

Best practice in insulin injection technique

A simplified guideline

Adapted from the FIT-India Guidelines 2012
and 2015



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PREFACE

This book has been developed under the NIROGI Lanka Project of the Sri Lanka Medical Association (SLMA), primarily as a reference guide for healthcare professionals of countries of South Asian Federation of Endocrine Societies (SAFES) on the recommended insulin injection technique.

The book is based on the first and second Indian recommendations for best practice in insulin injection, published by the Forum for Injection Techniques (FIT) India in 2012 and 2015. It has been summarised and simplified for easy reference and provides practical guidelines for insulin injection at both healthcare and home settings. Results of Sri Lankan studies have been included regarding use of subcutaneous insulin injecting devices.

Insulin therapy is an essential part of the management in all with type 1 diabetes and many with other types of diabetes. Insulin is commonly prescribed. However, poor practices in insulin injection compromise the quality of the insulin injected and the safety of the patient, resulting in sub-optimal blood glucose control and preventable adverse effects.

The guidelines provided here are a step towards improving the practices in insulin injection among healthcare providers as well as patients and their caregivers. It is hoped that these guidelines and the tools for implementation included here will result in optimal blood glucose control and thereby prevent short-term and long-term complications of diabetics on insulin.

Kusum de Abrew

August 2016

INTRODUCTION

Diabetes mellitus is a non-communicable disease. There are three main types of diabetes. Type 1 diabetes develops as a result of complete absence of insulin production by the pancreas. Hence, people with Type 1 diabetes need insulin for survival. In Type 2 diabetes, there is impaired insulin secretion and reduced action (tissue responsiveness). Gestational diabetes is any degree of impaired glucose tolerance detected for the first time during pregnancy.

There is rising global prevalence of diabetes, with a majority of those affected being from low and middle income countries. Type 2 diabetes accounts for approximately 90% of the total population with diabetes, while Type 1 diabetes affects approximately 5%. Although most Type 2 diabetics are managed with diet and oral anti-diabetes medicines, some of them will need insulin therapy, e.g. to optimize blood glucose control, peri-operatively, during severe infection or other illness or during pregnancy. Most women with gestational diabetes too need insulin therapy for optimal blood glucose control.

Whenever insulin therapy is required, it is essential that best practices in insulin injection are followed. Selecting the injecting device, use of higher gauge fine needles and shorter length needles, correct injection technique, site rotation and proper storage are essential to ensure subcutaneous administration of the correct dose, of quality insulin with minimum pain. In this regard the patients on insulin should be given a prescription to get the correct insulin injecting device with specifications on the needle gauge and the needle length.

Best practices in insulin injection would improve and maintain adherence to insulin therapy and achieve recommended glycaemic targets.

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INSULIN

Insulin is a polypeptide hormone synthesized and stored in granules in the beta cells of the pancreas. Human insulin for injection is found in the form of hexamers (6 molecules together), whereas insulin analogues are found as monomers which diffuse rapidly (Fig 1). Hexamers take approximately 30 minutes to breakdown to monomers in subcutaneous tissue.

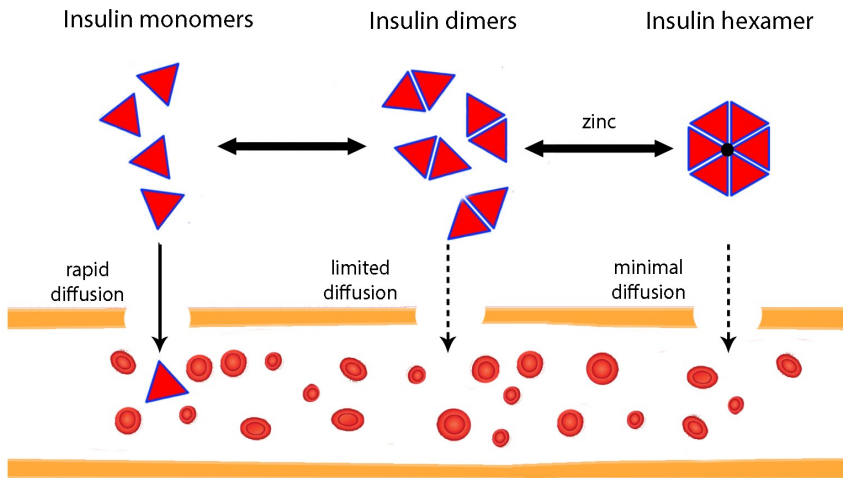


Figure 1: Insulin molecular arrangement and rate of subcutaneous absorption
(adapted from Holleman, 2014)

SOURCES OF INSULIN

Insulin was initially extracted from animal sources, until advances in technology enabled the production of biosynthetic human sequence insulin (Figure 2). Insulin analogues are synthetically produced.

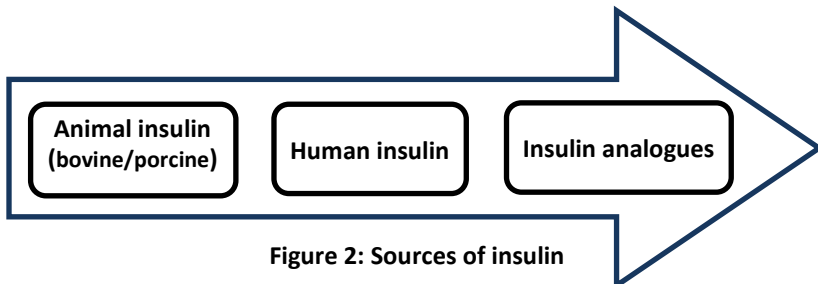


Figure 2: Sources of insulin

INSULIN FORMULATIONS (preparations)

Insulins differ in their constituents, appearance, action and the price. The main formulations are

1. **Soluble insulin:** clear and colourless solution. It is fast acting and has a short duration of action.
2. **Isophane insulin (Neutral Protamine Hagedorn, NPH):** a suspension that contains added protamine for an intermediate duration of action. It appears cloudy.
3. **Biphasic insulin:** some insulins come mixed together (e.g. soluble and isophane insulin is available pre-mixed in different proportions, such as 30/70 or 50/50, in the same vial). It is not possible to adjust the dose of one insulin independently, which is a disadvantage. These are also known as pre-mixed biphasic insulins.

Table 1: Activity of insulin preparations (approx.)

Insulin	Onset	Peak	Duration
Human soluble	<30min	1.5 to 3.5h	7 to 8h
Human isophane	<1.5h	4 to 12h	24h
Rapid acting analogue			
Aspart	10 to 20min	1 to 3h	3 to 5 h
Lispro	15 min	1.5h	2.5h
Long acting analogue			
(e.g. glargine, detemir)*	2.5hr	-	24hr

Adapted from Bennett, Brown & Sharma, *Clinical Pharmacology (11th Ed)*, p. 575.

***Note** long acting insulin analogues glargine and detemir are clear and colourless solutions and should **NOT** be mistaken for soluble insulin.

Note: each component of pre-mixed insulin will have the individual onset, peak and duration, contributing to the final effect. E.g. 30/70 biphasic insulin will have an onset of action <30 minutes (effect of short acting component), peak action lasting for 2-8 hours (effect of both components) and a duration of 24 hours (effect of intermediate acting component) .

STRENGTH OF INSULIN IN A FORMULATION

Insulin is measured in units. “U100” insulin is so called as there are 100 international units (IU) of insulin in 1 milliliter of the preparation. Therefore a 10ml vial of insulin contains 1000 units of insulin. U100 insulins must be injected with a U-100 insulin syringe (not with U-80 or U-40 insulin syringes). Some countries may still use lower strength insulins, which should be used with appropriate syringes. U-40 and U-80 syringes should be used for 40 IU/ml and 80 IU/ml strengths respectively.

Always ensure syringe and vial (strength) compatibility

U100 insulin (100 IU/ml) → U-100 syringe*

U80 insulin (80 IU/ml) → U-80 syringe*

U40 insulin (40 IU/ml) → U-40 syringe*

*Note: all are 1 ml syringes

STORAGE AND STABILITY

Insulin vials should ideally be stored between 2-8⁰C in the middle compartment of a refrigerator (Figure 3A). In settings, where a refrigerator is not available, at higher room temperatures, the vial in use should be stored wrapped in a plastic bag in a cool place <25⁰C, in a clay pot or a flask (Figure 3B) and discarded in 30 days.

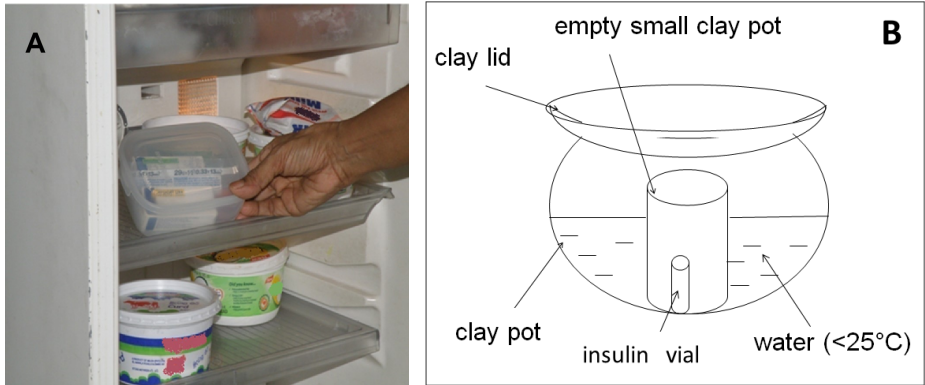


Figure 3: Insulin storage

If stored above 25°C it may be used for a few weeks and should be discarded in 2-3 weeks. Do not use insulin past the expiry date.

In hospital settings, vials in use by in-ward patients should be stored in a refrigerator, even if the room temperature is between $15\text{-}25^{\circ}\text{C}$. This is to reduce chances of contamination or sudden fluctuations in temperature and prevent medication errors.

Extreme temperatures destroy insulin. Do not freeze insulin. If frozen by mistake, it should be discarded. Vials should not be exposed to direct sunlight or heat. Avoid storing in the kitchen, on top of electrical appliances or heaters. Do not keep vials in the glove compartment (cubby) of a car and leave in a stationary car with closed windows.

Prior to use, insulin vials should be inspected thoroughly. Soluble insulin should appear clear, colourless and have no floating particles (Figure 4).



Figure 4

Insulin suspensions (e.g. Isophane or any pre-mixed insulin) form a sediment at the bottom of the vial if allowed to stand for a while (Figure 5). All insulin suspensions should be re-suspended by gently rolling between the palms (Figure 6) or tilting 20 times for even mixing. Do not shake the vials.

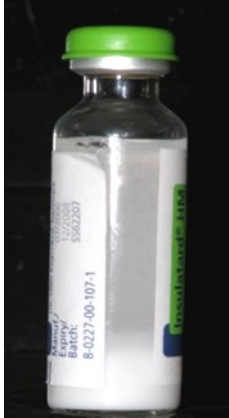


Figure 5



Figure 6: re-suspension of insulin

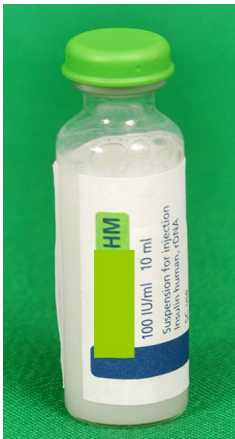


Figure 7

The re-suspended insulin should be visually checked to ensure a uniform milky white appearance prior to injection (Figure 7). There should be no discolouration, floating particles or crystals after re-suspension. Inadequate re-suspension leads to the following dosing errors:

- An incorrect dose of the preparation is drawn into the syringe.
- The remaining insulin will be of inappropriate strength and proportion.

STORAGE OF INSULIN DURING TRAVEL

Surface travel: Carry in a handbag or insulated container. A separate ice pack can be used if outside temperature is $>30^{\circ}\text{C}$. The ice should not touch the insulin vial. Insulin should never be kept in the glove compartment (cubby) of a car.

Air travel: Take sufficient/extra supplies of insulin and devices in the hand luggage to last the trip. Insulin should not be packed in checked baggage. Patients should be advised on change of the injection schedule if they are crossing 2 or more time zones.

SELECTION AND USE OF INSULIN DELIVERY DEVICES

1. Syringes and needles
2. Insulin pens

Syringes and needles

Many people who take insulin use a syringe. The current recommendation is to use short and fine gauge needles with a special coating to ensure injections are as smooth, easy and painless as possible.

Syringe specifications: Syringe and vial compatibility has to be checked at all times.

- Insulins of 100 IU/ml (strength) should always be used with a U-100 syringe.
- All 1ml syringes are not insulin syringes. Check if the syringe is clearly marked as a U-100 syringe with the correct needle gauge and length (Figures 8 & 9). See page 9 for needle specifications.

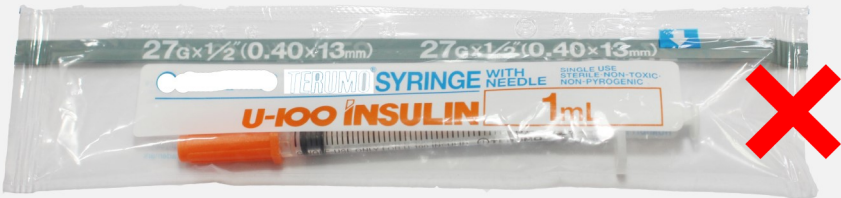


Figure 8: U-100 syringe, 27G x 13mm (NOT recommended: see page 9)

A



B

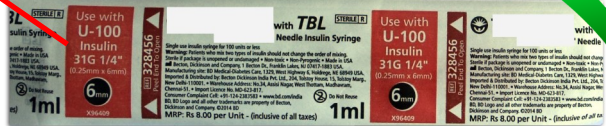


Figure 9A: U-100 syringe (30G x 8mm: use with a skin fold)

Figure 9B: U-100 syringe (31G x 6mm)

- The U-100 syringe is a 1ml syringe with an orange needle cover and black calibrations up to 100. Usually, each black scale marking indicates two (2) units (Figure 10).

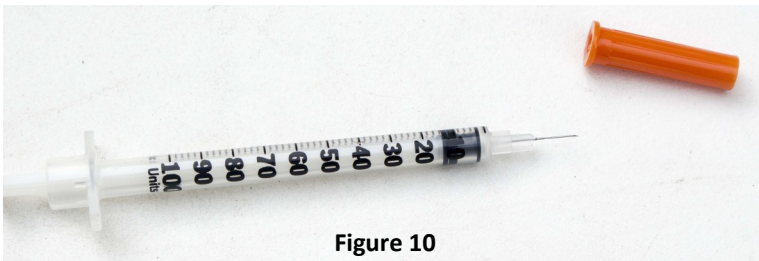


Figure 10

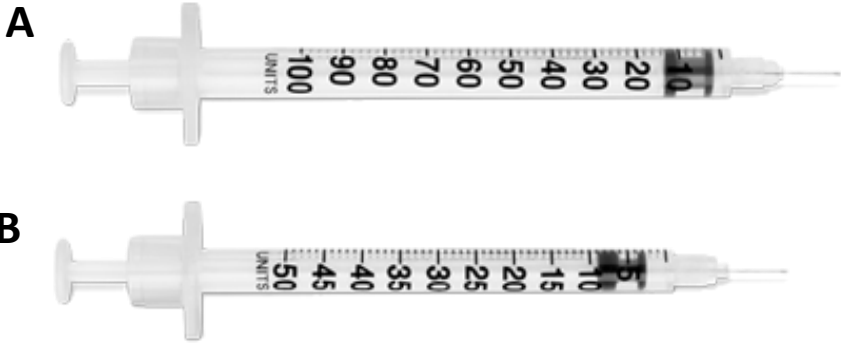


Figure 11

- Sometimes in U-100 syringes each marking may indicate one (1) unit and these syringes are suitable for use in children. (Figure 11A)
- Sometimes 0.5ml U-100 syringes marked up to 50 (where each marking indicates 1 unit) may be available. These are suitable for use in children and also in adults on doses less than 50 units. (Figure 11B).

Note: for countries using U-40 syringes: the syringe specifications are different. This 1ml syringe has a red needle cover and scale marking in red up to 40. Each marking indicates one (1) unit (Figure 12). U-40 syringes should only be used with insulin of 40 IU/ml strength.



Figure 12

Needle specifications for insulin injection

Gauge and length of needles

- recommended needle gauge for subcutaneous insulin injection is 29G to 31G.
- Needles less than 29G **should not** be used as they cause more pain. Higher the gauge of the needle, the finer and thinner it is, causing less pain.
- For subcutaneous injection in children, adolescents and adults the current recommendation is to use needle lengths of 4-6mm. They are long enough to pass through the skin which has a mean thickness of about 2.2 mm, measured by ultrasonography. Short needles are safe (does not pierce the underlying muscle), efficacious and cause a less painful injection. There are less leakage events compared to longer needles.
- Shorter needles help minimize injection fear and improve adherence to injection therapy.
- There is no clinical reason to use a needle longer than 6mm in children, adolescents and in adults (even if obese).

Needles longer than 6mm are more likely to pierce the underlying muscle and may cause a sudden drop of blood glucose due to rapid absorption of insulin from the injection site causing hypoglycaemia. Hence, needles of 8mm and above should always be used with a skin fold to prevent inadvertent intramuscular injection.

[Intramuscular insulin injections are recommended only in the management of hyperglycaemic emergencies, when there is non-availability of an insulin infusion pump.]

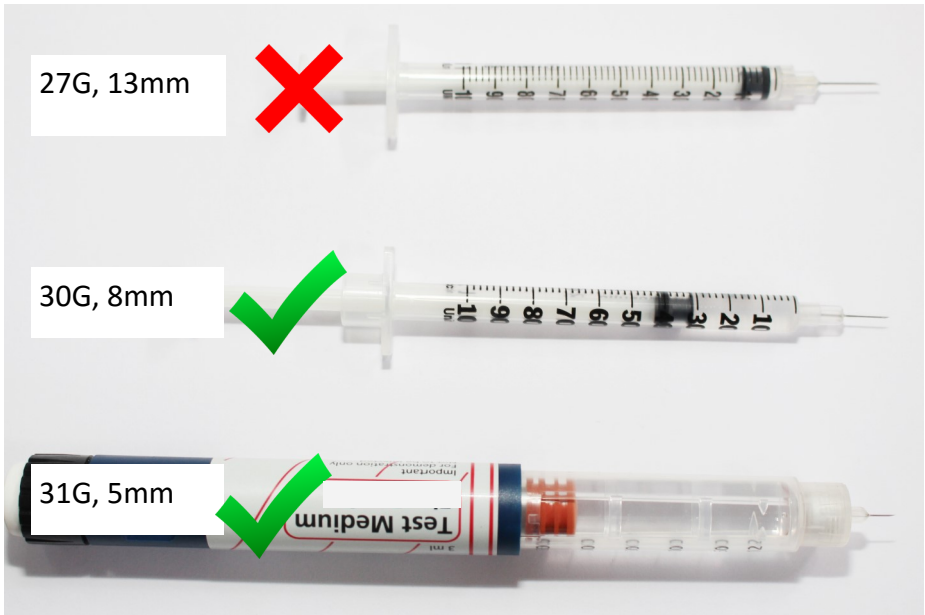


Figure 13: Comparison of lengths and gauges of needles

- ◆ Both the needle gauge and the length are inappropriate in 27G, 13mm needles.
- ◆ Although the needle of 30G is recommended, the 8mm needle length is recommended only if 6mm needles are not available and the injections with 8mm needles should always be given to a raised skin fold or injected at an angle of 45° to the skin where appropriate.
- ◆ Insulin pens with 31G, 5mm needles; insulin should be injected into a skin fold in children (Figure 13).

The needles fixed to the syringe is preferred over needles that can be separated. This prevents leakage from the needle-syringe junction.

ESTIMATED INTRA-MUSCULAR INJECTION RISK WITH DIFFERENT NEEDLE LENGTHS IN SRI LANKAN ADULTS AND CHILDREN

Subcutaneous thickness of potential insulin injection sites were ultrasonically measured in adults and children. Results are summarized in Table 2.

Table 2: Estimated % risk of IM injections

Needle length	Arm %		Thigh %		Abdomen %	
	No skin-fold	With skin-fold	No skin-fold	With skin-fold	No skin-fold	With skin-fold
Adults						
n=188						
13 mm	63	47	64	43	33	17
8 mm	36	25	33	21	19	6
Children						
n=131						
15 mm	97	88	98	86	83	70
5 mm pen needle	41	12	38	12	37	9

*de Abrew K *et al.*, 2015

Tuberculin syringes and other 1 ml syringes are not recommended for insulin injection. Before selecting an insulin injection device confirm the syringe is a **U-100 INSULIN SYRINGE** with a needle gauge of 30 -31, needle length of 6-8mm for adults and 4-6mm for children and adolescents. All injections with **>4mm needle length** should be given to a raised skin fold. In **children aged 2-6 years** injections with even a 4 mm needle should be given to a raised skin fold.

A “Tuberculin syringe” (Figure 14) has a needle gauge of 25 with a needle length of 15-16mm and results in painful injections, high risk of intramuscular injections and non adherence to insulin therapy. The graduation are in 0.01cc, which makes it difficult to draw the correct dose of insulin, which is prescribed in units.



Figure 14: tuberculin syringe

A clinical audit in 63 wards of the NHSL has revealed that tuberculin syringes and 15mm needles are being used for insulin injection by 84% and 92% of wards respectively. Needles with inappropriate needle gauge was used in all wards; 54% (25G), 46%(26G). (de Abrew K *et al.*, 2015).

Insulin pens

An insulin pen is like a fountain pen, and can be carried around in the pocket (Figure 15). Instead of the writing point, there is a needle. Instead of ink, there is an insulin filled transparent plastic container (cartridge). An insulin cartridge contains only 3ml of insulin (300 IU of insulin), compared to a 10ml vial of insulin which contains 1000 IU of insulin.

An insulin pen can only use one type of insulin cartridge at a time (either soluble, isophane or pre-mixed human insulin or insulin analogues). There are 2 types of insulin pens; reloadable and disposable.

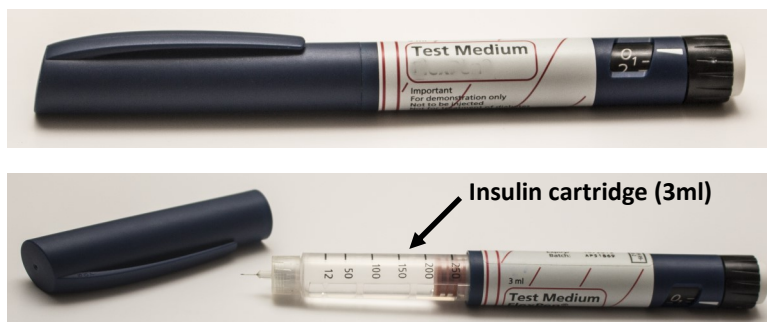


Figure 15: disposable insulin pen

Injecting with insulin pens is convenient and accurate. They are particularly useful for children, and for people with busy work schedules, field work and during long distance/air travel.

Insulin pen needles

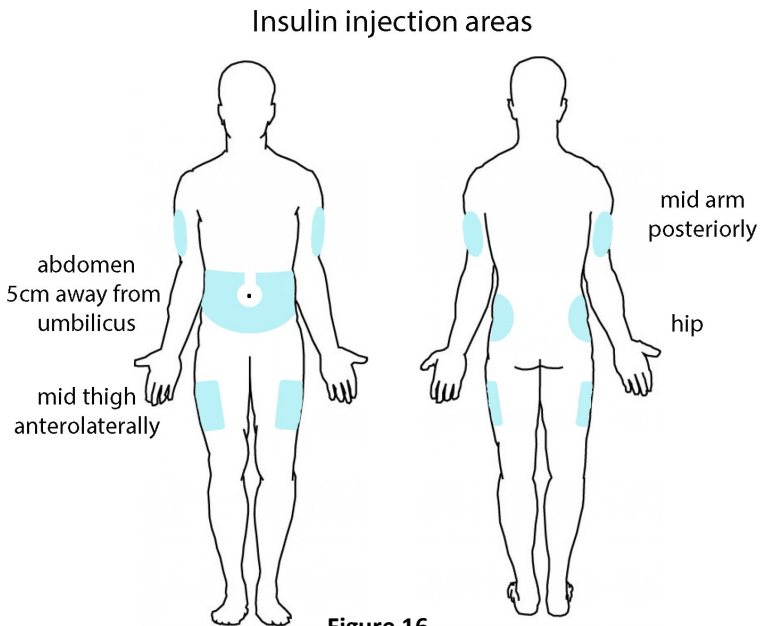
Gauge and length of needles

- The standard gauge is 30G to 32G. The length may be 4-6mm.

AREAS FOR SUBCUTANEOUS INSULIN INJECTION (Figure 16)

Insulin is injected into the fat tissue layer under the skin (subcutaneously) and should not be given into the muscle (intramuscularly)

1. Anterior abdomen: 5cm away from the umbilicus laterally , and 2.5cm above and below the umbilicus.
2. Arm: posterior middle third of the arm, between the shoulder and elbow joints.
3. Thigh: anterior and outer aspect of the middle third of the thigh, between the anterior superior iliac spine and the knee joint.
4. Buttocks: upper outer quadrant, more suitable for children. (Buttocks are usually avoided for insulin injection in older children and adults).



CLEANING THE INJECTION AREA

This is the single most important procedure for preventing infection.

1. Ensure the area is “socially clean”: Injections should never be given to skin considered “unclean” i.e., the skin should be free of dirt, secretions, etc. If found unclean, it should be cleaned with soap and water. Injections should always be given to a clean area with clean hands.

Dermatological disease

Insulin injection should be avoided at areas of active or recently healed infection or inflammation. Avoid keloids, scars and lesions such as in psoriasis. Areas with stable vitiligo and acanthosis nigricans are not contraindications for insulin injection.

Do not inject to areas of lipohypertrophy (see page 37). Areas of lipotrophy; may inject to a **raised skin fold** provided that a **short needle** is used as there is very little subcutaneous tissue.

2. Cleaning immediately prior to injection
 - Alcohol swabs or cotton balls dipped in water may be used.
 - Clean the entire area.
 - Start from the middle and move outwards in a circular motion.
 - Do not use soaps or detergents for cleaning immediately before injection.
 - The area should be completely dry before Injection.

LIFTING A SKIN FOLD

This is considered when the distance between the skin and the muscle is less than the length of the needle. Use of a skin fold avoids indentation of skin and soft tissue and prevents the injection penetrating the muscle.

- The thumb and index finger (if necessary the middle finger as well) are used to lift a skin fold properly.
- Avoid use of the whole hand to lift the skin as it risks lifting the muscle as well (Figure 17).

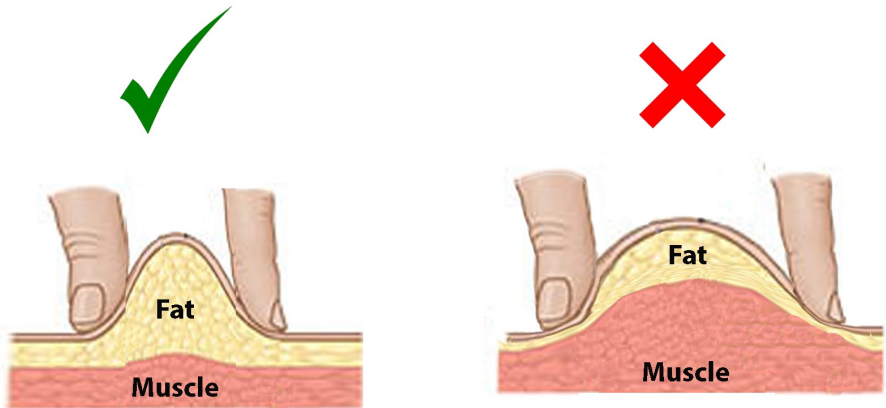


Figure 17: lifting a skin fold

- There should not be skin blanching or pain when lifting a skinfold.
- The technique of lifting a skin fold should be demonstrated and also provided in writing to the patient/caregiver.

People with diabetes on insulin therapy and caregivers should be taught the correct technique of lifting a skin fold from the onset of insulin therapy.

RATE OF INSULIN ABSORPTION FROM DIFFERENT AREAS

The rate of insulin absorption varies in the different injection areas,

Rate of absorption from abdomen > arm > thigh

Daily injection of insulin should be to the same area, and this same area can be used for 6-12 weeks. Injection of insulin into the same area (abdomen OR upper arm OR thigh) ensures absorption at the same rate. This will avoid fluctuation of blood glucose levels due to different rates of absorption from different areas.

If a person is on more than one insulin injection per day, different areas may be used to inject at different times. For example a person taking insulin twice a day may inject the morning dose to the thigh and the evening dose to the abdomen. This same pattern of area selection should be used daily.

At the end of 6-12 weeks, when the area of injection for a given time is changed (e.g. the area for the morning dose may be changed from the thigh to the arm) blood glucose should be monitored for a few days as the rate of absorption of insulin is different.

ROTATION OF INJECTION SITES

The point or site of insulin injection should be changed daily, within the same area.

- If insulin is injected to the same site (point on the surface of the skin) in a particular area, it leads to lipodystrophy (lipohypertrophy with human insulin and lipoatrophy with animal insulin).

- Insulin injected to areas of lipodystrophy is absorbed irregularly.
- Repeated injection to the same site can also cause skin damage, bleeding etc.

SITE ROTATION SCHEME

Option 1

The selected area for injection should be divided into halves or quadrants depending on the size of the area (Figures 18 & 19).

- Within each division, the injection site should be rotated .
- This should be in the same direction either clockwise or anti-clockwise .
- Each site (point of injection) should be spaced a minimum of 1 cm from the others to avoid repeated tissue trauma.
- The point of injection should be rotated in each division over several days. Then move on to the next division.

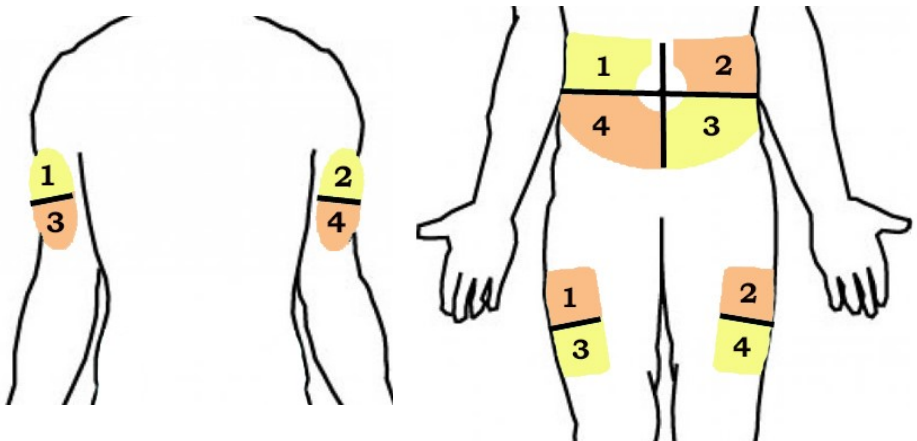


Figure 18: division of injection areas
(adapted from FIT India, 2015)

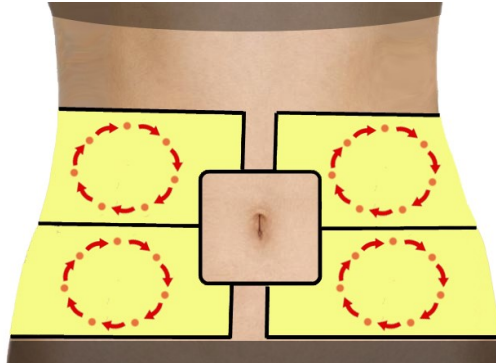


Figure 19: rotation within areas (adapted from FIT India, 2015)

Option 2

The area may be divided into outer and inner circles. Site rotation can be done either clockwise OR anti-clockwise consistently (Figure 20).

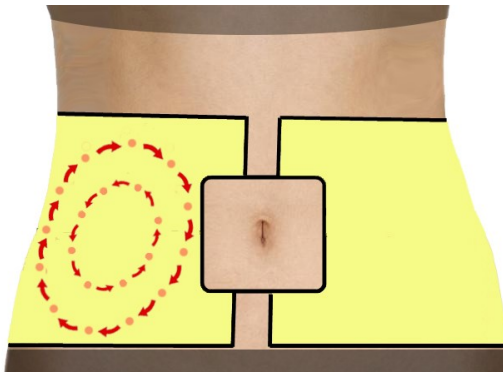


Figure 20: inner and outer circles

Allow the patient or care giver to select the most convenient method of site rotation from the options above.

- Site rotation should be audited at review and recorded (see insulin initiation card, page 50).

A site rotation scheme should be followed to optimize insulin absorption, reduce risk of lipodystrophy and maintain healthy skin

INJECTION TECHNIQUE

TIMING

Timing of insulin injection with respect to meals is critical for proper glycaemic control as well as preventing hypoglycaemia. Insulin injections are most effective and safe when given before a meal.

INJECTION - TO - MEALTIME GAP

- Soluble (short acting), isophane (intermediate acting) and pre-mixed (biphasic) insulin have a delayed onset of action and should be injected 30 minutes before a main meal.
- For patients who experience post meal hypoglycaemia, injecting soluble insulin 15–20 minutes before a meal would be helpful to prevent hypoglycaemia.
- Rapid acting insulin analogues (lispro/aspart/glulisine) can be injected up to 15 minutes before or 20 minutes after starting a main meal, as there is less delay in the onset of action.
- Long acting insulin analogues (detemir/glargine) should be injected once a day. While there is no specific injection to mealtime gap, it should be injected at the same time everyday.
- The mealtime may be decided according to the routine of the patient (e.g. some may have breakfast at 6.30am while others may prefer it at 8.00am). However, the timing should be consistent so that the injections can be administered at the same time every day. A steady time interval between daily injections enhances the glucose lowering effect and prevents blood glucose fluctuations.

Where ultra long acting insulin (degludec) is used, no specific injection - to - mealtime gap is recommended. Thus, the injections are independent of the mealtimes. The injections may therefore be given at any time of the day, preferably at the same time daily. However, a minimum of 8 hours between injections should always be ensured.

The inter-injection period may vary between 8-40 hours, depending on the patient's requirement as recommended by the physician.*

**Type 2 diabetes: insulin degludec, NICE advice [ESNM25], September 2013*

Table 3: Summary of insulin to mealtime gap

Insulin	Recommendation
Human soluble	20-30 minutes before a meal as required
Human isophane	
Pre-mixed (biphasic)	
Rapid acting analogue	Up to 15 minutes before or up to 20 minutes after starting the meal
Long acting analogue	None
Ultra-long acting analogue	None

INJECTION TECHNIQUE - SYRINGE AND VIAL

IMPORTANT

- Ensure the insulin is at room temperature, by taking the vial out of the refrigerator 15-30 minutes prior to injection
- Check expiry date
- Check vial for damage, change in colour, clarity or presence of unusual particles

WHEN ONE TYPE OF INSULIN IS USED (Figure 21)

STEP 1 : Wash your hands and wipe with a clean cloth/tissue

STEP 1A : Select and clean the injection area (refer page 14)

STEP 2: If isophane or pre-mixed (cloudy) insulin is used roll the vial 20 times between the palms until it is uniformly cloudy (mixed). Never shake a vial of insulin.

Step 3: Wipe the top of the insulin vial with a surgical spirit swab.

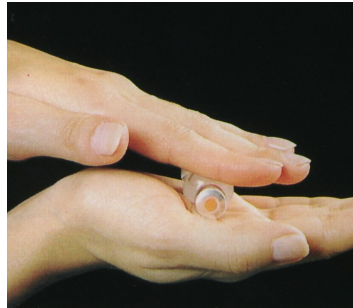
Step 4: Draw air into the syringe equal to the insulin dose to be injected.

Step 5: With the same needle and syringe, pierce the centre of the rubber stopper of the vial gently without touching the metal part at a 90° angle and push the air into the vial.

Step 6: Turn the insulin vial upside down and slowly and steadily draw insulin into the syringe equal to the dose to be injected. The needle should be carefully removed from the vial by holding the syringe by the barrel.



Step 1



Step 2



Step 3



Step 4



Step 5



Step 6

Figure 21: insulin injection steps 1—6

REMOVING AIR BUBBLES

- Check for air bubbles before removing syringe and needle from vial
- If air bubbles are present, tap on the syringe to make the bubbles rise up
- Push back insulin and the bubbles into the vial
- Slowly draw the correct dose of insulin again
- Repeat the process until there are no air bubbles

STEP 7 : Lift a skin fold in the selected area between the thumb and the index finger (refer page 15 and figure 22). Push the needle through the skin and inject rapidly and smoothly. Avoid indenting the skin as it makes the needle penetrate deeper than intended.

STEP 8 : Wait for ten seconds (count to ten) before pulling the needle out. This prevents leakage of insulin from the injection site.

STEP 9 : Release the skin fold after withdrawing the needle.

STEP 10 : Press a dry cotton wool swab on the area. Do not massage.

STEP 11 : Dispose of the used syringe and needle carefully by either clipping off the needle with a safe clip or placing in a sharps collector. If a sharps collector is not available, a hard plastic or metal container with a screw-on or tightly secured lid may be used.

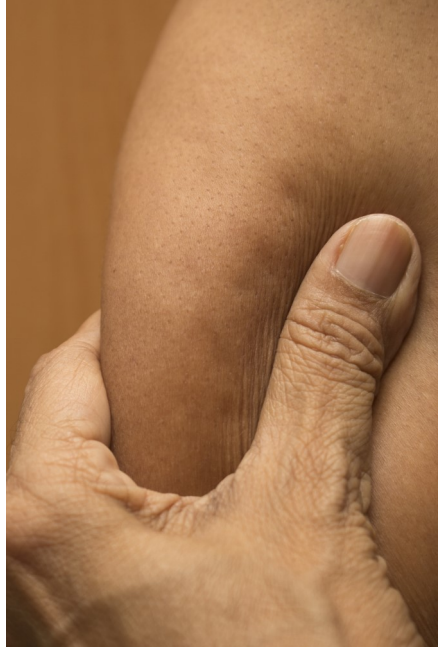
REUSING NEEDLES

Ideally, a needle should never be reused. In resource poor settings, the needle may be reused if no alternative is available (see page 32).

TAKING A SKIN FOLD



Correct method



Wrong Method

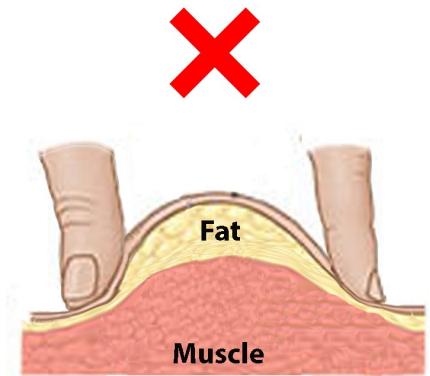
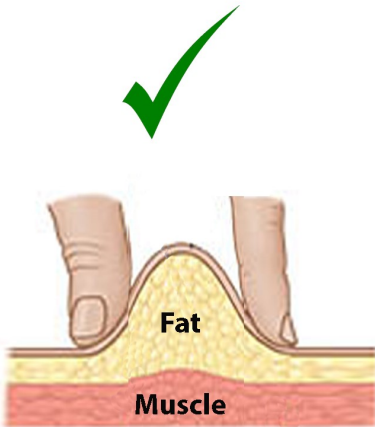


Figure 22: lifting a skin fold

MIXING TWO TYPES OF INSULIN (drawing two types of insulin into the same syringe)

Sometimes it may be required to mix short acting insulin or a rapid acting insulin analogue with intermediate acting insulin in the same syringe. This may be done in the following situations

- Unavailability of pre-mixed insulin
- Requirement of a specific proportion of each type, that is not available as pre-mixed insulin e.g. 35:65
- Pre-mixed insulin is unaffordable by the patient

RECOMMENDATIONS

- Human short acting insulin can be mixed with intermediate acting human (NPH) insulin in the same syringe, in every ratio.
- Rapid acting insulin may be mixed with isophane insulin (protamine stabilized insulin, NPH).
- During mixing, the short acting/rapid acting insulin should be drawn into the syringe **first**, followed by the intermediate acting insulin.
- Insulin should be injected **immediately** after drawing (both insulins) into the syringe.
- Insulin glargine **should not be mixed** with other insulins, because of the resulting low pH of the diluent would interfere with its rate of absorption.

WHEN TWO TYPES OF INSULIN ARE USED (MIXING)

STEP 1: Wash your hands and wipe with a clean cloth/tissue

STEP 1A: Select and clean the injection area (refer page 15)

STEP 2: If isophane (cloudy) insulin is used roll the vial 20 times between the palms until it is uniformly cloudy (mixed). Never shake a vial of insulin.

STEP 3: Wipe the top of both insulin vials with a surgical spirit swab.

STEP 4: First draw air into the syringe equal to the dose of isophane (cloudy) insulin, pierce the centre of the rubber stopper of the vial gently without touching the metal part at 90⁰ angle and push the air into the isophane insulin vial. Do not draw insulin at this stage. Now remove the empty syringe and needle from that vial.

STEP 5: Having the same syringe used in step 4, now draw air into the syringe equal to the dose of soluble (clear) insulin and push the air into the soluble insulin vial.

STEP 6: Turn the soluble insulin vial upside down and slowly and steadily draw insulin into the vial equal to the dose to be injected. Remove any air bubbles (refer page 24). Carefully remove the needle from the vial by holding the syringe by the barrel.

STEP 7: Using the soluble insulin containing syringe used in step 6, hold the vial of isophane (cloudy) insulin and insert the needle carefully through the rubber stopper. Slowly draw insulin into the syringe up to the **total dose** of insulin. Ensure that you do not draw extra insulin as it cannot be pushed back into the vial.

STEP 8: Lift a skin fold in the selected area between the thumb and the index finger (ref. page 24). Push the needle through the skin inject rapidly and smoothly.

STEP 9: Wait for ten seconds (count to ten) before pulling the needle out.

STEP 10: Release the skin fold after withdrawing the needle.

STEP 11: Press a dry cotton wool swab on the area. Do not massage.

STEP 12: Dispose of the used syringe and needle carefully by either clipping off the needle with a “safe clip” or placing in a sharps collector. If a sharps collector is not available, a hard plastic or metal container with a screw-on or tightly secured lid may be used.

CHANGING FROM PRE-MIXED INSULIN TO MIXING OF INSULIN

E.g. changing from 18 units of pre-mixed (biphasic) insulin 30/70

- * To match the 30/70 proportion, $1/3^{\text{rd}}$ the dose (6 units) should be short acting and $2/3^{\text{rds}}$ should be intermediate acting insulin (12 units).

Similar proportions of the short acting and intermediate acting insulin are used.

Pre-mixed insulin

30/70

100 IU/ml

Dose: 18 units



Short acting

($1/3^{\text{rd}}$) = 6 units



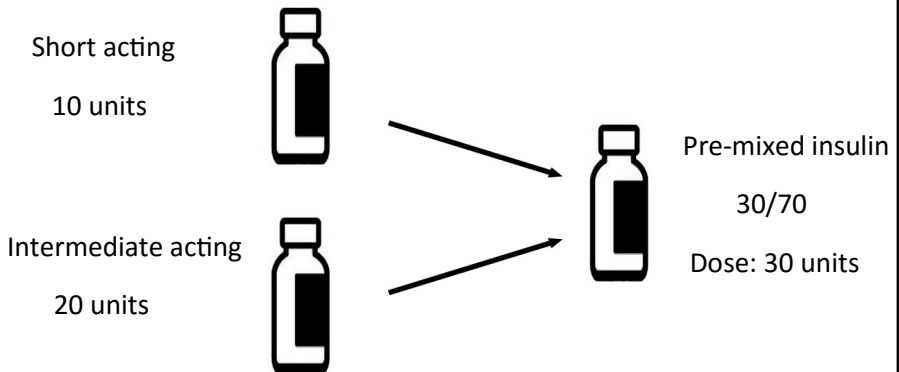
Intermediate acting

($2/3^{\text{rds}}$) = 12 units

CHANGING FROM MIXING INSULIN TO PRE-MIXED INSULIN

E.g. changing from mixed insulin 10 units of short acting + 20 units of intermediate acting insulin

- * 30 units of pre-mixed (biphasic) 30/70 insulin (100 IU/ml strength) can be given as this contains a similar proportion original dose.



If equal proportions of soluble and isophane insulin are required, it is necessary to use 50/50 Pre-mixed insulin

INJECTION TECHNIQUE - INSULIN PEN

There are two types of insulin pens

1. Disposable pens with a fixed cartridge
2. Pens that use reloadable insulin cartridges.

An insulin pen can hold only one type of insulin at a time, either short acting, intermediate or pre-mixed (biphasic). Therefore, if more than one type of insulin is used during a day, there should be separate pens carrying each type.

Pen devices and cartridges are for single person use only. These should never be shared with others.

Priming of the insulin pen

Prior to **each** injection, select 1-2 units of insulin. Hold the needle upwards and press the push button to release any air bubbles and discard any residual insulin.

REUSING NEEDLES

- Ideally, a pen needle should not be reused.
- Use of a new pen needle at each administration reduces clogging of the needle and prevents inaccurate dosing and needle breakage while in the skin.
- In resource poor settings, the needle may be reused 2-4 times if no alternative is available (see page 32)

Injection technique with the insulin pen

STEP 1 : Wash your hands and wipe with a clean cloth/tissue

STEP 1A : Select and clean the injection area (refer page 15)

STEP 1B : If an insulin **suspension is used** tilt the pen 20 times up and down to evenly mix the suspension

STEP 3: Attach new needle. Select 1-2 units of insulin and prime the needle

STEP 4 : Select the dose to be injected by turning the dose dialing device clockwise. Each unit is indicated with a click and the dose is displayed on the dose display window (see figure 15)

STEP 5 : Approach the skin at 90° and insert the needle rapidly and smoothly.

STEP 5A : Usually pen needles are 4-5mm of length. Administration into a skin fold prevents piercing the muscle, even with short needles.

STEP 6 : Press the push button until the dose display comes to zero.

STEP 7 : Wait for ten seconds (count slowly to ten) before pulling the needle out. This is to ensure full dosage administration and to prevent leakage. With higher doses a longer waiting period may be required.

STEP 8 : Press a dry cotton wool swab on the point of injection. Do not massage the injection site.

STEP 9 : Immediately after the injection, remove the needle from the pen and dispose safely. Do not leave it attached to the pen. This is to prevent air entry into the cartridge and leakage of insulin from the cartridge.

PREVENTION OF NEEDLESTICK INJURIES

Needlestick injuries commonly occur in patients as well as in healthcare professionals while recapping needles.

It is essential to instruct the patient on disposal of used needles and syringes at the time of initiation of insulin therapy

The syringe with the needle should be put into a sharps bin (Figure 23A) immediately after injection (without recapping) in hospital or healthcare settings. In other settings, the needle should be clipped off with a “safe clip” (Figure 23B) and the syringe thrown into garbage.

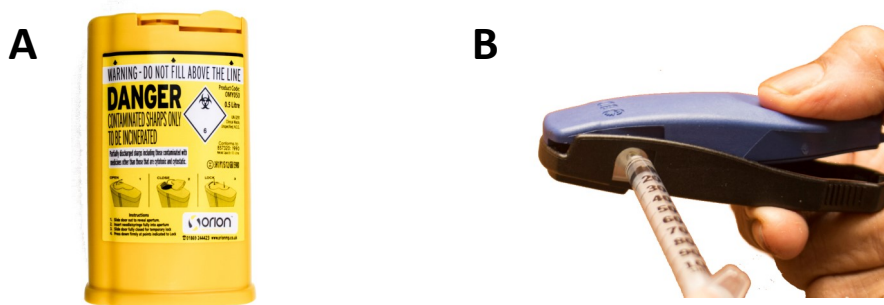


Figure 23: sharps bin and “safe clip” for needle disposal

If a “safe clip” is not available, the patients and family should be instructed to put used needles and syringes into a puncture proof box labelled ‘used needles and syringes; biohazard’. They should not be thrown into public trash bins or areas. When the box is full it should be handed over to appropriate centres such as hospitals, or waste management centres for disposal. The disposal mechanisms may vary from time to time according to national/ local regulations and guidelines. Empty pen devices can be disposed with the household garbage.

NEEDLE/SYRINGE HYGIENE

Injection through clothing is not recommended due to the following reasons

- The sterility and lubrication of the needle is lost
- It is not possible to clean the site of injection

Even though the United States Food and Drug Administration (USFDA) recommends an insulin needle to be used only once, due to economic reasons patients tend to re-use a single needle several times. Patients should be educated on the hazards of needle re-use, importance of not sharing the same needle with others, and on technique of recapping the needle aseptically.

The following consequences of needle reuse should be discussed with patients:

- Damage to the thin tip of the needle making it blunt; needle may bend; silicone lubricant coating of the needle is lost; higher chance of insulin getting deposited within the needle. These lead to painful injections, dosage inaccuracy, damage to tissues causing lipohypertrophy, bleeding and bruising, needle breaking off and lodging under the skin.
- Increase the risk of contamination and infection
- When using insulin pen: Leaving the needle attached to pen after injecting insulin may lead to air passing into insulin chamber causing air bubbles and resultant inaccurate dosage.
- Cleaning the needle with alcohol prior to re-use should be discouraged as this removes the silicone coating of needle leading to more painful injections.

EXTERNAL INSULIN PUMP INFUSION

Insulin pumps are small programmable devices that can deliver a continuous subcutaneous infusion of insulin (Figure 24). Insulin infusion pumps are indicated when;

1. Attempts to reach target haemoglobin A1c (HbA1c) levels with multiple daily injections result in the person having 'disabling hypoglycaemia', or
2. HbA1c levels have remained high (8.5% or above) with multiple daily injections (including using long-acting insulin analogues, if appropriate) despite the person and/or their carer carefully trying to manage their diabetes (NICE guidance, 2008).

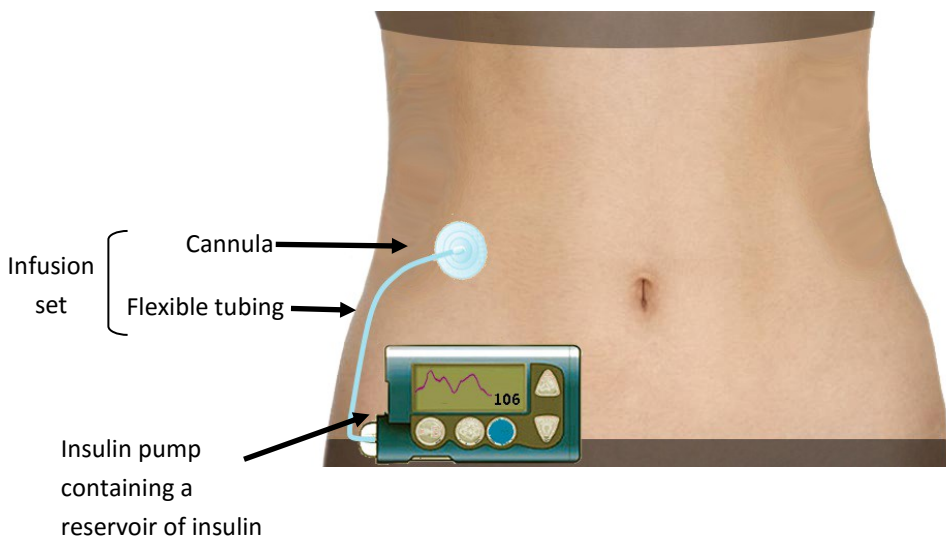


Figure 24: insulin infusion pump

Typical devices have a two to three day supply of short acting insulin connected to an infusion set attached to a small needle or cannula.

Insulin can be delivered as

1. A continuous basal dose
2. Bolus doses during meal times or for correction of hyperglycaemic episodes

Insulin pump therapy should only be started by a trained specialist team. This team should include a doctor who specializes in insulin pump therapy, a diabetes nurse and a dietitian. This team should provide structured education programmes and advice on diet, lifestyle and exercise that is suitable for people using insulin pumps.

Summarizing existing guidelines for insulin pump infusions is beyond the scope of this publication. There is a need to develop customized guidelines on for SAFES Countries, considering the education, ethnicity, dressing styles, resources and weather, while ensuring clinical efficacy and avoiding infections (FIT India addendum).

TROUBLE SHOOTING

PAIN

Patient adherence to insulin therapy is largely affected by pain associated with insulin injections, which may result from incorrect injection technique or irritation of nerve endings by the needle. Some patients develop needle phobia due to previous undesirable experiences with insulin injections.

Ten steps towards a painless injection

1. Use new needles; (Do not use bent or blunt needles)
2. Use short needles of fine gauge
3. Allow the alcohol or water used to clean the site of injection to dry completely before injecting
4. Inject insulin once it is at room temperature as cold insulin causes pain
5. Remove air bubbles if any from insulin in the syringe before injection
6. Avoid injecting at hair roots
7. Insert the needle at 90° to skin
8. The injecting procedure; inserting the needle through the skin, injecting the insulin and withdrawing the needle should be done gently, smoothly yet quickly
9. Keep the hand steady during injection process; do not rotate needle (injecting into a skin fold would help needle stability)
10. If using a large dose, consider splitting it into smaller doses and

LIPHYPERTROPHY

Lipohypertrophy is a localized lesion at the injection area often resulting from chronic reuse of needles or not rotating injection sites (repeated injections at the same site). Patients may prefer to use areas of lipohypertrophy as they feel less pain. However, absorption of insulin from lipohypertrophic areas is unpredictable and could lead to post meal hyperglycaemia or delayed hypoglycaemia. Therefore when there is poor glycaemic control, look and feel for lipohypertrophy at the injection areas before increasing the dose of insulin. This can be palpated as an elevated area of tissue that is thickened, soft or firm to the touch. It may have a “rubbery” feeling.



Figure 25: lipohypertrophy

Tips for prevention and early identification of lipohypertrophy

- Avoid reuse of insulin needles.
- Use good quality insulin, stored as recommended.
- Rotate injection site (point of injection) daily within the selected area of injection.

- Injection areas should be inspected at every clinic visit to detect lipohypertrophy early.
- If lipohypertrophy is detected, avoid injecting into the lipohypertrophic area until the area returns to normal.
- Patients too should be educated on inspecting and detecting lipohypertrophy.

Note: If a patient has been injecting to an area of lipohypertrophy

- Change to an area with normal subcutaneous tissue
- The dose may have to be reduced as more insulin will be absorbed compared to the hypertrophic area
- Monitor blood glucose closely for a few days and adjust the insulin dose accordingly

BLEEDING AND BRUISING

Bleeding and bruising may occasionally occur following insulin injection. This is less with short needles.

Tips to prevent bleeding and bruising

- If persistent bruising occurs, review injection technique.
- Avoid areas with bleeding and bruising until completely recovered.
- Avoid injecting into hair roots (particularly in adult males) and to visible blood vessels.

TRYPANOPHOBIA (BELONEPHOBIA)

Fear of pricking and self-injecting may delay initiation of insulin therapy in type 2 diabetes. Needle phobia may be associated with some misbeliefs and misperceptions. Hence, prior to initiating insulin, patient should be counselled regarding reasons for initiation and benefits of insulin therapy.

Patients who are anxious regarding injecting insulin may benefit from a brief trial of insulin therapy in a supportive, supervised, guided environment.

MISSING INJECTIONS

Insulin may be missed by patients on purpose to avoid pain, due to forgetting, or unavoidable circumstances (e.g. sudden unplanned travel etc). All patients should be counseled about harmful effects of missing even a single dose of insulin, particularly in type 1 diabetes.

Change of insulin regime, type, or brand should only be done under medical supervision after informing the patient. During such a time, blood glucose should be closely monitored.

PERIODIC CLINICAL AUDITS

A periodic audit of injection practices is highly recommended. This helps determine patient knowledge about administration of insulin, selecting correct injection areas, site rotation and correct injection technique (see insulin initiation card, page 50).

SPECIAL POPULATIONS

PREGNANCY

Close monitoring of blood glucose should be done, especially in the first trimester. The abdomen is a safe area for insulin administration during pregnancy.

Injections can be given to the thigh, upper arm or abdomen. The abdominal injection should be given **only to a raised skin fold**. The injection site should never be massaged before or after an injection of insulin.

Patients should be reassured that insulin is safe in pregnancy and also improves maternal and foetal well-being.

FIRST TRIMESTER

- Women already on insulin should be reassured that no change of insulin injection area or technique is required.

SECOND TRIMESTER

- The lateral parts of the abdomen can be used to inject insulin, avoiding the area overlying the fetus.

THIRD TRIMESTER

- Insulin can be injected to the lateral parts of the abdomen **ONLY** if a skin fold can be properly raised. Avoid the area overlying the fetus. Avoid the area around the umbilicus.
- If a skin fold cannot be raised, injections should be given to the thigh or arm.

ELDERLY

Age alone is not a factor to delay or avoid insulin when indicated. Evaluate cognition, vision, hearing and dexterity before initiating insulin and during follow up.

Encourage to obtain a caregivers assistance. Caregivers should be educated regarding the importance of correct insulin injection technique as well as prevention, detection (early features) and emergency management of hypoglycaemia and hyperglycaemia.

The use of an insulin pen device should be encouraged (when affordable) because of

- Simplicity and convenience of use
- Less painful injections
- Easy pre-selection of the prescribed dose

All elderly patients and their caregivers/family members should be trained in close monitoring of blood glucose and dose titration particularly to avoid hypoglycaemia.

HYPOGLYCAEMIA

- Early features: sweating, headache, hunger, tremor and sometimes, aggressive behavior.
- Recurrent hypoglycaemia leads to hypoglycaemic unawareness. Then, there is risk of losing consciousness without any preceding warning signs. Therefore, any hypoglycaemic episode should be prevented as far as possible.
- Hypoglycaemic unawareness may be reversed by strictly preventing further episodes of hypoglycaemia.

INSULIN INJECTION FOLLOWING RECENT ABDOMINAL SURGERY

- The thigh or arm may be preferred as areas for injection.
- In patients with recent surgical wounds, open fistulas, ileostomies, colostomies etc., a different quadrant of the abdomen may be used.
- **Ensure adequate pre-injection cleansing.**

VISUAL IMPAIRMENT/DISABILITY

Caregiver assistance is recommended in administering insulin to the visually disabled patients.

Pens are easier to use than drawing doses from vials using syringes.

- Visually disabled patients can be guided by the clicking sound of the rotating dial in the pen to draw up the correct number of insulin units.
- Before drawing up the prescribed dose a 'test dose' of 1- 2 units of insulin could be drawn up; the patient can press the button on top of the pen to release the insulin while holding the hand beneath the pen to feel the drops of insulin; the patient can identify insulin by smelling it as well. Patients should be advised against contaminating the needle by touching it to see whether insulin is coming out.
- A pen device with suitable colour contrast, larger dose selector window with clear numbering of units should be selected by visually impaired patients.
- The patient should use the pen only in a well lit environment.

- The patients should achieve maximum correction of vision by appropriate lenses and a magnifying glass could be additionally used to facilitate the process.

Self-monitoring of blood glucose is a challenge for visually impaired patients. For patients with some vision remaining, the following may facilitate the process.

- Using a glucometer with a large display screen
- Placing the meter on a nonslip mat that has a contrasting color to make it more visible and to help keep it from sliding around.
- A colored lancing device may be easier to see than a white one.
- Marking the strip insertion slot in the meter with a permanent marker to make it more visible.
- ‘Talking’ blood glucose meters may facilitate this process further.

HEARING IMPAIRMENT/DISABILITY

Hearing impaired patients instructions should be given in a well-lit and noise free room.

Pictograms and visual sequence maps (step wise alignment of pictograms to convey the steps of insulin injection technique) should be used to explain the insulin injection technique.

Demonstration of the injection technique on a model by the doctor followed by demonstration of the newly learnt technique by the patient on the model is important to facilitate the learning process.

Patients who have lost hearing in early childhood or were born with the disability poorly comprehend written information; as such they may not comprehend written instruction leaflets.

The insulin pen device may be more suitable for hearing impaired or disabled patients compared to syringes.

PATIENTS WITH HIV OR HEPATITIS (IMMUNOCOMPROMISED)

Early initiation of insulin therapy should be considered. They should never re-use or share needles and syringes due to high risk of infections and transmission of blood borne pathogens (HIV and hepatitis). Persons administering injections to them are at risk of blood borne infections and should be aware of such and strictly adhere to universal safety precautions. Patients should be counseled regarding the importance of adhering to hygienic, aseptic injection technique.

INDOOR PATIENTS/NURSING HOME PATIENTS

Patients in hospitals, nursing homes and elderly care facilities who share a common refrigerator should put their name labels on insulin pen devices, insulin vials used by them and store them in a separate labelled transparent container to prevent mix up with medications of others.

DISASTER PREPAREDNESS

Patients on insulin should be educated regarding the importance of disaster management. This is especially important for patients with type 1 diabetes in whom lack of insulin can be life threatening.

They should have a personalized, portable, insulated and water proof disaster management kit with adequate supplies for 30 days to tide them over a period of disaster such as a flood or landslide. The kit should have

- a supply of insulin syringes for at least 30 days with insulin vials; or pen, insulin cartridges and needles
- cold packs: sealed packages containing ice (home made or commercially available)
- blood testing kit: glucometer with battery, test strips, lancets
- a sharps container for the disposal of needles and lancets
- at least a 3 day supply of nonperishable food and bottled water
- The kit should be kept in a handy spot ready to go

BARRIERS TO STARTING INSULIN THERAPY

PATIENT RELATED BARRIERS

- Myths, misunderstandings, fear of injections, and negative approaches act as barriers to insulin therapy in patients.
- Open-ended and non-judgmental questions can help resolve these barriers effectively.

PHYSICIAN RELATED BARRIERS

- Physician's decision to commence insulin may be affected by patient related barriers.
- Misconception that insulin therapy is expensive even though costs are reduced by decreased complication rates and management burden.
- Desire to prolong non-insulin therapy
- Lack of supporting staff, counseling and motivational skills

DRUG RELATED BARRIERS

- Side effects such as hypoglycaemia and weight gain
- Complex insulin regimen and timing of injections that interferes with lifestyle of patient
- Lack of efficacy from the insulin type and regimen that a patient is taking

HEALTHCARE SYSTEM BARRIERS

- Lack of resources; Lack of trained diabetic educators
- Lack of training facilities and training programs. Health care professionals to be educated on key areas such as use of insulin pens and other insulin injection devices, insulin injection technique, counseling patients on insulin etc.

OVERCOMING BARRIERS TO STARTING INSULIN THERAPY

OVERCOMING PATIENT - RELATED BARRIERS*

- Empowerment of the patient: improving the mindset, knowledge and ability of the patient to participate actively in decisions regarding their health, disease and medicines.
- Improving the health literacy of the patient: This is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions. It has several aspects such as print literacy (ability to read and understand written health information) and oral literacy (ability to speak and listen).
- Improving the health numeracy of the patient: It is the ability to apply numbers as needed to manage one's health. This is also known as quantitative literacy. This is necessary to calculate the correct dose of a drug, to decide on drugs based on pricing, take decisions to be treated or not based on risk levels and efficacy rates etc.

(*Institute of Medicine, 2004)

OVERCOMING DRUG - RELATED BARRIERS

- Achieve maximum efficacy: Select appropriate insulin type and preparation; plan the insulin regime carefully; be flexible in timing of injections to suit lifestyle of patient.
- Should advice patient on correct storage and transport of insulin to maintain efficacy of insulin preparation.

OVERCOMING PHYSICIAN RELATED BARRIERS

- Empathy: understanding the patient's requirements and emotions related to treatment by how the patient talks and behaves (body language).
- Improving communication skills
- Develop competence and confidence

Attend to insulin related factors; take maximum precautions to prevent hypoglycaemia and weight gain, thereby ensure safety and tolerability.

WATER approach to improve adherence to therapy

- **Warmly** welcome the patient from the outpatient counter onwards by all categories of staff.
- **Ask** for any issues to be clarified and assess the patient. Asking questions by the patient should be encouraged.
- **Tell** the patient truthfully the current situation and outcome if there is non-adherence to therapy.
- **Explain** to the patient with empathy and help to develop coping skills.
- **Reassure** the patient and tell him to return for further clarification.

Optimise insulin related factors and device related factors such as the correct needle gauge, length and the injection technique to improve adherence to therapy.

ONGOING PATIENT AND PHYSICIAN EDUCATION

Educational sessions can be conducted for individual patients or for groups; both methods may be used for a particular patient.

- The program should be planned according to learning abilities, learning styles and needs of patients.
- A one-time educational program at initiation of insulin is not adequate; information should be given in short sessions and regularly reinforced.

PHYSICIAN EDUCATION (THERAPEUTIC EDUCATION)

PRE-INJECTION ASSESSMENT AND PROCEDURE

- Verify the indication
- Address injection related concerns of patients. Pre-injection counselling should be offered to all patients
- Confirm the following
 - ◆ Type of insulin (including visual assessment of the vial)
 - ◆ Insulin regime
 - ◆ The choice and method of use of insulin needles: optimum lengths, gauges, reuse
 - ◆ Syringe-vial compatibility
- Physical examination: assess dexterity, visual impairment, inspect injection site for ulcers, scars etc.
- Proper injection technique including site rotation
- Care and maintenance of devices used
- Complications of subcutaneous injections (lipohypertrophy)

Insulin Injection initiation Card

Name with initials Date of initiation.....

Age..... Clinic number..... Hospital.....

Occupation Highest exam passed.....

1. Diagnosis	<input type="checkbox"/> Type 1 DM <input type="checkbox"/> Gestational DM	<input type="checkbox"/> Type 2 DM <input type="checkbox"/> Other
2. Type of insulin(s)	<input type="checkbox"/> Short acting (human) <input type="checkbox"/> Rapid acting (analogue)# <input type="checkbox"/> Premixed (analogue)# <input type="checkbox"/> Premixed (human)	<input type="checkbox"/> Short acting (animal)* <input type="checkbox"/> Intermediate acting <input type="checkbox"/> Long acting
3. Regimen	<input type="checkbox"/> Once a day <input type="checkbox"/> Three times a day	<input type="checkbox"/> Twice a day <input type="checkbox"/> Other
4. Device	<input type="checkbox"/> Syringe and needle <input type="checkbox"/> Insulin pen	Needle gauge Needles length

5. Sites selected and checked for suitability (check for scars, ulcers etc.)

Left Upper arm Thigh Abdomen Gluteal region
 Right Upper arm Thigh Abdomen Gluteal region

6. Storage facilities Refrigerator Other (specify)

7. Dexterity good Yes No

8. Visual impairment Yes No

9. Injection to be given by Self Other person (specify).....

*Bovine and porcine insulins are more immunogenic and cause lipodatrophy, while human insulins cause lipohypertrophy which could be prevented by injection site rotation. The patient to be educated accordingly.

#Insulin analogues are to be injected 15 minutes before meals or up to 20 minutes after starting the meal due to their rapid action. The patient to be educated accordingly.

Verification of skill transfer

	Date of training	Signature
1. Insulin selection		
2. Dose selection		
3. Correct site		
4. Site rotation		
5. Drawing of insulin/change of pen cartridge		
6. Injection technique		
7. Storage		
8. Disposal of needle and syringe		
9. Avoidance and management of hypoglycaemia		

Correct technique observed by Name :
Date :

Injection site inspected and
site rotation satisfactory Name :
Date :

Technique reviewed at 1 month Name :
Injection site inspected and
palpated for lipohypertrophy Date :

Technique reviewed at 3 months Name :
Injection site inspected and
palpated for lipohypertrophy Date :

Comments

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