INSULIN DELIVERY -PUMPS & PENS CLINICAL CASE STUDIES

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Pens & calculators at the ready?!.....

APPROPRIATE INJECTION TECHNIQUES

Robert, age 42. Type 1 diabetes for 26yrs. HbA1c 76mmols/mol 2 recent severe hypoglycaemia events – urgent review in clinic



F H

Poor/unpredictable absorption of insulin Variability in Blood glucose control Hypoglycaemia Diabetic Ketoacidosis

Frid et al, 2010

- 4,300 (999 in UK) surveyed
- 52% use needles longer than 6mm
- 60% not changed needle size since commencing injectable therapy
- 72% did not rotate sites
- 54% reported lipohypertrophy at some point
- 45% report bleeding/bruising

The Forum for Injection Technique (FIT) (UK)Recommendations 2010

Annual check on technique:

- Skin thickness 1.2-3mm
- Use 4-6mm needles can avoid lifted skin fold (No need for longer needle for obese patients)
- Use lifted skin fold with children and very slim adults
- 90° angle
- Leave needle for 10seconds after insulin injected
- Single use needles
- Do not inject through clothing
- Use appropriate site rotation
- Avoid Lipohypertrophy
- (Reduce dosing when moving to new sites up to 50% Overland et al 2009)
- www.fit4diabetes.com
- Blanco M, Hernandez MT, Struass KW, Amaya M (2013) Diabetes Metab J 39:445-53







Other Recommendation.....

Move to Insulin pump therapy!!







INSULIN PUMP SET UP..... THE CALCULATIONS..

Determining Total Daily Insulin Doses (TDD)
Determining & adjusting Basal Rates
Calculating Insulin:Carb Ratio (ICR)
Calculating Insulin Sensitivity Factor (ISR)
Choosing the right pump

Calculations



• Wilmot G, Choudhary P, Grant P, Hammond P. Practical Diabetes 2014 31:3, 121-125

Walsh J, Roberts R. Pumping Insulin, 4th edn. San Diego:Torrey Pines Press, 2006;pp120-1

Determining Total Daily Dose

- 1. Based on patients' pre-pump insulin doses
 - Average over 4 days combined
 - Background dose
 - Meal doses
 - Correction doses

 Reduce by 5-30% depending on glycaemic control pre-pump or daily carbohydrate intake

2. Based on body weight

Wt (kg) x 0.6units *

* Walsh PA, Roberts R. Pumping Insulin, 4th edn. San Diego: Torrey Pines Press, 2006; pp 120-1.

Key determinant of ICR & ISF and of level of glycaemic control

Case study

- John is about to start Combo pump.
- Has attended intensive education but continues to suffer with frequent hypoglycaemia and reduced awareness
- HbA1c = 55mmols/mol.
- Weight = 70kg
- Usual Daily Insulin Doses
 - Lantus dose 26units
 - Total meal doses average 22units
 - Correction doses average 2units
 - Total pre pump daily dose <u>50units</u>

Calculate John's Pump TDD

Pre-pump dose reduction

- Pre-pump daily insulin dose =50units
- Reduce by 25%
 (hypoglycaemia, HbA1c 55mmols/mol)
- Pump TDD = ? units

Weight based calculation

- 70 x 0.6u/day
- Image: Image:

Combine both calculations.....

Calculate John's Pump TDD

Pre-pump dose reduction

- Pre-pump daily insulin dose =50units
- Reduce by 25%

(hypoglycaemia, HbA1c 55mmols/mol)

• Pump TDD = 38 units

Weight based calculation

- 70 x 0.6u/day
- = 42 units

Combine both calculations.....

Mean TTD value = (38 + 42)/2 = 40units / day

Determining Basal Rate

APP study (Walsh 2010)
 Basal rate equated to 48% TDD

40 TDD x 0.5 = 20units

King A, Armstrong D. J Diabetes Sci Technol 2007;1:36–41.

Walsh J, Roberts R, Bailey T. J Diabetes Sci Technol 2010;4(5):1174-1181

Walsh J, Roberts R. Letter to the editor. J Diabetes Sci Technol 2007;1(4):L3-6.

Flat Rate or Circadian Profile?

Flat Rate or Circadian Profile?

Flat Rate

- Simple
- Total Basal (20units) /24hrs

<u>0.83u/hr</u>



Circadian

- More physiological
- Takes account of Dawn effect.
- Total Basal automatically profiled according to age
- Based on Rainer Bachran et al. Pediatric diabetes 2011
- Immediately provides for variable insulin requirements.
- Minimises the changes to optimise control
- Evidence based on paediatric populations

Freckmann et al 2008 The Dawn Phenomenen

- 12 adults randomised to either 1 flat basal rate or multiple basal rates
- Standard meals

With 1 basal rate....

- Small increase blood glucose between 4am and wake up
- 1.5mmol/l increase between getting up and breakfast
- Get up phenomenon caused by starting activity

This effect was not seen in multiple basal because of increased basal rates

Freckmann G, et al. Diabetes Care 2008;31(11):e85.

Easier using technology?

BASAL RATE PROFILE AND PHYSIOLOGICAL INSULIN NEEDS



Using Accu-Chek Insulin Configuration - up to 5 different profiles

also with new Medtronic systems?

Basal Rate Reviews

- Carb free profiles
- Downloaded information
- Other clues:



- What happens to BG levels if a meal is delayed/ skipped
- Any suggestions of hypos at night
- What happens to BG levels between waking & breakfast
- Frequent use of temp basal changes

Rules for basal reviews

- Very important... Foundations
- Eat low fat meal 4-5hrs before starting test
- Avoid alcohol
- Only miss one meal during a test period
- Have carb free foods during test period
- Avoid exercise and testing after hypoglycaemia
- Repeat tests to see patterns
- Abandon if hypo consider basal change.
- Use Expert meter tags
- Useful prior to clinic visits
- Beware of patients maths skills do they see the same patterns you see?!





When to test?



Overnight — have an early evening meal which is low in fat and known carbs then after 5 hours test BG every 2 hours throughout the night. Ideally repeat.

Morning – miss breakfast; test BG every 1-2hrly until lunch time

Afternoon – miss lunch; start testing 5 hours after breakfast, test 1-2hrly until evening meal

Evening — miss evening meal; start testing 5 hours after lunch, test 1-2hrly until bedtime

Test day_2

Date:

- Have breakfast just before 8am
- Miss lunch or have carbohydrate free meal
- Dinner with carbohydrate after 6pm (18.00h)

Carbohydrate value of breakfast; 55g Insulin dose for breakfast: 5.5u

Time of breakfast: ...8.00

TIME (HRS)	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00
		No food or carbohydrate free food only										
BGL	6.4	7.1		8.9	(6.5		8.1		9.5	\mathcal{V}	9.1
Basal	0.5	0.6	0.6	0.5	0.4	0.3	0.3	0.3	0.2	0.2	0.4	0.4
BGL = Blood glucose (sugar level)												

Test day 3

Date:

- · Have lunch just before midday
- Miss dinner or have carbohydrate free meal
- Meal with carbohydrate after 10pm (22.00h)

Carbohydrate value of lunch: 72g Insulin bolus for lunch: 8.2

Time of lunch: 11.30

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	TIME	11.00	12.00	13.00	14.00	15.0	16.00	17.00	18.00	19.00	20.00	21.00	22.00
	(HRS)					0							
					N	lo food	or carbo	nydrate	free foo	od only			
	BGL	7.8	8.9		9.7		6.4		4.3		3.6*		5.1
	Basal	0.4	0.4	0.4	0.4	0.3	0.2	0.4	0.4	0.6	9.5	0.3	0.3
6	BGL = Blood glucose (sugar level)												





Making changes

- Note time of change in BG level (or).
- Increase or decrease basal rate by 0.05-0.1u/hr)
 1-2 hrs prior to this.
- No need to change at point BG level is stable, even if stable at high level.
- Important to review by repeating basal check...
 One change does not, necessarily make things right!

Calculating insulin:Carb Ratio (ICR)

- 500 Rule (or 450)
- 500/TDD
- Or
- Walsh 5.7x kg/TDD
- Post prandial BG levels target
- Expect BGL to rise by 2-4mmol/l (30-70mg/dl) 2 hrs after eating
- Variability according to meal composition e.g. Glycaemia load

Walsh J, et al. J Diabetes Sci Technol 2010;4:1174–81. Davidson PC, et al. Diabetes Technol Ther 2003;3:237–42. Elleri D, et al. Diabetologia 2013;56:1108–17. More accurate calculations Important effectiveness E.g. change from 1:10g to 1:9g can lower postprandial BGL by 1.8-2.9mmol/ I at a meal of 60-100g CHO.

Case Study Calculation

John's TDD = 40units/day
500/40 = ?g
1 unit insulin for every ?g carbohydrate

Wt x 5.7Kg/TDD Wt = 70kg 70 x 5.7 = ?/40 =?g 1 unit insulin for every ?g carbohydrate

Case Study Calculation

John's TDD = 40units/day
500/40 = 12g
1 unit insulin for every 12g carbohydrate

70 x 5.7 = 399/40 =10g 1 unit insulin for every 10g carbohydrate

Test day_2

Date:

- Have breakfast just before 8am
- Miss lunch or have carbohydrate free meal
- Dinner with carbohydrate after 6pm (18.00h)

Carbohydrate value of breakfast; 55g Insulin dose for breakfast: 5.5u

Time of breakfast: ...8.00

TIME (HRS)	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00
					No too	lor carb	ohydrate	e free fo	ood only	/		
BGL 🜔	6.4	7.1		8.9		6.5		8.1		9.5		9.1
Basal	0.5	0.6	Û.Ô	0.5	0.4	0.3	0.3	0.3	0.2	0.2	0.4	0.4

BGL = Blood glucose (sugar level)

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	(HRS)					0							
					N	o feed	or carbo	hydrate	free foo	d only			
								-					
	BGL (7.8	8.9		9.7		6.4		4.3		3.6*		5.1
	Basal	04	04	04	<u>î</u> /i	03	0.2	0 /	0 4	0.6	05	03	03
l		0.4	0.4	0.4	0.4	0.0	0.2	0.4	0.4	0.0	0.5	0.5	0.5

BGL = Blood glucose (sugar level)

*Treated with glucose

Calculating ISF -Insulin Sensitivity Factor (Correction Ratio)

100 Rule (100/TDD) or 1700 Rule

How much 1 unit insulin lowers BGL by (mmol/l or mg/dl) Goal to return BGL to target by 4hrs post-correction

 Walsh 109 (1960)/TDD calculates a smaller correction dose

Davidson PC, et al. Diabetes Technol Ther 2003;3:237–42. Walsh J, Roberts R, Bailey T. J Diabetes Sci Technol 2011;5(1):129-135

Case Study Calculation

100/40 = ? mmols/l
1unit insulin drops BGL by ?mmols/l

1700/40 = ?mg/dl
 1unit insulin drops BGL by ?mg/dl

Case Study Calculation

100/40 = 2.5mmols/l1unit insulin drops BGL by 2.5mmols/l

1700/40 = 42mg/dl
 1unit insulin drops BGL by 42mg/dl

Case study 2

Julie

- HbA1c 75mmols/mol. Good hypoglycaemia awareness
- Wt = 72Kg
- Pre-pump TDD 48units

Pump Setting	Calculation
Pump TDD (90% pre-pump) 72kg x 0.6	
Basal hourly Rate (50%TDD)	
ICR (500 rule) Wt x5.7 /TDD	
ISF 100 Rule 1700 Rule	

Case study 2

Julie

- HbA1c 75mmols/mol. Good Hypoglycaemia awareness
- Wt = 72Kg
- Pre-pump TDD 48units

Pump Setting	Calculation
Pump TDD (90% pre-pump)	43
72kg x 0.6	43 units
Basal hourly Rate (50%TDD)	21.5/24 = 0.9u/hr flat rate
ICR (500 rule)	1:11g
Wt x5.7 /TDD	1:10g
ISF 100 Rule	2.3mmols/l
1700 Rule	39 mg/dl

Bolus Calculators

Consist of:

Target BG (Range)



- In agreement with patient encourage regular evaluations
- ICR
- ISF
- Active Insulin Time
 - Length of time calculator tracks active insulin following bolus (correction & bolus)
 - Adults 4-5hrs
 - Children 3-4hrs

Calculation Summary



Patient Confidence?



Pump Choice

- Waterproofing
- Continuous glucose monitoring
- Low glucose suspend
- Remote control
- Bolus calculator
- Prefilled cartridges
- Visual Clarity
- Patch pump free from tubing
- Financial arrangements













Summary & Considerations

- Accurate calculations important for effective glycaemic control in pump therapy – with all pump systems!
- Patients level of glycaemic control pre-pump
- Different calculations options
- Patients' perspective/health beliefs. Need to problem solve and agree targets etc.
- Can patient comprehend the maths?
- Do they need to (bolus calculators)?
- Are they able to review & adjust settings as they progress?
- Don't forget importance of effective insulin absorption good cannula care/avoid LH!



Thank you – good luck with your calculations!

Raine & Louis