Insulin Management in the Hospital Setting

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Disclosures: none

Overview of presentation

- Review of different types of insulin
- Focus on newer agents
- Insulin administration
- Standing orders

What percentage of medication errors result from insulin misadministration?

- 2%
- 5%
- 11%
- 42%

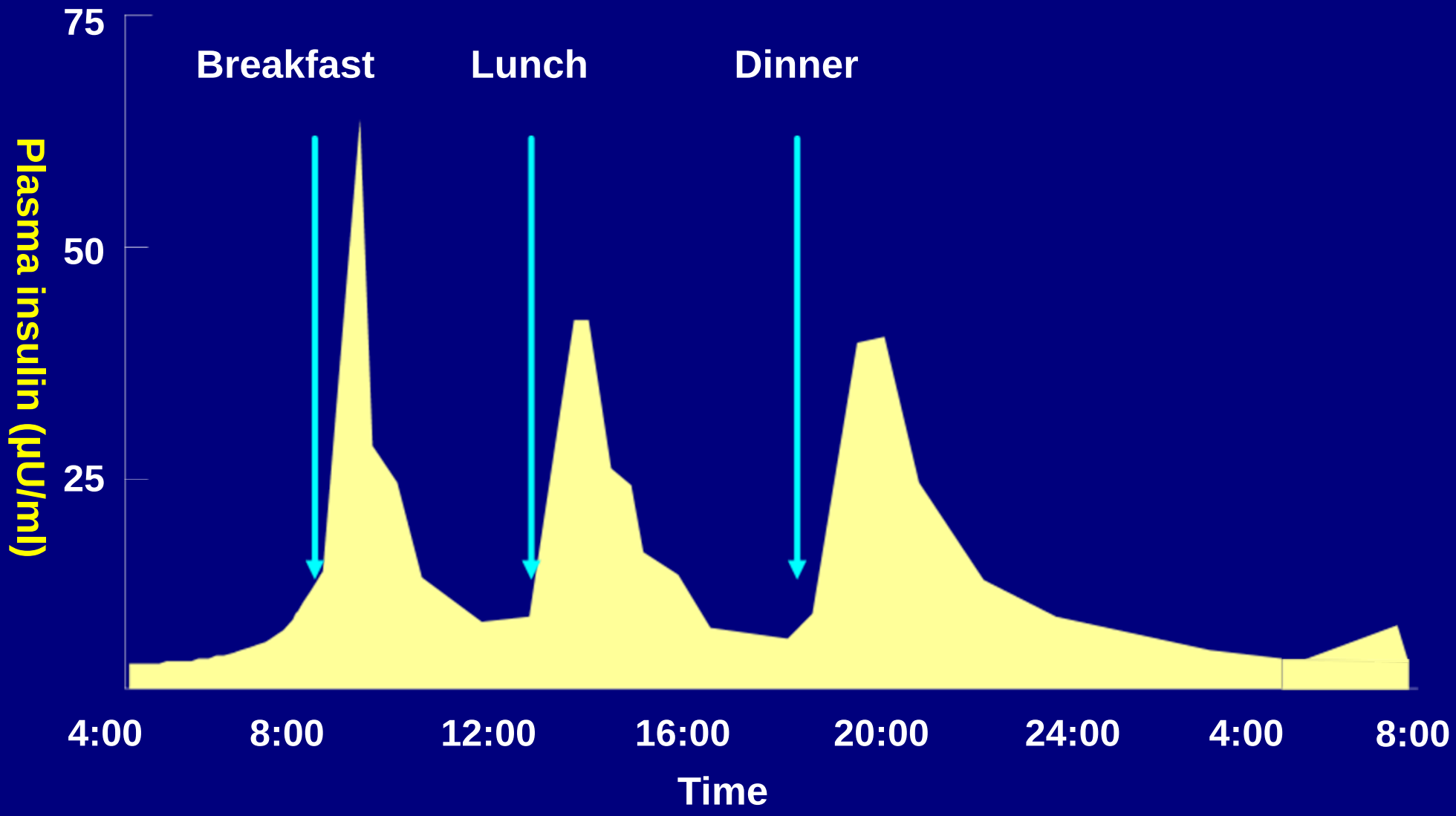
J Health Risk Management. 18:16-27:1998

Insulin

- Insulin is identified as 1 of top 5 “high risk medications” in the hospital setting
- CDA 2008: Healthcare institutions should have a systems approach to reduce errors which include preprinted orders… and unambiguous standard orders for insulin administration.

How does the “normal” pancreas release insulin throughout the day?

Physiological Serum Insulin Secretion Profile



Suppose a pt is on the following regimen:

• Levemir	0	0	0	16
• Humalog	5	5	5	0

His sugars are:

AM	lunch	supper	bed
6	7	14	10

Types of Human Insulin

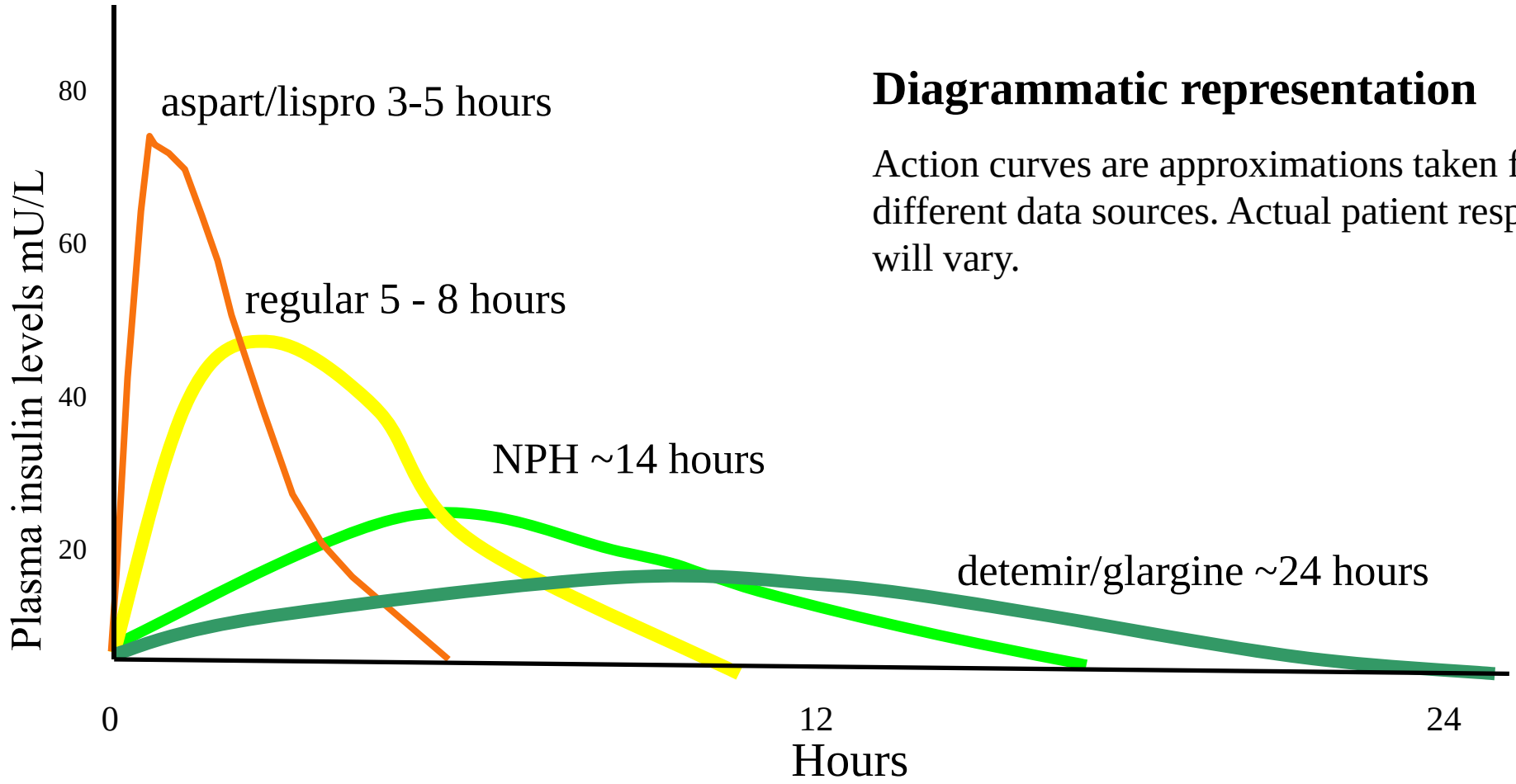
Insulin Type	Brand	Onset of Action	Peak Response	Duration of Action
Insulin, Rapid- Acting	**Humalog (Lispro)**	10-15 minutes	1-2 hours	3.5-4.75 hours
	NovoRapid (Aspart)	10-15 minutes	1-1.5 hours	3-5 hours
	Apidra (Glulisine)	10-15 minutes	1-1.5 hours	3-5 hours
Insulin, Short-Acting	**Humulin R**	30 minutes	2-3 hours	6.5 hours
	Novolin ge Toronto			
Insulin, Intermediate Acting	**Humulin N**	1-3 hours	5-8 hours	Up to 18 hours
	Novolin ge NPH			
Insulin, Long acting	**Lantus (Glargine)**	90 minutes	Not applicable	Up to 24 hours (glargine 24 hours; detemir 16-24 hours
	Levemir (Detemir)	90 minutes	Not applicable	

Table 4 Selected insulins and costs in Nova Scotia

	Generic name	Examples of trade name	Approx cost for 3mL (cartridge or penfill)[a]	NS formulary coverage (April 2010)
Rapid-acting insulin analogues	Insulin aspart	NovoRapid	$12	Full benefit for children ≤ 18 yrs old. Exception status for ≥ 19 years old. For management of type 1 and type 2 diabetes mellitus in patients undergoing intensive therapy.
	Insulin lispro	Humalog	$11.70	
	Insulin glulisine[b]	Apidra	$10.30	
Regular insulin	Regular	Humulin R Novolin GE Tor	$8.60	Regular benefit
Long-acting insulin analogues	Insulin glargine	Lantus	$19	Not a benefit
	Insulin detemir	Levemir	$24	Not a benefit
NPH insulin	NPH	Humulin N Novolin GE NPH	$8.60	Regular benefit

a – costs from McKesson Feb to April 2010
b – not discussed in COMPUS review

Time-action profiles of bolus & basal insulins



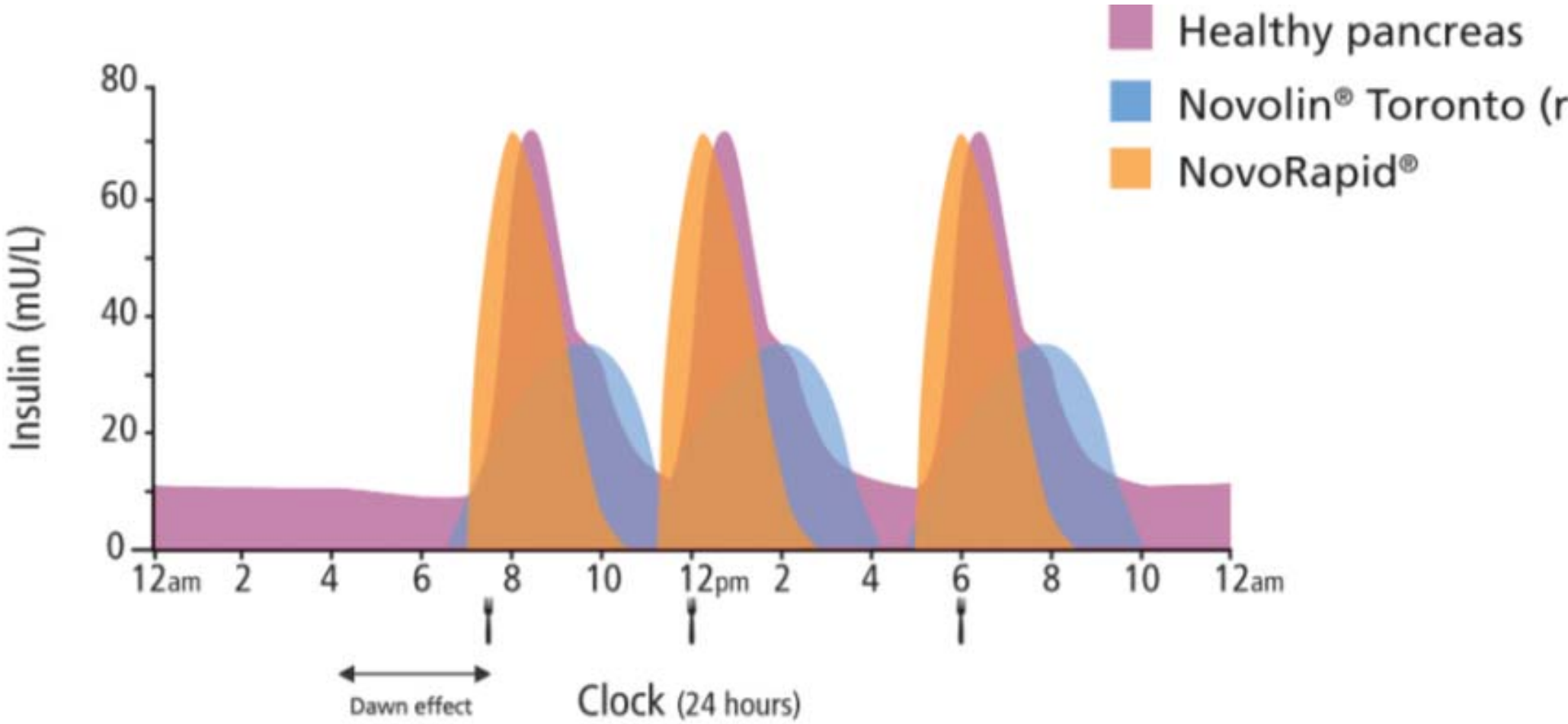
Diagrammatic representation

Action curves are approximations taken from different data sources. Actual patient response will vary.

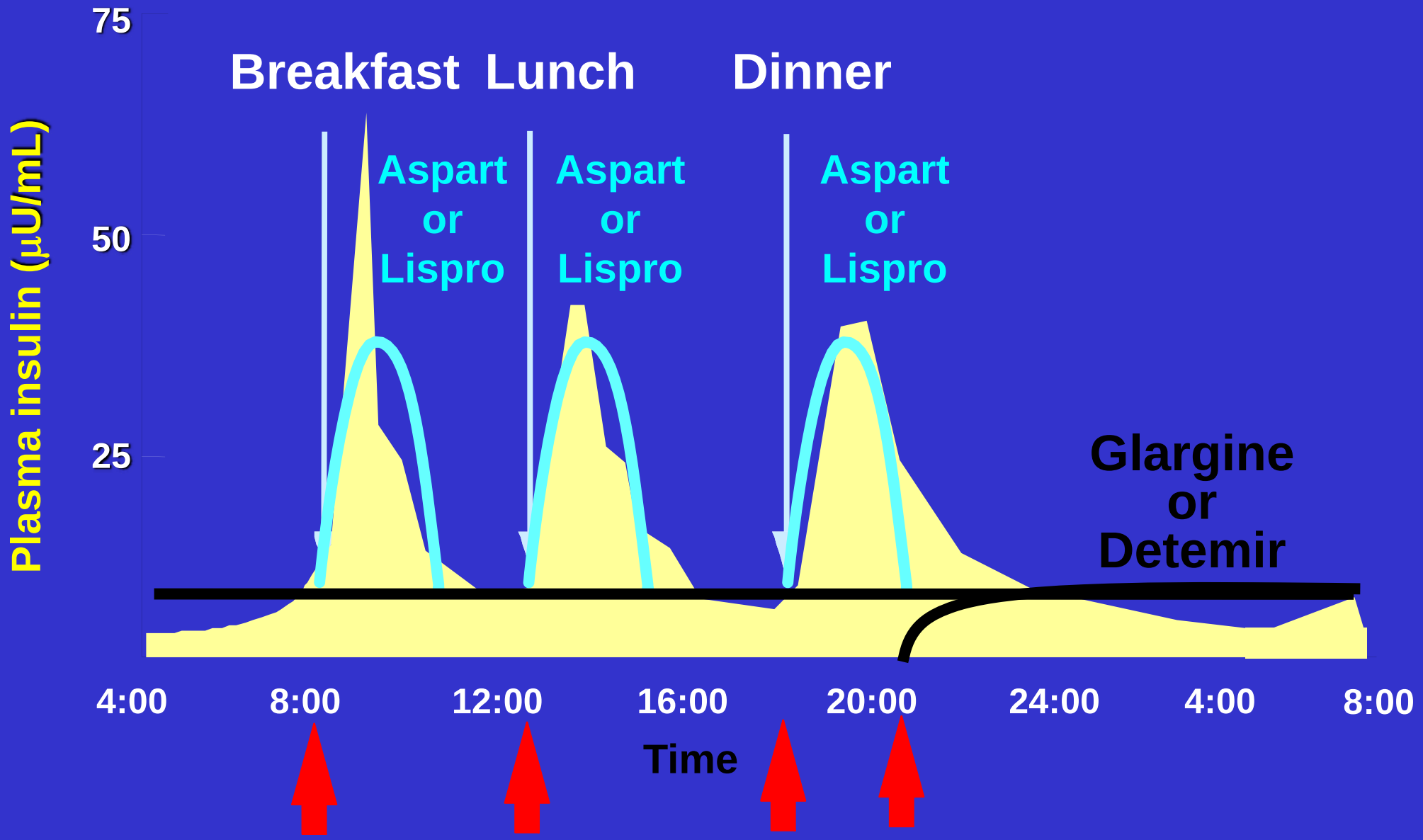
Lispro, aspart, and glulisine (vs regular insulin)

- More “physiologic”
- Administration at mealtime (no waiting)
  - Convenience factor
  - Allows flexibility with timing of meals.

- If child or demented pt, can administer after meal.


Healthy pancreas
Novolin® Toronto (r
NovoRapid®
Insulin (mU/L)
80
60
40
20
0
12am
2
4
6
8
10
12pm
2
4
6
8
10
12am
Dawn effect
Clock (24 hours)

Basal/Bolus Treatment Program with Rapid-acting and Long-acting Analogs



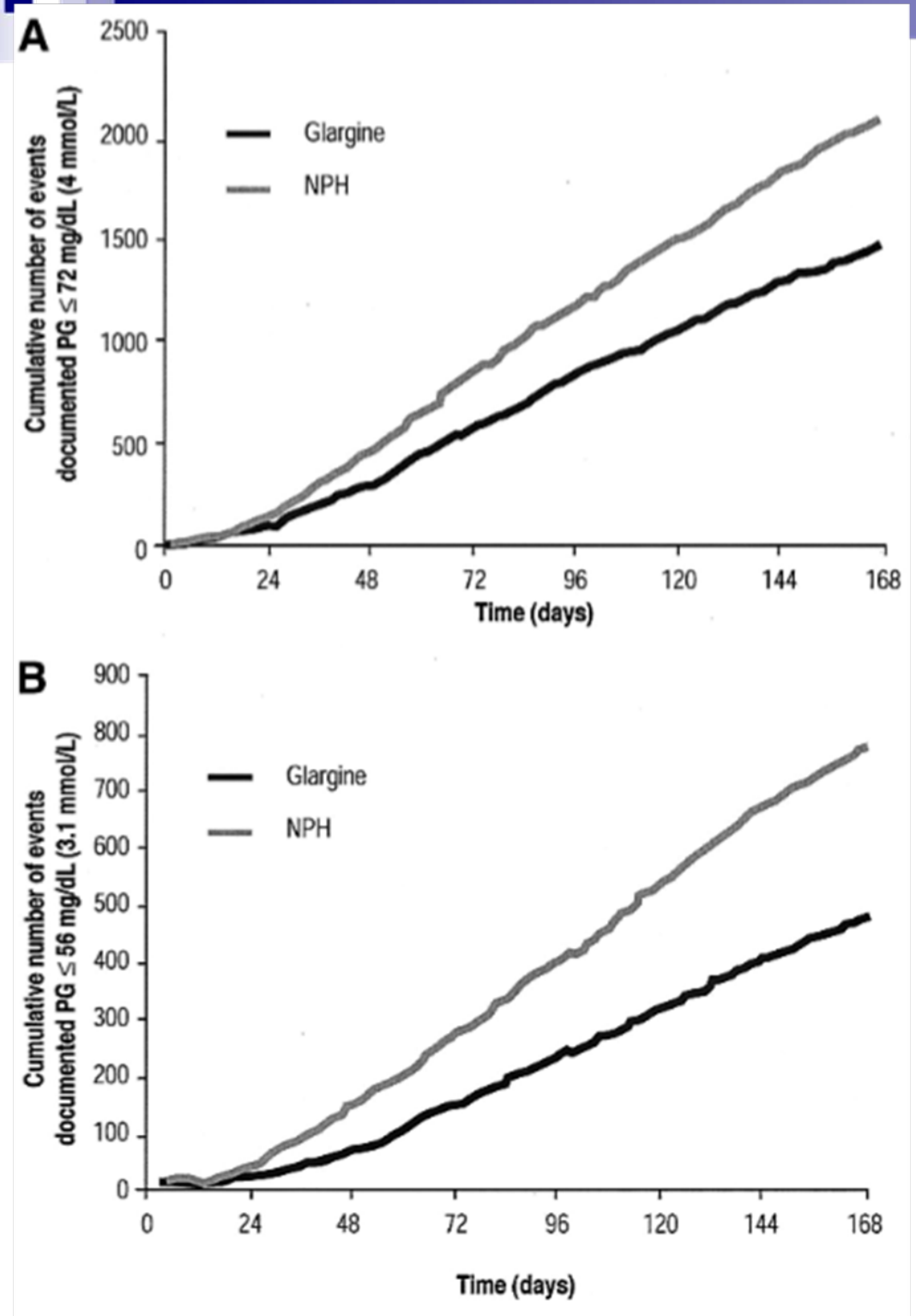
Lispro, aspart, and glulisine (vs regular insulin)

- ↓ risk of late hypoglycemia.
- Possibly better control of postprandial hyperglycemia.
- Agent of choice for SS (?)
- Less chance of stacking.
- I have no preference between the 3 analogs.

Lantus and Levemir (vs NPH)

- More “physiologic”.
- Less nocturnal hypoglycemia (major advantage).
- Not better at lowering HbA1c.
- Less intra individual variability.

Treat To Target trial

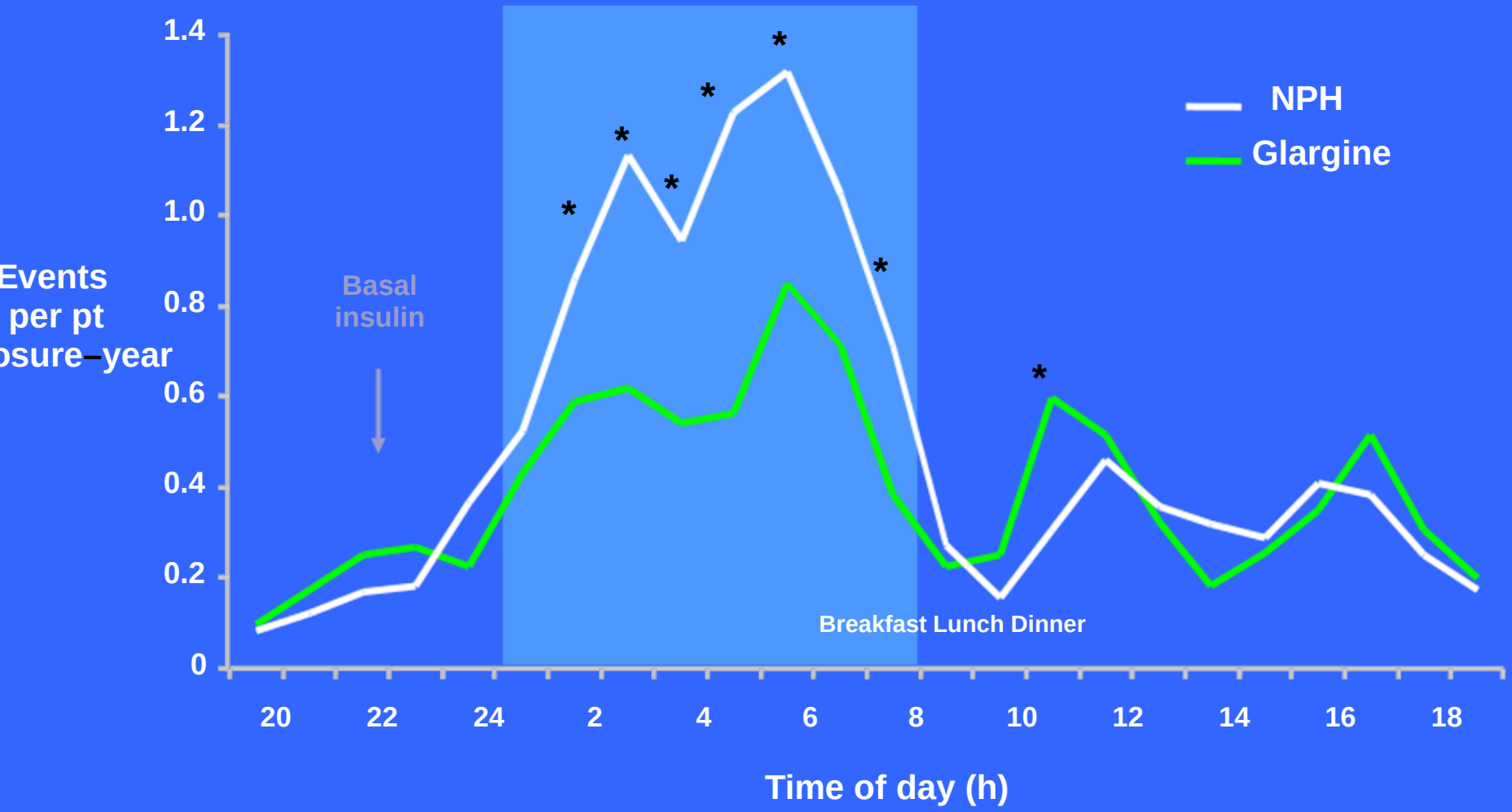


Documented bg ≤ 4 mmol/L

Documented bg ≤ 3.1 mmol/L

***Diabetes Care* 26:3080–3086, 2003**

Symptomatic Hypoglycemic Events: Glargine vs NPH

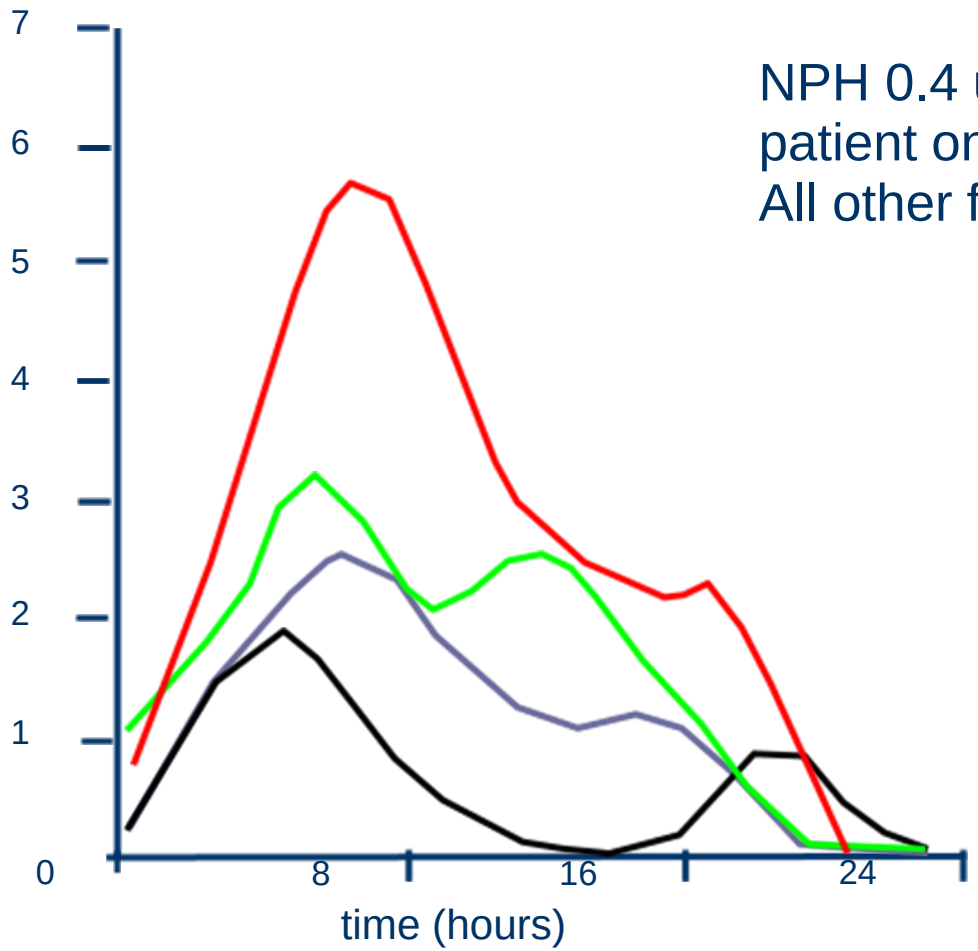


*$P<0.05$ vs insulin glargine.

Adapted from Riddle M et al. *Diabetes Care.* 2003;26:3080-3086.

What do I mean by intra patient variability?

Glucose infusion rate (mg/kg/min)



NPH 0.4 unit/kg action for 1 patient on 4 different days. All other factors controlled.

Heise T et al. *Diabetes* 2004;53:1614-20

Premixed insulin

Insulin Mixtures	Brand	Onset of Action	Peak Response	Duration of Action
Rapid-Acting/ Intermediate Acting	**Humalog Mix 25** **Humalog Mix 50**	Faster than Humulin 30/70	0.75-2.5 hours	Effective: 10-14 h Max: up to 18-24 h
	Novomix 30	10-20 minutes	1-4 hours	Up to 24 hours
Short Acting/ Intermediate Acting	**Humulin 30/70**	30-60 minutes	2-4 hours	Effective: 10-14 h Max: up to 18-24 h
	Novolin ge 30/70 **Novolin ge 40/60** **Novolin ge 50/50**	30 minutes	2-8 hours	Max: up to 24 hours

Case: new admission

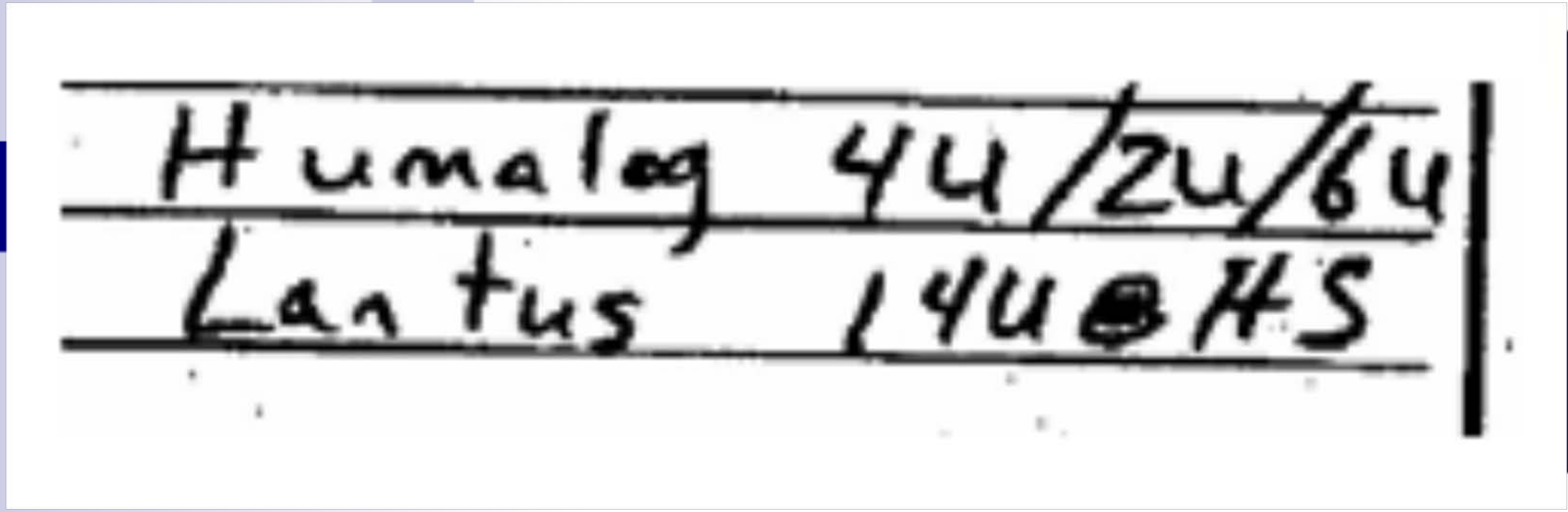
- Order reads:
  - NPH 13 u QAM 22 u QPM

- Why might I consider this to be an ”unacceptable” order?

Case: new admission

- Order reads:
  - NPH 13 u QAM 22 u QPM

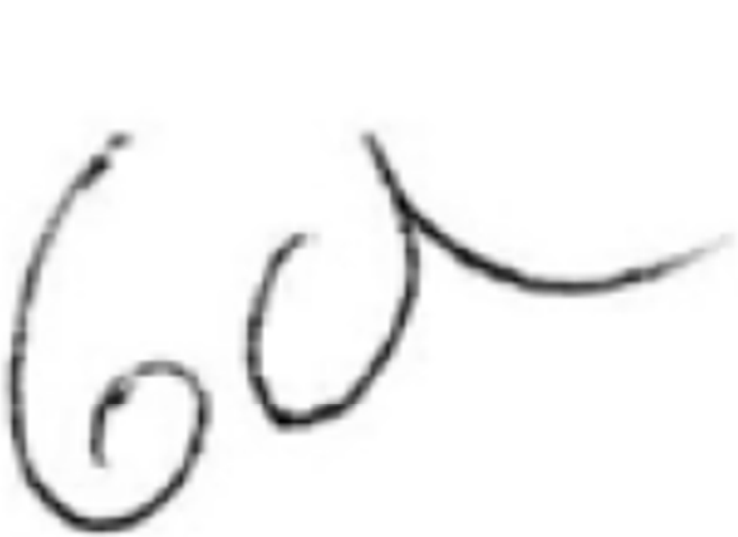
- What is “PM” ?
  - very important re premixed insulin (ie 30/70)
  - HS NPH may be preferred over supper.
  - But what was pt doing at home? What is she willing to do?



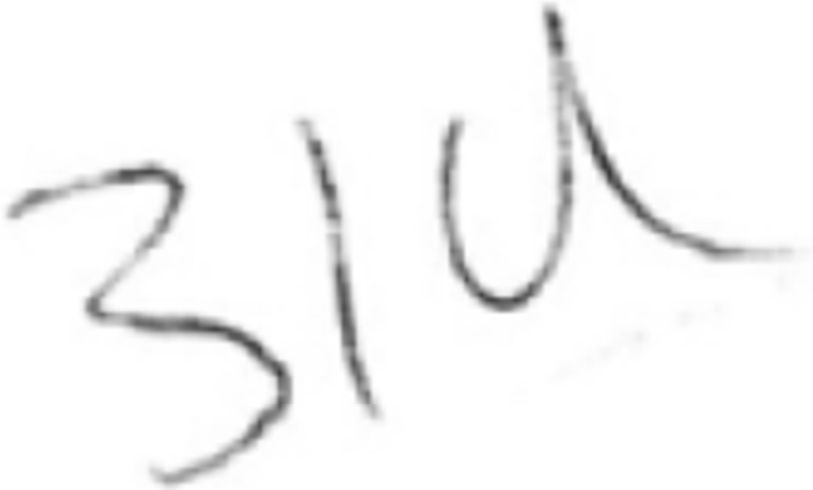
Intended dose of 4 units interpreted as 44 units.

Abbreviations

- Use “units”
  - *Not IU*
  - *Not U*
  - “U” has also been misread as “cc”
    - ie ↑drip rate by 2u/h could be misread as 2cc/h.

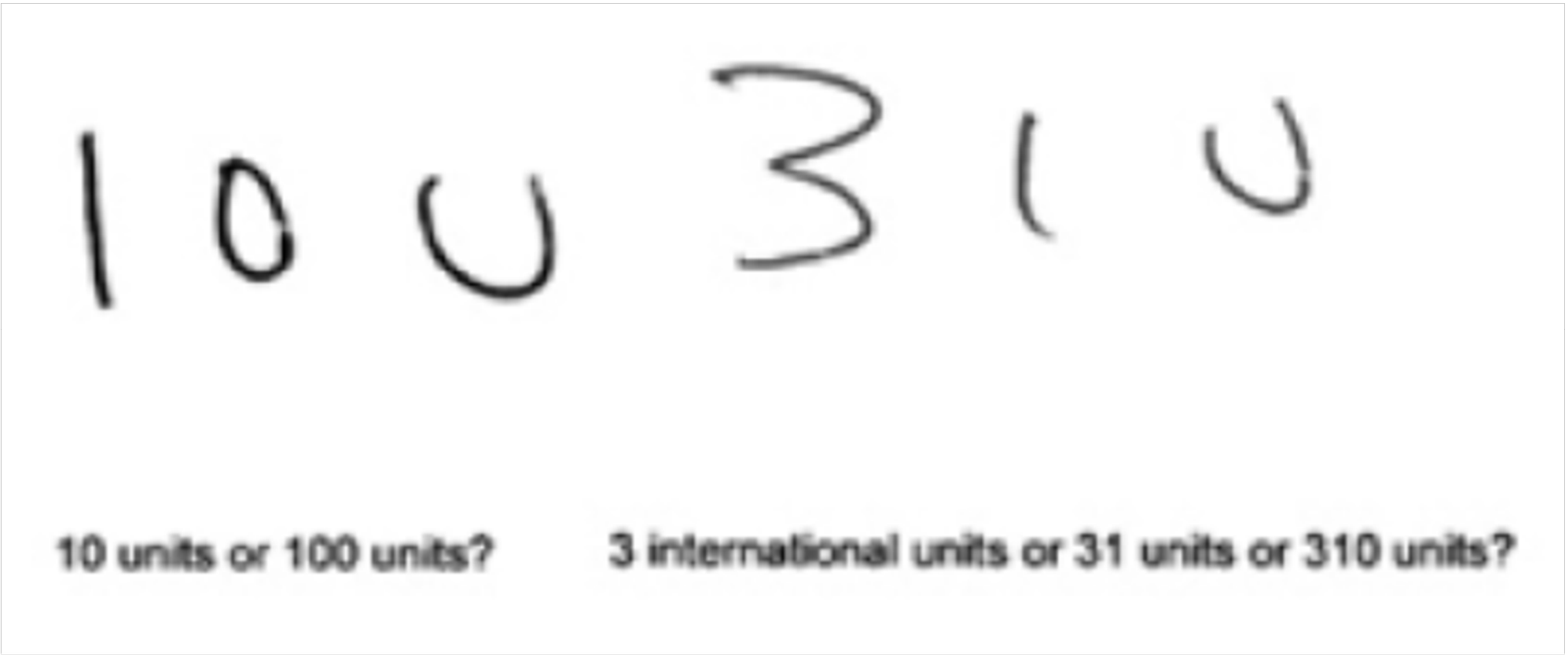


6 units or 60 units ?



3 international units or 31 units?

BMJ 2010;341:c5269



BMJ 2010;341:c5269

Other cautions

- Don’t refer to long acting insulin as “the cloudy insulin”
  - Lantus and Levemir are clear.

Back to the case…

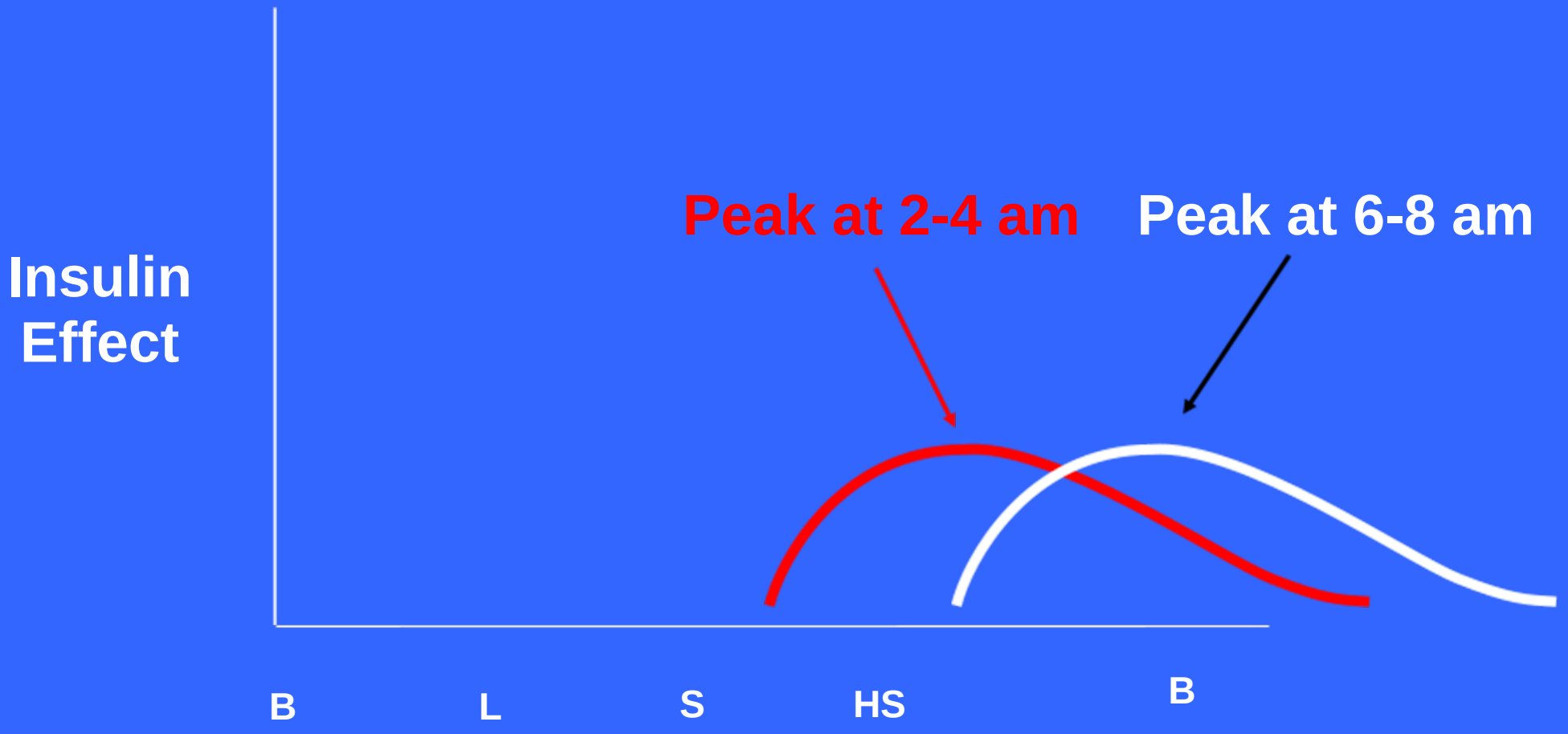
- Admitting order reads:
  - NPH 13 u QAM 22 u QPM
- Clarified to:
  - NPH 13 u QAM 22 u Qsupper
- QAM Chemstrip is > 12 for next 3 days.
- 0300h Chemstrip ordered.
  - Why?

NPH

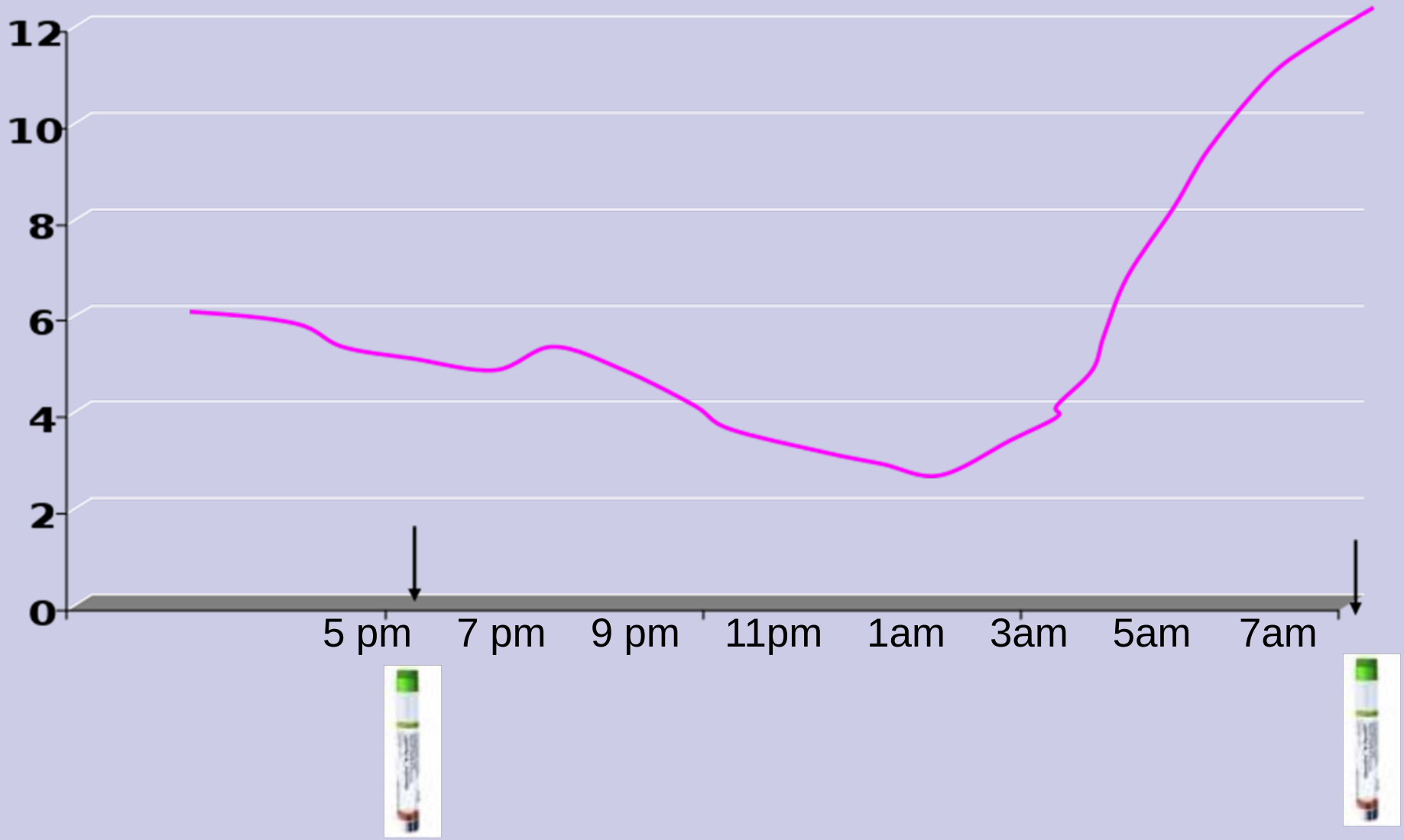
- Supposed to act as a “basal” insulin…
- But it has a peak!

- NPH q supper peaks ~ 3 AM.

NPH at supper vs NPH at bedtime.



Somogyi effect



NPH…

- HS NPH may be better than Q supper NPH
  - o ↓ overnight hypos

However, if it ain’t broke, don’t fix it!

Orders for “PM” insulin should always be clarified.

Nursing student question

- AM sugar 6.9
- Patient due for NPH 62 units, R 22 units.

- Which insulin to hold?

This is a product of the sliding scale mentality, I suspect.

Why not sliding scales?

- Retroactive, not proactive.
- No evidence of benefit.
- In some instances, a “don’t call me” order.
- Glycemic control rarely assessed.
- Doesn’t provide basal insulin.

Is there no place for sliding scales?

- May have a role in some patients.
- Should generally not be used alone.
  - Especially in T1DM.
- Should be reassessed regularly.

Is there a “standardized” sliding scale?

- No.
- Consider BG of 20 in:
  - 92 YO 46 kg woman with dementia
  - 56 YO 192 kg male with sepsis in ICU
  - 18 YO male with T1DM and UTI
    - All have different levels of insulin resistance and requirements.

Moving right along to our next admission

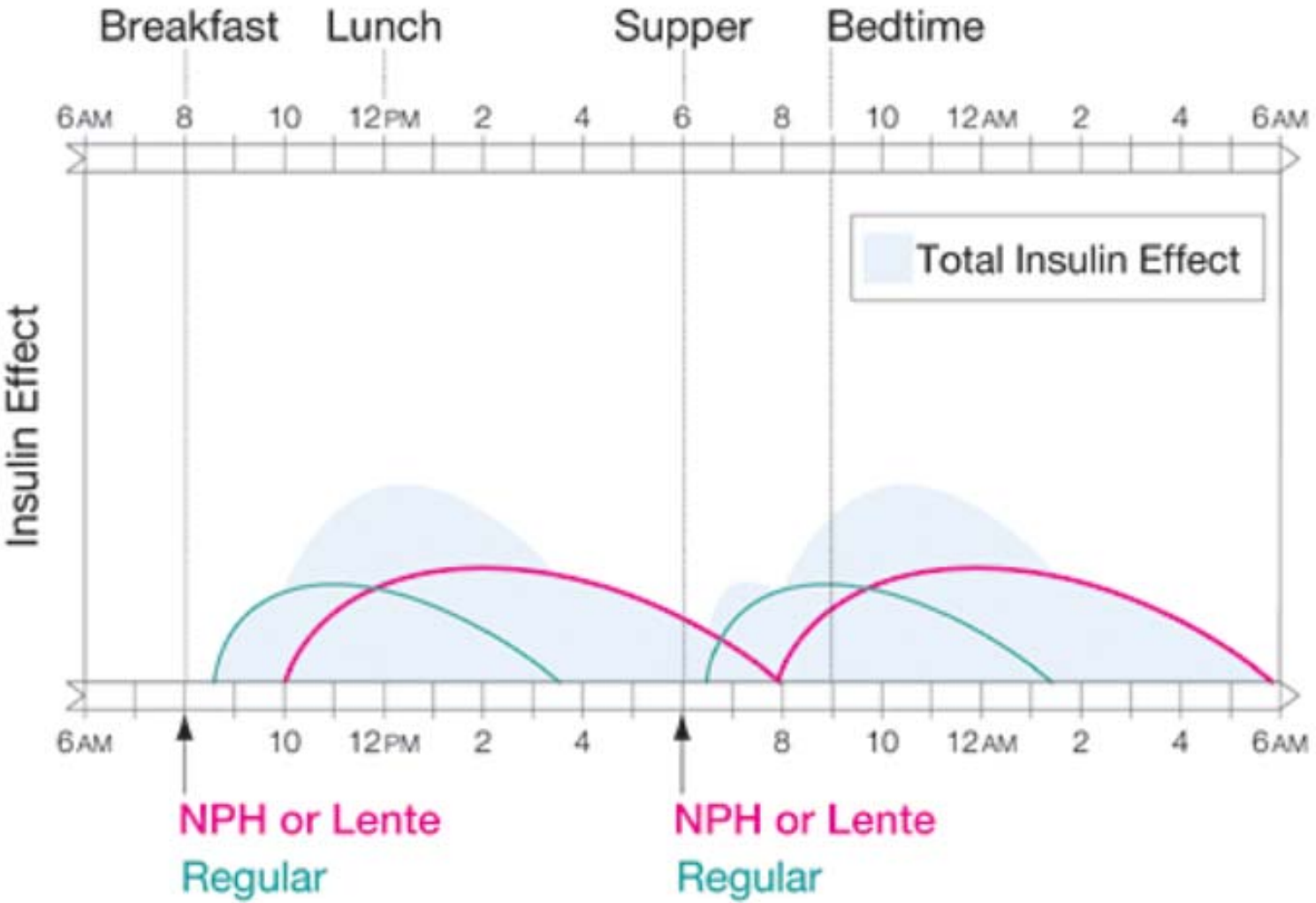
- KL, 68 YO woman with T2DM and CHF
- Using 30/70 for 4 years.
  - 16 units QAM 12 units qsupper

- Sugars:
  - AM 6-8
  - Lunch 5-6 (gets hypo if eats late)
  - Supper 10-14
  - Bed 4-7

KL

- Why does she get hypo if she eats lunch late?

KL: why does she get hypo if she eats lunch late?



What are our options for KL to reduce her risk of pre lunch hypos?

AM	6-8
Lunch	5-6 (gets hypo if eats late)
Supper	10-14
Bed	4-7

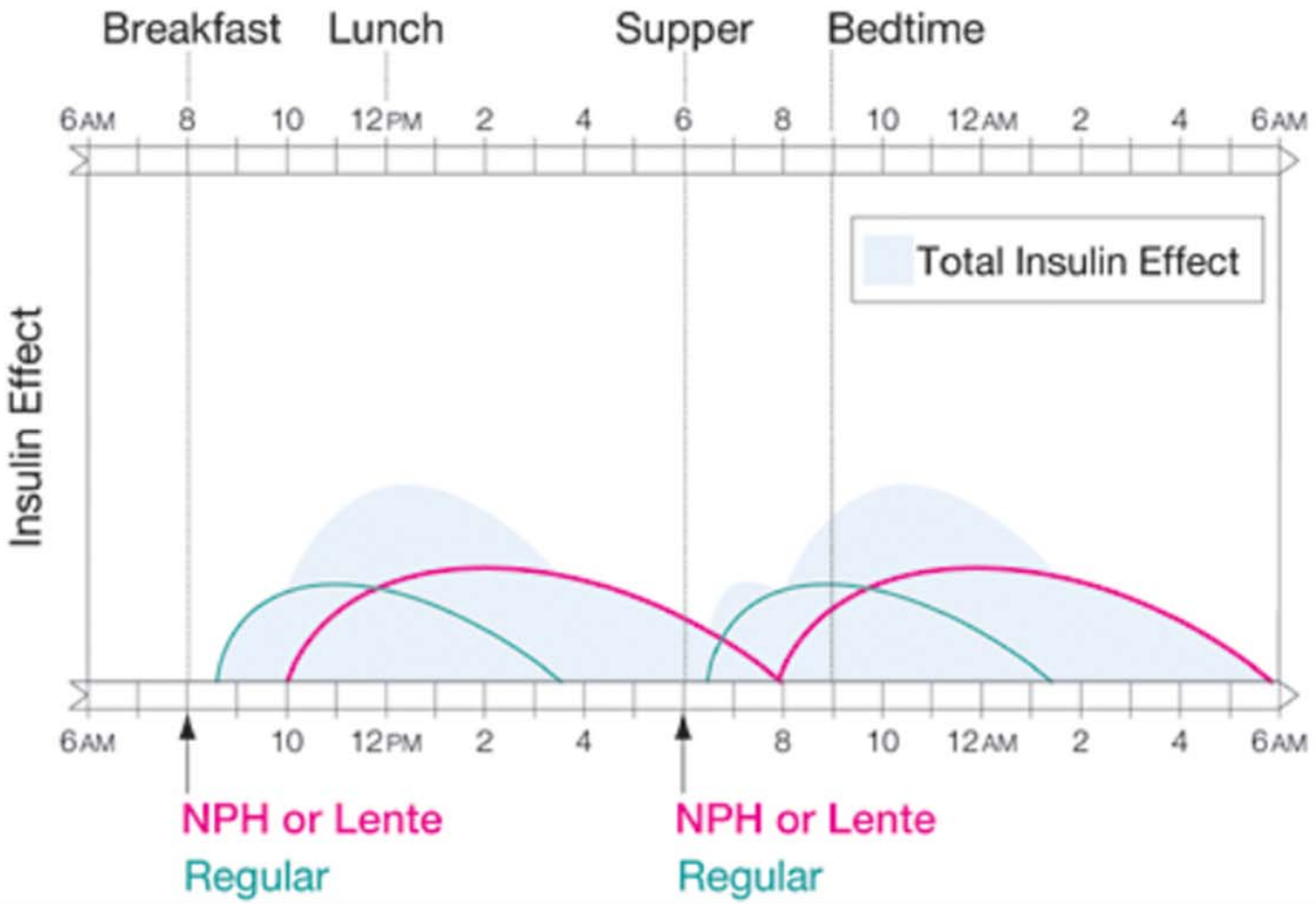
KL was eventually changed from 30/70 to Humalog 25 mix at the same dose (16 units QAM; 12 units q supper).

Why does this make sense?

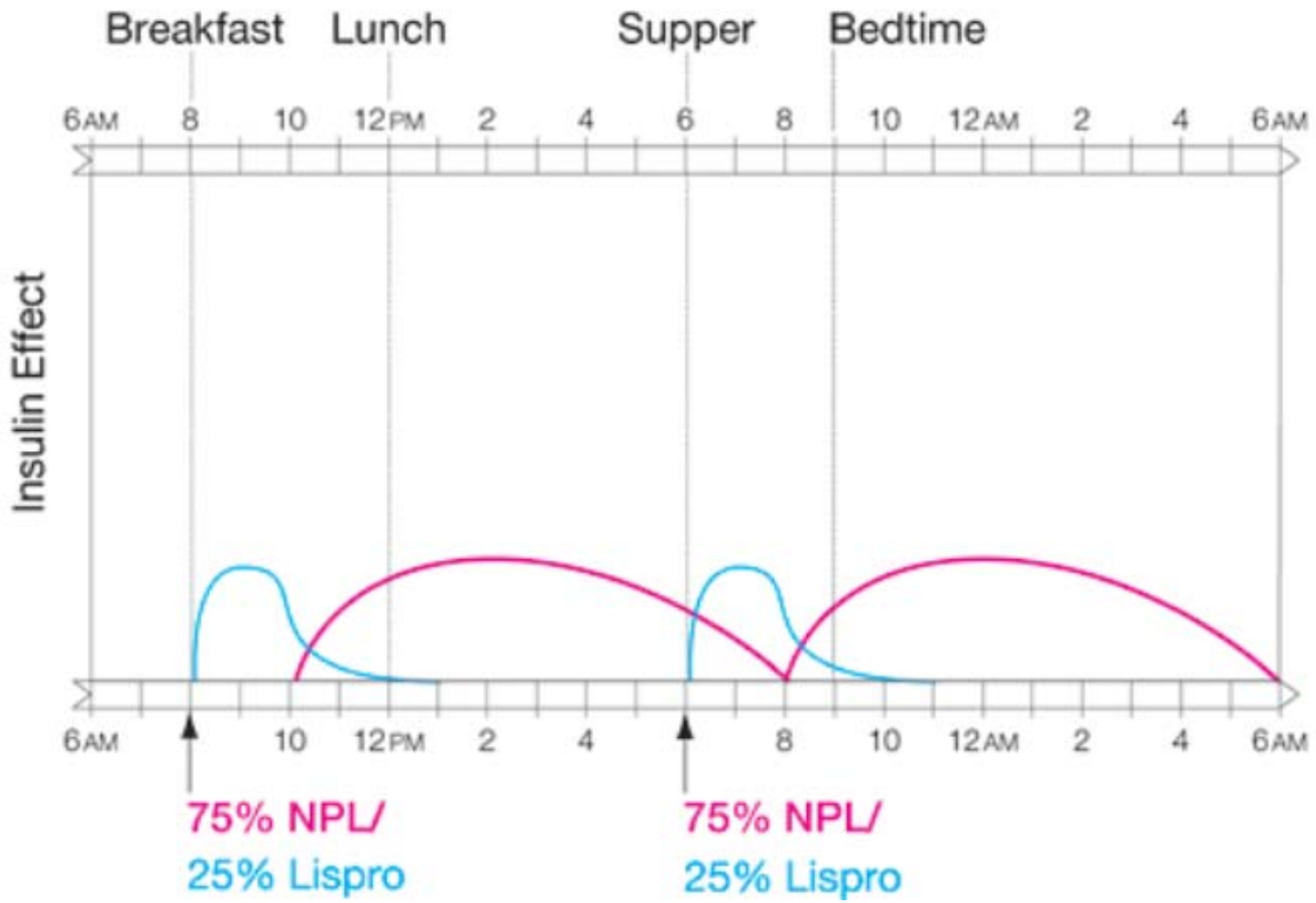
KL

- Humalog 25 mix is:
  - 75% NPL (essentially NPH)
  - 25% Lispro (fast acting analog)
  - So, similar to 30/70, right?
  - But compare the profiles.

Remember, this is 30/70…



Here is the Humalog mix.



Quiz break…

What do we often forget to tell patients who start NPH via pens?

What do we often forget to tell patients who start NPH via pens?

- Resuspend the insulin!
- Roll the pen between the palms 10 times…
- Then invert it 180^{o} 10 times.
- If not done, can lead to ↑↑↑ hypos!

- Jehle et al 1999.
  - Significant ↓ in hypoglycemic reactions after proper instruction.

Jehle et al. Lancet 1999;354(6)
Humulin N pen monograph/ insert

Insulin administration

- Can disposable syringes and needles be reused?

Manufacturer will no doubt say no.
But ADA says yes.
Smaller (30 gauge) needles may develop barbs easily.

Insulin administration

- Should the skin be swabbed with an alcohol swab before injecting a pen?

  This is not necessary for pens or syringe/ needle.

Insulin administration

- Can pens be injected through clothing?

Sure.

What short acting insulins can be mixed with Lantus (glargine)?

- none

What short acting insulins can be mixed with detemir (Levemir)?

- none

Recent case: FR

- 79 YO man with long standing DM
- 130 lb
- h/o recurrect hypoglycemia; admitted for fall.
- ? gastroparesis; limited intake over last few days.
- Last A1c 7.8%

Recent case: FR

Home regimen:

- NPH 24 0 0 0
- R 10 0 2 0

- In hospital:
  - NPH 20 0 0 0
  - R 0 0 0 0

Recent case: FR

- Several episodes of symptomatic hypoglycemic episodes in first 3 days in hospital (BG 1.3 on one occasion).
- Staff asks how to change to glargine.
- How to proceed?

Recent case: FR

- First things first:
  - Review chart.

Each AND EVERY episode of hypoglycemia was directly induced by hospitalization.

Recent case: FR

- Wednesday at 16:45: BG = 1.2.
- What do you suppose his sugar was at 11:50?

11:50 BG = 22.1

And what was done about this?

10 units Novorapid sc x1

What else do we need to know about noontime on Wednesday?

He ate very little lunch, secondary to nausea.

FR

- Each of the 3 cases of hypoglycemia in FR could easily be traced directly back to overzealous correction doses of insulin.
- I felt no need to Δ him to Lantus.

5. INSULIN CORRECTION DOSE ORDERS

If pre-meal blood glucose is above 8 mmol/L, give the following ***additional*** *subcutaneous doses with the regularly scheduled orders above using:*

☐ Aspart (NovoRapid) ☐ Lispro (Humalog) ☐ Other _____

Pre-meal blood glucose (*half-dose at bedtime)	☐ **Patients on a low dose regimen (receiving less than 40 units/day prior to admission)**	☐ **Patients on a medium dose regimen (receiving 40–80 units/day prior to admission)**	☐ **Patients receiving high dose regimen (receiving greater than 80 units/day prior to admission)**
8 to 10.9 mmol/L	1 unit	1 unit	2 units
11 to 13.9 mmol/L	2 units	3 units	4 units
14 to 16.9 mmol/L	3 units	5 units	7 units
17 to 20 mmol/L	4 units	7 units	10 units
Greater than 20 mmol/L	5 units	8 units	12 units

* **The above algorithm may be used for bedtime correction by using only ½ of the suggested insulin dose (rounded down to the nearest unit)**

If blood glucose is less than 4.5 mmol/L pre-meal, and patient is taking the provided meal, ***decrease*** *the regularly scheduled* ***pre-meal*** *insulin according to the following:*

Pre-meal blood glucose	☐ **Patients on a low dose regimen (receiving less than 40 units/day prior to admission)**	☐ **Patients on a medium dose regimen (receiving 40–80 units/day prior to admission)**	☐ **Patients receiving high dose regimen (receiving greater than 80 units/day prior to admission)**
Less than 3 mmol/L	2 units	2 units	4 units
Less than 4.5 mmol/L	1 unit	2 units	4 units

Sliding scale case

Date	Time	BG (mmol/L)	R Insulin/ comments
Fri Sept 2 (admit)	1700 2200	7.7 13.7	0 4
Sat Sept 3	0745 1300 (return) 1700 2200	20.4 22.3 2.3 21.2	10 12; d/c IV (12 oz OJ, crackers) 10
Sun Sept 4	0730 1145 1710 2145	12.9 20 23.1 22.2	4 10 12 12
Mon Sept 5	0815 1145 1345 you are called	4.3 20.2	(12 oz OJ, crackers)

TYPE	TREATMENT	FOLLOW-UP
Mild to Moderate <4mmol/L	Treat with **15g** of carbohydrate by mouth **(200mL or 6oz of orange juice OR 3 pkgs of sugar alone without the juice)** *For patients with **swallowing difficulties**—options may be 1 ½ tablespoon of Regular Jam, or ½ cup applesauce.* *For patients on **Acarbose** use milk, honey or Dextrose Tablets as this medication delays the digestion of sucrose and starch.*	Wait **10 minutes**, retest blood glucose and retreat with another 15g of glucose (carbohydrate) if the blood glucose remains <4.0 mmol/L
Severe hypoglycemia in a conscious person < 2.8mmol/L	Treat with 20g of carbohydrate by mouth (**250mL of orange juice or 125mL of orange juice mixed with 2 packages of sugar**	Wait **10 minutes,** retest blood glucose and retreat with another 15 g of glucose (**200 mL of orange juice)** if blood glucose remains < 4.0 mmol/L
Severe hypoglycemia in an unconscious person < 2.8mmol/L	**CALL PHYSICIAN: REFER TO HYPOGLYCEMIA PRE-PRINTED ORDERS** **Start IV with D5W and PREPARE to give D50W (20-50mL over 1-3 minutes)**	**REFER TO HYPOGLYCEMIA PRE-PRINTED ORDERS**

Standing orders

- CDA 2008:

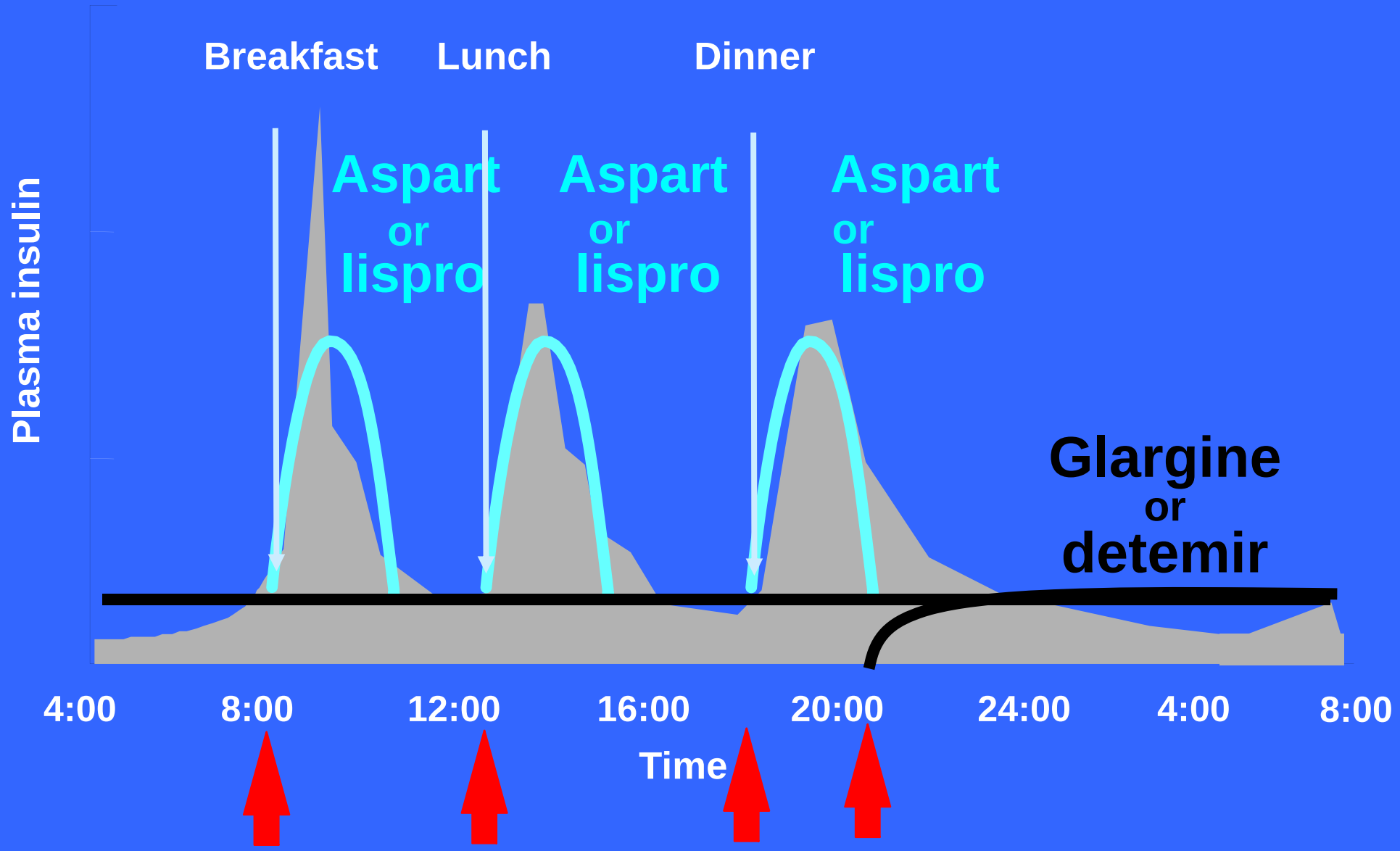
- Healthcare institutions should have a systems approach to reduce errors which include preprinted orders… and unambiguous standard orders for insulin administration.

Insulin Orders

Basal Insulin

Prandial

Adjustment scale


Breakfast
Lunch
Dinner
Aspart
or
lispro
Aspart
or
lispro
Aspart
or
lispro
Glargine
or
detemir
Plasma insulin
4:00
8:00
12:00
16:00
20:00
24:00
4:00
8:00
Time

BASAL (Background) Insulin:

Breakfast		Supper	Bedtime
Give _____ units subcut of:		Give _____units subcut of:	Give _____units subcut of:
☐ NPH (Novolin NPH)		☐ NPH (Novolin NPH)	☐ NPH (Novolin NPH)
☐ NPH (Humulin N)		☐ NPH (Humulin N)	☐ NPH (Humulin N)
☐ Other _____		☐ Other _____	☐ Other _____

PRANDIAL (with meal) insulin

Breakfast	Lunch	Supper
Give _____units subcut of:	Give _____units subcut of:	Give _____units subcut of:
☐ Aspart (NovoRapid)	☐ Aspart (NovoRapid)	☐ Aspart (NovoRapid)
☐ Lispro (Humalog)	☐ Lispro (Humalog)	☐ Lispro (Humalog)
☐ Other _____	☐ Other _____	☐ Other _____
☐ Regular (Novolin Toronto)	☐ Regular (Novolin Toronto)	☐ Regular (Novolin Toronto)
☐ Regular (Humulin R)	☐ Regular (Humulin R)	☐ Regular (Humulin R)

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Less than 3 mmol/L	2 units	2 units	4 units
Less than 4.5 mmol/L	1 unit	2 units	4 units

Enhancing Insulin Safety: Improving Insulin Storage


Novolin®ge
Humulin
R
U-100
NovoRapid
DATE
INSULIN WITH


5 x 3 mL
DIN 02024284
Humulin
R
U-100
KEEP IN
INSULINS / PROTAMINE

Insulin 6-Packs… What's Inside?

Rapid Acting in ***BLUE*** bins

- ***Novorapid (Aspart)***
- ***Humalog (Lispro)***

Intermediate Acting in ***RED*** bins

- ***Novolin NPH***
- ***Humulin N***

Short Acting in ***YELLOW*** bins

- ***Novolin Toronto***
- ***Humulin R***

A pen, you say? You've been brutally stabbing me on a daily basis all these years and only now I find out it comes in a pen?

Any other questions?