Type 1 Diabetes Mellitus

Type 1 Diabetes

- Condition of insulin deficiency
- Autoimmune mediated b-cell destruction
  - Patients with T1D are at greater risk of other autoimmune disease – coeliac disease and thyroid disease
- Incidence of T1D peaks in adolescence and early adulthood
  - But can occur at any age
- Rate of B-cell destruction in infants and children is often faster

Symptoms: presentation of hyperglycaemia → polyuria, polydipsia, weight loss

Presentation of symptoms of hyperglycaemia is medical emergency → prevent DKA

Refer for specialist assessment and management

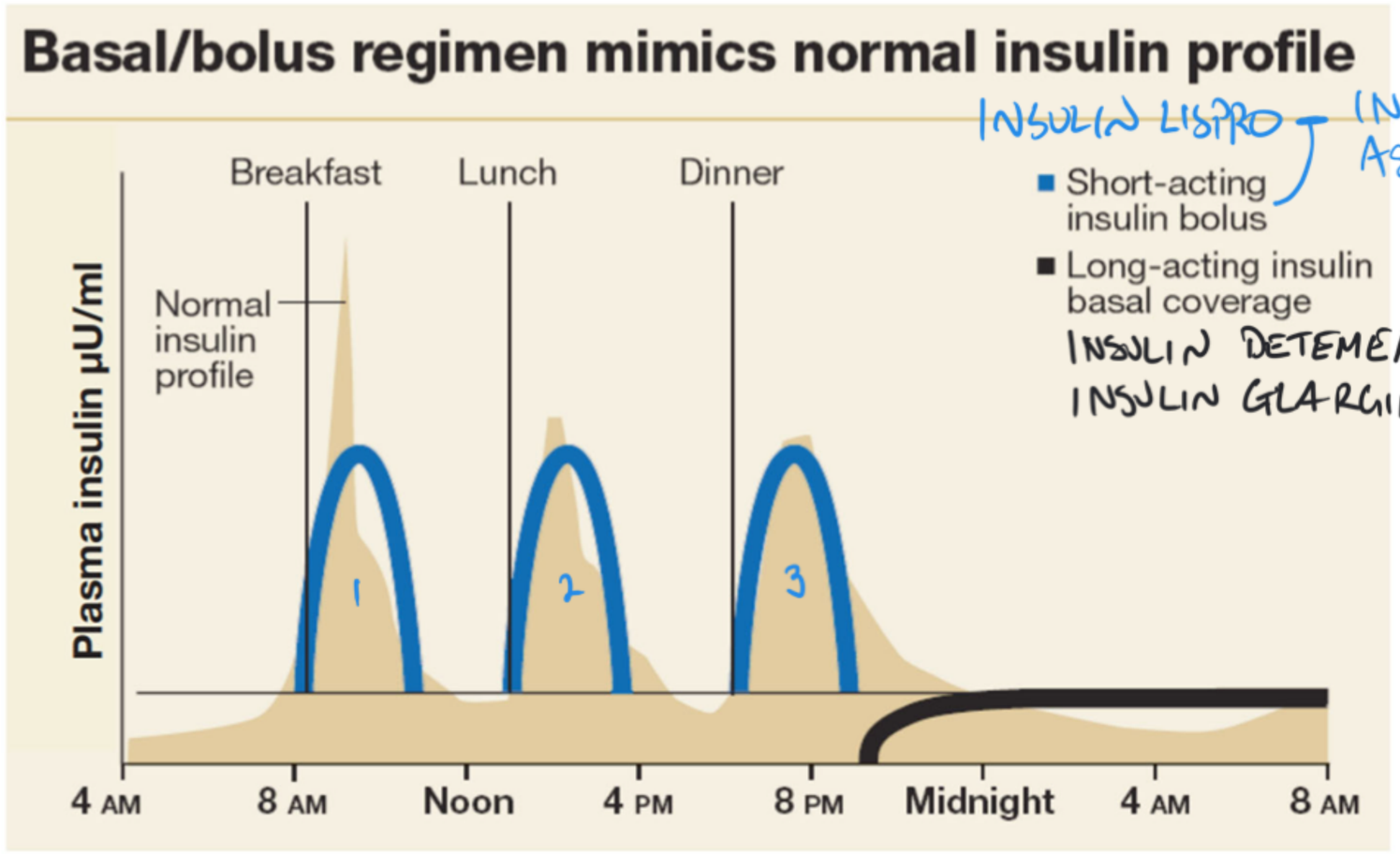
Treatment of T1D

- Insulin
  1. • Multiple daily injections (usually 4 injections a day) BASAL-BOLUS
  2. • Continuous subcutaneous insulin infusion (CSII) by portable pump
  3 • Premixed insulin (usually 2 injections a day)

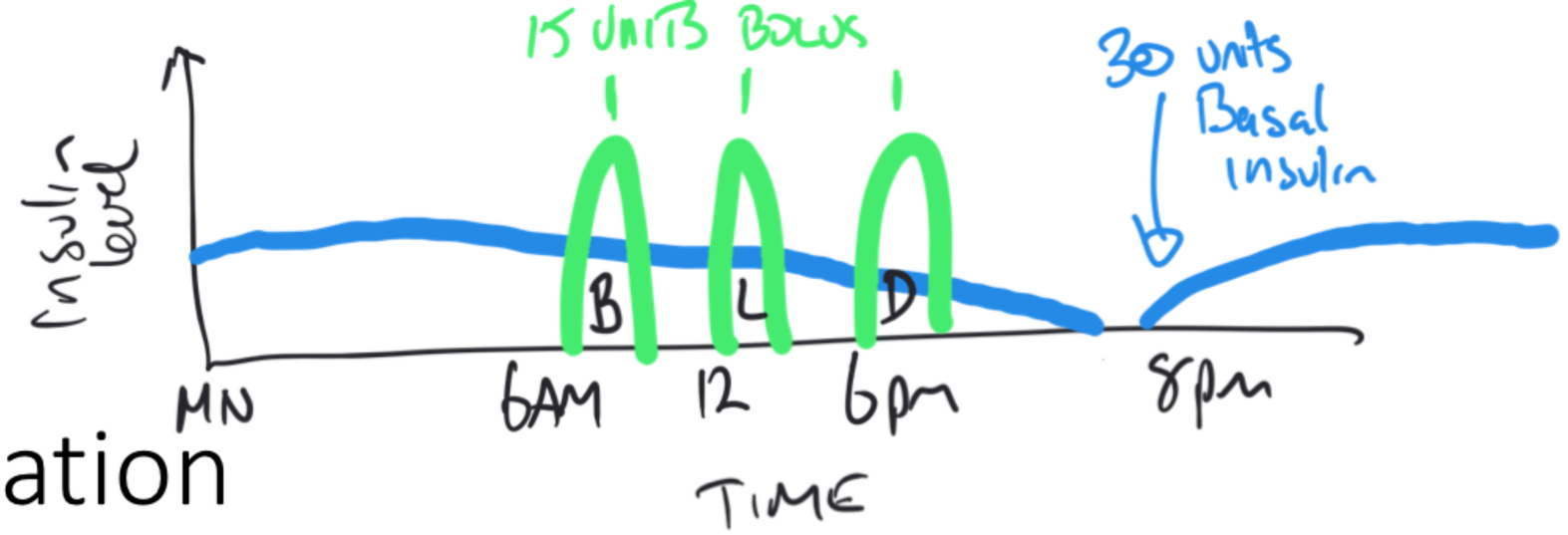
- Dose using a target oriented approach
- Blood Glucose concentration
  - 4-8 mmol/L
- Glycated haemoglobin (HbA1c)
  - Less than 7% (53mmol/L)

Insulin regimens – Basal-Bolus injections

- Multiple daily (basal-bolus) injection regimen
- 4 x a day
- Basal insulin – long or intermediate acting insulin – 40-50% of insulin dose
- Bolus insulin – rapid acting insulin before meals



Magaji, V. & Johnston, J. Inpatient management of hyperglycaemia and diabetes. Clinical Diabetes. Vol. 29:Number 4. 2011.



Insulin calculation

- during remission phase for all ages—less than 0.5 units/kg daily
- beyond remission phase for pre-adolescent children—0.7 to 1 unit/kg daily
- beyond remission phase during puberty—1.2 to 1.5 units/kg daily.

- 15 year old female with T1D
- Weight 50kg
- Dose 1.5 units/kg

50 kg × 1.5 units/kg

75 units of insulin DAY.

Basal Dose 40-50% TDD

75 units × 0.4 = 30 units Basal insulin

Bolus Dose

75 units × 60% = 45 units

45 / 3 doses = 15 units/dose ←

Adult Insulin Therapy

- Starting Dose 0.3 – 0.4 units/kg/day
- Healthy Adult 0.5 – 0.8 units/kg/day.

---

80 kg patient @ 0.4 units/kg/day

80 ~~kg~~ x 0.4 units/~~kg~~/day

32 units/day.

Basal dose @ 40% Split

32 units x 0.4 = 13 units/day

Isophane Insulin, NPH

Bolus dose

32 units x 0.6 = 19 units/day

19 units / 3 = 6.0 units

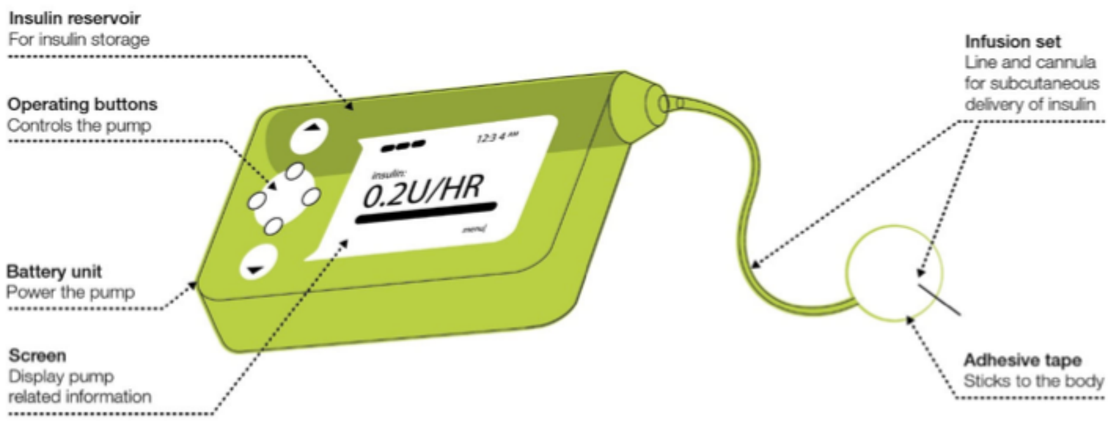
3 x a day.

@ meal times

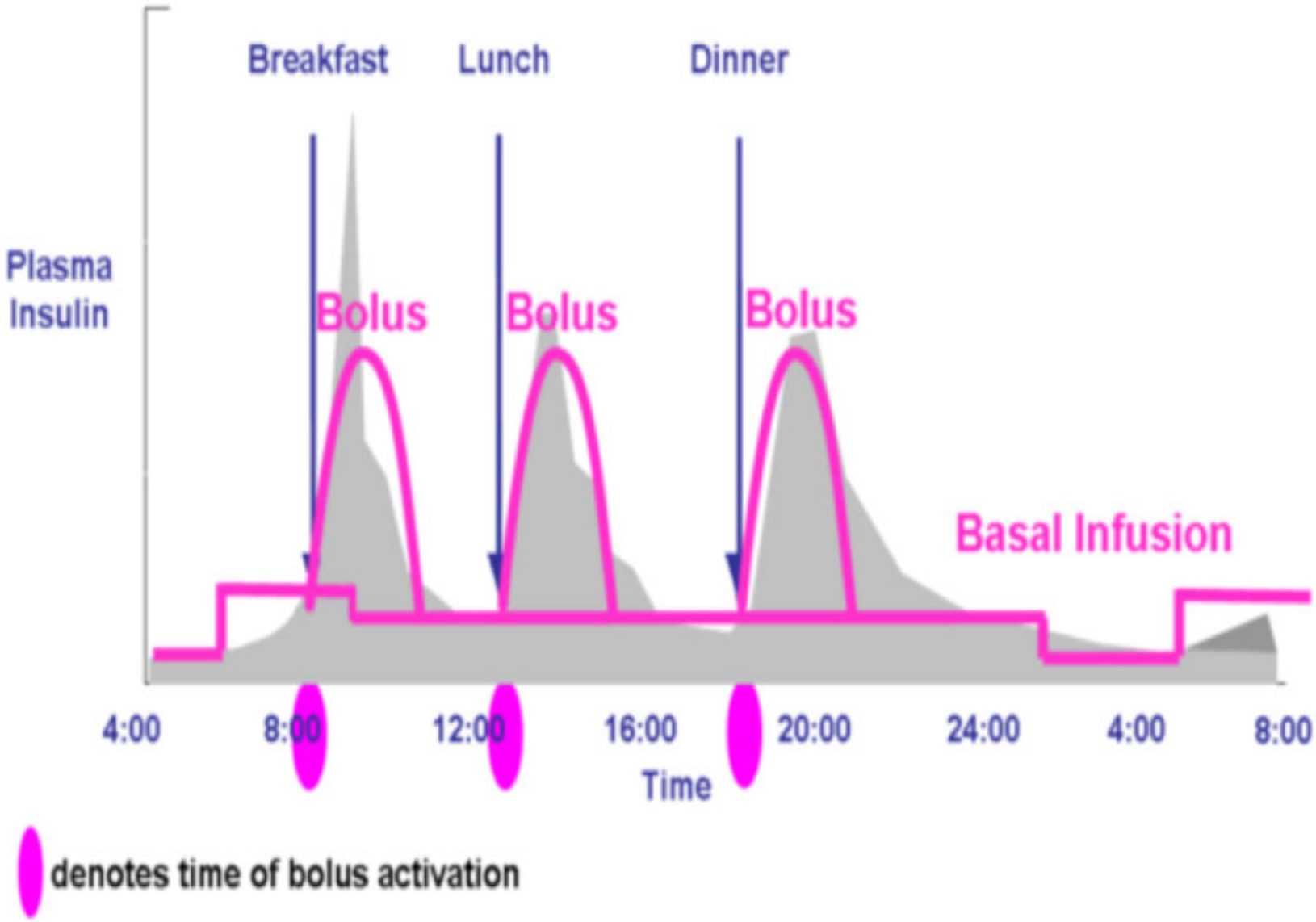
Insulin Aspart.

CSII

- Continuous subcutaneous infusion pump
- Basal rapid acting insulin via SC cannula
- User initiated bolus before meals
- Similar total daily dose as for Basal-Bolus regimen
- Supplemental correction doses can be programed



Cohen, N. 2015. Continuous glucose monitoring and pumps. Australian Family Physician, Volume 44, No.5, 2015 Pages 284-287.

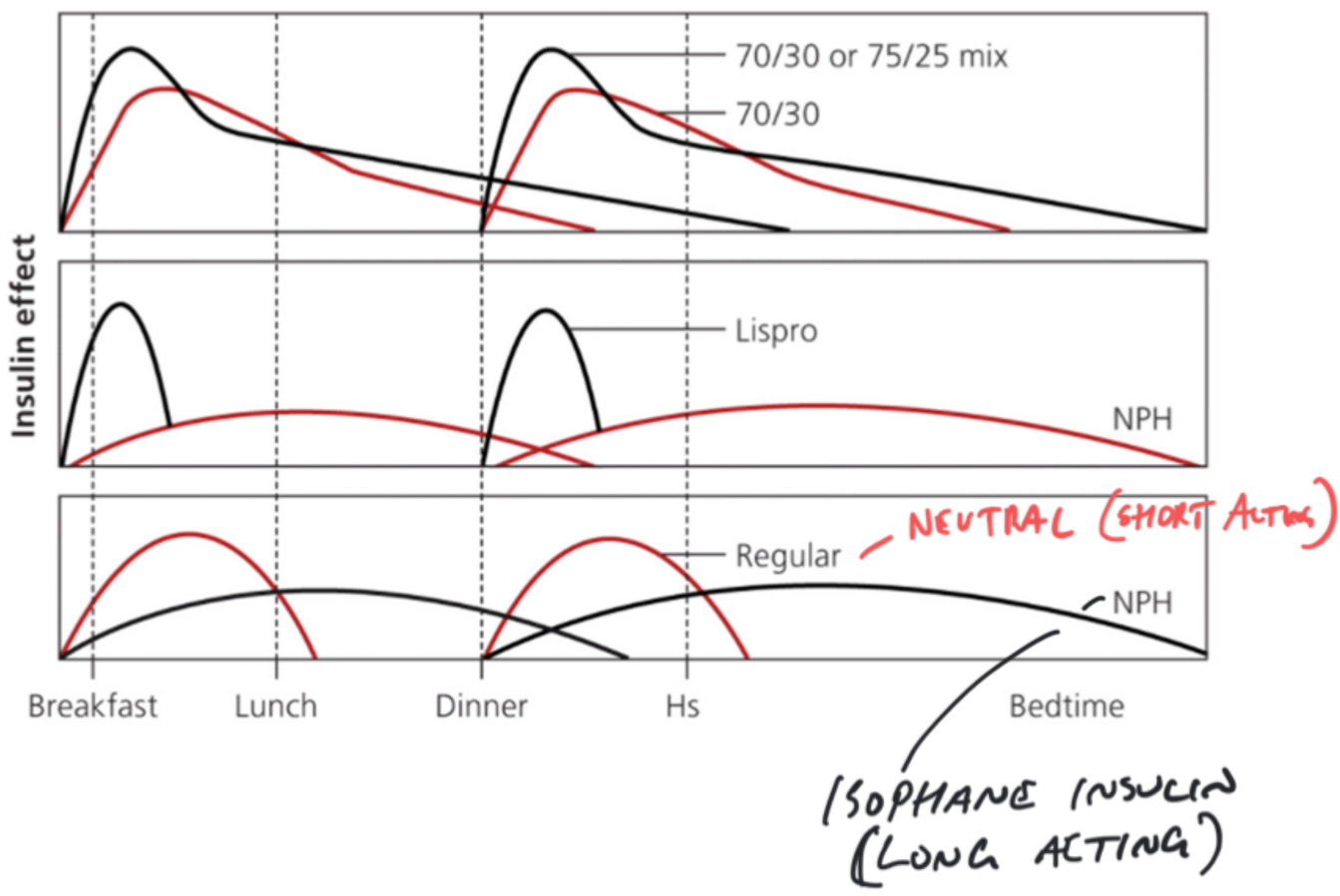


Subramanian S, Baidal D, Skyler JS, et al. The Management of Type 1 Diabetes. [Updated 2016 Nov 16]. In: Feingold KR, Anawalt B, Boyce A, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-2021.

Mixed insulin regimen

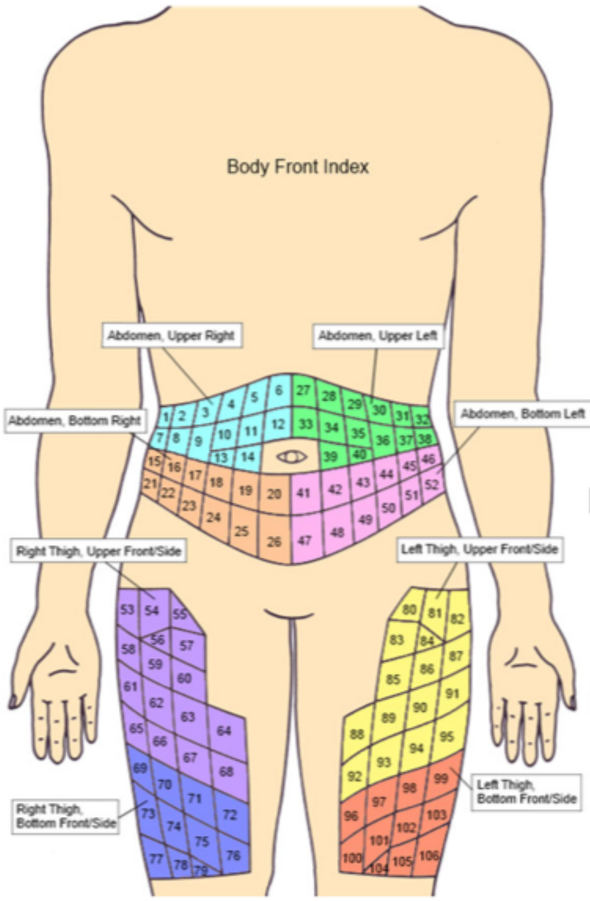
2 types combined in single ampule + injected (usually) 2 x a day

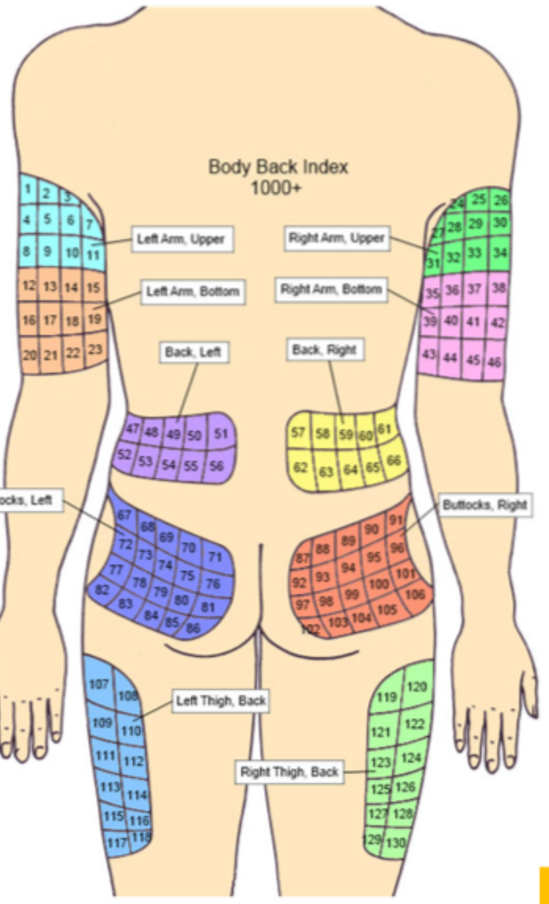
- Mixture of rapid or short acting and an intermediate-acting insulin
- Given 2 x a day
- Can use free-mixing or pre-mixed fixed dose combination

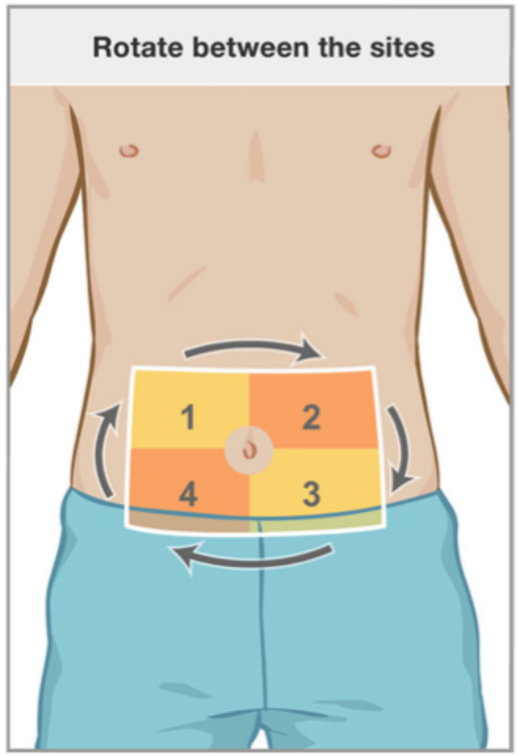


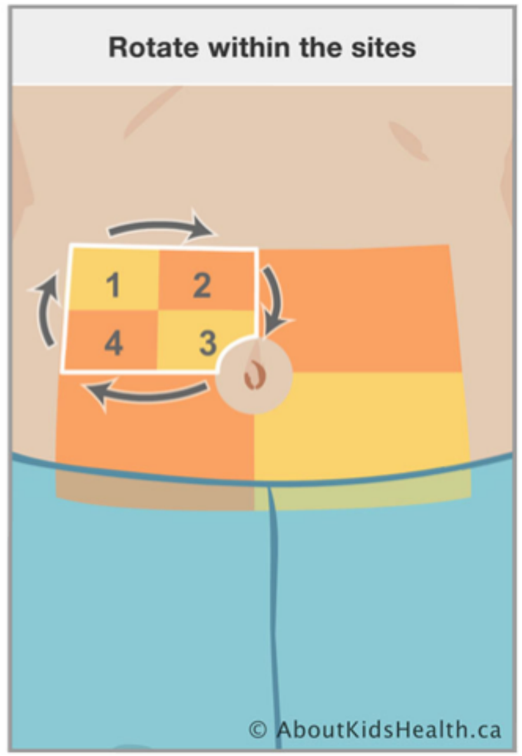
Petznick, A. Insulin management of type 2 diabetes mellitus. 2011. American Family Physician. 2011 Jul 15;84(2):183-190.

Injection sites and rotation









Abdomen → arms → Legs → Buttocks

Fastest → → → Slowest

Fastest → Abdomen → Short acting insulin

Slowest → Thigh and buttocks → long and intermediate acting insulin

Insulin rotation avoids lipodystrophy

Lipohypertrophy

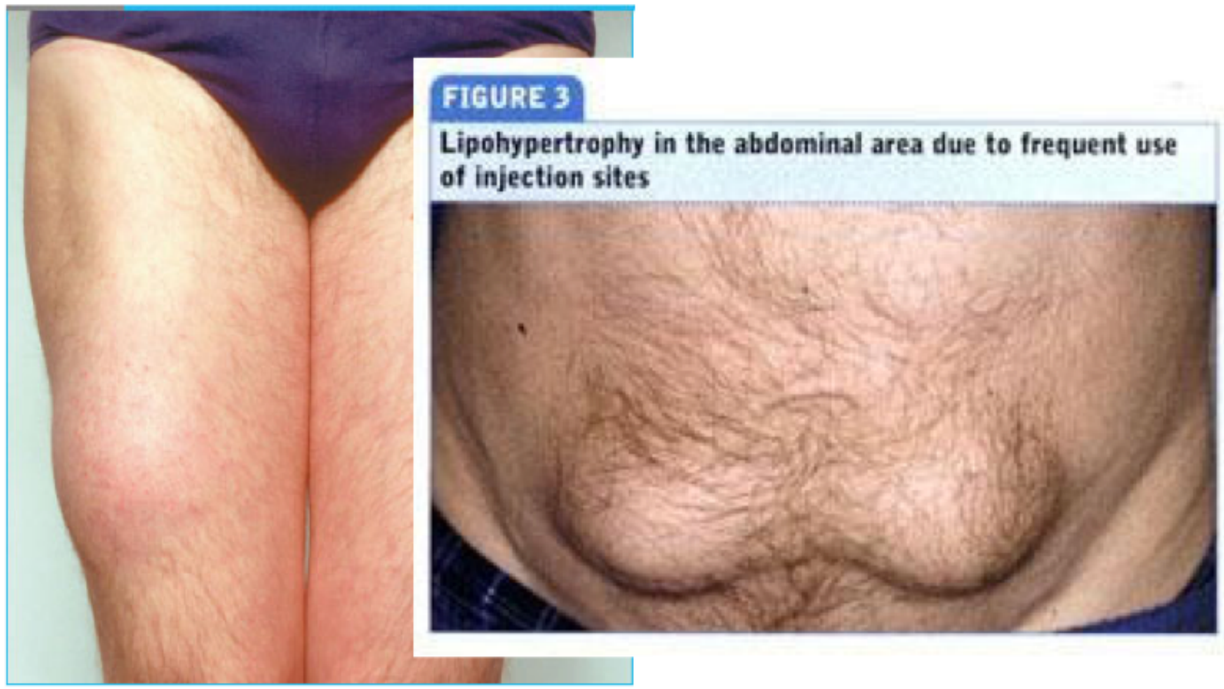


FIGURE 3

Lipohypertrophy in the abdominal area due to frequent use of injection sites

Lipoatrophy

Storage of insulin

- Store insulin in the refrigerator (between 2ºC and 8ºC), away from the freezer or freezing coils.
- Insulin can be kept out of the refrigerator for up to one month (below 25ºC)
  - This avoids stinging when injecting cold insulin and makes re-suspension of cloudy insulin easier.
- Insulin should not be exposed to excessive heat or sunlight.
- Insulin must not be frozen = > discard
- Keep insulin in boxes when not in use to protect from light.

Classification of insulins

- Classified according to duration of action
  1. Ultra-short acting (analogues)
     - Aka. bolus insulin
  2. Short acting/regular/neutral (human)
  3. Long acting (human)
  4. Long acting –(analogues)
     - Aka. Peakless
     - Aka. Basal
  5. Biphasic (mixed)
     - 1. + 4.
     - 2. + 4.
     - 2. + 3.

Most commonly seen today

1. Ultra short acting – analogue insulin

Bolus insulin

Onset	5-15 minutes
Peak	0.5-1.5 hours
Duration of action	3-5 hours

1. Insulin lispro *(Humalog ®)* ***
2. Insulin aspart *(NovoRapid ®)* ***
3. Insulin glulisine *(Apidra ®)*

- Rapid acting insulin analogues
- Given at start of meals or up to 20 after
- Clear solution
- Less risk of severe hypoglycaemia

**Available in combination with modified form to increase duration of action

2. Short acting/ regular insulin/neutral

Onset (S/C)	30 minutes
Peak	2-3 hours
Duration	6-8 hours

AMH

- aka: Soluble/ regular/neutral insulin
- Given ~30 minutes before meals
- Can be given IV (Emergency for DKA) , or SC
- Clear solution
- IV: t½ = 5mins, and action of 30 minutes
- *(Actrapid®, Humulin R ®)* ** Human **
- Bovine (SAS) *(Hypurin Neutral ®) – no longer marketed in Australia*

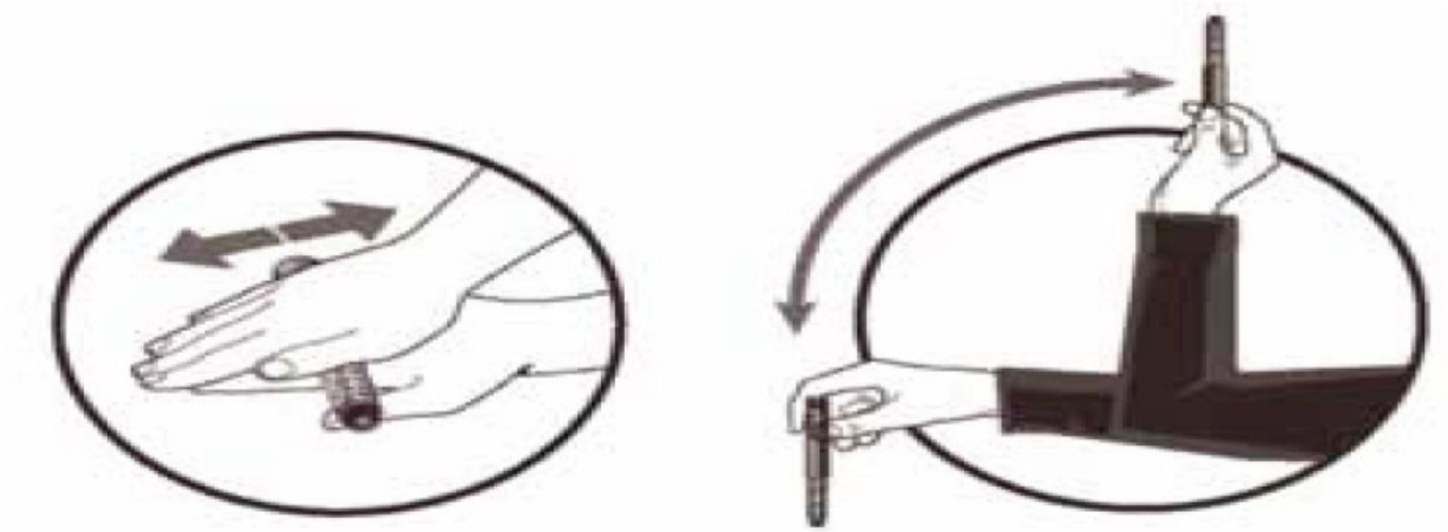
3. Intermediate – Long acting

NPH – neutral protamine Hagedorn (developer)

Onset (S/C)	1-2.5 hours
Peak	4-12 hours
Duration	16-24 hours

- Isophane insulin (NPH) *(Humulin NPH®, Protaphane ®)*
  - Bovine *(Hypurin Isophane®) (SAS)*
  - Suspension with protamine to delay absorption at injection site
  - Give once or twice daily

- **Cloudy** insulin suspensions
- **Cloudy** – rotate/move vial to disperse
- Mixed with short-acting insulin



•Cloudy insulin should be re-suspended by gently rolling the vial between palms of hand OR moving insulin vial (pen) up and down at least 10 x to ensure insulin is

•**Always refer to the instructions provided with the insulin and injection device.**

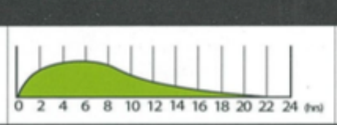
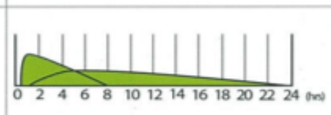
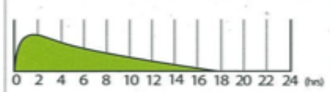
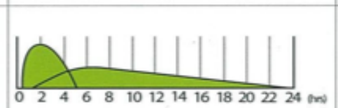
4. Long acting – peakless, basal (analogues) 2018

1. **Insulin detemir** *(Levemir®)*
   - Can be given once or twice daily
   - Dose often wears off before 24 hours
   - Clear
   - Do not mix

2. **Insulin glargine** *(Lantus®)*
   - Constant basal insulin over 24 hours
   - Clear solution
   - Once daily dosing
   - Comes in 2 strengths – not interchangeable
   - Don't mix with other insulins

	Detemir	**Glargine**
Onset (SC)	1-2 hrs	1-2 hrs
Peak	6-8 hrs	No Peak
Duration	12-24 hrs	24hrs

Insulin Time Action Profiles

TYPE OF INSULIN*	INSULIN PATTERN[9]	ONSET OF ACTION (Min)	PEAKTIME (maximal effects) (Hrs)	DURATION OF ACTION (Hrs)	ADMINISTRATION TIME	ROUTE OF ADMINISTRATION
LONG ACTING (Basal Insulin)						
Lantus[®1]			No Peak	24	Same Time Every Day	subcutaneous
Levemir[®2]			3-14	up to 24		
RAPID ACTING						
Apidra[®3] Humalog[®4] Novorapid[®5]		10-20	1-3	3-5	Immediately Before Meal	subcutaneous, *intravenous only in acute conditions*
SHORT ACTING						
Actrapid[®6] Humulin R[®7]		30	2-4	8	30 Minutes Before Meal	subcutaneous, *intravenous only in acute conditions*
INTERMEDIATE ACTING						
Protaphane[®6] Humulin® NPH[7]		60-90	4-12	16-24	Same Time Every Day	subcutaneous
BIPHASIC						
Humulin® 30/70[7] Mixtard® 30/70[6]		30	2-12	16-24	30 Minutes Before Meal	subcutaneous
Mixtard® 50/50[6]		30	4-8	24		
Humalog® MIX 25[4]		15	1	16-18	Immediately Before Meal	
Humalog® MIX 50[4]		15	1	16-18		
NovoMix® 30[8]		10-20	1-4	24		

5. Biphasic – mixed insulins

Premixed combinations

Of fast acting and intermediate acting insulin (analogue)

- Insulin aspart + insulin aspart protamine suspension *(Novomix 30 ®)*
- Insulin lispro + insulin lispro protamine suspension *(Humalog Mix 25 & Humalog Mix 50 ®)*

Of short acting insulin and intermediate [illegible]

- Insulin neutral +insulin isophane (biphasic isophane)
- *(Mixtard® or Humulin ® 30/70, 50/50, 20/80)*
- OR + long acting

Save patient drawing up and mixing insulins before dosing

Improved compliance

Decreased risk of error

Better control

Good summary of insulin in AMH

Do not use insulin when

- The clear soluble insulin has turned cloudy.
- The expiry date has been reached as shown on the vial, cartridge or prefilled device label and carton.
- The insulin has been frozen or exposed to high temperatures.
- Lumps or flakes are seen in the insulin.
- The insulin is discoloured.
- Deposits of insulin are seen on the inside of the vial which remains after initial shaking.

When traveling with insulin

- Keep insulin as cool as possible.
- Store insulin in a small insulated container.
- Protect insulin from temperature extremes (not in check-in luggage)
- Take twice as much insulin as needed in case of breakage or loss.
- Do not keep insulin vials or cartridges in the glove box of a car, as the high temperatures, which may occur especially in summer, may damage insulin.
- Any supplies should be divided and transported in different pieces of hand luggage, so that if one piece of luggage is mislaid, supplies are still available.
- Remember that insulin should not be stored in luggage that will enter the hold of an aircraft as the insulin may freeze during the flight and its action may be altered.