MediConf Study Morning

Insulin in Type 2 Diabetes

Paul Dromgoole

RGN, RNMH , MSc Diabetes, PGCE

DSN / Clinical Lecturer in Diabetes

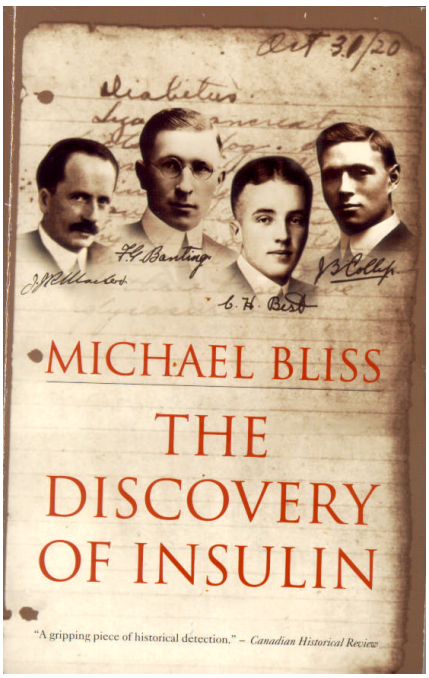
Sort of ground rules

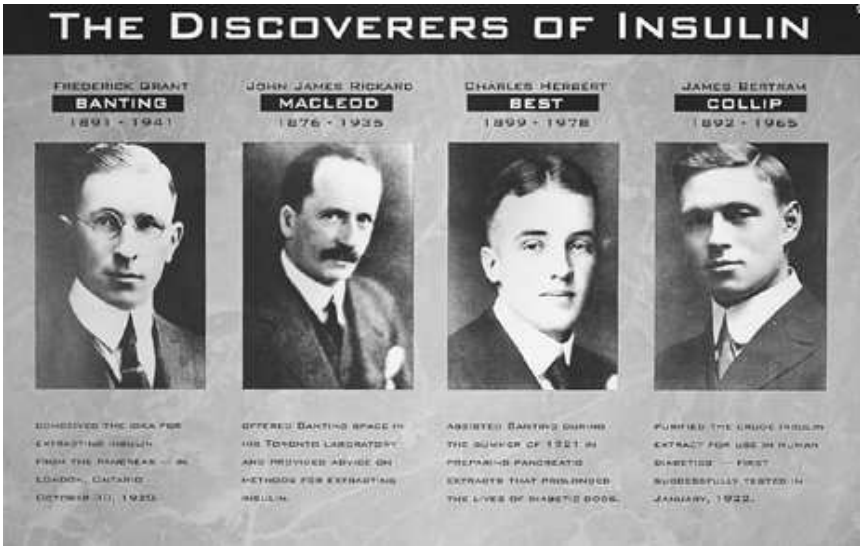
There is no such thing as a daft question!

There is no such thing as a daft response!

If you are uncertain or confused you can be pretty sure others are too.

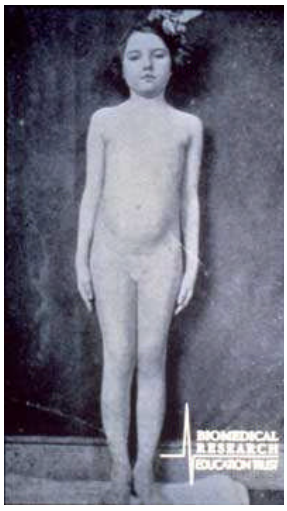
If we do not understand we should not move on!!


Diabetes
F.G. Banting
J.B. Collip
C.H. Best
MICHAEL BLISS
THE DISCOVERY OF INSULIN
"A gripping piece of historical detection." – Canadian Historical Review


THE DISCOVERERS OF INSULIN
FREDERICK GRANT
BANTING
1891 - 1941
JOHN JAMES RICKARD
MACLEOD
1876 - 1935
CHARLES HERBERT
BEST
1899 - 1978
JAMES BERTRAM
COLLIP
1892 - 1965

Banting and Best … but not Marjorie!

Dramatic effect of insulin in reversing keto-acidosis and death!

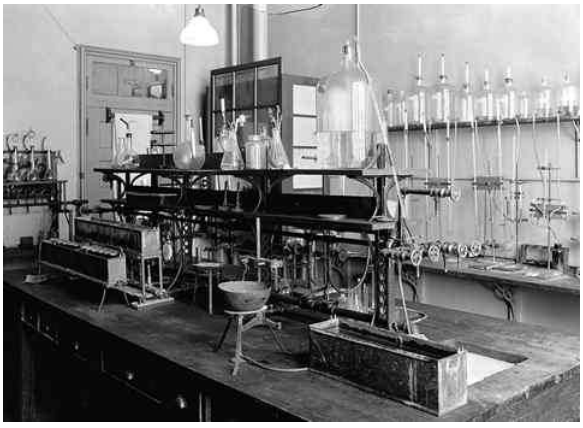


Leonard Thompson (1908 - 1935)

Diagnosed 1919. First patient to be treated with insulin in 1921

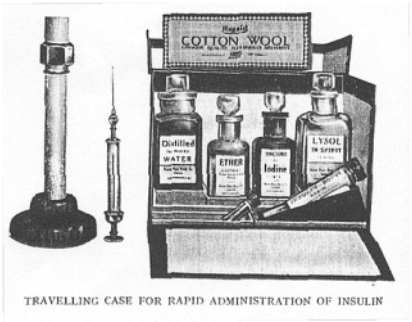


Connaught laboratory - University of Toronto



Early insulin kit!

Fig. 20.—An Ever Aseptic Syringe. (From Eli, Lilly and Co.)

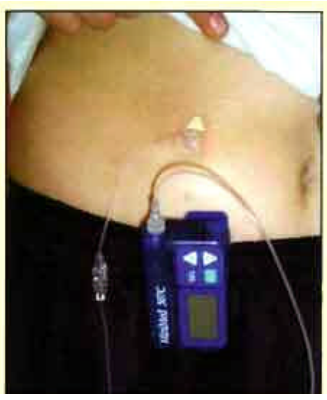


TRAVELLING CASE FOR RAPID ADMINISTRATION OF INSULIN

Insulin pump therapy

CSII or Continuous Subcutaneous Insulin Infusion

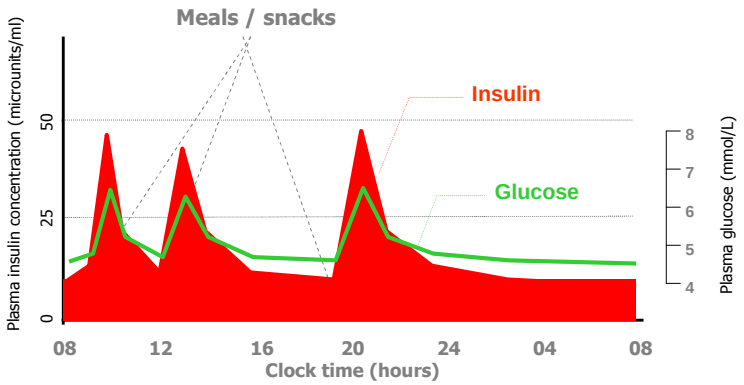
Indiana 1963. The first insulin pump



A now out-dated insulin pump!

Insulin secretion in normal physiology

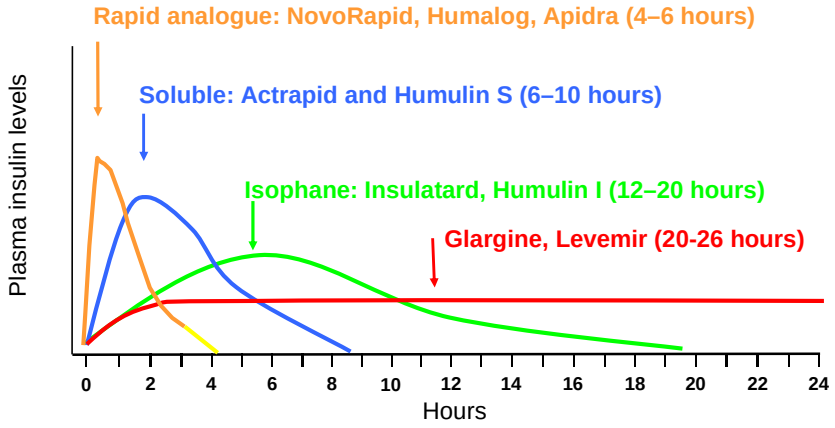
Profiles of plasma glucose and insulin concentrations in non-diabetic individuals.



In normal subjects, blood glucose concentrations are maintained within relatively narrow limits at around 5 – 7 mmols/L. By the balance between glucose entry into the circulation from the liver and from intestinal absorption and glucose uptake into the peripheral tissues such as muscle and adipose tissue. Insulin is secreted at a low basal level, with increased, stimulated levels at meal times.

Williams G, Pickup J (2006) Handbook of Diabetes. Blackwell Science

Profiles of Human & Analogue Insulins



Adapted from: Balance Guide to Testing & Treating (2007) Balance, Jan / Feb. Diabetes UK: London

Insulin in Type 2 Diabetes

Insulin in Type 2 Diabetes

- 25-30% of people with T2DM will require insulin therapy

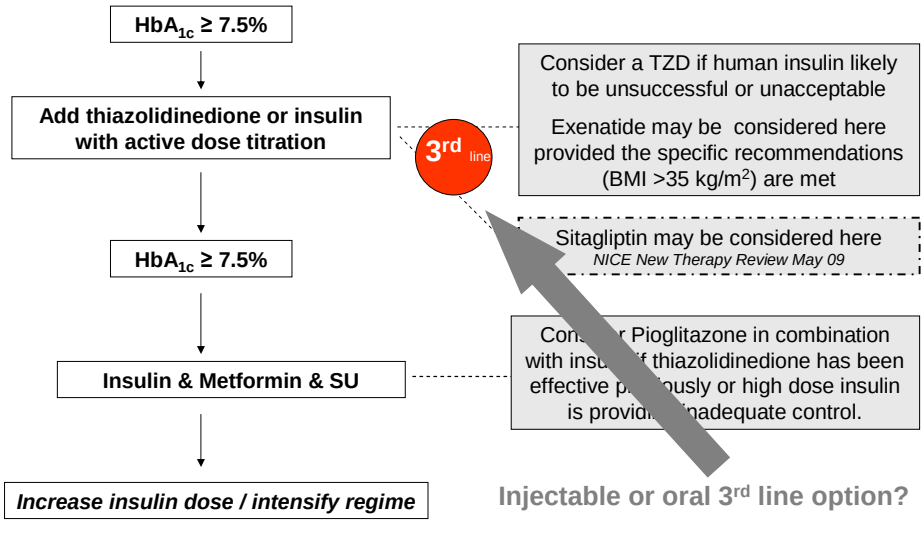
  Mayfield, 2004 American Family Physician Aug.
- Insulin resistance and beta cell dysfunction mean that T2DM is progressive.
- Around 50% of beta cell output is lost by time of diagnosis of T2DM.
- Mean duration from diagnosis to insulin is 7 years (although large range).
- Increasingly insulin management in T2DM is the remit of primary care.
- Principle of once or twice daily insulin treatment is straight-forward although there are some important principles to follow.

Other injectable therapies

- Insulin receptor agonists (GLP1's) are also becoming well established as (usually) 3rd line alternatives to insulin or oral hypoglycaemic agents.
- In certain circumstances 2nf line glucose lowering options.
- Initiation of these is slowly but steadily being rolled out to Primary Care.
- Byetta (10mcg twice daily), Liraglutide (1.2 mg once daily), Bydureon 2mg (once weekly).
- See BNF / SmPC for dosing and prescribing information.

Glucose lowering in T2DM

NICE Guidance (2009 & 2010)



Trypanophobia ?

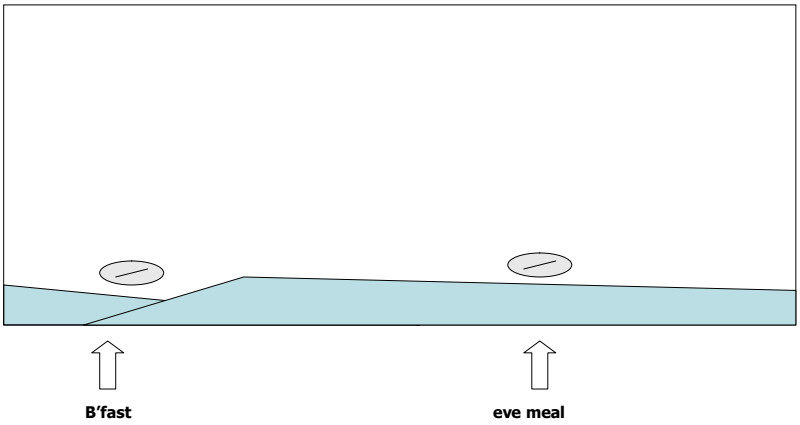
… Fear of the needle

- What perceptions of injecting do patients with diabetes have?
- A ‘dummy’ injection with take 2 minutes in the clinic room

- … but will dramatically alter most patients perception of moving onto injectable therapy.

Replacing insulin secretion

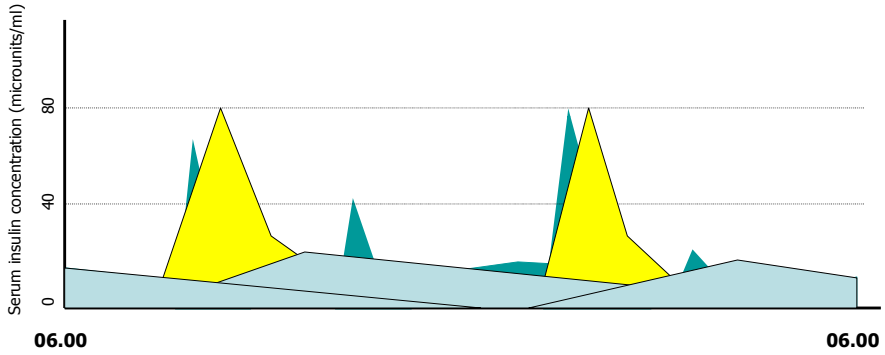
Basal only insulin regimes



Glargine or Levemir *(Analogues)* Insulatard or Humulin I *(Isophanes)*

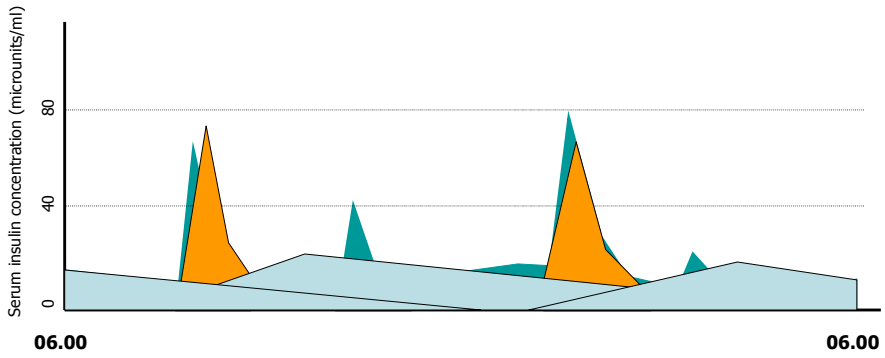
Replacing insulin secretion

Conventional twice daily soluble mix:
Humulin M3 / Insuman Com 25



Replacing insulin secretion

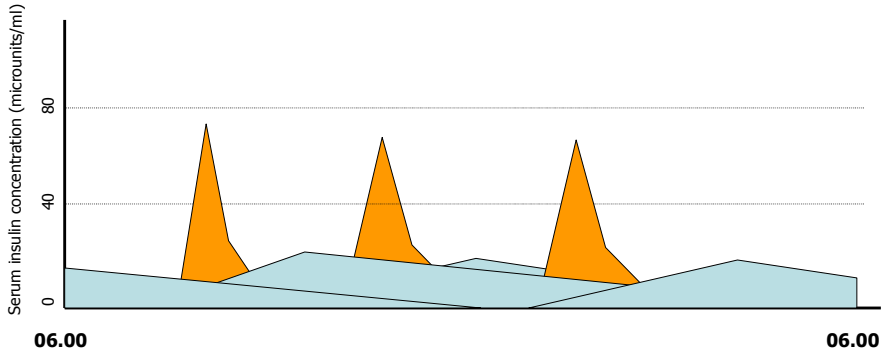
Twice daily analogue mix:
Novomix 30 or Humalog Mix 25



Adapted from: Balance Guide to Testing & Treating (2007) Balance, Jan / Feb. Diabetes UK: London

TDS Mixed insulin

For high dose, very insulin resistant patients *(less commonly*) three times daily analogue mix:
Novomix 30 or Humalog Mix 25 or Humalog Mix 50



Garber AJ, Wahlen J, Wahl T et al. Attainment of glycaemic goals in type 2 diabetes with once, twice, or thrice-daily dosing with biphasic insulin aspart 70/30 (The 1-2-3 study). Diabetes Obes Metab. 2006 Jan;8(1):58-66

Match insulin type with group 1

- Humulin M3

A/ Short acting (soluble) insulin

B/ Short acting / Isophane mix

C/ Analogue mix

D/ Long-acting isophane

Match insulin type with group 2

- NovoMix 30

A/ Short acting (soluble) insulin

B/ Short acting / Isophane mix

C/ Analogue mix

D/ Long-acting isophane

Match insulin type with group 3

- Porcine Neutral

A/ Short acting (soluble) insulin

B/ Short acting animal insulin

C/ Short acting analogue

D/ Long-acting isophane

Match insulin type with group 4

- Levemir (Detemir)

A/ Basal analogue insulin

B/ Short acting animal insulin

C/ Short acting analogue

D/ Long-acting isophane

Match insulin type with group [5]

- Humalog Mix 50

A/ Soluble mix

B/ Analogue mix

C/ Long acting analogue

D/ Long-acting isophane

Insulin choices - Summary

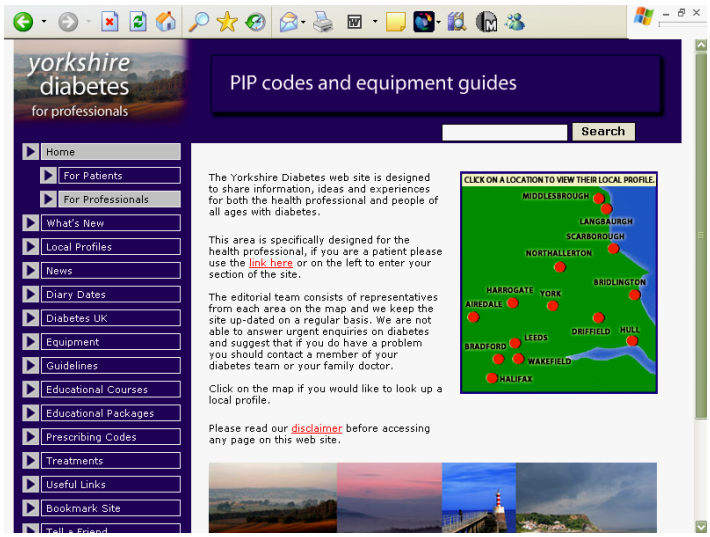
- There are many insulin types – but in Type 2 Diabetes – 3 main choices:
- Soluble mix, given 20-30 minutes before eating: Humulin M3 or Insuman Comb 25.
- Analogue mix, given immediately before (or after) eating: Humalog Mix 25, NovoMix 30.
- Once daily Glargine or Levemir or isophanes Humulin I or Insulatard.

Insulin delivery systems

Insulin Delivery Systems

- Numerous insulin delivery systems currently available in the United Kingdom.
- Choice of insulin device is mainly determined by:
- Patient usability bearing in mind any visual or dexterity issue. Choice should ideally be determined by the patient themselves.
- Availability of device.
- Preference for a particular insulin type or manufacturer, hence determining certain device or devices.
- The following website gives details of all insulin delivery systems in use in the UK and their compatibility with presently available insulins.

www.yorkshirediabetes.com



Insulin adjustment principles

Insulin Adjustment Principles

- The following ‘chart’ illustrates blood glucose readings for an insulin treated patient.
- Briefly scan the whole page: what overall pattern is occurring?
- Look down the individual columns, what is happening at different times of the day?
- Read the information given about the patient concerned.

	Before b'fast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Sat 5th			13.8		15.5		14.6	
Sun 6th	14.2		7.1		5.4			Gardening most of day
Mon 7th	9.6							
Tues 8th	16.9				15.1		13.6	
Wed 9th	14.7				18.2			
Thur 10th								
Fri 11th	15.0		12.9		14.3		17.1	

Started on b.d. NovoMix 30. 16 // 10 units, 6 weeks ago. What guidance can you give him on adjusting his own insulin doses.

Continued next slide

Insulin Adjustment Principles

- Read the ‘comments’ if any.
- How do comments relate to blood glucose levels on the associated day (or perhaps the day afterwards)?
- What action if any do you think needs to take place?
- If suggesting an alteration to insulin dose, work through that proposed adjustment … what will the change achieve?

	Before b'fast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Sat 5th			13.8		15.5		14.6	
Sun 6th	14.2		7.1		5.4			Gardening most of day
Mon 7th	9.6							
Tues 8th	16.9				15.1		13.6	
Wed 9th	14.7				18.2			
Thur 10th								
Fri 11th	15.0		12.9		14.3		17.1	
Started on b.d. NovoMix 30. 16 // 10 units, 6 weeks ago. What guidance can you give him on adjusting his own insulin doses.								

Continued next slide

Insulin Adjustment Principles

- Will there be any ‘knock on effects’ from what you are suggesting?
- Generally insulin increases to address higher blood glucose levels are undertaken as 10% increases, perhaps weekly.
- Insulin reduction to prevent hypoglycaemia episodes is usually undertaken by slight larger percentage reductions of perhaps 20%.

	Before b'fast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Sat 5th			13.8		15.5		14.6	
Sun 6th	14.2		7.1		5.4			Gardening most of day
Mon 7th	9.6							
Tues 8th	16.9				15.1		13.6	
Wed 9th	14.7				18.2			
Thur 10th								
Fri 11th	15.0		12.9		14.3		17.1	
Started on b.d. NovoMix 30. 16 // 10 units, 6 weeks ago. What guidance can you give him on adjusting his own insulin doses.								

Insulin adjustment principles

Examples

David – 54. T2DM for 6 years

	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Sat 5th			13.8		15.5		14.6	
Sun 6th	14.2		7.1		5.4			Gardening most of day
Mon 7th	9.6							
Tues 8th	16.9				15.1		13.6	
Wed 9th	14.7				18.2			
Thurs 10th								
Fri 11th	15.0		12.9		14.3		17.1	
Started on b.d. NovoMix 30. 16 // 10 units, 6 weeks ago. What guidance can you give him on adjusting his own insulin doses.								

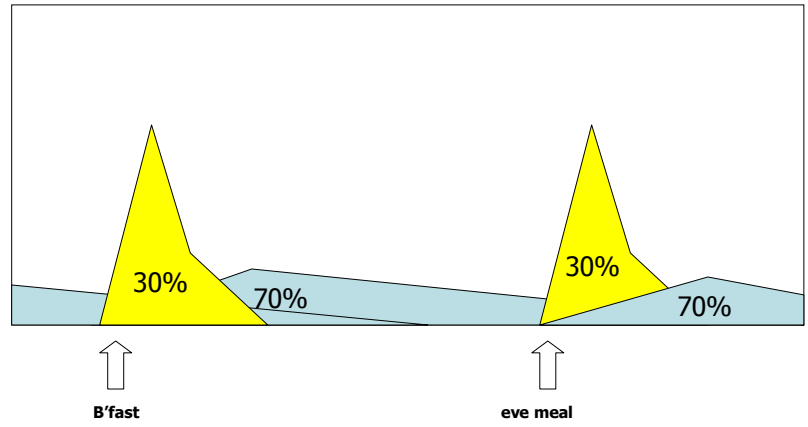
David - Summary

- New to insulin – looks like he steadily needs to increase insulin doses
- Ideally should be starting to adjust his own insulin now.
- Blood sugars generally 'high' - needs to increase both insulin doses by 2 units or 10%. 2 units on a weekly or twice weekly basis if often regarded as easier by patients
- On gardening or other sustained physically active days needs to reduce morning insulin dose by possibly 25% or eat more or if very active, possibly both. He will know if this works by his home blood tests.
- If overweight may be better to reduce morning insulin or at least to think of eating more as mid-morning and mid-afternoon fruit.

Jane – 66. T1DM for 48 years

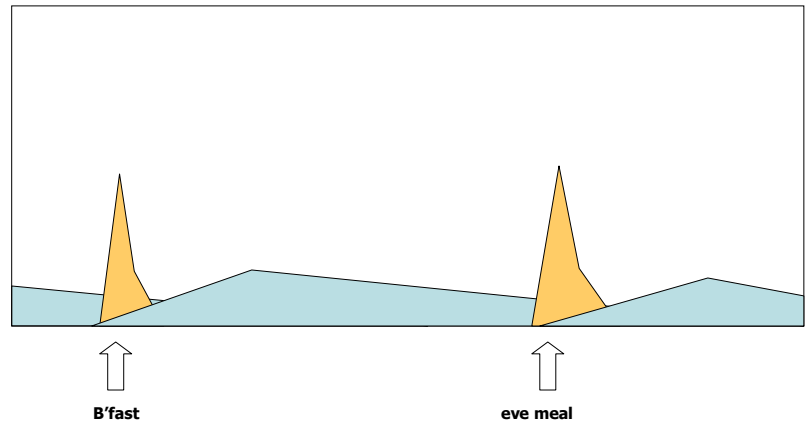
	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Mon 7th	5.0							Hypo 01:00
Tues 8th	17.2						3.9	
Wed 9th	4.4		7.6					
Thurs 10th	5.8							
Fri 11th	6.1							Hypo around midnight
Sat 12th	13.3		8.4		5.5		5.3	Woke hypo @ 01:50
Sun 13th	18.1						7.4	
On twice daily Humulin M3, 34 units a.m. 26 units p.m. HbA_{1c} 8.6% (71 mmol/mol). Proliferative retinopathy. Problem with night-time hypoglycaemia occasionally requiring paramedics. Lives with partner								

Twice daily biphasic soluble insulin



Humulin M3

Analogue insulin regimes – usually twice daily



NovoMix 30 or Humalog Mix 25

Jane - Summary

- Night-time hypo's really on quite a regular basis.
- Night hypo's can tend to pre-dispose to further night-hypo's.
- Can be scary for patient and partner although rarely cause actual harm.
- Encourage pre-bed snack if not already take and reduce evening insulin by 20%.
- She may need to slowly re-increase evening insulin dose according to blood glucose levels.
- May be better on a shorter analogue mix such as NovoMix 30 or Humalog Mix 25.
- Husband should be trained in GlucoGel and Glucagon use, latter if willing.
- Seek specialist advice if hypoglycaemia does not resolve.

Hypoglycaemia management

1st line: Rapid acting carbohydrate

Initially glucose 10-20g given by mouth.

Approximately 10g of glucose is available from 2 teaspoons of sugar, 3 sugar lumps, 50-55 ml Lucozade®, 90 ml Coke®, Ribena® 15ml (neat, to be diluted).

If necessary this should be repeated in 10-15 minutes*.

The insulin treated person **MUST BE PREPARED** at all times with hypoglycaemia treatment readily to-hand.

Note: all the above work quickly but STOP WORKING quickly so should be followed up as soon as possible with a carbohydrate snack or next meal is that is due.

** British National Formulary (BNF) vol. 51 2006*

Glycaemic Index and Hypo Treatment

Type of food	Glycaemic Index		Measure providing 20g CHO
Apple juice from concentrate	40 ± 1		1 x 200ml carton
Banana	52 ± 4		$^{2}/_{3}$ of 120g bag
Bassett's Jelly babies	78 ± 2		4 Jelly Babies
Bassett's Liquorice Allsorts	78 ± 1		5 sweets
Coca Cola	58 ± 5		$^{1}/_{3}$ of 500 ml bottle
Dextrosol Glucose tablets	103		7 tablets
Lucozade Original	95 ± 10		$^{1}/_{3}$ of 380 ml bottle
Mars Bar	65 ± 3		½ a 62.5 g bar
McVities Digestive Biscuits	59 ± 2		2 biscuits
Orange juice from concentrate	46 ± 2		¾ of a 200ml carton
Potato Crisps	54 ± 3		1.15 packets
Ribena	66 ± 8		½ a 288ml carton

GI ≥70 = High **56-69 = Medium** **≤ 55 = Low**

Adapted from: Practical Diabetes International (2006) vol23: 5

Hypoglycaemia management

2nd line: Rapid acting carbohydrate

GLUCOGEL©, Formerly known as '*Hypostop*'

Available in triple pack of tubes, each containing 10g of glucose or an 80g bottle containing 32g glucose.

For oral oral use only.

NOT to be given to unconscious individuals*.

Note: GLUCOGEL© works quickly but STOP WORKING quickly so should be followed up as soon as possible with a carbohydrate snack or next meal is that is due.

** Taken from drug information insert for GlucoGel. Manufactured by BBI Healthcare, Swansea*

Hypoglycaemia management

1st or 2nd line: Rapid and carbohydrate

HYPO-FIT® syrup 74.5% is a premium product, which is a unique combination of three sugars – glucose, sucrose and fructose – water and flavouring (mint, orange and tropical). e in triple pack of tubes, each containing 10g of glucose or an 80g bottle containing 32g glucose.

Available of NHS drugs tariff (12 x 18 gr sachets)

GI of sugars varies from:

100 Glucose, 60 Sucrose, 20 Fructose

For oral oral use only.

NOT to be given to unconscious individuals*.

** Taken from www.Arctic Medical.co.uk – manufactures of HypoFit*

Hypoglycaemia management

3rd line: Glucagon injection

GLUCAGON, a polypeptide hormone produced from alpha cells of the Islets of Langerhans increases plasma-glucose concentrations by mobilising glycogen stored in the liver.

Administered if glucose can not be given by mouth.

Carbohydrates should be given as soon as patient recovered to restore liver glycogen*.

May be issued to close relatives of insulin treated patients particularly if prior severe hypo episode. Training clearly being necessary and advise to call 999 for paramedic assistance regardless.

NOTE: Severe hypoglycaemia should be investigated by specialist diabetes service in order to uncover underlying reason and aim at future prevention.

** British National Formulary (BNF) vol. 51 2006*

Quiz

Appropriate management of recurrent hypo is to:

A. Keep calm and carry on.

B. Encourage better self-management of hypo episode.

C. Encourage self management of hypo, look for underlying causes, consider reduction to insulin and or increased carbohydrate intake.

D.Simply refer to secondary care specialist diabetes team.

Treating Impaired Awareness of Hypoglycaemia

- Frequent blood glucose monitoring (including nocturnal measurements)
- Avoid blood glucose values <4.0mmols
- Set target range of blood glucose higher than for "aware" patients (e.g.pre-prandial between 6.0 and 12.0 mmols/l; bed-time > 8.0 mmols/l).
- Avoid HbA_{1c} in non-diabetic range.
- Use predominantly short acting insulins (e.g. basal bolus regimen; insulin analogues).
- Consume regular snacks between meals & at bed-time, containing lower GI carbohydrate.
- Investigate other endocrine causes

Refer secondary care diabetes service

Frier M, Fisher B. (1999) Hypoglycaemia in Clinical Diabetes. Wiley: Chichester.

Clara – recently started Glargine od

	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Sun 14th	12.7							
Mon 15th	13.1							
Tues 16th	10.2							
Wed 17th	11.8							
Thurs 18th	15.2							
Fri 19th	10.6							
Sat 20th	13.3							
Presently taking 12 units Glargine pre-bed. Most recent HbA1c pre-insulin 8.9%								

Clara - Summary

- On once daily Glargine (could otherwise be Levemir)
- Blood results consistently raised.
- Clearly needs to increase insulin dose and repeat on regular basis.
- Most would advocate increasing every 3 days if fasting blood sugars >10 mmols/L
- Needs to watch she is not running higher later in day

Carl – 40. T1DM for 27 years

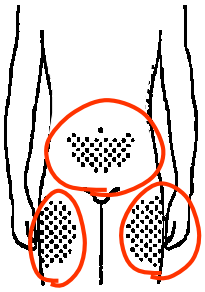
	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Sun 3rd	4.3		8.9		16.1			
Mon 4th	13.8		4.5		5.7			
Tues 5th	9.6						12.2	
Wed 6th	15.5		14.9		12.5		10.0	
Thurs 7th	3.7		3.1		14.2			
Fri 8th	11.0		hypo		8.6		10.3	
Sat 9th	15.1		16.4		17.2		11.6	
NovoMix 30 26 units a.m. 22 units p.m. Erratic blood sugars! Occasional unpredictable hypo's. Steady, predictable lifestyle – office job.								

Lipohypertrophy

- Repeated injection into the same subcutaneous site may in the long-term give rise to an accumulation of fat (lipohypertrophy) because of the trophic action of insulin.
- Lipo's 'can be unsightly and can dramatically increase the variability of insulin absorption.
- These sites may become painless – so being favoured even more by the patient*.
- If advising new, undamaged sites, a significant reduction to insulin dose of perhaps 30% should be made for these new sites – seek specialist advice regarding this before taking action.

** Williams G, Pickup JC (2006) Handbook of Diabetes. Blackwell: London*

Insulin injection sites



- Recommended sites for subcutaneous injection: tissue of lower abdomen, upper outer thighs, upper outer arms & buttocks.*
- More recently, advice appears to have altered to encouragement of legs and abdomen due to ease of injection and less likelihood of inadvertently performing an intra-muscular injection
- Males may struggle to use thighs due to lack of subcutaneous fat.
- Rotate well **within** sites. Injection sites should be examined yearly for damage at annual review.
- Needle length, 4, 5, 6 mm to 8mm max

** Williams G, Pickup JC (2006) Handbook of Diabetes. Blackwell: London*

Carl - Summary

- Could be many reasons for his erratic blood glucose control but he has a steady job and predictable lifestyle so it is fairly unusual to experience such erratic blood glucose readings.
- Could be alcohol or activity related but he has had his diabetes for 27 years so you must exclude over-used injection sites.
- The clue for this is often erratic pre-breakfast readings. These if anything should usually be the most stable of the day.
- Check injection sites. If overused he must be advised on alternate sites and advised to make dramatic reduction of insulin due to much better absorption of insulin from new sites if existing sites very over-used.
- Needs to blood glucose monitor very closely over next few days, be prepared for hypo's and adjust insulin doses according to patterns of blood glucose after the switch to new sites.
- If not happy to offer this advice, advise to continue with present insulin and present sites but phone for guidance from specialist diabetes service and / or urgent appointment to given him guidance

James (74) – on bd NovoMix30

	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Sun 4th								
Mon 5th	15.2							
Tues 6th					9.6			
Wed 7th							3.1	
Thurs 8th	17.4							
Fri 9th								
Sat 10th								
Feels unwell – thinks it might be his diabetes. Recent nocturia x3-4 Doses: 46 units a.m. 14 units p.m.								

James - Summary

- Simply not enough information to go on.
- Main message here was, however often patients choose to test their blood glucose levels, clearly if they sense something is wrong, increasing blood glucose monitoring to perhaps 3 or 4 times daily for a few days and importantly adding in comments as to any symptoms, changes in lifestyle, worries etc can be invaluable in ruling diabetes on or out as possible causes.
- Needs to return in a week or two following close monitoring and recording of blood glucose and adding in 'comments' on variations from his 'normal' day.

Vera – 68.

	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Fri 14th	8.6		10.4		19.2		12.8	
Sat 15th								
Sun 16th	7.7		12.2		18.6		10.9	
Mon 17th								
Tues 18th	8.1		13.6		17.9		13.2	
Wed 19th								
Thurs 20th	8.8	11.4			16.8		13.9	
On twice daily Human M3. Recently started Prednisolone for PMR. Plan to remain on this for several weeks. Feels unwell.								

Vera - Summary

- Recently started on Prednisolone and this appear to have a dramatic effect on her blood glucose levels.
- Typically, if steroids are taken in the morning, as is usual practice,. Blood glucose levels tend to dramatically increase during the day, settling down again by the following morning.
- Easiest option is to keep on increasing her morning dose of insulin every 2 – 3 days to start to pin down rising blood glucose levels later in the day.
- Remember you are not aiming for perfect glucose control, but to pin down blood glucose to possibly under 12 or 14 mmols/l
- She MAY need a more aggressive 50 / 50% mix of insulin in the morning if above advice does not work but in this case, seek specialist advice.
- MUST reduce insulin doses steadily as steroids treatment is reduced.
- She needs to glucose monitor closely and will, need close (probably over the 'phone) support regarding insulin doses.

Tom – T2DM – 64 years

	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Wed 12th	9.3				14.8			
Thurs 13th	6.5							
Fri 14th	8.6					12.2		
Sat 15th	8.8		14.1					
Sun 16th	9.1							
Mon 17th	7.9				15.9			
Tues 18th					13.6			
Commenced o.d. Glargine 2 years ago.HbA_{1c} then 7.6% now 8.9%. Currently on 34 units pre-bed. Also on Metformin 1 gr b.d. and Gliclazide 160mg b.d.								

Tom - Summary

- Glargine, which perhaps had been working well does not now appear to be controlling blood glucose levels later in the day.
- Could look at lifestyle, whether his diet has slipped on activity reduced but it is more likely to be an effect of steadily deteriorating beta cell function and subsequent rising blood glucose values.
- You could add in rapid acting insulin to prevent meal time rises of blood glucose but it may be preferable to convert him to a twice daily mixture of insulin.
- So, his present 34 units once daily of long acting Glargine might be converted to a 30% / 70% (M3, Mixtard 30 or NovoMix 30) insulin or 25% / 75% (Humalog Mix 25) insulin.
- Doses would be a split of his current 34 units but with a slightly higher dose I the morning:
- 20 units a.m., 14 units p.m.

Rajesh - T2DM - 53 year of age

	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Mon 17th	14.2				13.2	19.1		
Tues 18th			13.8					
Wed 19th	9.6	16.0			12.4			
Thurs 20th	11.4	18.2				17.7		
Fri 21st					9.9			
Sat 22nd	10.6				10.8	16.4		
Sun 23rd		17.7						
On bd Humalog Mix 25, 96 units a.m. 84 units p.m. HbA_{1c} 9.5% (80.5mmol/mol) and slowly rising. BMI 46.2 mg/m2 (45.0kg/m^2 July 2009). Also on Metformin 500mg bd and Gliclazide 160mg b.d.								

Case Study Discussion

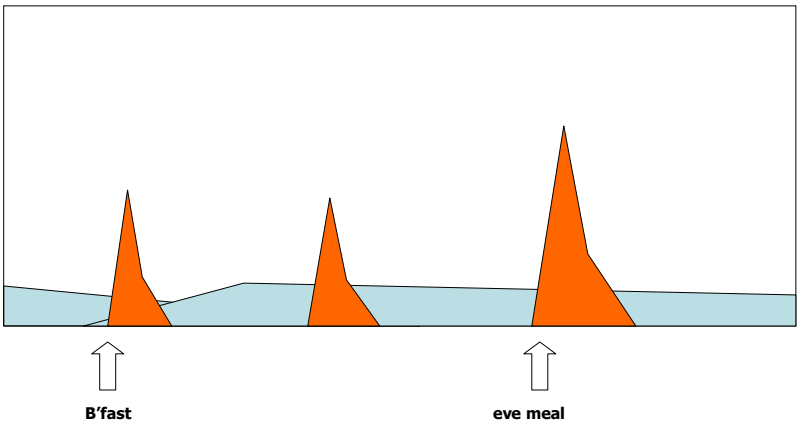
- Blood glucose levels 'jumping' post prandially for breakfast and lunch.
- On 25/75 mix i.e. 25% rapid, 75% long-acting. Needs more rapid acting to cover breakfast and evening meal so switch to 50/50 mix: Humalog Mix 50.
- I would reduce doses by 20% when doing this so: Humalog Mix 50 75 units a.m. 68 units p.m.
- Increase Metformin to optimal 1gr bd using Glucophage SR if GI intolerance. Stop Gliclazide.
- Ask to test ++ for week or so afterwards and titrate up insulin according to BG profiles.
- Empower to self-adjust if possible.

Steve – 31. T1DM. Builder

	Before breakfast	2 hours after b'fast	Before lunch	2 hours after lunch	Before eve meal	2 hours after eve meal	Before bed	Comment
Wed 11h					14.4			
Thurs 12th			3.7					
Fri 13th	10.4					8.2	15.9	
Sat 14th	12.6							
Sun 15th			15.1					
Mon 16th	14.1				4.2			
Tue 17th	11.2				18.2			
On twice daily Humulin M3 42 // 34. HbA_{1c}'s generally run between 9 and 10%. Wants to try and take charge of his diabetes. Finds present insulin inflexible.								

Multiple Injection Therapy (MIT)

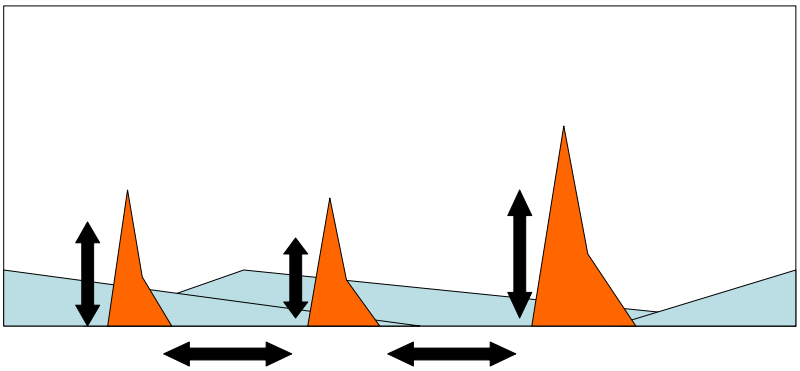
With rapid and long-acting analogues



Glargine or Levemir with Humalog, NovoRapid or Apidra

MIT

Only as flexible as you make it



Steve - Summary

- Seems keen to take control of his diabetes.
- Discuss possible benefits of switching to a 4 or 5 a day multiple injection therapy (MIT) regime, also termed Basal Bolus.
- This will give him much more flexibility to vary timing of his meal-time injections according to how much and when he is eating, and possibly including larger snacks and vary his insulin doses according to his activity.
- Clearly he will need to blood glucose monitor frequently and become adept at adjusting his own insulin.
- If his background (basal) insulin is split between morning and evening, this will also give him the flexibility to alter the morning doses of long-acting basal according to how busy he believes he is going to be during the day.

Steve - Summary

- This is a fairly complex transition and needs expert guidance so for most health professional in general practice it will be a case of having the discuss in surgery as to the dramatically increased flexibility he will gain from an MIT regime and then referring on to secondary care diabetes service.
- Nevertheless there is no reason why this initial conversion can not happen in the confident, experienced GP practice.

A note on HbA_{1c} …

How does the long-term diabetes test (HbA_{1c}) relate to home blood glucose levels?

HbA_{1c} (%) *IFCC figures in grey*	Average blood glucose (mmols/L) *Note: Range might be greater or smaller*	What does this mean?
4 *(20)*	3.0 - 4.0	Normal HbA_{1c} in a person without diabetes
5 *(31)*	5.0 - 6.0	
6 *(42)*	6.5 – 8.5	On target in diabetes. This level of HbA1c will minimise your risk of diabetes complications or help stabilise any complications if you already have them.
7 *(53)*	7.5 – 11.5	
8 *(64)*	9.5 – 13.5	This may be slightly raised, you may want to look at your diet and levels of activity
9 *(75)*	11.5 – 15.5	High, this level of HbA_{1c} increases your risk of diabetes complications.
10 *(86)*	13.5 – 17.5	Very high this puts you at high risk of diabetes complications. You must discuss this with your health professional to find out ways of tightening your diabetes control.
11 *(97)*	15.5 – 19.5	
12 *(108)*	17.5 – 21.5	

Comments extrapolated from evidence from United Kingdom Prospective Diabetes Study (UKPDS 33). Lancet 1998;352:837–853.

Quiz

- How do the following HbA_{1c} values convert from % to mmols/mol: 7%, 9% and 10.5%

A.53.0, 70.0 and 91.5 mmol/mol

B.53.0, 75.0 and 91.5 mmol/mol

C.70.0, 90.0 and 105.0 mmols/mol

D.53.0, 75.0 and 86 mmols/mol

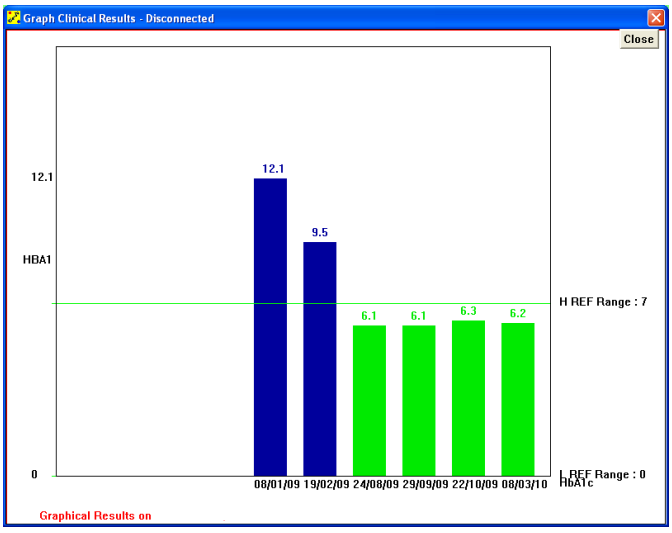
Determining target HbA_{1c} in insulin (sulphonylurea) treated patients

Younger age	Older age (?)
Planning pregnancy or pregnant	Frailty / confusion / previous falls
Advanced and deteriorating microvascular disease	No evidence of severe and / or deteriorating microvascular disease
Non-hazardous occupations	Hazardous occupations
Good hypo warning signs	Poor hypo warning signs / hypo unawareness
Lack of preceding severe hypoglycaemia	Preceding severe hypoglycaemia
Favours tighter glycaemic control	**Favours more relaxed glycaemic control**

Lower ---------- HbA_{1c} 7.5% ---------- Higher

80 year old chap – frail – very unsteady on feet

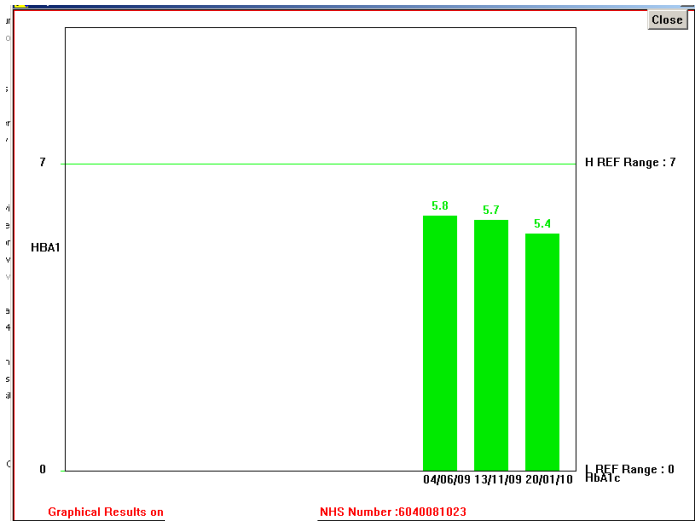
Currently in hospital. BG levels 4 – 6 mmols/L Frequent hypo's whilst in



86 year old gent on twice daily insulin

36 units a.m. 26 units p.m.

Regular hypoglycaemia and currently in hospital severe hypo!

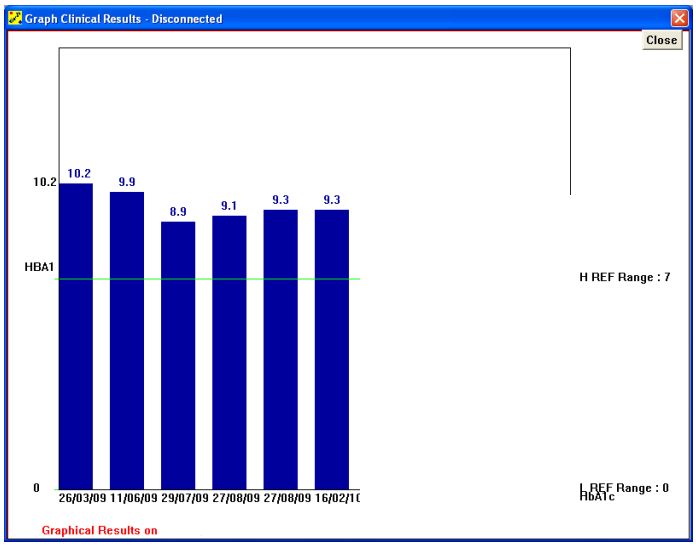


DMMAX

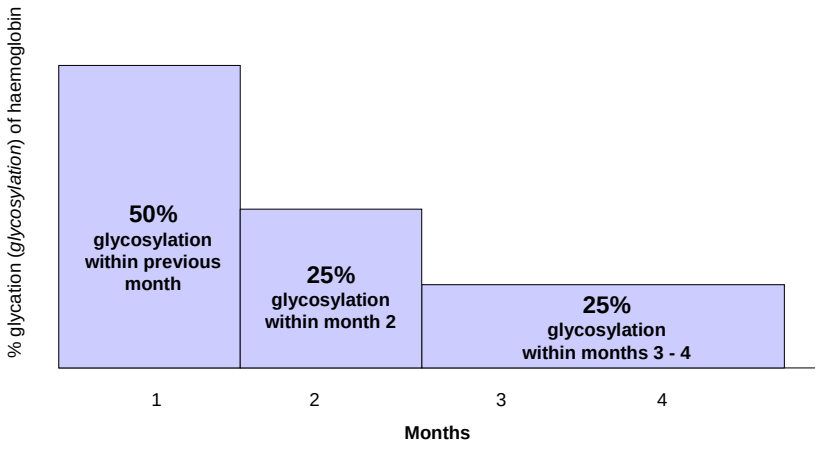
Diabetes Maximum Tolerated Treatment

QOF code XaJ5J

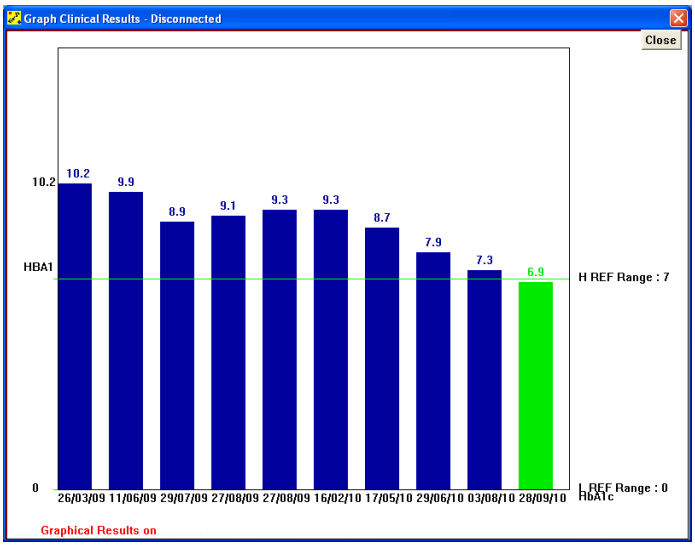
Regular follow-up, education & support and frequent feedback from HbA_{1c}



Supporting behaviour change by close HbA_{1c} measurement



Regular follow-up, education & support and frequent feedback from HbA_{1c}



Quiz

How would you describe strategies for glucose lowering in Type 2 Diabetes?

A.Tight glucose control matters above all else

B. Don't go below HbA_{1c} of 8.0% in those with CVD

C. Individualise HbA_{1c} targets especially in those at high CV risk but aim for HbA_{1c} of <6.5%

D. Lower HbA_{1c} slowly, as far as possible avoiding hypoglycaemia and to individualised targets.

Other insulin related issues

Driving and hypoglycaemia

Progressive hypoglycemia's impact on driving simulation performance. Occurrence, awareness, and correction

Variable	Blood glucose level (mmol/l)		
	4.0 - 3.4	3.3 – 2.8	<2.8
Composite driving impairment score	0.83a	1.83b	1.52
Subjects who detected hypoglycaemia (%)	15	33	79
Subjects who took corrective action (%)	5	3	22

[a] $p<0.01$ [b] $p<0.005$

Cox D (2000) Diabetes Care; 23(2): 163–70.

- An illustration of the dangers of hypoglycaemia whilst driving came form this controlled (driving simulator) experiment.
- Subjects were slowly taken into varying degrees of controlled hypoglycaemia and required to take pre-defined 'appropriate corrective action'.
- The figures opposite show the vast majority did not do so.

DVLA, Diabetes & Driving 2011

Changes to the standards for driving Group 2 vehicles (buses and lorries).

- From October 2011, to be able to apply for entitlement to drive Group 2 vehicles, applicants will have to meet the following standards when treated with insulin. When treated with medication other than insulin which carries a risk of inducing hypoglycaemia (including sulphonylureas and glinides), the following standards have applied since September 2010.
- There has not been any severe hypoglycaemic event in the previous 12 months
- The driver has full hypoglycaemic awareness

http://www.dft.gov.uk/dva/medical/Annex%203%20changes%20to%20diabetes.aspx?keywords=diabetes accessed 20/09/11

DVLA, Diabetes & Driving 2011

Changes to the standards for driving Group 2 vehicles (buses and lorries).

- The driver must show adequate control of the condition by regular blood glucose monitoring, at least twice daily and at times relevant to driving*
- The driver must demonstrate an understanding of the risks of hypoglycaemia and
- There are no other debarring complications of diabetes
- Applicants with insulin-treated diabetes will need to have used blood glucose meters **with a memory function** to measure and record blood glucose levels for at least three months prior to submitting their application.
- Will also need to meet the Group 2 standards for all the other medical conditions from which they suffer.

http://www.dft.gov.uk/dva/medical/Annex%203%20changes%20to%20diabetes.aspx?keywords=diabetes accessed 20/09/11

DVLA, Diabetes & Driving 2011

Changes to the standards for driving Group 1 vehicles (cars and motorcycles)

- The following changes introduced by the European Union have applied since September 2010:
- Must not have had more than one episode of severe hypoglycaemia within the preceding 12 months
- Must not have impaired awareness of hypoglycaemia which has been defined by the Diabetes Panel for Group 1 vehicles as "an inability to detect the onset of hypoglycaemia because of a total absence of warning symptoms"

http://www.dft.gov.uk/dva/medical/Annex%203%20changes%20to%20diabetes.aspx?keywords=diabetes accessed 20/09/11

Driving: Hypo avoidance & Management

- Always keep an emergency supply of fast-acting carbohydrate within reach in the vehicle.
- Carry your blood glucose meter / strips with you.
- Check blood glucose before driving (even on short journeys) and test regularly (every 2 hours) on long journeys.
- If blood glucose is 5.0mmol/l or less, take a snack before driving.
- Take regular meals, snacks and rest periods on long journeys.
- Avoid alcohol.
- DO NOT DRIVE if feel hypoglycaemic or blood glucose is less than 4.0 mmol/l.
- If hypoglycaemia while driving stop vehicle immediately in a suitable location, switch off the engine.
- Remove the keys from the ignition and vacate the driving seat.
- Do not resume driving until 45 minutes **after** blood glucose has returned to normal (it takes this time for the brain to fully recover).

http://www.diabetes.highland.scot.nhs.uk/Guidelines/12-Hypoglycaemia/12_7.htm Accessed 11 May 2009

Driving: Hypo avoidance & Management

- Carry personal identification indicating that you have diabetes in case of injury in a road traffic accident.
- Be particularly careful and not drive if insulin regimen has just changed or if taking insulin for the first time.
- If trying to tighten blood glucose control, have changed physical activity or are pregnant monitor blood glucose very carefully, extra care should be taken when driving.
- If a disabling attack of hypoglycaemia occurs during waking hours the DVLA **MUST** be informed
- If warning symptoms of hypoglycaemia are lost do **not** drive until advised by diabetes specialist, and if loss of warning symptoms persist then inform the DVLA.

http://www.diabetes-highland.scot.nhs.uk/Guidelines/4-Hypoglycaemia/12_7.htm Accessed 11 May 2009

Managing Illness 'Sick Day Rules'

- During illness '*never stop your insulin*!!'
- Test blood sugar more regularly – at least 4 times daily.
- If Type 1, test blood or urine for ketones especially if previous DKA.
- Increase insulin every day or 2 days: If blood sugars over 13 mmols; if a clear pattern of hyperglycaemia is seen; if illness expected to continue.
- If feeling sick, **sip** on sugary fluids.
- Keep hydrated on non-sugary drinks.
- If vomiting administer anti-emetic (home visit).
- In T1DM, if vomiting does not settle – arrange admission.

Exercise and Hypo's

- Many people under-estimate the effect of increased activity and the risk of hypoglycaemia.
- Anecdotally, shopping appears to be the leading cause of hypo in relation to activity.
- Avoidance of hypoglycaemia:
- Insulin reduction of 25-30% prior to prolonged, planned increased activity and / or increase carbohydrate intake.
- Increase carbohydrate intake for unexpected / unplanned activity if insulin already taken.
- Glucose testing pre-post activity – note effect of exercise on hypo risk can be prolonged.
- Exercise diary until fine-tuned?
- Diabetes & Sports website www.runsweet.com

Summary – a few insulin tips [1]

- There are principles with insulin but few 'rules'.
- Its about good detective work.
- Comments can be as valuable as readings … if detective work fails to gain clear picture, consider sending patient away to return with comments and their own detective work.
- In general, increase insulin by 10% reduce for hypo prevention by 20%
- Work through your proposed actions to look for any knock on effect.

Summary – a few insulin tips [2]

- With any change in dose or insulin type, encourage patient to test more often and to be extra aware and prepared for hypoglycaemia.
- Individualise the HbA_{1c} target - one size QOF does not fit all.
- As a rule of thumb, in older folk, do not treat HbA_{1c} (%) to less than age.
- Consider frequent HbA_{1c} assessment whilst supporting demotivated patient in particular.
- Don't be afraid to refer complex patients including those on multiple injection therapy and hypo unaware to colleagues in secondary care.

Any question?