control on CSII
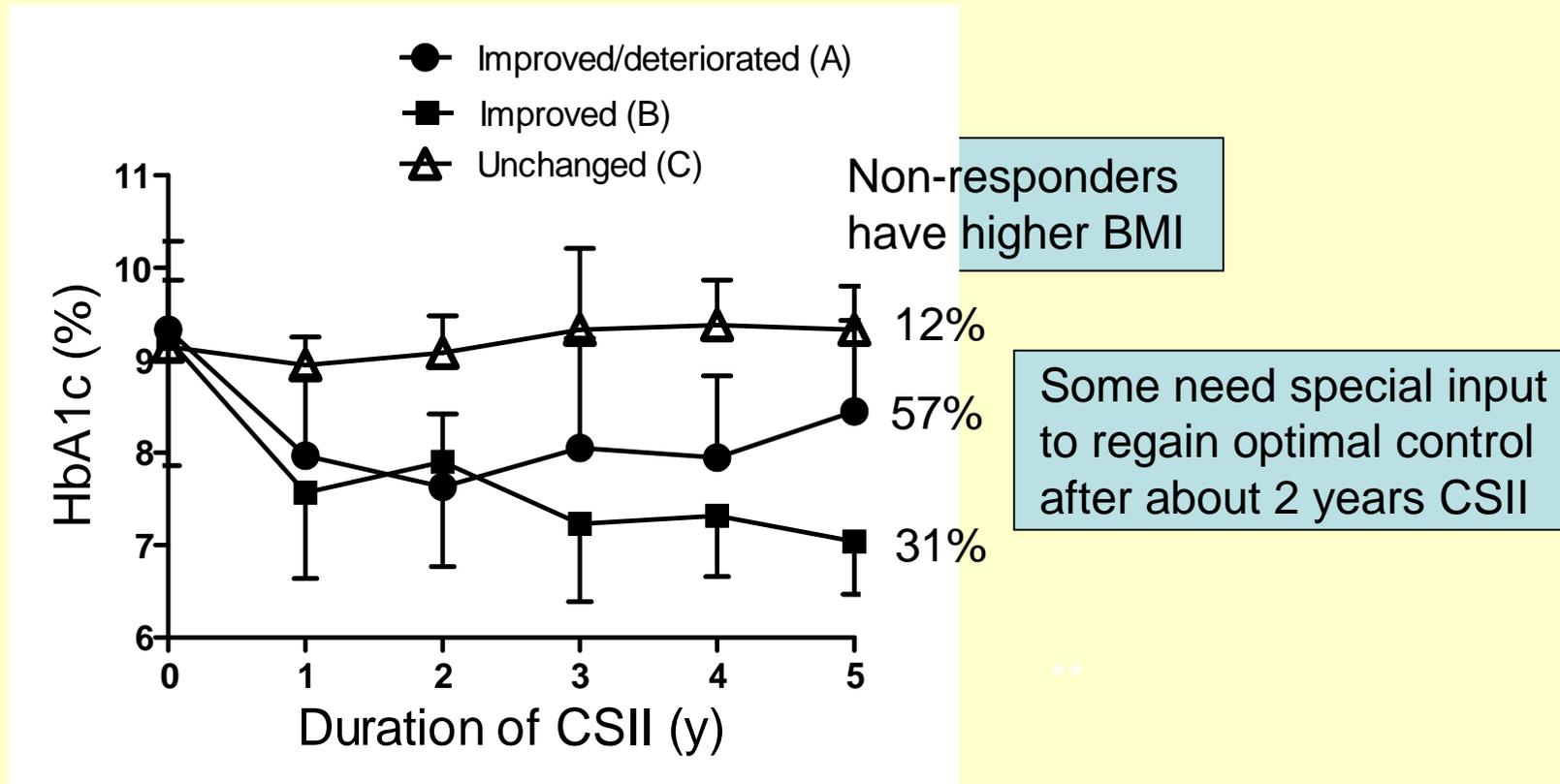maintained over many years in all
patients with type 1 diabetes?

(and how can we re-establish
good control on CSII, if HbA1c worsens)

Long-term control on CSII

- All adults on CSII for ≥6 mo at Guy's Hospital, London surveyed

- Selected for analysis: those started on CSII because of elevated HbA1c (≥8% [64 mmol/mol]) and with ≥5 years pump duration

Five-year changes in HbA1c on CSII

88% improve on CSII but some deteriorate after 2-3 years

Non-responders have higher BMI

Some need special input to regain optimal control after about 2 years CSII

Nixon R, Folwell R, Pickup JC. Diabetic Medicine 2014; 31: 1174-1177

Long-term follow-up and therapy adjustments in CSII practice are essential
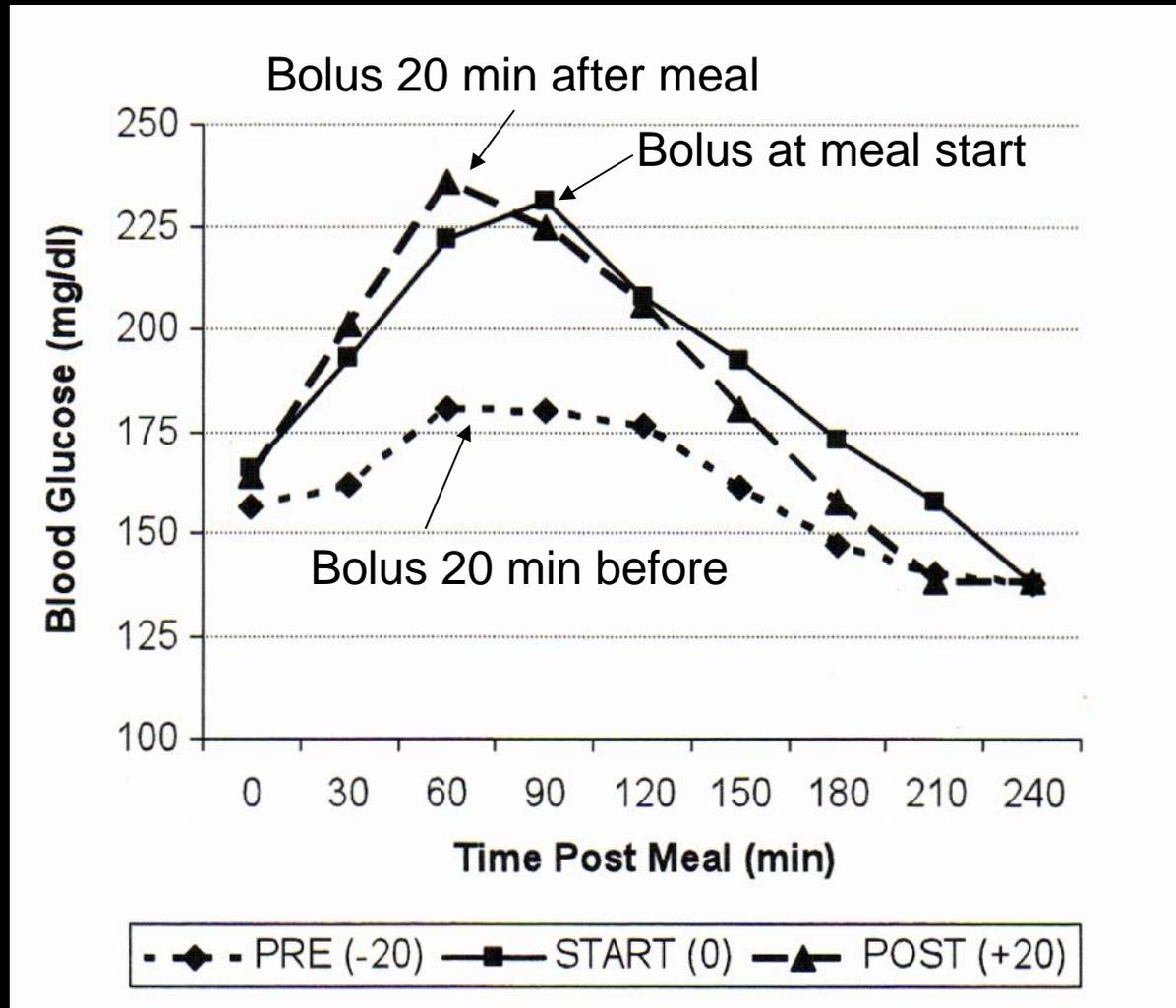
How can we re-establish the best control on CSII?

Improving control on CSII:
my five (research-based) checks

1. Review bolus insulin
   - Timing before meals
   - Appropriate meal profiles
   - Missing boluses

2. Review basal rates – e.g. reduce number

3. Review infusion set practice

4. Review diet - weight gain in about one third

5. Consider CGM when elevated HbA1c or hypoglycaemia persists

Giving meal insulin bolus
~15-20 min before meal start
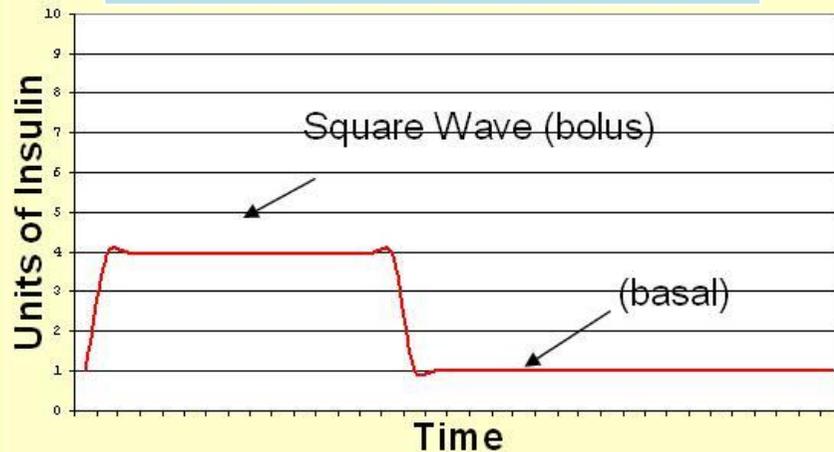should be the standard

(many patients do not do this)

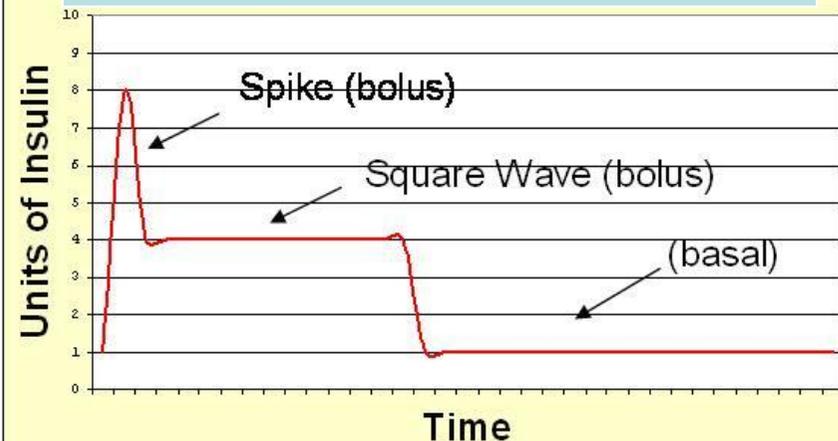# Bolus 20 min prior to meal reduces postprandial hyperglycemia

23 type 1 DM patients using CSII

Cobry et al Diabetes Technol Ther 2010; 12: 173-177

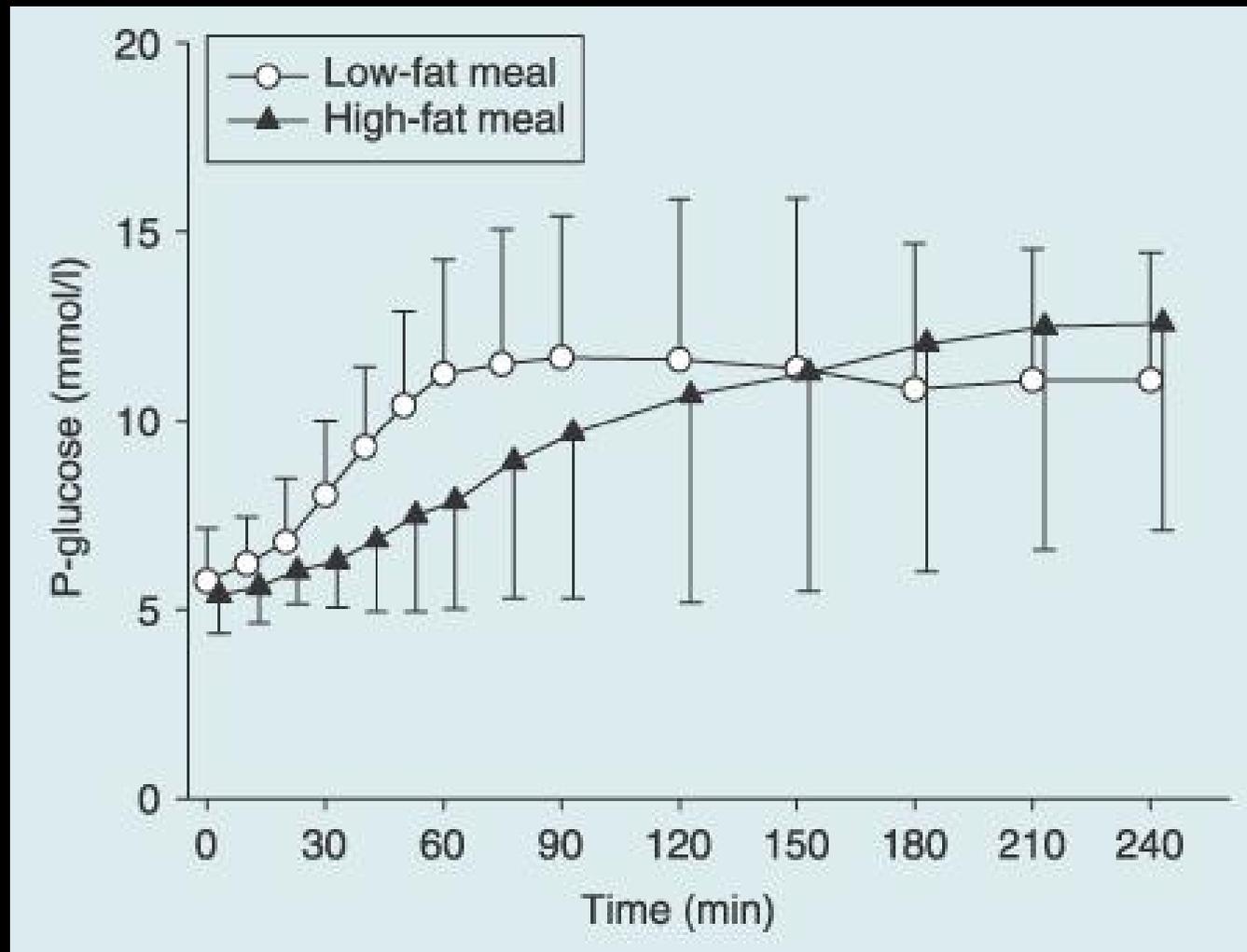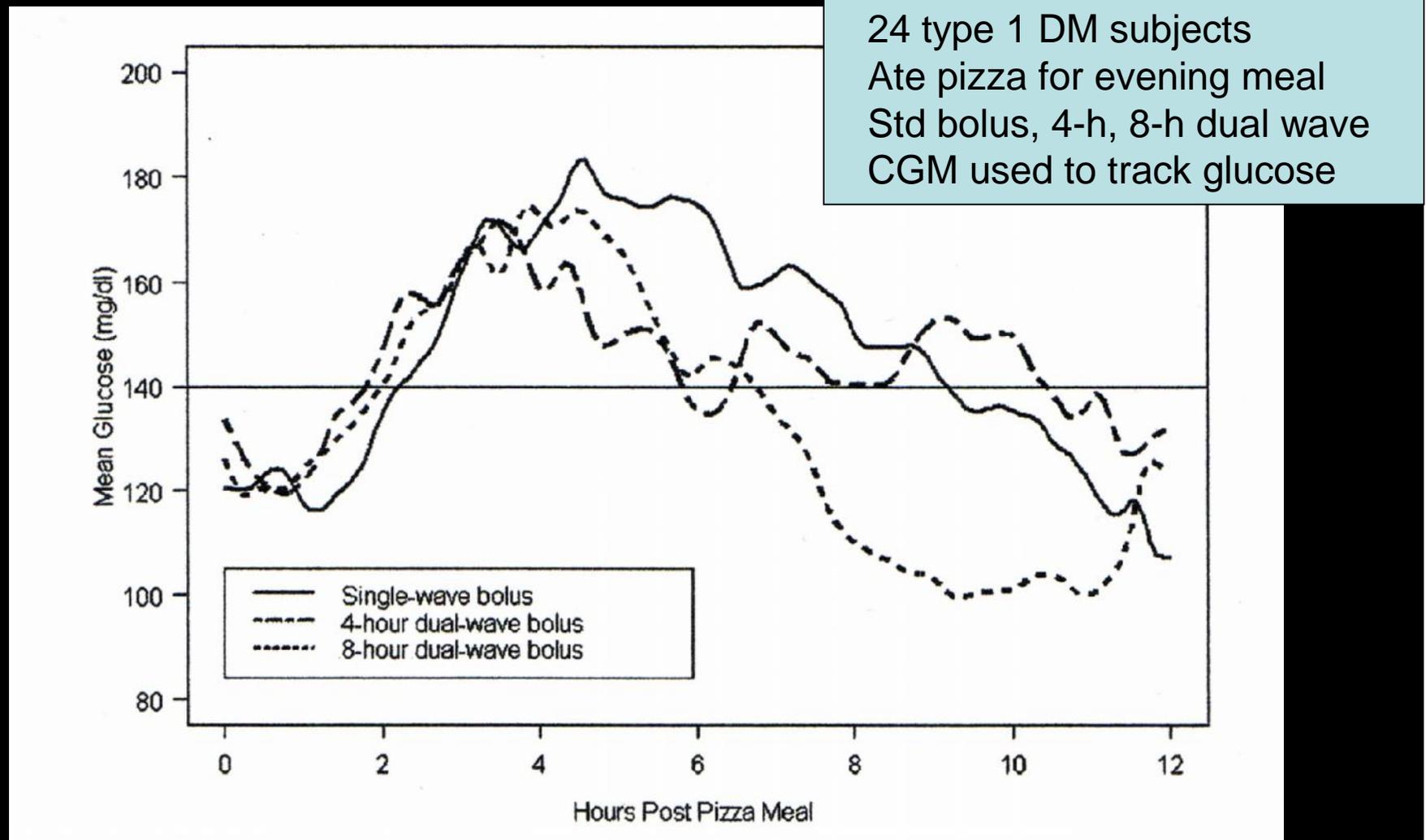# Consider square- or dual-wave bolus for fatty meals

Square or extended wave

Dual wave or combination bolus

High fat meals delay gastric emptying and may cause insulin resistance and late hyperglycemia

Lodefalk et al Diabetic Med 2008; 25: 1030-1035

Dual-wave bolus reduces postprandial hyperglycaemia after a fatty meal

24 type 1 DM subjects
Ate pizza for evening meal
Std bolus, 4-h, 8-h dual wave
CGM used to track glucose

Jones SM et al. Diabetes Technol Ther 2005; 233-239

Check for missing boluses:
Dependence of CSII HbA1c on bolus number

r = 0.68, p = 0.001

Those with poor glycemic control give few bolus doses

Kerr D et al. Infusystems 2008; 7: 1-4

Missed meal bolus is relatively common

- 90 adolescents type 1 DM on CSII surveyed, meal intake on previous day compared with pump download data

- 38% missed >15% of bolus doses

- HbA1c was higher in those who miss boluses (7.8 ± 1.2 vs, 7.0 ± 1.0%, P<0.001)

- Basal rate was higher in those who miss boluses (65 ± 14 vs. 55 ± 12 per cent total dose)

Missing meal boluses

Various reasons

- Forgotten

- 'Can't be bothered'

- Attempt to avoid hypoglycemia

- Attempt to control weight

How to detect and treat

- Identify with computer downloads

- Advice to bolus before meal may help to increase number of boluses given

Try reducing the number of basal rates

- Frequent basal rate changes are now possible and popular with some pump users

Sample Basal Rate Profile and Physiological Insulin Needs

- After changing the basal rate, it takes about 6 h to reach a new steady-state insulin level

- Changing the basal rate every 1 or 2 hours can cause erratic glycemic control

Heinemann L et a. Diabetes Care 2009; 32: 1437-9

Infusion set problems are a cause of poor and erratic control on CSII:

- Guy's survey of CSII complications:

- Infusion site lipohypertrophy frequent:
  - Reported by ~25% of patients
  - Known to impair insulin absorption, cause poor and erratic control

- Infusion set blockage/kinking occurred in 64%
  - Strongest risk factor for blockage is infusion set use for >3 days
  - Associated with insulin aggregation and cannula blockage
  - Known cause of poor and erratic control

Pickup JC et al. Diabet Technol Therapeut 2014; 16: 1-5

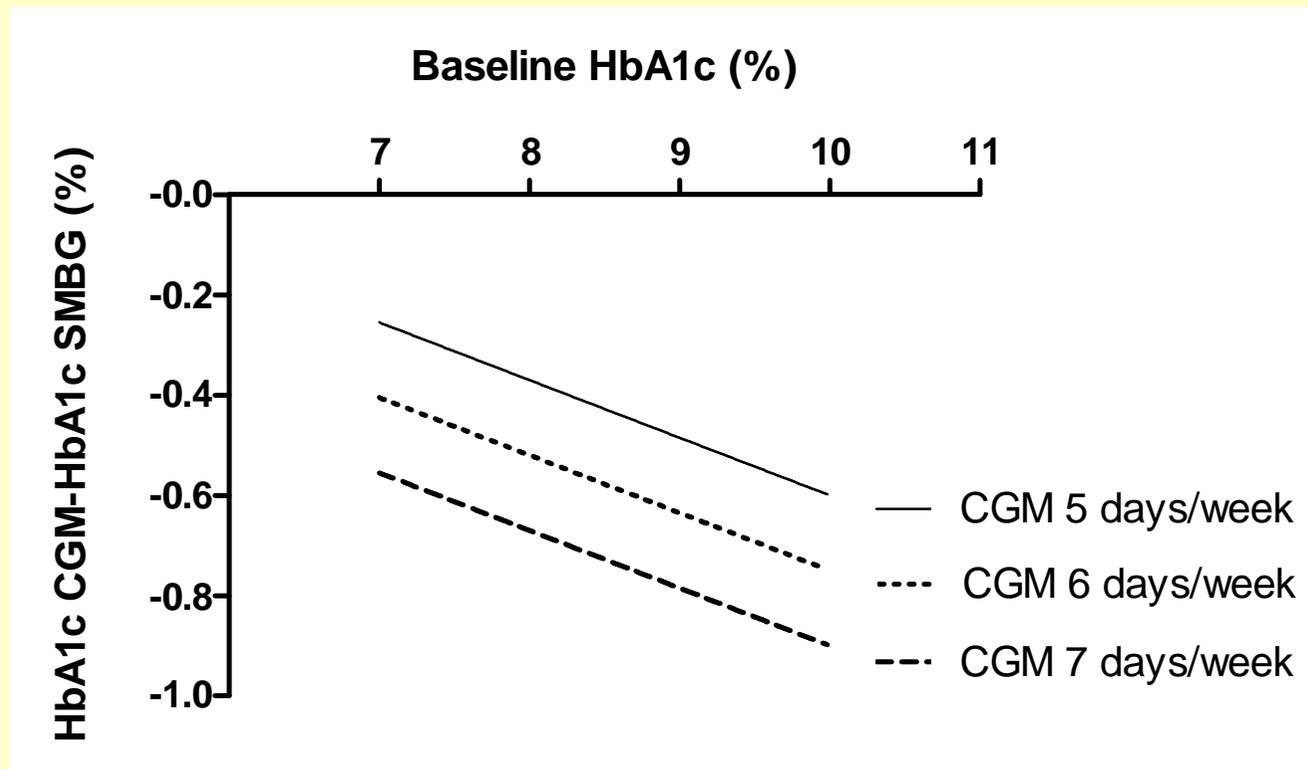# Check infusion sites and infusion set use

Rotate infusion sites and limit set duration to 3 days or less

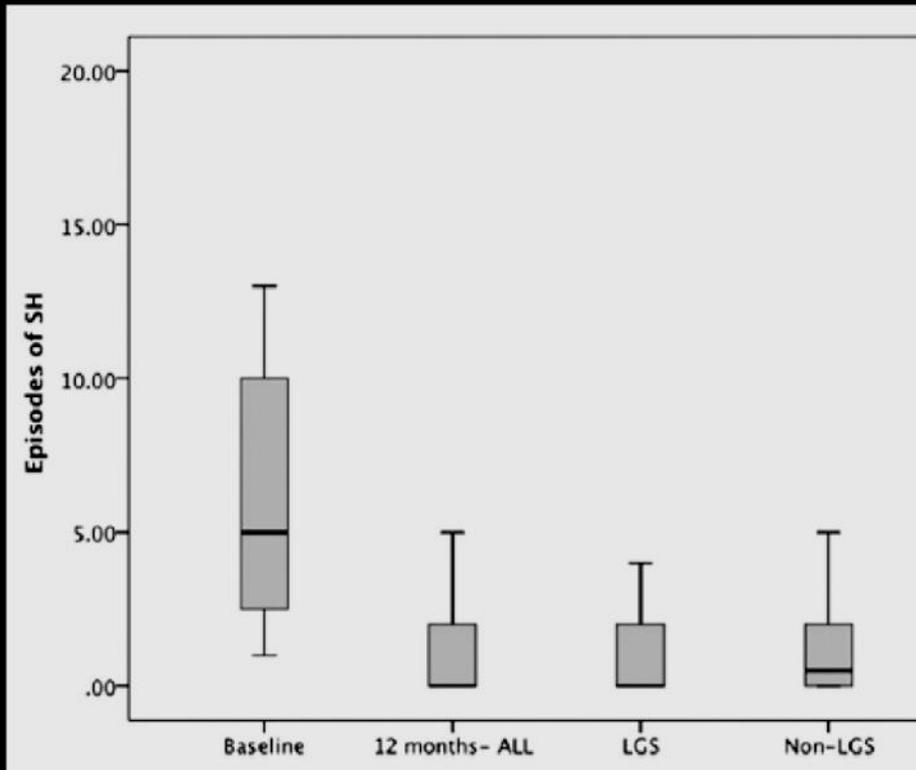# When poor control persists on insulin pump therapy

Consider a trial of CGM + CSII (sensor-augmented pump therapy)

Additional HbA1c lowering of CGM vs. SMBG
Model based on individual patient data meta-analysis of RCTs

Pickup JC, Freeman SC, Sutton AJ. BMJ 2011; 343: d3805.

CGM/LGS reduces severe hypoglycemia

- 35 type 1 DM patients with problematic hypoglycaemia and unawareness

- Not improved by CSII/MDI or structured education

- CGM for at least 1 year

- HbA1c reduced from 8.1 ± 1.2 to 7.7 ± 1.0%, $p < 0.005$

- Severe hypo reduced from median 5.0 (0.75-7.25) to 0 (0-1.25) episodes/yr, $p < 0.001$

Choudhary P et al. Diabetes Care 2013; 4160-4162

Conclusion

- Research studies using data from insulin pump clinics have provided valuable results directly applicable to clinical practice

- Similar research could be done by IPN UK

Suggestions for research

- CVD and microvascular complications on long-term CSII vs. MDI
  - Swedish study did not measure BG variability, SMBG frequency, CSII durn or severe hypos, other than those requiring hospital admission

- All patients in IPN UK on CSII for >5 years
  - Pair-matched with MDI patients for age, sex, diabetes duration
  - Moderate hypo and BG variability from SMBG records, severe hypo frequency and HbA1c from clinic records
  - CVD questionnaire, retinopathy from records

- Test difference in CVD and retinopathy grading, MDI vs. CSII

- Test hypo, BG variability and HbA1c in treatment groups and as predictors of clinical outcomes

Consider research as a major function of IPN UK