# Correct Insulin Technique


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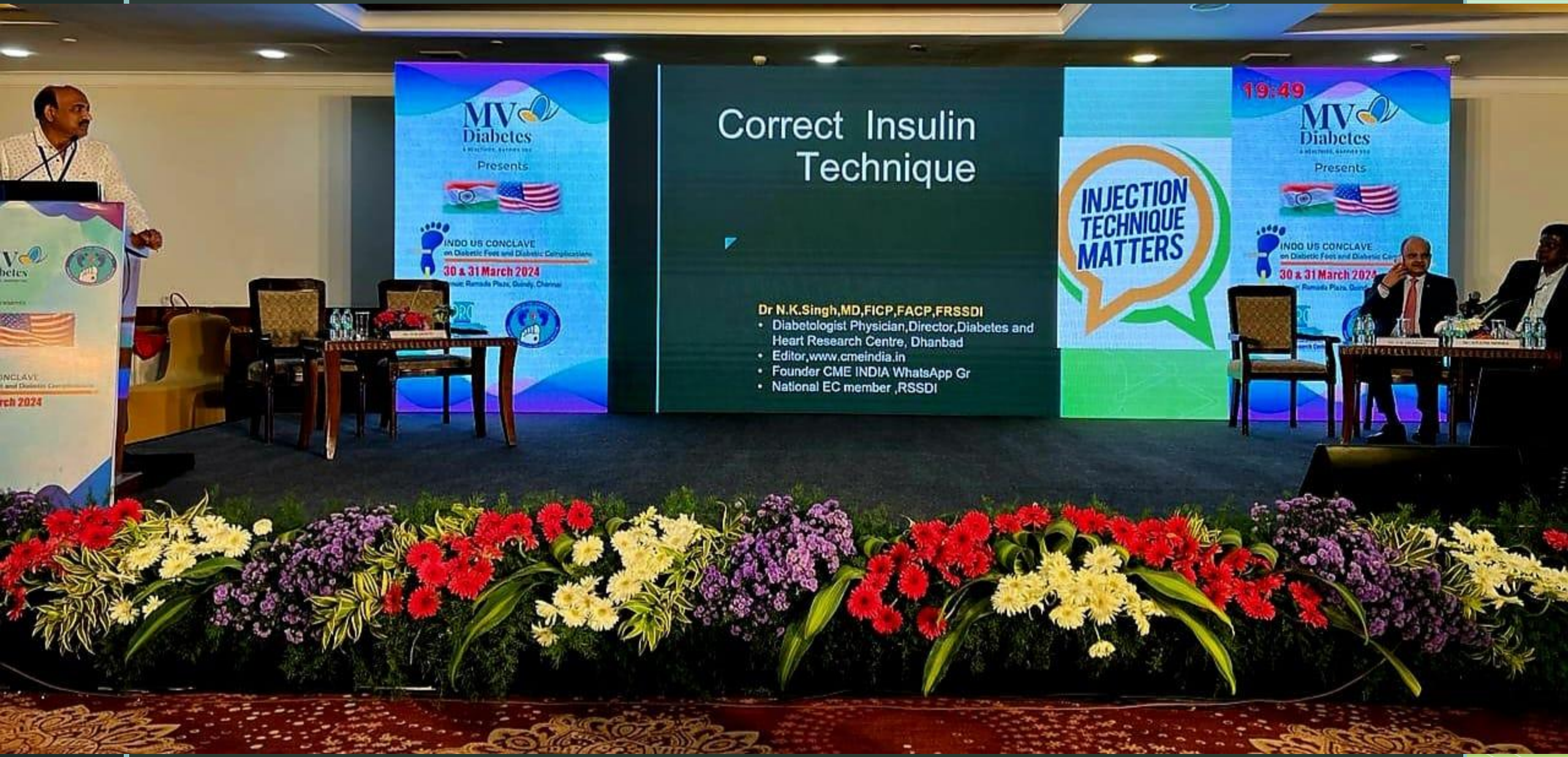
MV Diabetes
Presents
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Correct Insulin Technique
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INJECTION TECHNIQUE MATTERS
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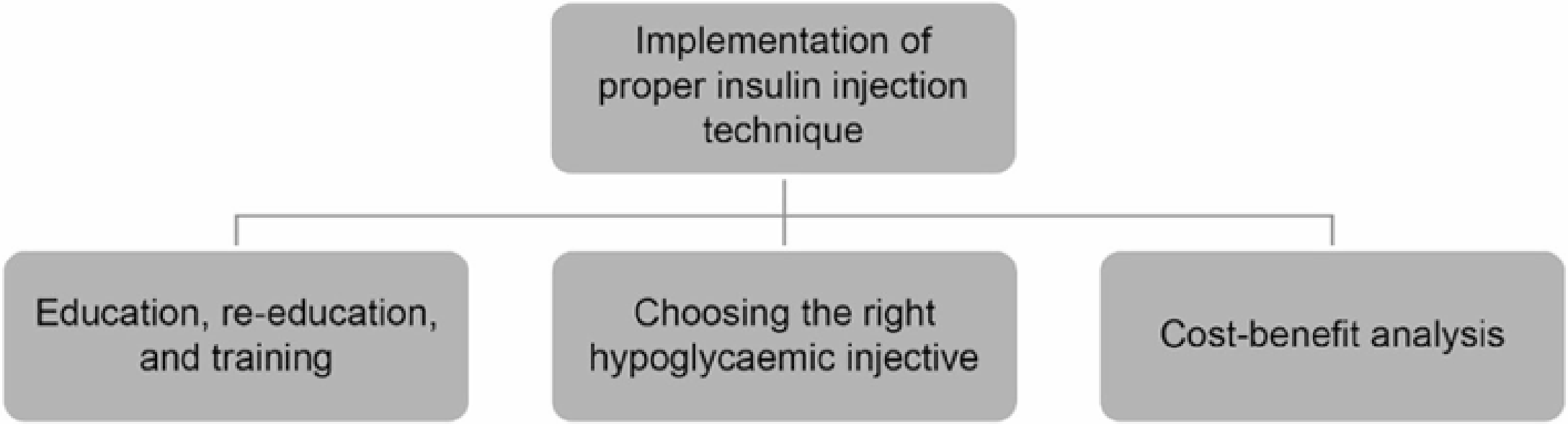
# AGENDA




Key aspects in the implementation of a safe insulin injection technique

# Let us Know the Problem

- Why this topic is of utmost Importance?

Age 41

H/o of diabetes since age 20, was following advice from tertiary centre near Chennai for last 3 yrs ,on mixtard 22 ....18 U ,

Takes insulin by using syringe, uses one needle for 4 times,

Random 349mg

## Bitter Truth

Despite significant advancements in technology and therapy over the last decade, insulin injection techniques among patients have not improved

Standardised and proper injection techniques should be adhered to, as they have been associated with improved outcomes in patients with diabetes

A proper injection technique is defined as the technique that successfully delivers the drug into the subcutaneous area with minimal pain and no leakage

A good technique includes proper injection site rotation and not injecting into lipohypertrophic areas

**Smart pens have progressed over the last decade from traditional insulin pens in terms of functionality, and they have the potential to facilitate the use of optimal doses of insulin and improve diabetes management by offering automated storing and transmission of insulin dosing data.**

**To encourage the usage of smart pens, patients and HCPs must be educated on the benefits of smart pens and provided with recommendations on how to use the technology, evaluate data, and execute suitable treatment strategies**

Many studies noticed that the **education resulted in the improvement of insulin injection technique i**n number of patients who: properly remix cloudy insulin, more often inject correctly into a lifted skin-fold with proper releasing and at an angle of 90° and keep the pen needle under the skin for > 10 s, who change every time the injection site and who use the pen needle only once, correctly prepare a pen for injection and store it properly.

**Injection Technique Questionnaire (ITQ) survey** which was conducted with 13,289 patients from 423 centers in 42 countries showed also not satisfactory injection practices, e.g. only 31.9% of patients left the needle under the skin the recommended 10 s or longer; whereas 63.7% of patients lifted a skinfold, and 75.0% of these did it correctly.

- **In ITQ survey the 4- and 8-mm needles are each used by approximately 30% of the total and the 5- and 6-mm needles each by approximately 20% .**

- **The needle length can determine intramuscular injection risk which can lead to glucose variability and hypoglycemia .**

- **In recent years the needle length has decreased to lower this risk and to reduce anxiety, injection pain and risk of bleeding and bruising.**

- **BMI and body site are the most important factors which influence subcutaneous fat thickness .**

- **The risk of intramuscular injection increase in men (they have less fat than women for the same BMI), lower BMI and site of injection- thigh or arm. Thus recommendation propose to use shorter needles (4, 5, and 6 mm) by any adult patient, including obese individuals, which should be given at 90° to skin surface and do not generally require the lifting of a skin fold.**

**According to an ITQ survey, nearly 50% of patients have or have had symptoms that suggest lipohypertrophy (LH), and 21% of patients reported repeating a whole day or even a few days of daily injections at the same spot.**

**26% of respondents reported that they have occasionally injected insulin into lipohypertrophic sites.**

De Coninck C, Frid A, Gaspar R, Hicks D, Hirsch L, Kreugel G, et al. Results and analysis of the 2008–2009 insulin injection technique question naire survey: insulin injection technique survey. J Diabetes. 2010;2:168–79. https://doi.org/10.1111/ j.1753-0407.2010.00077.x.

**Implementing correct injection techniques and providing structured education on the technique play an important role in decreasing skin complications, including LH, insulin-derived amyloidosis (IDA), local inflammation,bruising, and subsequent hypoglycaemia .**

LH manifests as an abnormal build-up of fat under the skin surface and is associated with recurrent trauma related to performing frequent or daily insulin injections at the same site .

**The prevalence of LH has been reported to be 38% in insulin-treated patients according to a recent meta-analysis**

Deng N, Zhang X, Zhao F, Wang Y, He H. Preva lence of lipohypertrophy in insulin-treated diabetes patients: a systematic review and meta-analysis. J Diabetes Investig. 2018;9:536–43. https://doi.org/ 10.1111/jdi.12742.

Risk factors associated with the development of LH include **the reuse of needles, site rotation frequency, duration of insulin treatment, high doses of insulin, glycaemic control issues, and a lack of patient education**

Insulin injections into LH lesions can result in an erratic increase in insulin dose and, as a result, the patient may incur greater costs

When insulin analogues were used instead of human insulin, the risk of LH in patients receiving numerous daily insulin injections was lower

LH prevention should be a priority for physicians. Visual and physical examinations are crucial to detect abnormalities at the injection site. Patients should also be educated on how to inspect and recognise LH at injection sites

- **Most of the subjects correctly store used and unused insulin, in ITQ survey 88.6% of subject store insulin in refrigerator, but after opening it, 43.0% continued to store it in the fridge and only 56.3% of these, let it warm up to room temperature before injecting it Cold insulin is connected to more painful injections.**

- **Another problem in this study showed changing every time the injection site, which was performed only by 63.5% patients. Rotation of the injection site is very important to prevent lipohypertrophy (LH). This is the most common skin complication of insulin therapy which affects almost 50% of diabetic patients**

- **LH can significantly reduce the absorption of insulin by up to 25% and thus could worse diabetes control.**
- **In the Injection Technique Questionnaire (ITQ) survey 83.9% of patients claimed to rotate injection site, however 70.6% of these did it correctly .**

- **Correct injection site rotation means injecting at least 1 cm from a previous injection.**

- **In ITQ survey more than half of the subjects had painful injections, usually connected with bleeding .**

- **Pain was also associated with: injecting through clothes, injecting cold insulin, LH, injecting into LH, incorrect site rotation, hypoglycemia and hyperglycemia, higher HbA1c levels, lower BMI, younger age, and higher doses of insulin .**

- **This study noticed significant decrease in sensation of pain in both groups and thus could be explained by improved injection technique after education, with greater decrease in group treated with GensuPen.**

- **There is a strong evidence that proper use of insulin injection technique is crucial for optimizing the efficacy of the therapy.**

- **Many recommendations published by different diabetes associations are based on the results of Injection Technique Questionnaire (ITQ), which is one of the largest multinational studies of this kind**

- **Recent studies showed that only too few patients can understand this problem.**

- **Providing better devices with many modern solutions can result in higher effectiveness of insulin therapy.**

Frid A.H., Hirsch L.J., Menchior A.R., Morel D.R., Strauss K.W. Worldwide injection technique questionnaire study: population parameters and injection practices. Mayo Clin Proc. 2016;91:1212–1223

# Will this session change Orientation?

Gorska-Ciebiada M, Masierek M, Ciebiada M. Improved insulin injection technique, treatment satisfaction and glycemic control: Results from a large cohort education study. J Clin Transl Endocrinol. 2020 Feb 4;19:100217. doi: 10.1016/j.jcte.2020.100217. PMID: 32071879; PMCID: PMC7013331.

# Highlights

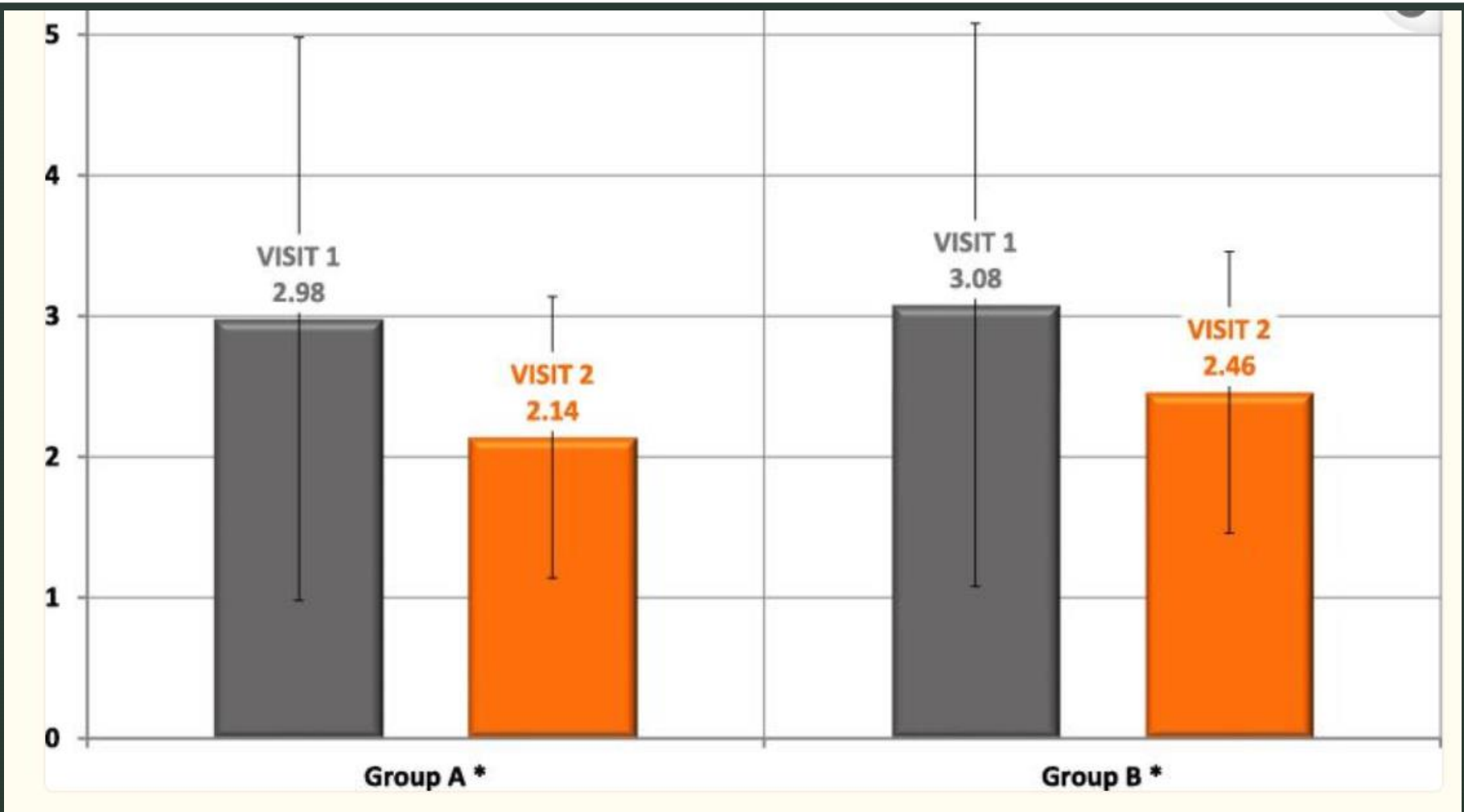
- The efficacy of insulin therapy in diabetes depends on proper injection technique.
- Professional education can results in higher patients' satisfaction.
- Proper insulin injection is important to good glycemic control.

# Effects of education and training on administration techniques in type 2 diabetic patients treated with insulin injections.

| Number of patients who: | Group A before education (visit1) | Group A after education (visit 2) | Group B before education (visit1) | Group B after education (visit 2) |
|---|---|---|---|---|
| properly remix cloudy insulin | 1878 (51.4%) | 2864 (79.2%)* | 420 (57.8%) | 572 (80.8%*) |
| inject correctly into a lifted skin-fold with proper releasing and keep the pen needle under the skin for > 10 s | 2091 (90.3%) | 2488 (98.8%)* | 433 (92.5%) | 509 (99.6%*) |
| inject correctly at an angle of 90° | 2373 (66.2%) | 2525 (70.5%)* | 486 (66.8%) | 503 (70.9%*) |
| change every time the injection site | 2379 (64.5%) | 2964 (80.0%)* | 488 (69.0%) | 594 (80.9%*) |
| use the pen needle only once | 250 (6.7%) | 1068 (28.4%)* | 59 (8.0%) | 213 (28.8%*) |
| correctly prepare a pen for injection | 1714 (46.1%) | 3087 (83.4%)* | 388 (52.7%) | 614 (83.4%*) |
| correctly store used insulin | 3258 (87.0%) | 3513 (93.8%)* | 664 (89.9%) | 700 (94.3%*) |
| correctly store unused insulin | 3571 (95.0%) | 3719 (99.1%)* | 721 (96.9%) | 741 (99.6%*) |

*Difference statistically significant, $p < 0.001$, visit 1 vs. visit 2.

**Sensation of pain scale in type 2 diabetic patients treated with insulin injections before (visit 1) and after education (visit 2).**




significant decrease in sensation of pain in both groups ($p < 0.001$).

# The utility and comfort during using new automatic injection system

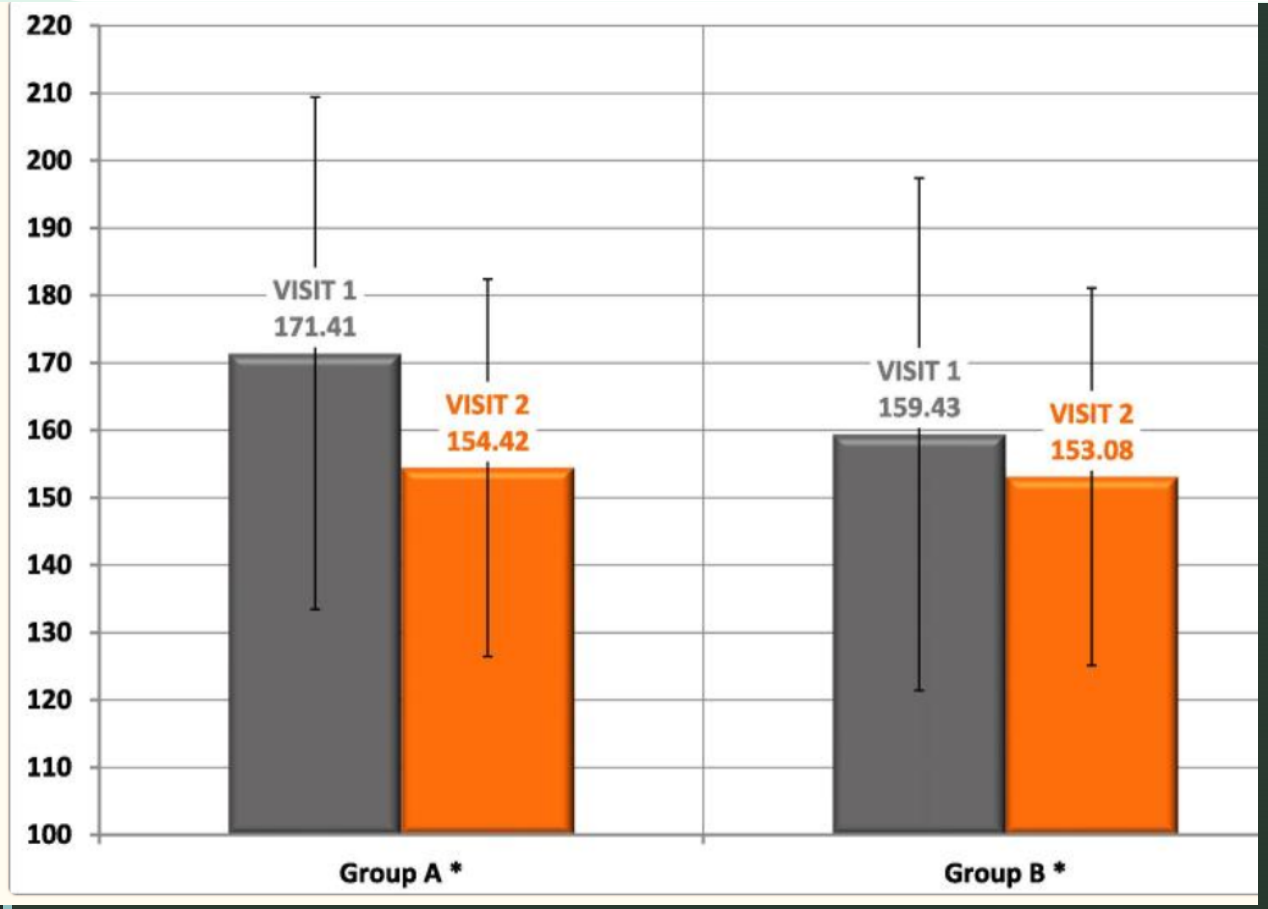
| Parameter assessed by patient | Group A before education (visit1) | Group A after education (visit 2) | P value |
|---|---|---|---|
| Proper thickness of pen | 2912 (77.9%) | 3645 (97.2%*) | p < 0.001 |
| Proper weight of pen | 2918 (78.0%) | 3683 (98.2%*) | p < 0.001 |
| Easiness removing pen cap | 2890 (77.6%) | 3593 (96.3%*) | p < 0.001 |
| Easiness in cleaning the pen | 2442 (66.9%) | 2978 (80.5%*) | p < 0.001 |
| Easiness in twisting a pen | 2927 (81.9%) | 2416 (95.6%*) | p < 0.001 |
| Easiness in keeping a pen in hand | 3107 (83.1%) | 3622 (97.4%*) | p < 0.001 |
| Easy dial the dose | 3256 (87.1%) | 3595 (96.4%*) | p < 0.001 |
| Readable signaling of injected dose | 2748 (73.7%) | 3621 (97.3%*) | p < 0.001 |

*Difference statistically significant, p < 0.001, visit 1 vs. visit 2.

*Difference statistically significant, p < 0.001, visit 1 vs. visit 2.

**The study showed that proper selection of pen and professional education can results in the improvement of insulin injection technique, higher patients' satisfaction and better glycemic control.**

**Insulin administration remains one of the crucial elements of the patient education. This study showed that knowledge and practical skills of diabetic patients are insufficient which confirm a need for further education seen as a lifelong process with regular repetition.**



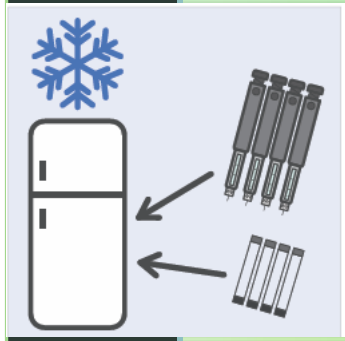

Mean glucose level in self-control diary in type 2 diabetic patients treated with insulin injections before (visit 1) and after education (visit 2).

# Now Let us take the Main Course

## Recommended topics for diabetes educators

- Education about injection technique for delivery of insulin, including a review of Periodic review of injection technique and sites, especially when blood glucose control is suboptimal
- Choice of injection devices, considering ease of use and patient limitations including cost, manual dexterity, hearing and visual impairment
- For pre-filled devices, considering opened expiration date, total number of units/mg in device and daily dose when choosing devices, when applicable
- Injection site selection and rotation, including teaching patient to examine sites for lipohypertrophy
- Choice of needle: length and gauge to maximise comfort and efficiency

## Unpredictable blood glucose control leading to unexplained hypoglycaemia, glycaemic variation and above target HbA1c may be caused by



- Incorrectly stored injectable agents, allowed to freeze or become too hot >30oC

- Failure to perform correct test dose before injection
- Failure to correctly mix cloudy insulin
- Using needle length longer than 4mm
- Failure to use correct lifted skinfold when required
- Not rotating or incorrect rotation of injection sites
- Withdrawing the needle from the skin before full dose is administered i.e. not counting to 10
- Needle reuse
- Time site rules not known

# Technique

- Timing of injection, related to the effect of the medication, meals, activity and stressors
- Targets for dosing adjustments related to monitoring, activity stressors, and meals
- Injection discomfort and complications
- Safe disposal of used sharps
- Quality control including medication storage considerations, opened and unopened expiration dates
- Inspection of the injectable medication before each use

# Therapeutic Education

- **Therapeutic education is a process where the competencies (knowledge, skills and attitudes) and the necessary support for self-control of a disease are provided to the patient and his/her family and the competencies integrated into the treatment**

- **Traditionally, diabetes educators "instruct" patients and their relatives to follow the prescribed treatment. Such information is not sufficient to change their health behaviour.**

- **Therapeutic education for diabetes should accompany dispensing of insulin**

# The First Injection

- Around 40% of diabetes patients are scared of needle pain. Therefore, the first injection should be taken by the patient under the observation of a trained health care worker. The following steps help to overcome the fear

- The patient should be counselled and be informed that most people are afraid of the needle prick, until they do it and see how relatively pain-free it actually is.

- The sizes of the needles available should be demonstrated to reassure the patient that the needles are thin and short.

# Time site rules not known

1. If insulin  is frozen, kept in direct sunlight or stored in temperature greater than 86F or 300C it will result in loss of efficacy

2. Intermediate-acting Neutral Protamine Hagedorn (NPH) insulin (also known as isophane insulin) and premixed insulins are in a suspension and need to be properly mixed before injecting

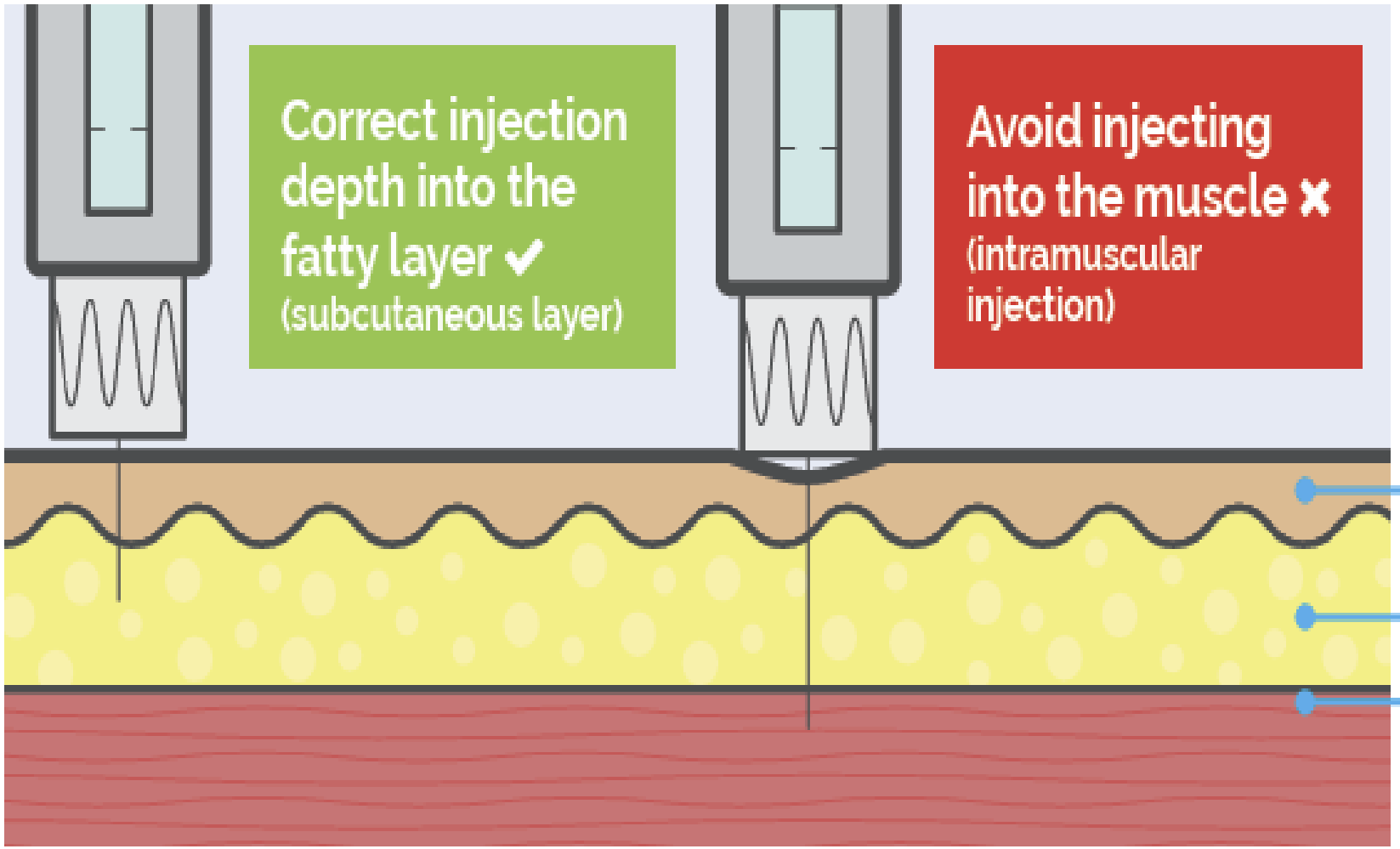
3. If insulin is injected into a muscle (which can occur when longer needles are used or a lifted skin fold is not performed correctly) it will be absorbed more quickly and could cause hypoglycaemia

4. Repeatedly injecting into a particular area or site can damage the tissue and result in a condition known as lipohypertrophy

5. If the needle is withdrawn too quickly then the full dose of medication will not be delivered and may lead to hyperglycaemia

6. If used repeatedly needles become distorted, lose lubrication and cause damage to the skin (as well as more painful injections)

7. Insulin is absorbed at different rates from different injection sites .




Health professionals must teach best practice injection technique when insulin initiated

Storage: Store unopened insulin in the fridge, as per manufacturer's instructions at 4-8 degrees

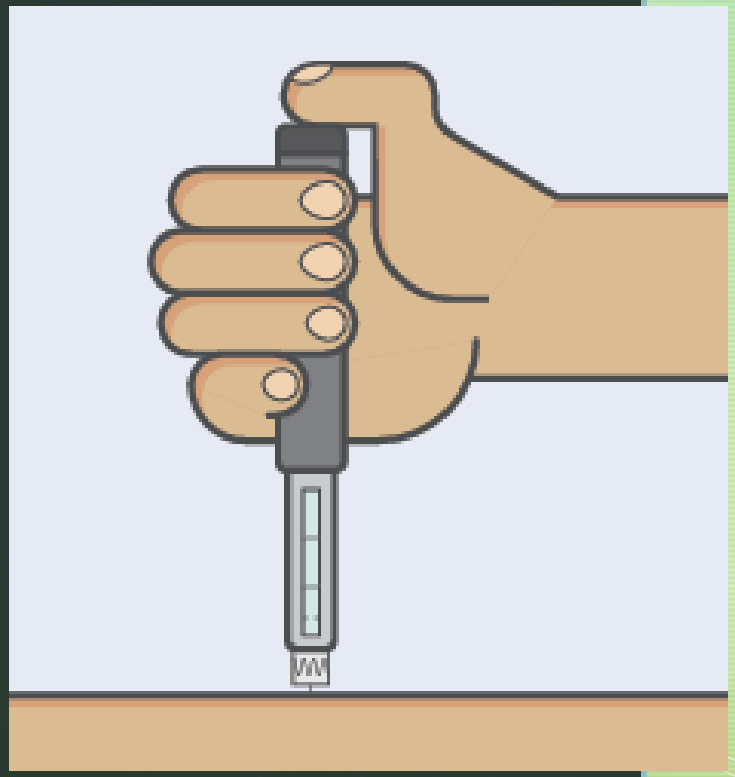
**Re-suspending Cloudy Insulins: Resuspend cloudy or premixed insulin by rolling 10 times in**

**Recommendations**

**Cloudy insulins**

- Cloudy insulin (e.g. NPH and pre-mixed insulins) must be gently rolled and/or tipped (not shaken) for 20 cycles until the crystals go back into suspension (solution becomes milky white) before being injected. **Grade A**

- Needle Length: Use 4mm or 5mm needles at 90 degrees to the skin .
- Only use 4mm needles for children, young people or very slim adults.
- A lifted skin fold may be required for some group, even when using 4mm needle, to prevent giving an intramuscular injection.



# VIALS AND SYRINGES

- **Insulin was initially delivered using heavy reusable syringes with long, large-bore needles that needed to be disinfected by boiling to enable efficient reuse**

- **In 1924, Becton Dickinson (BD) manufactured the first specialised syringe for insulin injection, which was followed by the launch of the “Novo Syringe” by Novo Nordisk in 1925.**

- **The patented inn tly decreased syring t of disposable Luer l**

- **One-millilitre Luer l introduced by BD in the 1960s, ated infections**

- **In 2012 a less painful BD Veo insulin syringe with an ultra f ine 6-mm needle was introduced, which pre sented a lower risk of intramuscular injections and a decreased plunger force to improve the flow of high insulin doses .**

Even though the demand for the “conventional” syringe technology has decreased in recent times, vials and syringes were the only choices for insulin delivery for more than five decades

# PENS AND NEEDLES

- **Insulin pens provide several advantages over conventional vial and syringe injections, including ease of use, particularly for individuals with eyesight or motor dexterity issues, and discretion of use**

- **Attachment of pen needles is required for injecting insulin with pen devices, and this provides a more convenient injection experience**

- **Pen needles have become shorter and thin ner over the years [4]. Needles of a smaller bore size and shorter lengths (3.5–4.0 mm) are currently used instead of long, large-bore-sized, reusable needles for insulin injection .**

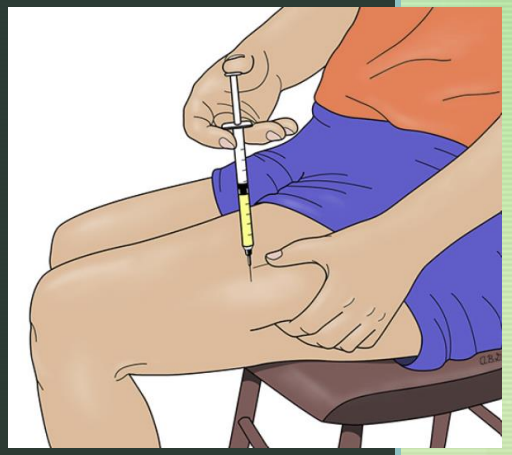
- **The advantages of short, fine-gauge needles over longer needles have been reported in a series of clinical trials, specifically for quality-of life metrics, such as decreased pain and increased patient preference**

| | Advantages | Disadvantages |
|---|---|---|
| Vials and syringes | • Allow the mixing of two different types of insulin<br>• More affordable than pens and needles[a] | • Inconvenient to use and carry<br>• Increased pain during injection compared to pens<br>• May not be suitable for individuals with impaired vision or dexterity |
| Pens and needles | • Greater convenience to use and carry<br>• A suitable option for individuals with impaired vision or dexterity<br>• Allows for more accurate dosing compared to syringes | • Does not facilitate the mixing of two different types of insulin[b]<br>• More expensive than a syringe[a] |

# The advantages and disadvantages of insulin delivery devices

Diabetes Ther (2023) 14:1785–1799
https://doi.org/10.1007/s13300-023-01460-y

# EADSG Guidelines: Insulin Storage and Optimisation of Injection Technique in Diabetes Management.



Bahendeka S, Kaushik R, Swai AB, Otieno F, Bajaj S, Kalra S, Bavuma CM, Karigire C. EADSG Guidelines: Insulin Storage and Optimisation of Injection Technique in Diabetes Management. Diabetes Ther. 2019 Apr;10(2):341-366. doi: 10.1007/s13300-019-0574-x. Epub 2019 Feb 27. PMID: 30815830; PMCID: PMC6437255.

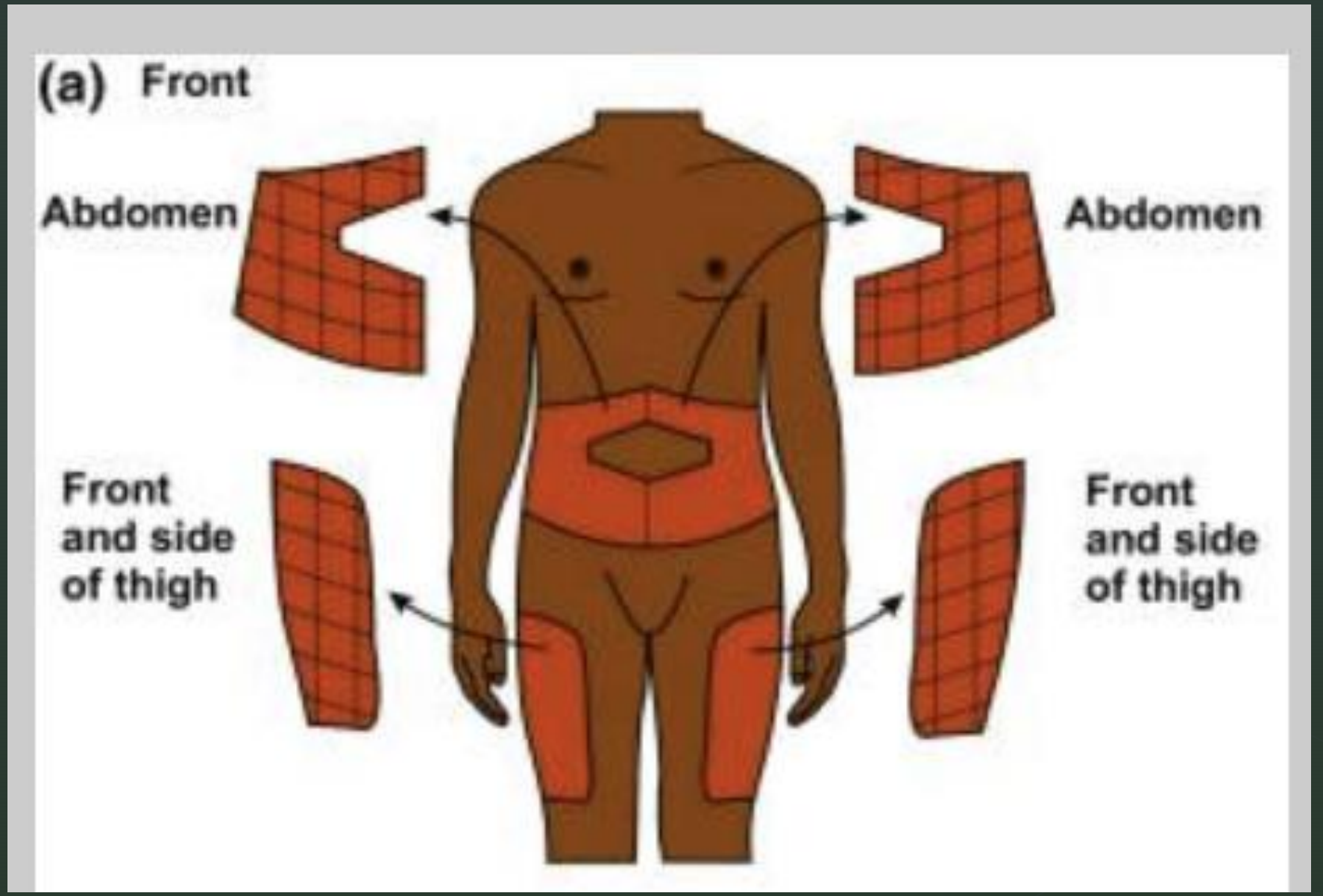
# Site of Injection

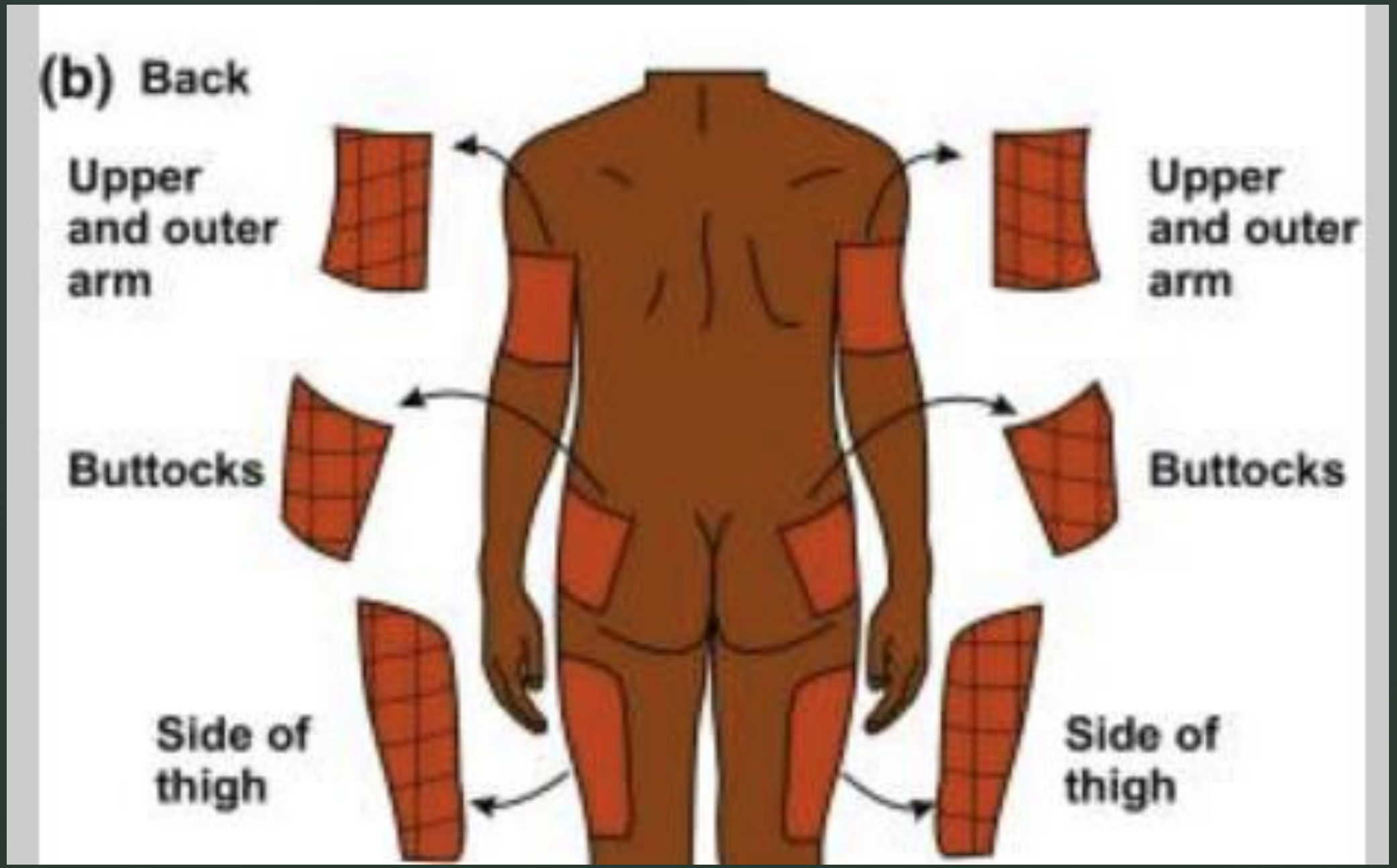
**The four safe areas for insulin injections are the sides of the thighs, the backs of the upper arms, the abdomen and the upper outer buttocks. To avoid bumps and scar tissue on the skin, rotation of insulin injection sites should be done and a systematic approach to injection site rotation adopted.**

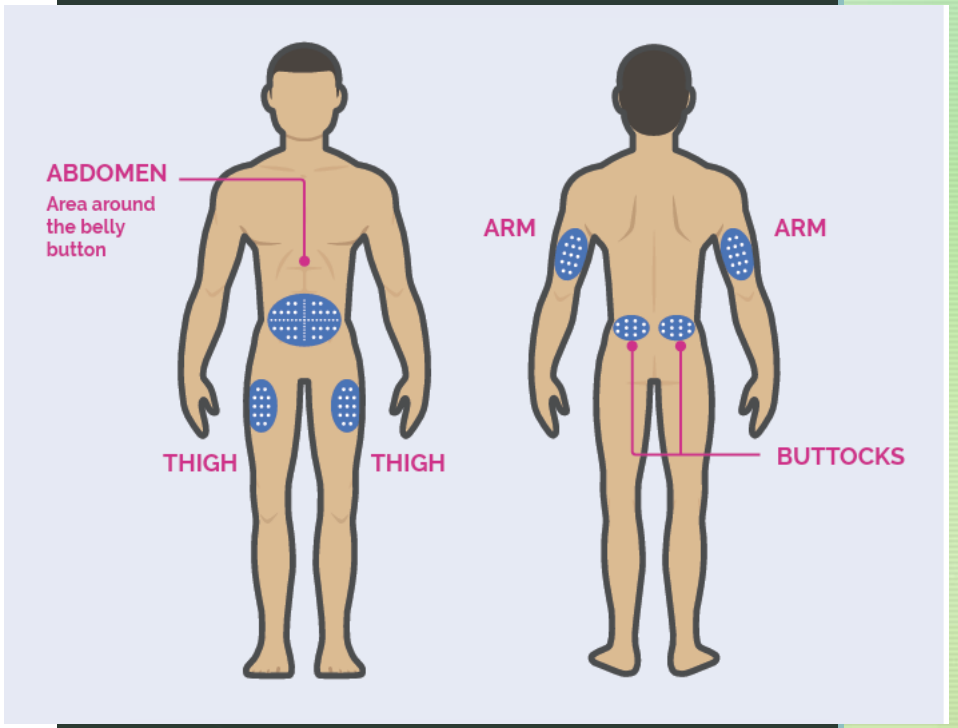
**Thus, injections may be given in the abdomen, outer thigh, back of the arm, and flank/buttocks regions**

**Insulin injected on the abdomen acts faster than insulin injected on the thigh. The rate of absorption of insulin injected on the arm is between that of insulin injected on the abdomen and that injected on the thigh**

# The sites for rotation




(b) Back
Upper and outer arm
Upper and outer arm
Buttocks
Buttocks
Side of thigh
Side of thigh


ABDOMEN
Area around the belly button
THIGH
THIGH
ARM
ARM
BUTTOCKS

# Care of Injection Site

**The nature of the fat tissue under the skin changes with repeated injections into the same site and subsequently insulin is not appropriately absorbed. Proper care of injection sites should be taken to prevent complications**

- **To always visually inspect the injection sites before injecting insulin.**
- **To palpate the injection sites before injecting insulin. Patients should be instructed on how this is done.**

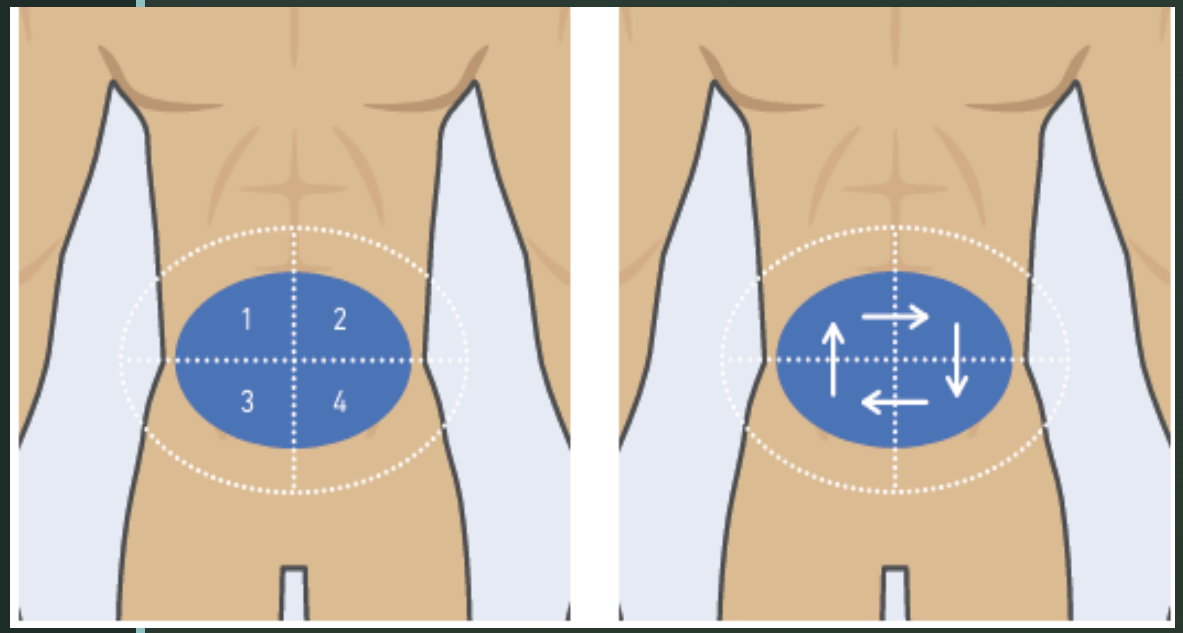
- **To avoid injecting into sites with lipohypertrophy, oedema, inflammation or signs of infection.**
- **To bathe with soap and water daily.**
- **To rotate sites of injection every day.**
- **Not to reuse the needle if possible; otherwise limit the reuse when injections become more painful; but should not reuse needles more than 5 times.**
- **There is no need to swab the area, if clean. If the injection site is not clean, clean with plain water. Swabbing with spirit-swabs is not recommended as it leaves the skin dry.**

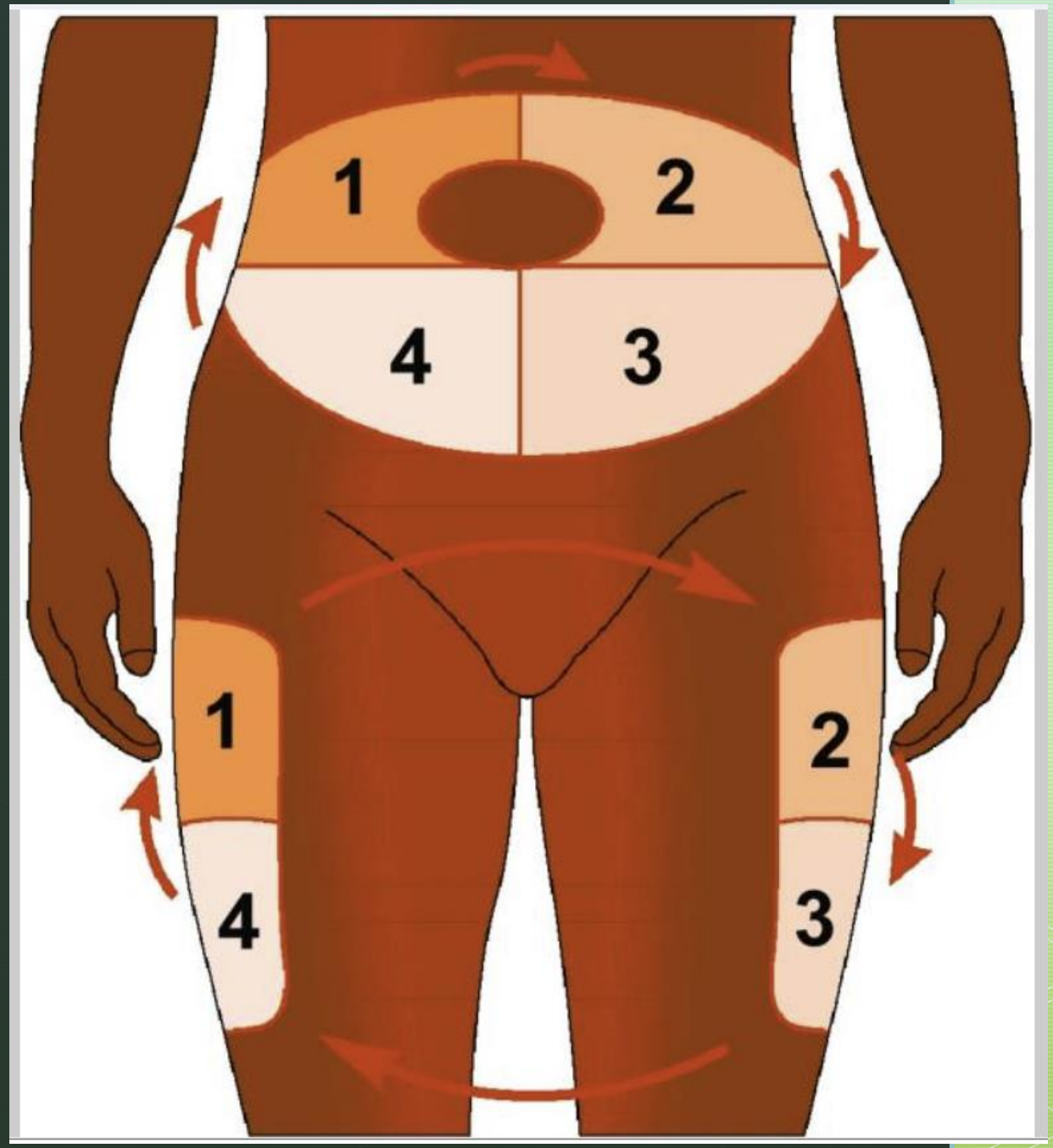
# Rotation of Sites

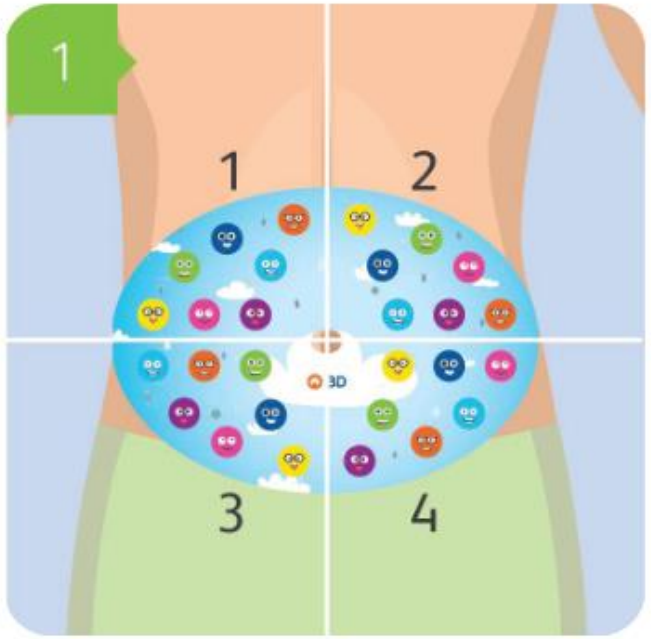
Although insulin injections usually cause no significant pain, injecting at the same spot repeatedly can cause inflammation or fat tissue increase (lipohypertrophy), or scarring.

- **The same site should be used for at least 1 month and rotation should be done within the same site, rather than rotating to different sites with each injection.**
- **Each injection should be away from the previous one by a fingerbreadth (2.5 cm).**
- **Use of same site decreases variability in day-to-day absorption of insulin. A site with open wounds or blisters should be avoided. Blood glucose monitoring should be done on change of site. Change of site of injection is frequently associated with hypoglycaemia**

**For small children, it is good to use all the areas — arms, legs, abdomen and backside. Bigger children and teens should use the abdominal area most often.**

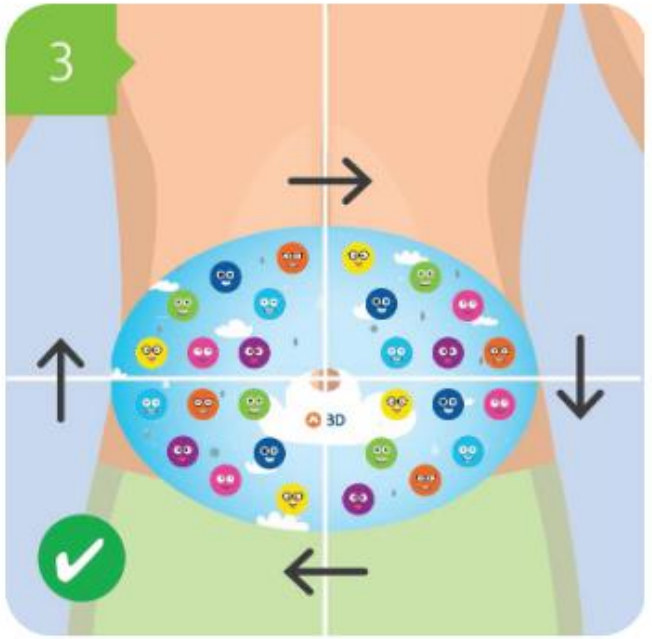





Choose a site (4 on the abdomen and one on each for buttocks, arm and thigh).


Injections in each spot should be 1cm from the last injection.




Rotate your sites regularly using abdomen, thigh, buttocks and arms if possible.

**Injections should be systematically rotated in order to avoid LH. This means injecting at least 1 cm (or approximate the width of an adult finger) from previous injections, a vital procedure which requires careful planning and attention. A2**

**Patients should be given an easy-to-follow rotation scheme from the beginning of injection/ infusion therapy. The HCP should review the site rotation scheme with the patient at least once a year**

• One evidence-based scheme involves dividing injection sites into quadrants (or halves when using the thighs or buttocks), using one quadrant per week and rotating quadrant to quadrant in a consistent direction (e.g.clockwise)

- **The patient’s injection site rotation scheme should be reviewed by HCPs at least once annually**

- **An effective and widely used rotation scheme involves dividing the injection site into quadrants for the abdomen or halves for the thighs, buttocks, and arms. The patient should use one quadrant or half per week and then switch to another quadrant or half, either clockwise or anticlockwise, the following week**

- **It is recommended that the new insulin injection site be at least 1–2 cm away from the previous injection site**

- **Gentile et al. defined a structured palpation technique that allows HCPs to detect skin LH lesions in insulin-treated patients with diabetes . After undergoing specialised training involving repeated and well-codified palpitation manoeuvres, inexperienced HCPs were able to quickly procure diagnostic accuracy in identifying LH lesions regardless of the site, size, and BMI**

- **The palpitation method is not always feasible and is likely insufficient to detect LH, particularly in individuals who need high-dose insulin to manage hyperglycaemia**

- **Superficial subcutaneous ultrasonography would be a suitable method to assess the exis tence of LH**

- Ultrasound examination offers higher sensitivity and specificity compared to physical evaluation, particularly in the case of LH lesions without visible or palpable changes

- Ultrasound examination provides a precise way to measure the subcutaneous fat thickness to select optimal injection sites for patients with diabetes who have concerns related to LH

# Absorption of Insulin

- Multiple and varied factors affect insulin absorption.
- Patients should be told about these factors and be allowed to discuss factors that do affect the absorption of insulin.
- The abdominal site is the least susceptible to factors affecting insulin absorption. To minimise the variability of insulin absorption, patients should use one site of injection for a particular time consistently

**Recommendation**

**Recommendations on Pre-mixed human insulin**

- In the morning, the regular/NPH mix should be given in the abdomen to increase the speed of absorption of the short-acting insulin in order to cover post-breakfast glycaemic excursions. **Grade C**
- In the evening, the regular/NPH should be given in the thigh or buttock as this leads to slower absorption and decreases the risk of nocturnal hypoglycaemia. **Grade D**
- Patients engaging in athletic activities after injecting pre-mixed human insulin should be warned about the occurrence of hypoglycaemia. **Grade A**

**Recommendation**

**Recommendations on human long-and short acting insulin injections**

- Intramuscular injection of NPH should be avoided since this may result in rapid absorption and consequent serious hypoglycaemia. **Grade A**
- The thigh and buttocks are the preferred injection sites when using NPH as the basal insulin since absorption is slowest from these sites; if possible NPH should be given at bedtime rather than at dinner to reduce the risk of nocturnal hypoglycaemia. **Grade B**
- The abdomen is the preferred site for the soluble human insulin (regular), since absorption is fastest there. **Grade B**
- Patients engaging in athletic activities after injecting long- and short-acting human insulin should be warned about the occurrence of hypoglycaemia. **Grade A**

**Recommendation**

**Recommendations on Insulin analogues**

- Rapid-acting insulin analogues may be given at any of the injection sites, as absorption rates do not appear to be site-specific. **Grade B**
- Rapid-acting analogues should not be given intramuscularly. **Grade B**
- IM injections of long-acting analogues should be avoided due to the risk severe hypoglycaemia. **Grade A**
- Patients engaging in athletic activities after injecting long-acting analogues should be warned about late onset occurrence of hypoglycaemia. **Grade A**

# Factors affecting insulin absorption

| Factor | Effect on insulin absorption |
|---|---|
| Exercise of injected area | Strenuous exercise of a limb within 1 h of injection increases insulin absorption. For example, injecting on the thigh and immediately riding a bicycle. This is clinically significant for regular insulin and insulin analogues |
| Local massage | Vigorously rubbing or massaging the injection site increases absorption |
| Temperature | Heat can increase absorption rate, including use of a sauna, shower, or hot bath soon after injection. Exposure to a cold environment has the opposite effect |
| Site of injection | Insulin is absorbed faster from the abdomen. Less clinically relevant with long and intermediate-acting insulins (NPH, insulin glargine and insulin detemir) |
| Lipohypertrophy | Injection into hypertrophied areas delays insulin absorption |
| Jet injectors | Increase absorption rate |

Administration

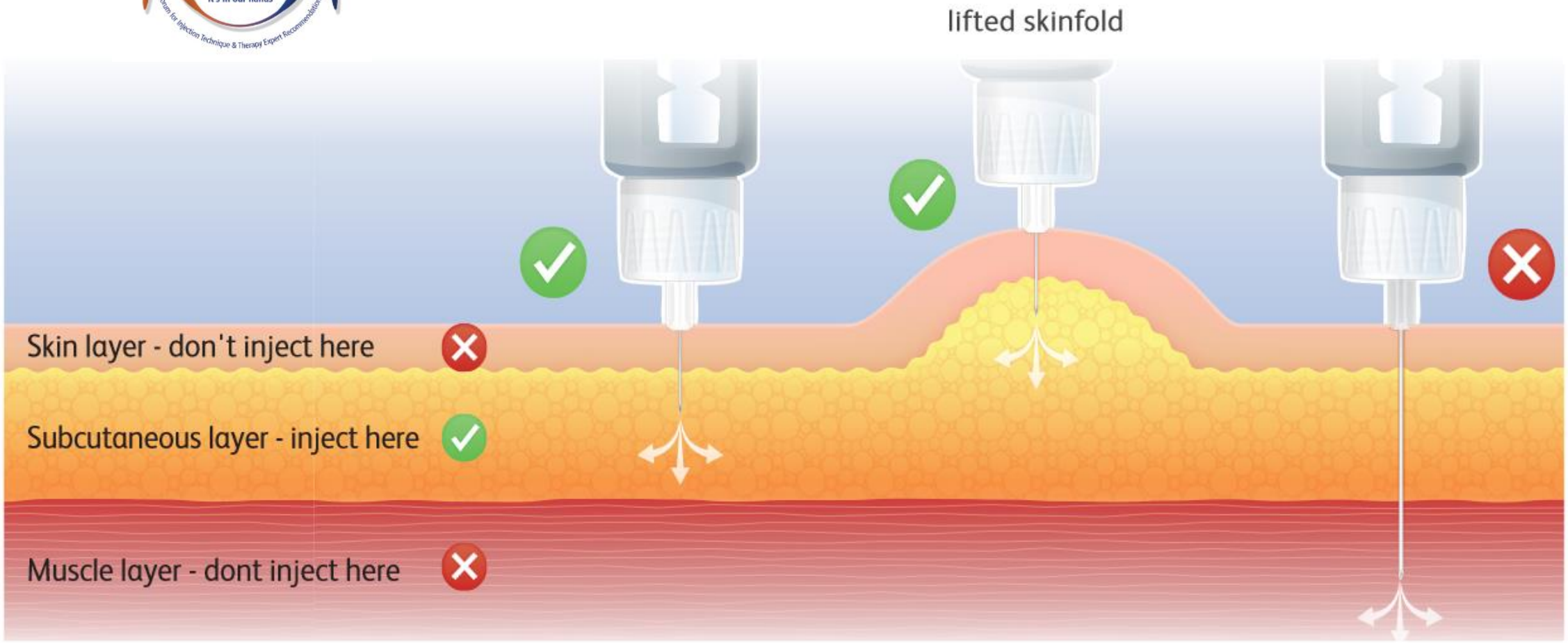
## Preparation of Skin for Injection

- **Washing of hands with soap and water or with an antiseptic is required as a hygiene process. Hands should be dried before starting the process of injecting insulin .**

**Recommendation**

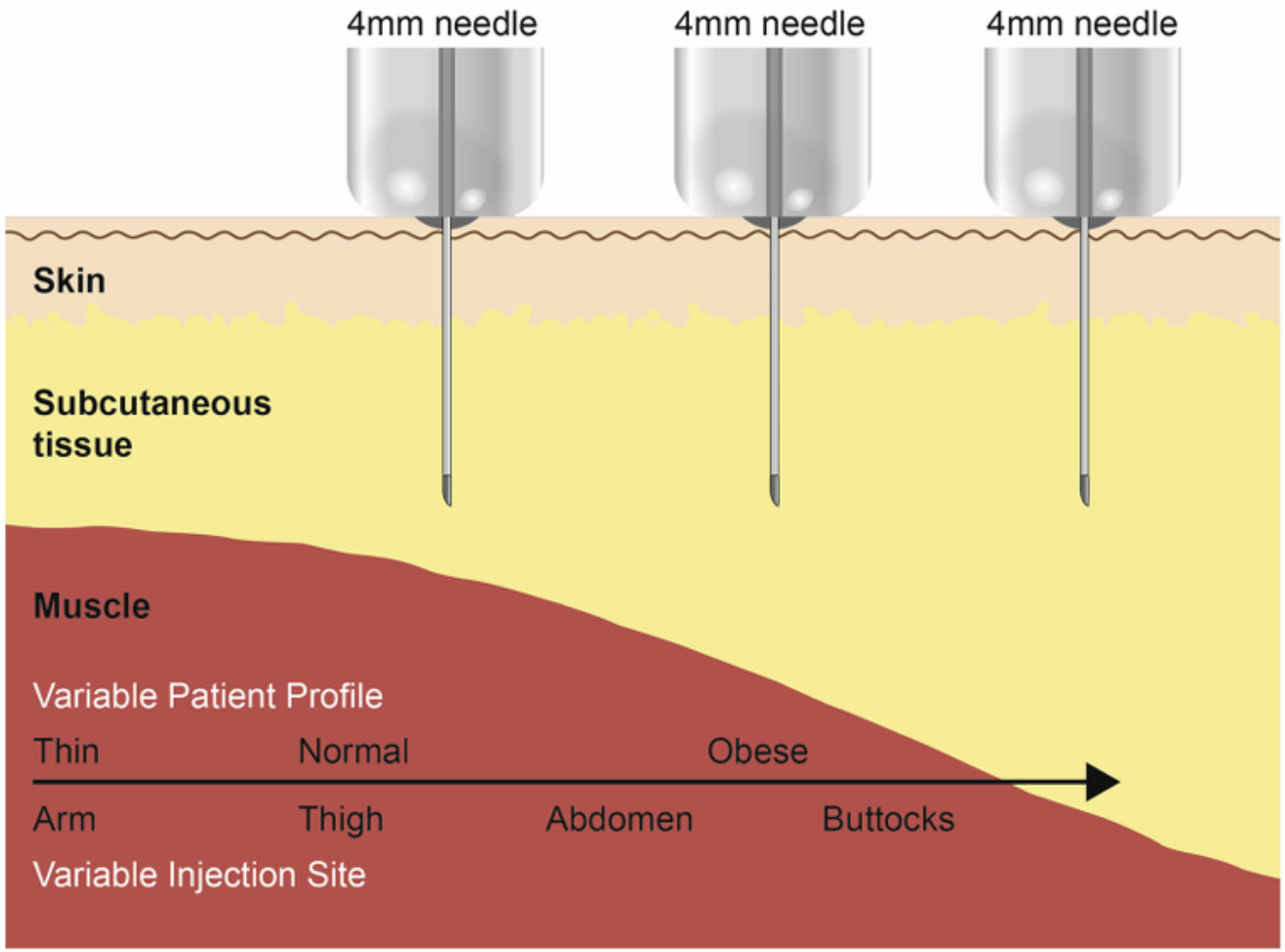
- Swabbing of the skin with an antiseptic is not required. If the skin appears dirty, use plain water and allow to dry before an injection is administered. Patients should bathe daily. **Grade B**

**water should be done and thereafter dried with a clean towel. If an antiseptic cleansing agent is used, then the skin should be allowed to dry before injecting insulin .**


FITTER
Better insulin therapy: it's in our hands
Forum for Injection Technique & Therapy Expert Recommendations
lifted skinfold
Skin layer - don't inject here
Subcutaneous layer - inject here
Muscle layer - dont inject here

# The use of a 4-mm needle is appropriate for subcutaneous injections at all injection sites

Diabetes Ther (2023) 14:1785–1799



- **A more recent innovation is the redesign of the needle hub, which is located at the needle shaft (cannula) base and connects the needle to an insulin pen**

- **To reduce the effects of varying the injection force, the rede signed hub design distributes insertion forces over a contoured and bigger surface area**

- **The re-engineered hub design of the BD Nano PRO needle was found to precisely accomplish the 4-mm target needle penetration depth with noticeably less variability than commercial posted-hub pen needle devices over the varied range of applied injection forces**

- **The BD Nano PRO needle was rated less painful and more comfortable, associated with better ease of administration, and overall preferred by patients compared to other pen needles of a similar gauge and length .**

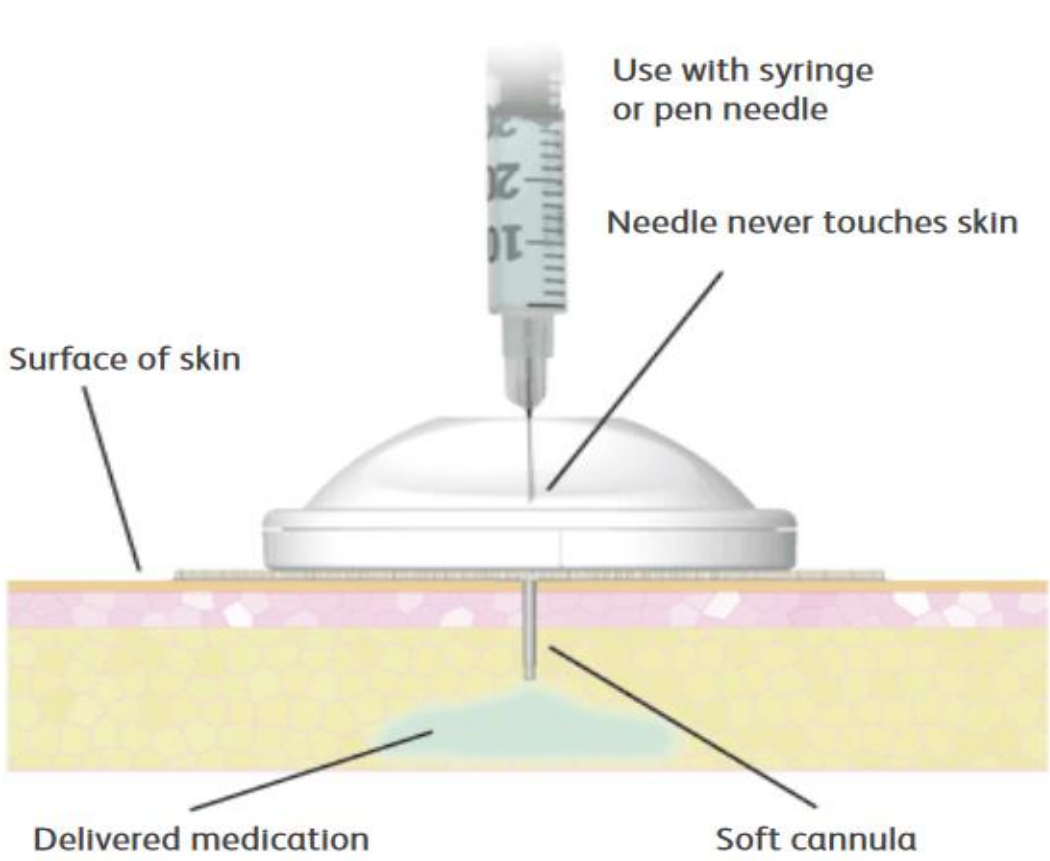
# Recommendations

- **The 4mm needle is long enough to traverse the skin and enter the SC tissue, with little risk of IM (or intradermal) injection. Therefore, it is considered the safest pen needle for children and adolescents regardless of age, gender, ethnicity or BMI. A1**

- **The 4 mm needle may be used safely and effectively in all obese children and**

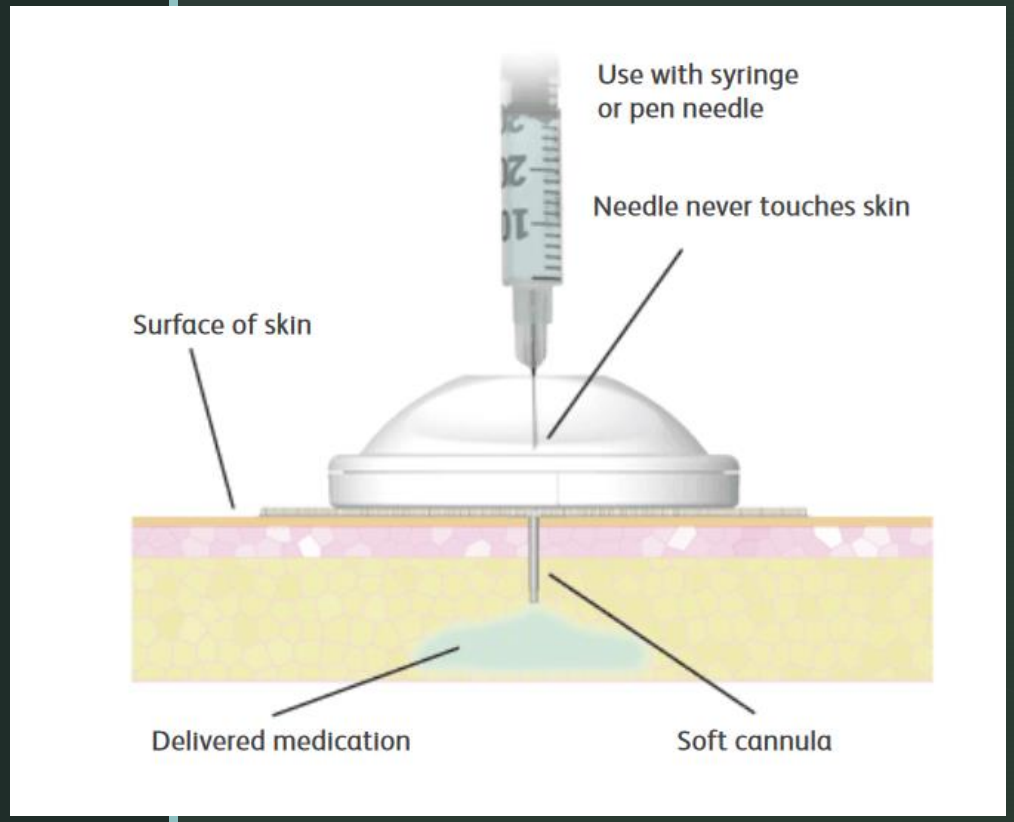
**Recommendation**

- A 4-mm needle is available for pens and a 6-mm needle is available for syringes; these are suitable for all people with no pinching. Pinching may be necessary for some individuals with thin skin when using the 6-mm needles. **Grade A**




# Injection port

- An injection port is a one-time, single patient use device.
- Reuse of the port may damage the cannula in the device and increases the risk of the tape becoming loose.
- Reuse of the port may result in infection or site irritation and inaccurate medication delivery. A1
- It should not be used for longer than 72 hours. B1
- Needles with a gauge smaller than 28 or greater than 32 should not be used. Doing so may damage the septum and may cause incorrect medication delivery. A1




- **Use of needles shorter than 8mm (5/16 in.) is suitable when injecting into the injection port. Longer needles may damage the device causing unnecessary punctures of the skin, or tearing or puncturing of the soft cannula, which may result in unpredictable medication delivery. A1**

.

- **Use of needles shorter than 5mm (3/16 in.) is not recommended when injecting into t injection port. Shorter needles may not pass through the port septum,which may prevent the medication from properly entering the body. A1**

- **Blood glucose 1 to 3 hours after using the injection port should be tested to ensure insulin delivery performs as anticipated.**

**Applying the injection port to sites that contain scar tissue, lipodystrophy, stretch marks or are injected/bruised should be avoided**

# Needle Reuse

Ideally, disposable syringes and pen needles should be used only once. Reuse of syringes and needles may not guarantee sterility.

Patients with poor personal hygiene, acute concurrent infections, open wounds on the hands, or decreased resistance to infection for any reason should not reuse a syringe or pen needle. The newer, smaller (30- and 31-gauge) needles have a thin tip.

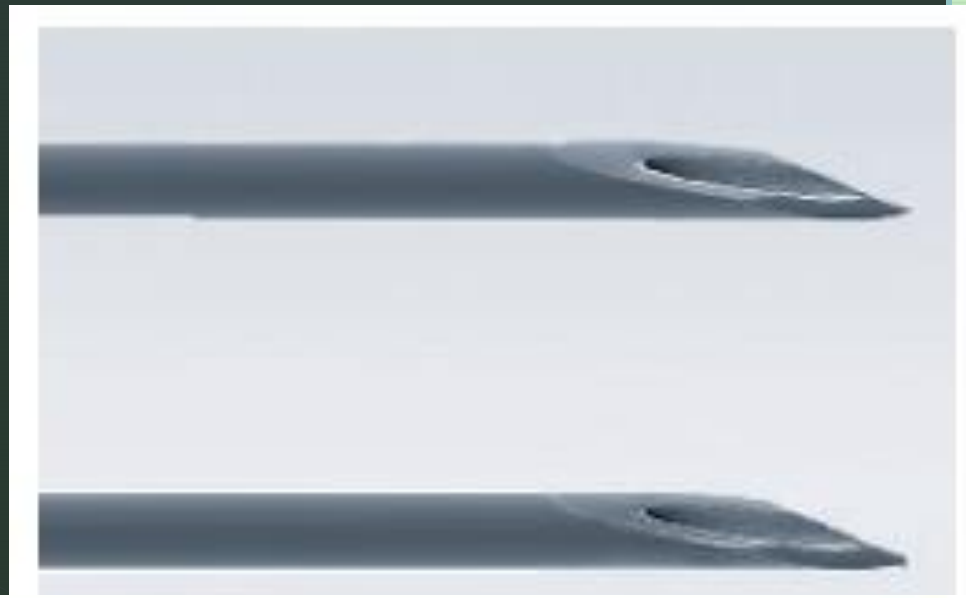
The needle tip can become bent to form a hook with single-use, which can lacerate tissue or break off to leave needle fragments within the skin.

**Some patients reuse the needles for various reasons. Many patients find it burdensome to carry extra needles when away from home. They are also reluctant to carry containers to dispose of used needles.**

**Others find that the injections from reused needles are not noticeably more painful. For reuse of a needle, it must be recapped after each use, and an inspection of the injection sites for redness or swelling must be done.**

**A needle should be discarded if it is noticeably dull or deformed or if it has come into contact with any surface other than skin**

If used repeatedly needles become distorted, lose lubrication and cause damage to the skin (as well as more painful injections)



**Recommendation**

- Use a new sterile syringe and needle for every injection. **Grade A**
- While reusing needles is not recommended, the practice is common. Reuse should be restricted to a maximum of 5 times; fewer if the needle causes pain. **Grade C**

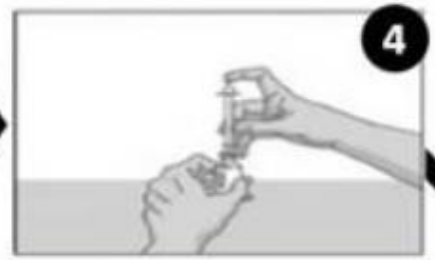
## STEPS that should be taken when insulin is injected.

1. Hands should be cleaned, and insulin gently mixed if it is the cloudy insulin.
2. The rubber on the bottle should be cleaned with spirit. If spirit is not available, cleaning should be done with water and the rubber dried with a tissue.
3. Air equivalent to the volume of insulin to be drawn, should first be drawn into the syringe, then injected into the bottle containing insulin. This is done to avoid creating a vacuum in the bottle containing insulin.
4. Insulin as required is then drawn into the syringe.
5. Ensure that the correct position of tilting insulin downwards is done, so to avoid drawing insufficient insulin. Insufficient insulin will be drawn if the bottle is not tilted appropriately and the needle sticks above the insulin level. Air bubbles should be removed.
6. The needle is pushed into the skin at 90°.
7. The plunger is advanced down and injection completed. It is recommended to allow the insulin injected to stabilise under the skin, by counting from 0 to 30.
8. The needle and syringe is removed from the skin and discarded into a plastic container, for appropriate disposal as hazardous waste


Wash hands, check insulin for lumps, crystals or discoloring. Gently roll between Hands until uniformly cloudy. Never shake insulin.


Wipe the top of the insulin bottle with an alcohol swab.


Pull the plunger down to let units of air into the syringe. The units of air should equal the units of insulin that will be drawn.




Push the air into the insulin bottle. Leave the needle in the bottle.


Turn the insulin bottle and syringe upside down. Be sure the needle is in the insulin, not in the airspace inside the bottle. Pull the plunger down to get right units of insulin in the syringe.


Look for air bubble in syringe. If there are bubbles, push insulin back into bottle. Start again from step 5. When you have the right insulin units with no air bubbles, pull syringe out of the bottle.

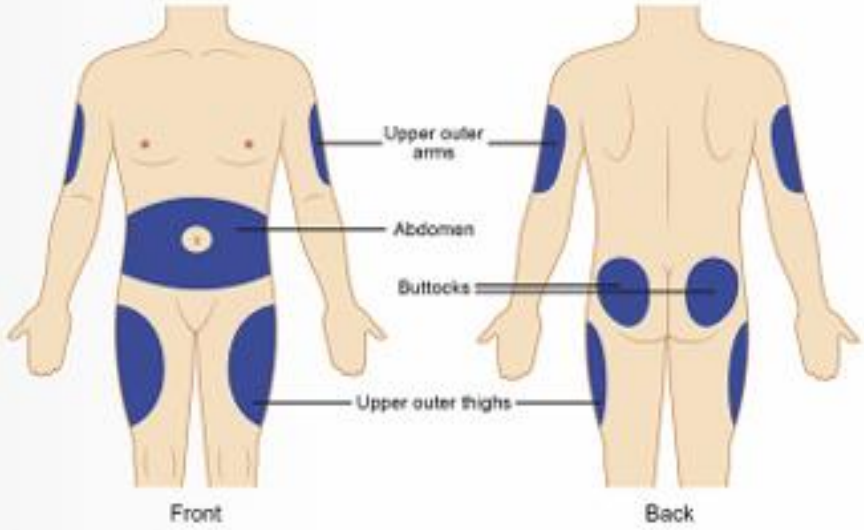

Push needle into skin at 90° angle.


Push plunger to inject insulin. Count from 0-30 (30 seconds) before withdrawing the needle.


Place the used syringe in a sharps container. Do not reuse the syringe if possible; limit re-use to maximum five times.

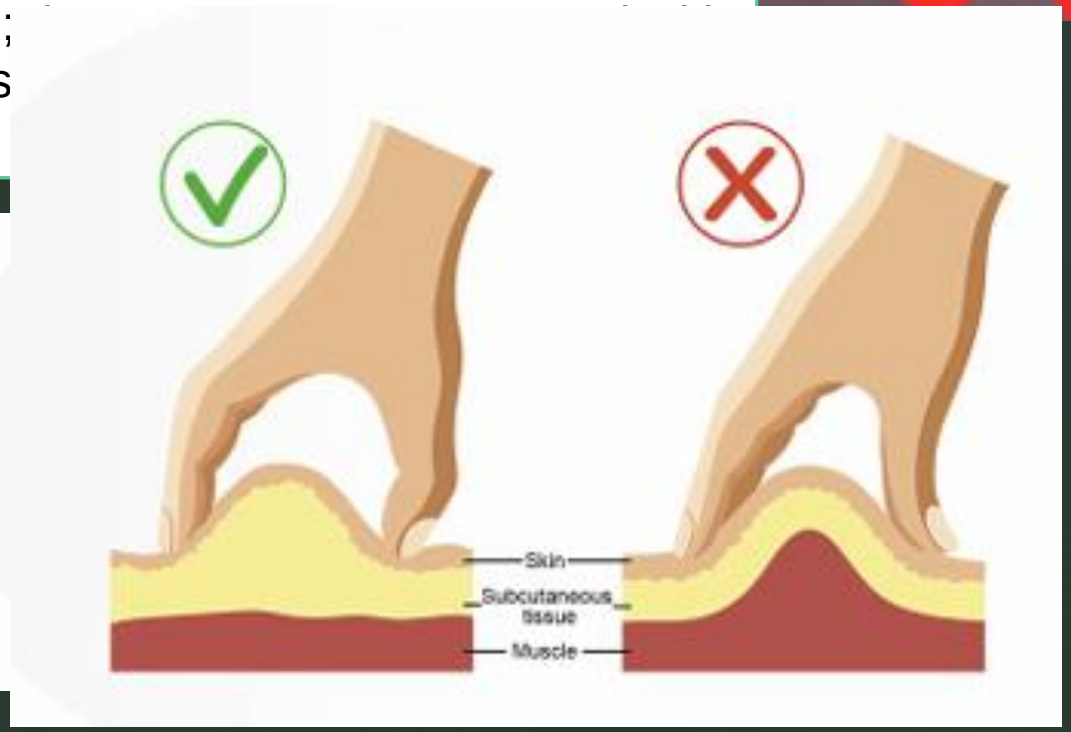
1

It is important to choose the right injection site. Typically, the abdomen, thighs, and buttocks are the most common sites due to their consistent absorption rates. It is not advisable to utilize the upper arm and lower leg regions as access to the correct zone may be limited and the lower thickness of subcutaneous fat in these regions may increase the risk of IM injection



The method of lifting up (pinching) a skin fold. The correct way is ticked with *green*; *red*. Only moderate pres skin

2 If required, it is essential to lift a fold of skin. This involves gently lifting the skin and the underlying subcutaneous tissue, or fatty layer between the thumb and index finger, while leaving the muscle untouched.



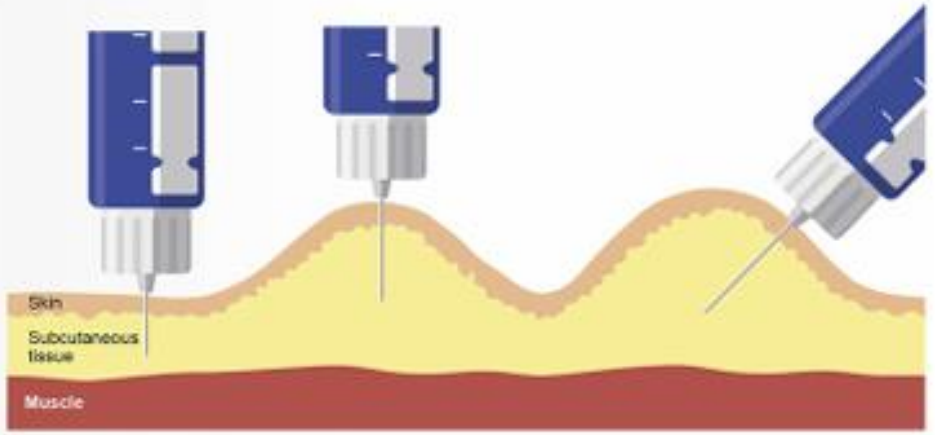
## Injection Technique Recommendations
## Lifting Skin Folds (Pinching)

- Lifting a skin fold (pinching) is done to avoid inadvertent intramuscular injection, and this should be done with 6-mm or longer needles, especially in children and other patients with thin skin.

- The correct technique for lifting a skin fold (pinching) for injection should be taught to all patients. The lifted skin fold should be lifted up gently and not squeezed tightly to causes skin blanching or pain.

3

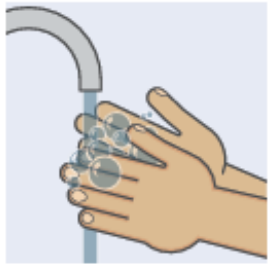
Insert the needle at a 90° angle into the skin. For patients with a lean build, combined use of lifted skin fold and angled insertion may be done. Avoid indenting the skin while injecting to prevent the needle from penetrating the muscle.




4

Inject insulin gradually and withdraw the syringe needle at the same angle. Keep the needle under the skin for at least 10 seconds after pressing the plunger.

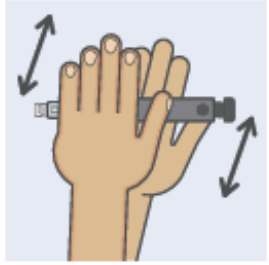
**1**



Firstly wash hands with warm water and soap

Dry thoroughly

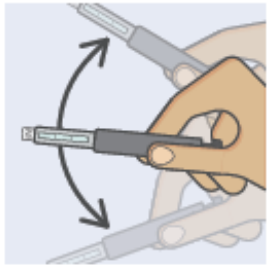
**2**



Remove pen cap

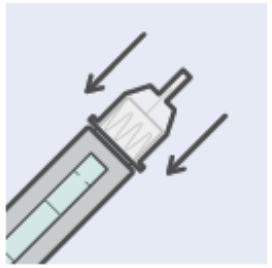
For cloudy insulins roll pen 10 times between the palms

**3**



Next, gently invert the pen 10 times to achieve an even milky appearance

**4**

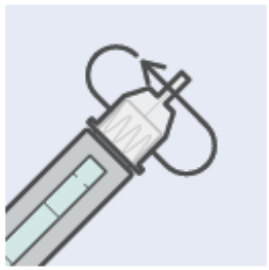


Select a new needle

Peel off paper seal

Apply new needle in line with pen

**5**



Screw on needle

Pull off protective caps

**6**

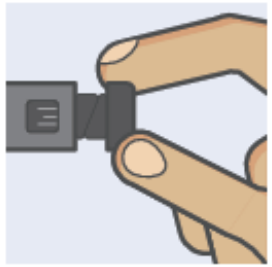
To ensure needle and pen are working correctly select 2 units on dose button

Hold pen with needle pointing upwards

Fully depress dose button looking for insulin to appear from needle tip

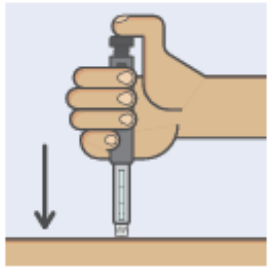
If not seen, repeat steps until insulin seen at needle tip

**7**



Dial the required dose

**8**



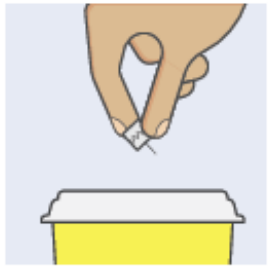
Fully insert the needle into the skin at 90 degrees, keeping the pen stable

Press dose button until dose fully injected

**9**

Before removing the needle from the skin, count to 10 to ensure the full dose is given

**10**



Safely remove the needle from the pen

Dispose of the needle into a sharps bin

5 Once done, discard the used needle safely.

# Disposal of Syringes

Incorrect disposal of sharp objects among diabetes patients and members of their family can lead to needle-stick injuries among domestic waste handlers, and the community.

# Barriers for proper disposal of needles and syringes which should be addressed by health workers as part of diabetes care

- **Lack of information** about how and where to dispose.
- **Lack of proper advice** by doctors and nurses.
- **Wrong perception** that sharps disposal information is meant only for illegal drug users,
- Some patients feel that using community sharps disposal services may result in **revelation of their diabetes status**, which may have been kept confidential.
- **The perception** that disposal of sharps into pit latrines or burning them in cooking fire stoves is a correct way of disposing of sharp hazardous waste, and cheaper.

- Sharps and, more specifically, needles, are considered to be the most hazardous category of healthcare waste for health care workers and the community at large, because of the risk of needle-stick injuries which carry a high potential for infection

- Waste should be segregated and disposed of safely. The correct segregation of health care waste is the responsibility of the health care provider and/or patient and care giver who produces each waste item.

- The simplest and safest waste segregation system is to separate all hazardous waste from non-hazardous general waste (which is generally of larger quantity) at the point of generation.

- The hazardous waste portion is very commonly separated into two parts: used sharps and potentially infectious items. Consequently, the segregation into separate containers of general non-hazardous waste, potentially infectious waste and used sharps is often referred to as the “three-bin system.

# Guidelines for disposal of hazardous and non-hazardous waste

| Step | Guidelines |
|---|---|
| Collection of used needles and syringes (sharp waste) | Puncture-proof box with lid at the top to be used and labelled as "BIOHAZARD" with a biohazard sign and yellow marked<br><br>Box should be filled up to 75% of its capacity only<br><br>Recapping the needle, bending/cutting etc., and transfer of sharps using hands should be avoided<br><br>It is recommended that if possible, a needle cutter is used to cut needles off syringes; and the needles then discarded into the sharp waste, while the plastic part of the syringe is disposed of into a thick plastic bag (non-hazardous waste). Should a needle cutter not be available and therefore the needle cannot be safely removed, the whole syringe should be disposed of into the sharps box (hazardous waste)<br><br>For picking up of needles or syringes, the syringe end should be preferred; if lying on the ground, a long-handled tong should be used |
| Storage and disinfection in DICs | Immersing the sharps in 1% sodium hypochlorite solution for 30 min |

*DIC* drop-in-centre

# Tips

- Pull the needle out at the same angle it went in. Put the syringe down.
- If insulin tends to leak from the injection site, put some pressure on the injection site with a piece of cotton swab for a few seconds: DO NOT RUB.
- If bleeding occurs, apply a cotton swab with some little pressure for 30 s. This is usually sufficient. DO NOT RUB.
- Place the needle and syringe in a safe hard container. Close the container, and keep it safely away from children
- . If the syringe and needle are to be reused, the needle should be carefully recapped, stored away in a clean container and reused later, but not more than 5 times.
- If more than 50 units of insulin is to be injected, it is advisable to split the doses and administer the divided doses either at different times or using different sites for the same injection.
- Large volumes of insulin are associated with more insulin absorption variability, which should be avoided.

# Special Situations

## Very Thin and Wasted Individuals

For lean patients, it is recommended to use a 4-mm needle with a pen injection device, otherwise employ the combined use of a raised skin fold and angled insertion of the needle, if using needles longer than 4 mm .

## Very Obese Individuals

Needle length should not be a concern in patients who are obese or overweight. In obese patients it still recommended to use 4- to 6-mm needles. Lifting a skin fold  is not necessary in obese patients .

# Lipohypertrophy: Recommendations:

•**Examine the sites for lipohypertrophy at least every 3 months**, or more frequently. Injection sites should be gently palpated in order to feel the lipohypertrophy.

•**Patients should be instructed on how to palpate the injection sites routinely;** and on how to inspect their own sites. Patients should be given training in site rotation and proper injection technique.

•**The size of the lipohypertrophy should be estimated** by feeling its extreme edge and measuring its longitudinal and transverse diameters using a point 5-cm (two finger breadth) away from the extreme edge of the lipohypertrophy. The site and the size of the lipohypertrophy should be documented in the patient's notes and referred to in future assessment of the lipohypertrophy.

Patients should be requested to avoid injecting into areas of lipohypertrophy until the next examination. Recommend use of larger injection zones, correct injection site rotation, and non-reuse of needles.

**Moving away from lipohypertrophy injections may require significant reduction in insulin dose.**

**Ensure**

**that blood glucose levels are checked frequently and insulin is adjusted according results**

# Travelling with Insulin

- Insulin may be packed in a tight polythene bag and kept inside a small thermos flask

- Do not keep insulin in a locked car or in the glove compartment. Temperature in closed vehicles may reach very high levels (above 32 °C), with loss of potency of insulin

- When travelling by air, carry insulin supplies, along with a prescription, in cabin baggage or handbag. Luggage which is checked-in is stored in the aircraft's hold and may freeze: any insulin in this luggage may lose its potency

- Do not store insulin near extreme heat (above 32 °C) or extreme cold sources (below 2 °C)

# Insulin in School

**•Identify an appropriate location for insulin storage and follow the guidelines for insulin storage.**

**•Train one person from the school about insulin administration, doses/injection times prescribed for specific blood glucose values and for carbohydrate intake.**

**•Identify a location in the school to provide privacy during insulin administration, if desired by the student and family.**

•The school authority should permit the student to check his or her blood glucose level and take appropriate action to treat hypoglycaemia or hyperglycaemia, when need arises.

•A school authority and preferably peers of the student to recognise symptoms of hypoglycaemia and hyperglycaemia and their immediate management.

•A school authority and preferably peers of the student to understand how participation in physical activity can be safely done.

•A school authority to receive instructions for handling diabetes emergencies.

•A school authority to have a plan for the disposal of sharps and other health waste.

# Pain

- Pain in injection therapy depends on the needle length and diameter, injection technique, and whether the injection is intramuscular
- Pain caused by intramuscular injections of insulin is described as stinging, and the pain is aggravated by contracting the muscle while the needle is in situ.
- Pain is also caused by reuse of a distorted or blunt needle. Use of short and narrow-gauge (4 to 5 mm × 32G) insulin pen needles reduces pain. Cold insulin is painful.

The following measures assist in minimizing pain from insulin injections:

- **Inject insulin that has a temperature of the surrounding room (20–30 °C).**
- **Avoid the use topical alcohol for swabbing.**
- **Relax the muscles at the site during the process of injection.**
- **Quickly penetrate the skin.**
- **Do not change direction of the needle during insertion or withdrawal.**
- **Do not reuse needles, if possible.**
- **Do not use an injection device that puts pressure on the skin around the injection site.**
- **Apply a little pressure for 5 to 8 s after the injection, without rubbing: this is advised if an injection seems especially painful**

# Paediatrics

Diagnosis of diabetes in childhood causes stress and anxiety which hinders a parent's ability to administer insulin or encourage children to self-administer insulin.

Health care professionals should give appropriate education and demonstration of injection technique on themselves ("walking in the patient's shoes"): it helps parents, care givers, and children to overcome anxiety and other issues.

Play therapy is a useful method of explaining injection technique. Injecting toys, dummies and "oranges" is strongly discouraged as it creates more fear and anxiety.

All those present (physician, nurse, parents and relatives) should give the injection "without insulin" and appreciate "there is no pain

# Self-Injection

- There is no right age for the child to start injecting on his or her own.
- Some children may want to get used to having injections given to them by an adult, before learning to inject themselves.
- Studies have shown that children above 11 years can independently inject insulin.
- Children should not be excessively pressurised to administer their own injections. When they're ready, encourage them to self-inject. They should always be supervised

# Pregnancy

**An optimal injecting technique during pregnancy has not established. However, the following recommendations are considered reasonable.**

- **The abdomen is generally a safe site for insulin administration during pregnancy. However, as thinning of abdominal fat from uterine expansion is common, pregnant women with diabetes (of any type) should use a 4-mm pen needle when injecting on the abdomen. Other areas follow similar recommendations as in non-pregnant state.**

- **First trimester: hypoglycaemic events are most common during the 1st trimester. Close monitoring and dose adjustments are important. No change in insulin site or technique is needed.**

- **Second trimester: insulin can be injected over the entire abdomen as long as properly raised skin folds are used. Lateral aspects of the abdomen can be used to inject insulin when no skin fold is raised.**

- **Third trimester: injections can be given into the lateral abdomen with properly raised skin folds. Apprehensive patients may use the thigh, upper arm, or buttock instead of the abdomen. Areas around the umbilicus should be avoided during the last trimester**

# Elderly

Geriatric patients often have limited dexterity, visual impairment, and hearing impairment.

**Recommendations**

- Counsel elderly diabetes patients about the course of diabetes and proper injection technique.
- The elderly should be assisted by a care giver.
- Prevention and treatment of hypoglycaemia should be emphasised.
- Insulin pens are beneficial in the elderly due to their discreetness, simplicity, convenience of use and dosage accuracy.
- For visually impaired patients, the use of acoustic devices for glucose measurement is recommended.
- In patients with both visual and dexterity impairment, pre-filled syringes may be helpful.
- For patients with impaired hearing and those who use hearing aids, conduct education in a noise-free environment.

## Health Care Recommendations Institutional Care

**In critically ill patients with hyperglycaemia, protocol-driven intravenous infusion is recommended. For achieving and maintaining glucose control in non-critically ill patients with diabetes or stress hyperglycaemia, scheduled subcutaneous insulin is recommended**

**Recommendations**

- **The use of insulin pens instead of vial and syringes can provide several advantages for hospitalised patients, including greater satisfaction among them and health care providers, improved safety and reduced costs.**

- **Nurses need to follow the same principles of injection.**

- **Note that when insulin has to be injected intramuscularly, a needle for intramuscular injection fitted to a syringe that can adequately measure insulin dosage should be used. The usual 6-mm needles or syringes will not deliver insulin intramuscularly**

## Thickness of Subcutaneous Fat

- The thickness of skin and subcutaneous tissue varies from 4.9 mm in the arms of 2–6 year olds to 8 mm in 14–17 year olds.

- The skin surface to muscle distance is < 4 mm in nearly 10% of children, especially in the 2- to 6-year age group.

- In this age group, the risk of intramuscular injections using the 4-mm pen needle, even when lifting a skin fold (pinching) is not done, is low (20.2%). The 4-mm pen needle should therefore be the recommended needle for all children.
- If the 4-mm needle is not available,it is recommended that a 6-mm needle and syringe be used along with appropriate lifting of a skin fold, to reduce the risk of intramuscular injection in children

## Barriers to Adopting the Recommendations

Decisions imposed on people suddenly, with no time to get used to the idea or prepare for the consequences, are generally resisted. This natural resistance to change may be the first barrier to the implementation of these guidelines; for example, health workers and policy makers may request more time to transition from longer needles to shorter ones.

### Lack of Resources for Education

- Health facilities in East Africa do care for patients with diabetes, both type 1 and type 2. However, only a few follow any specific guidelines, or have in-house protocols for managing diabetes [59–61]. Resources will therefore be required to mobilise the health care providers and educate them on the optimisation of insulin therapy and insulin injection technique. Patients with diabetes will also require a more detailed education on injection technique.

### Policy Change

- While the cost of smaller-sized needles is not different from that of longer ones which may be in current use in most health facilities [42], the change to smaller-sized needles implies a policy change that is a process. Keeping insulin and vaccines in the same refrigerator at the community health care facility may meet some resistance as it also requires a policy change.

### Consensus Statements and Lack of Evidence

- Consensus statements were produced because of lack of randomised controlled studies and other hard scientific data. These may meet challenges.

**If a child, young person or adult is nervous of giving themselves an injection of insulin then there are devices which could be discussed which may help.**

**iPort Advance injection port** is a small injection port that lets you take your injectable medications without having to puncture your skin for each injection. It's easy to wear and easy to use. The port can be worn for up to three days during all normal activities, including sleeping, bathing and exercise. See www.medtronicdiabetes.com for more information.

**InsulCheck Connect** is an example of a connected device that supports people with diabetes to achieve best practice, better adherence, avoid double dosing events and be more independent. See www.glucorx.co.uk for more information.

Health professionals also have a responsibility to reassess injection technique and examine injection sites as part of routine, on-going diabetes management. These are some of the questions you may choose to use during your consultation to assess injection technique.

| |
|---|
| 1. Where do you store your insulin? |
| 2. Show me how you mix your insulin before giving your injection (only if this is required). |
| 3. Show me where you inject your insulin? |
| 4. Do you check for lumps under the skin, have you identified any and if so do you avoid injecting into these areas? |
| 5. How often do you change the sites where you inject? |
| 6. How far apart do you space injections? |
| 7. How often do you change your needles? |
| 8. What angle do you insert the needle into the skin? |
| 9. How long do you leave the needle in the skin after pressing down the dose button? |
| 10. How do you dispose of used "sharps"? |

# INJECTION TECHNIQUE ASSESSMENT CHECKLIST

# MCQ

Which of the following regarding LH ( Lipohypertrophy) is not correct

1. The use of purified human insulin or analogues is the best strategy to reduce the risk of LH in patients receiving numerous insulin injections daily

2. Patients should also be educated on how to self-inspect and recognise LH at injection sites

3. In the case of LH lesions without visible or palpable changes, an ultrasound examination can not offer higher sensitivity and specificity compared to a physical evaluation

4. Insulin-derived amyloidosis (IDA) may be confused with LH in insulin-treated patients

**(CME INDIA)**

# Solve this case

A 21-year-old female patient was diagnosed with Type 1 Diabetes ten years ago. She reported the use of a combination of Insulin Isophane/NPH 70% and Human Insulin/Soluble with a BD syringe, employing the same syringe for a 15-day duration. The patient resides in a remote area in Jharkhand, India. She presented with several distinct, circular, well-defined, brown/black macular lesions arranged in a whorled pattern on her abdominal wall. The patient mentioned the persistence of these lesions for an extended period, spanning over six months.

Possible differential diagnoses for the patient's condition include:

1. **Wrong injection technique - Intradermal:** The possibility that the observed lesions are a result of an incorrect intradermal injection technique.
2. **Reaction to insulin injections:** Considering the potential for the lesions to be a reaction to the insulin injections, taking into account the type and formulation of insulin used.
3. **Insulin tattoo:** Exploring the likelihood of the lesions being related to an "insulin tattoo," potentially caused by repeated injections in the same area.
4. **Spotted dermopathy due to insulin allergy - Usually due to zinc component:** Considering the potential for the observed lesions to be indicative of a spotted dermopathy associated with an allergic reaction to insulin, particularly if it involves a zinc component in the insulin formulation.

**Final Diagnosis** was ascertained as Post Inflammatory Hyperpigmentation (PIH) based on biopsy.

Biopsy showed -Neutrophilic infiltration accompanied by erythrocyte extravasation and the presence of eosinophilic amorphous material was observed, surrounded by a neutrophilic infiltrate.

• **This case presents Post Inflammatory Hyperpigmentation (PIH)** resulting from incorrect insulin injection techniques. The patient exhibits multiple discrete, rounded, well-defined, brown/black macular lesions on the abdominal wall in a whorled pattern—characteristic of PIH, a common cutaneous adverse effect attributed to improper insulin injection practices.

• **Prolonged use of the same needle for multiple injections leads to needle tip blunting**, causing increased microtrauma and subsequent PIH. The key to managing this condition lies in preventing further inflammation. This can be achieved through the implementation of proper insulin administration techniques, emphasizing the importance of correct injection processes alongside insulin type and dosage considerations.

• **Advising the patient on regular site rotation, exploring newer delivery systems, and providing comprehensive counseling is crucial**. This approach significantly contributes to the control of cutaneous adverse effects associated with insulin injections, including but not limited to Lipoatrophy, Lipohypertrophy, Acanthosis Nigricans, PIH, and Amyloidosis.

- **For this specific case, a treatment plan involves:**

1. **Twice daily application of emollients.**
2. **Overnight use of topical Betamethasone Ointment on Saturdays and Sundays only.**
3. **This regimen, followed for 4-6 weeks, may effectively clear the PIH. Regular monitoring and further adjustments can be made as needed.**

- **Residual epidermal hyperpigmentation may persist for different durations, usually spanning from 6 to 12 months after the initial inflammatory process resolves. In certain instances, dermal post-inflammatory hyperpigmentation may endure for more prolonged periods, extending for years.**

# Know it

- A complication of insulin treatment that affects the skin is called INSULIN - DERIVED AMYLOIDOSIS[ IDA], a nodular form of the disease . The insulin-derived amyloid fibril protein creates deposits of amyloid at the sites of insulin injection . Despite the lack of actual prevalence data, IDA may be mistaken for LH in insulin-treated patients .

- As the insulin absorption at the IDA site is remarkably reduced compared to that at the normal site , IDA causes poor glycaemic control and increased insulin dose requirements . IDA results in hypoglcaemia due to the delivery of an increased dose of insulin into normal sites .

- Recently, cases of IDA without a palpable mass have been reported . In these cases, differentiating between IDA and LH by physical examination is difficult, and imaging studies, such as magnetic resonance imaging (MRI) and ultrasound, are necessary.

- Long-term, recurrent, same-site insulin injection is regarded as the most significant risk factor for developing IDA .

- To prevent IDA, it is important to educate patients about proper injection site rotation as well as ways to prevent LH

# Quick Take Aways

# Final Points

- The increasing prevalence of insulin regimens, preparations, and delivery methods raises the possibility of injection technique errors.
- This may jeopardise patient safety and well-being. Self-examination of the insulin injection site (SelfIE) is an important aspect of injection technique monitoring, as it may aid in the early detection of skin compli cations (such as LH) and unfavourable variability in glucose levels and may help to avoid excessive insulin use
- The development of an insulin strategy tailored to each intensive care unit or ward can enhance indoor glycaemic control and lower professional hazards associated with insulin injection.

Remember the 6 key points for optimal insulin delivery:

1. Correct insulin regimen
2. Correct insulin preparation
3. Correct insulin delivery device
4. Correct insulin dosage
5. Correct injection technique
6. Correct Insulin Storage

**The Forum for Injection Technique and Therapy Expert Recommendations (FITTER) in 2015 with general recommendations applicable to most patients on insulin therapy. However, these recommendations lacked specificity for low- and middle-income countries. They made several recommendations:**

1. Insulin should be transported safely, avoiding shaking and exposure to high temperatures (>32 °C).
2. Insulin should not be transported below 0 °C.
3. If insulin is stored at home for over 2 months, it should be kept at 2–8 °C.
4. Patients should receive appropriate instructions when given insulin.
5. Insulin in use should be kept at room temperature and never immersed in water to prevent contamination.
6. Shortest available needles (4 mm for pen and 6 mm for insulin syringe) should be preferred.
7. Intramuscular injections should be avoided, especially with long-acting insulins, due to risk of severe hypoglycaemia.
8. Excessive slanting of the needle should be avoided to prevent poor absorption and skin scarring.
9. In patients with "paper-like skin," pen injection devices with 4-mm needles should be used if possible.
10. Reuse of needles and syringes is not recommended, but if practiced, should be limited to discarding when injections become painful, not exceeding reuse of a needle more than 5 times.

# Final Point

## Did I talk about BIG CONCEPT ?

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# Challenges of Insulin storage in India and solution

## Insulin being a protein is liable to get denatured

- Insulin due to its colloidal nature is highly prone to precipitation induced by changes in the environmental pH and temperatures.
- Instability in the proteins is attributed to the differential level of changes in the protein structure.
- This happens when exposed to variable physicochemical changes in the environment.
- Insulin is very sensitive to sunlight and extreme temperatures resulting in its degradation.

# How variation in various storage conditions and climatic changes causes change in therapeutic efficacy

**Storage condition affects the stability of insulin as observed in a study in which insulin stored at temperature between 32 and 37°C showed**

**14 to 18% decrease in its potency and could not cause a significant decrease in blood sugar level when compared with those receiving insulin stored at 5°C.**

Effect of Climatic Changes and Storage Condition on Efficacy of Insulin Khurana, Gupta
Journal of Social Health and Diabetes Vol. 7 No. 1/2019

**In India heat can severely degrade the insulin.**

- **There is a small proportion of patients storing insulin by refrigerator**
- **Political challenges that unsettle people make most DM patients to live in very pathetic housing conditions, street families in particular.**
- **This makes correct home storage practice of insulin to be practically impossible for the low-income earners and the poverty-stricken class that constitutes about 70% of the urban population**
- **Twenty-six to 77% DM patients have refrigerators for storing insulin due to poverty and cultural social** demic knows no geographical boundaries

## Degradation can be broadly of two types:

**Physical degradation**

**(e.g., aggregation, adsorption, etc.)**

**It occurs when the physical state of the protein undergoes irreversible changes without any change in its covalent structure.**

**Chemical degradation**

**Refers to a change in the covalent structure of the protein. The relative susceptibility of insulin analogues to undergo chemical degradation depends on their** thermodynamic property and tendency to undergo transient conformational changes.

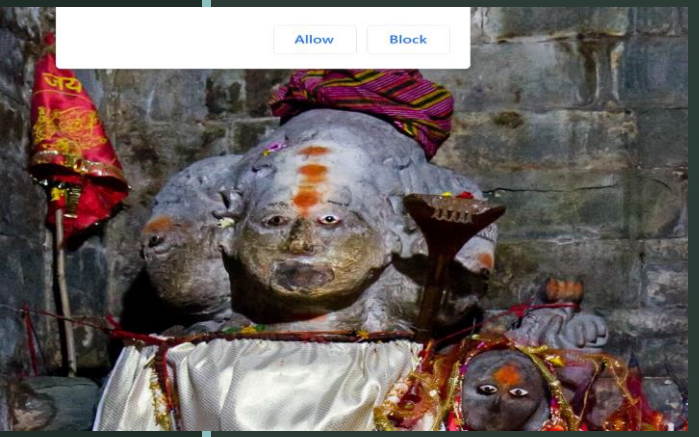
**In a pilot study conducted in JIPMER, Puducherry 131 diabetic patients, 59% of them had hyperglycemia, indicating poor glycemic control. Out of these hyperglycemic patients, 56% were storing the insulin vials at room temperature**

**Both physical and chemical degradations could result in loss of bioactivity of insulin. Hence un-opened vials of insulin have to be stored in a controlled environment of 2 to 8°C in a refrigerator protected from light**

Pot where the inside temperature will be a few degrees lower than the room temperature, to provide a near ideal storage environment for insulin to maintain the stability as far as possible.

During summers, as the room temperature rises, the pot temperature also may rise above 25°C or even beyond 35°C.

Therefore, even the insulin stored in a mud pot is not protected from denaturation due to high temperatures during summer. This could be one of the reasons why some patients require comparatively higher doses of insulin and show clinical symptoms of drug resistance




Lahaul-Spiti (cold desert) altitude of 8,000 to 16,000 ft above sea level

These tribal areas remain cutoff from rest of the country at least for 3 to 4 months in the winters with interrupted supply of electricity

People with diabetes usually seek specialized diabetic care from the state capital, located 250 to 500 km away (16–24 hours drive through one of the most treacherous roads in the world)

The challenges posed by diabetes on the top of the world have been addressed innovatively

# Challenges of Insulin Storage in Cold Climatic Condition

The biggest challenge remains how to store insulin in the winter when outside temperature dips to –30°C mostly during midnight and inside temperature of the living room goes up to 40 to 70°F due to constant burning of “Bukhari” made up of iron

- **Unique cloth people wear in the winter is an abdominal binder, which measures 2 to 3 ft in width and 5 to 15 ft in length.**
- **“It was thought to store insulin in multiple layers of abdominal binder, which prevents it from freezing in Winter**
- **They were advised to wrap the insulin vials and/or pens in “multiple layers” in the abdominal binder (where the temperature recorded was between 5 and 10°C**
- **The success of this practice was evident from the normal HbA1C values and the smiles on their faces, when they visit state capital for routine medical consultation.**


Brilliant
Blunders


Dose to be given was 40U before breakfast

Usual compounder was on leave at village

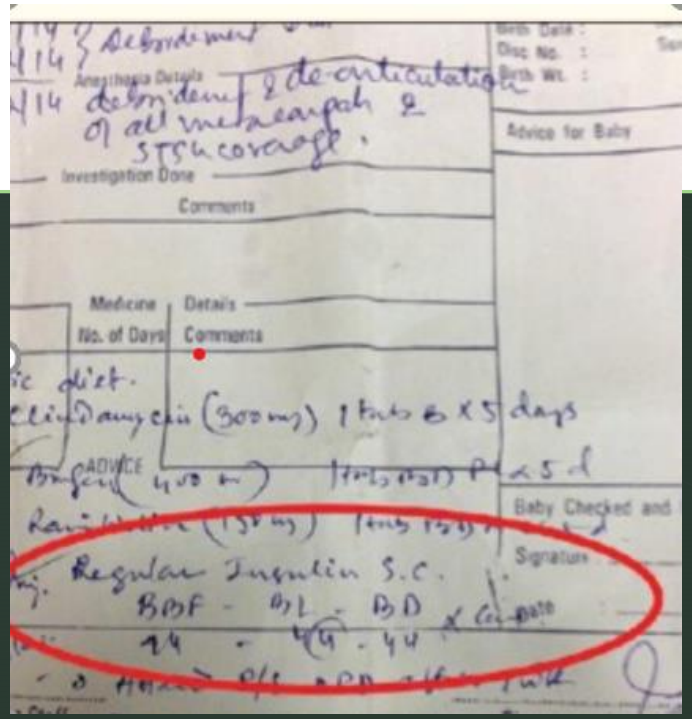
New vial was to be opened
His son thought 40 U = 10 mL

Gave whole vial

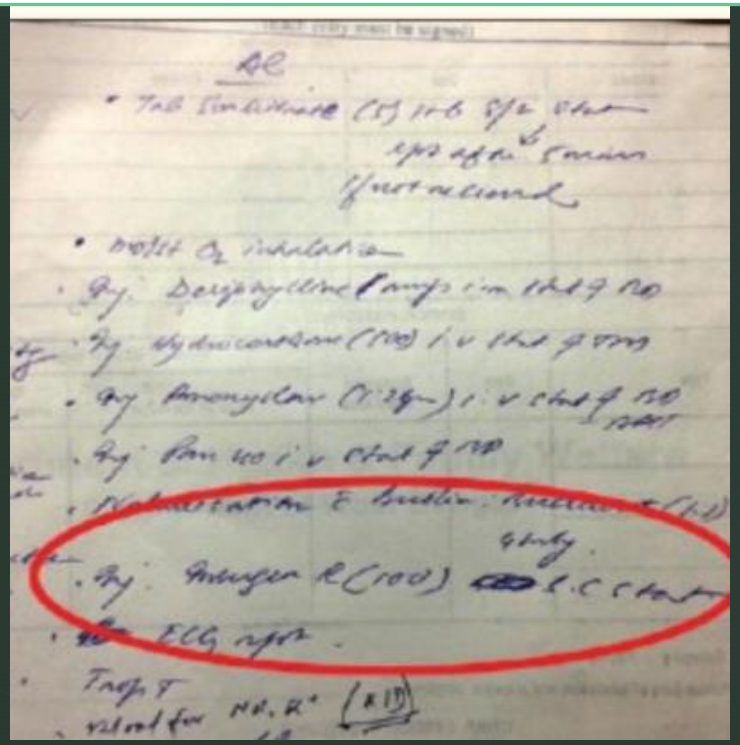
My own case in 1994

**Illegible prescription or inadequate explanation regarding injection technique/storage to the patients/accompanying party/health-care providers is an important cause of unacceptable outcome.**

**First Patient : Admitted with major hypoglycemia after using 44 U of insulin instead of 4 U**




**Second patient : 100 U instead of 10 U because of misinterpretation of the prescription**



**Potentially dangerous use of the abbreviation "u" to indicate the number of units while prescribing insulin**

- Insulin should never be allowed to be frozen and if frozen, it should be discarded.
- Ask our patients to keep insulin in a place within the refrigerator which is distant from the deep freezer compartment
- Insulin loses its bioavailability when vials were stored in the topmost part of the refrigerator door and getting exposed to the very low temperature of the deep freezer due to the malfunction and/or broken door of the deep freezer .
- Pens should not be stored with needles on to avoid potential air-clogging and leak in thermoinsulation.


???

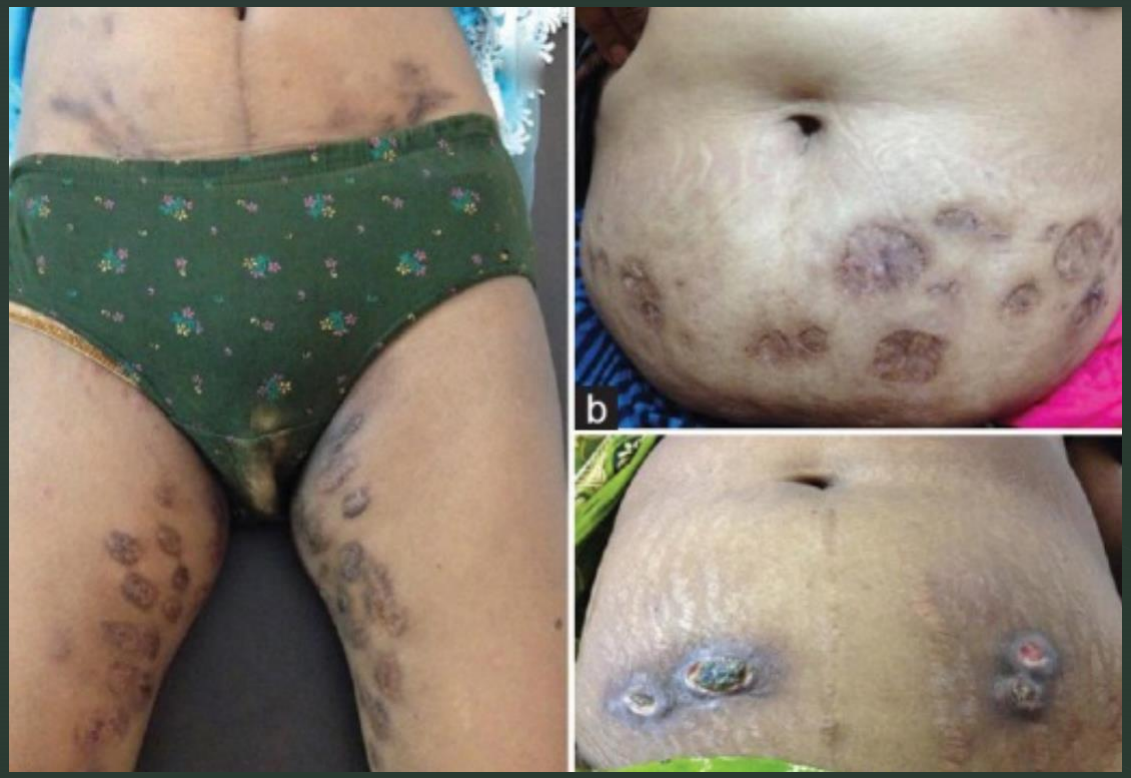
**Syringe-vial mismatch:**

**Patient drawing insulin from U-40 NPH vial with U-100 syringe**


Cloudy soluble insulin in the used vial (left) compared to its crystal clear appearance in the unused vial (right) due to improper mixing in split-mix regime

Improper and unhygienic storage leading to accumulation of dust over the rubber cap of the insulin vials

- **The top of the insulin vial (edge of the pen in pen-users) should also be cleaned with an alcohol swab.**
- **Improper care of the vials, injection sites, and poor hygiene leading to local infections are not uncommon in our patient populations**
- **These soft-tissue infections can potentially lead to surgical interventions, uncontrolled sugars, significant cosmetic disfigurements and ultimately end up in poor patient compliance.**
- **Needles should not be cleaned with alcohol as alcohol removes the silicon coating of the needle and makes injections more painful.**



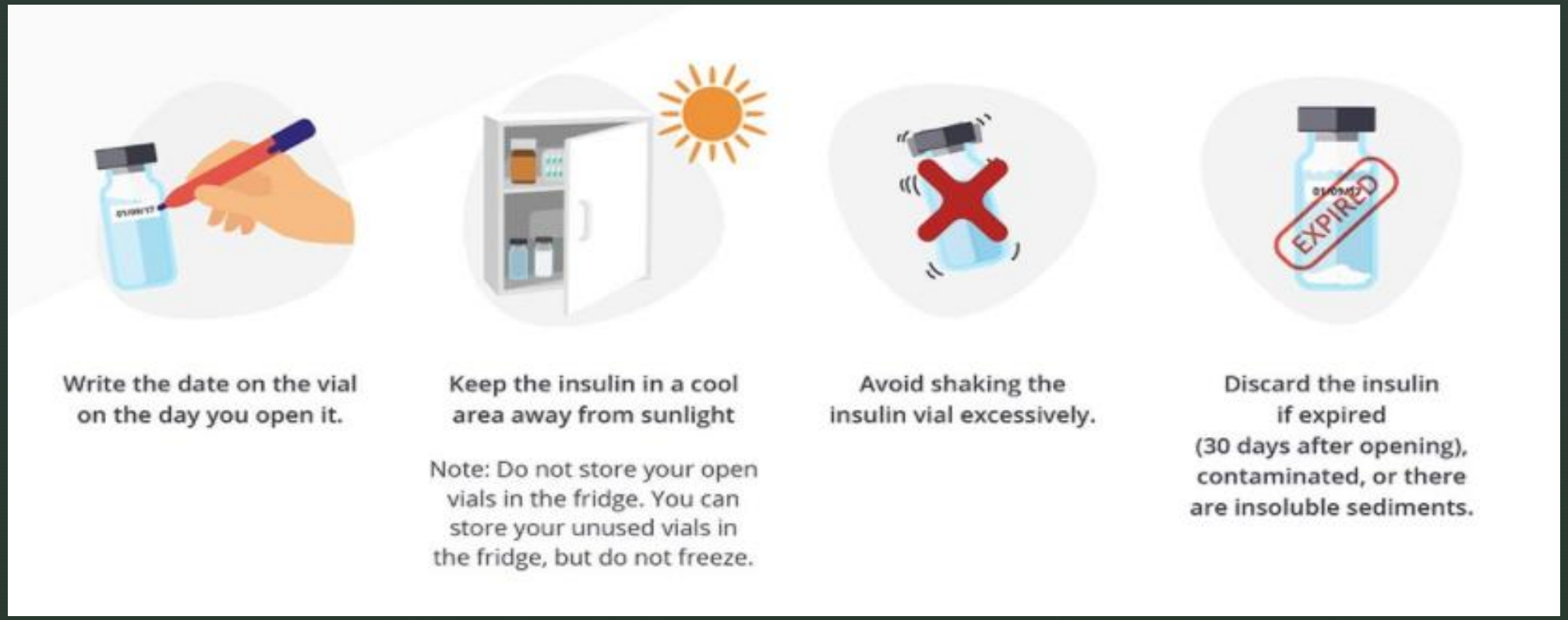

Postinflammatory hyperpigmentation following infection over injection sites: thighs and abdomen

Infection at injection sites due to poor hygiene and improper cleansing of injection sites

Chowdhury S, Chakraborty PP. Errors of insulin therapy: Real-life experiences from developing world. J Family Med Prim Care. 2017 Oct-Dec;6(4):724-729. doi: 10.4103/jfmpc.jfmpc_418_16. PMID: 29564252; PMCID: PMC5848387.

# General principles of insulin storage and use

- Insulin should be stored at refrigeration temperature (2–8ºC). Once in use, insulin may be stored at room temperature
- Insulin should never be frozen or exposed to extreme heat (> 30ºC) for prolonged periods as this will affect insulin potency and alter its action



# Factors affecting Insulin action
# Decreased potency over time: Setting the Scene

- **Most insulins remains potent and effective for up to a month after the vial/cartridge/pen has been opened (if kept in room temperature in between use)**
- **Potency begins to decrease after a period of one month**
- **Can be a problem for people who require very small insulin doses**
- **Advisable to start a new vial/cartridge/pen after every 30 days**

EADSG Guidelines: Insulin Storage and Optimisation of Injection Technique in Diabetes Management. Diabetes Ther (2019) 10:341–366

Factors affecting Insulin action

# Storage of insulins: Recommendations

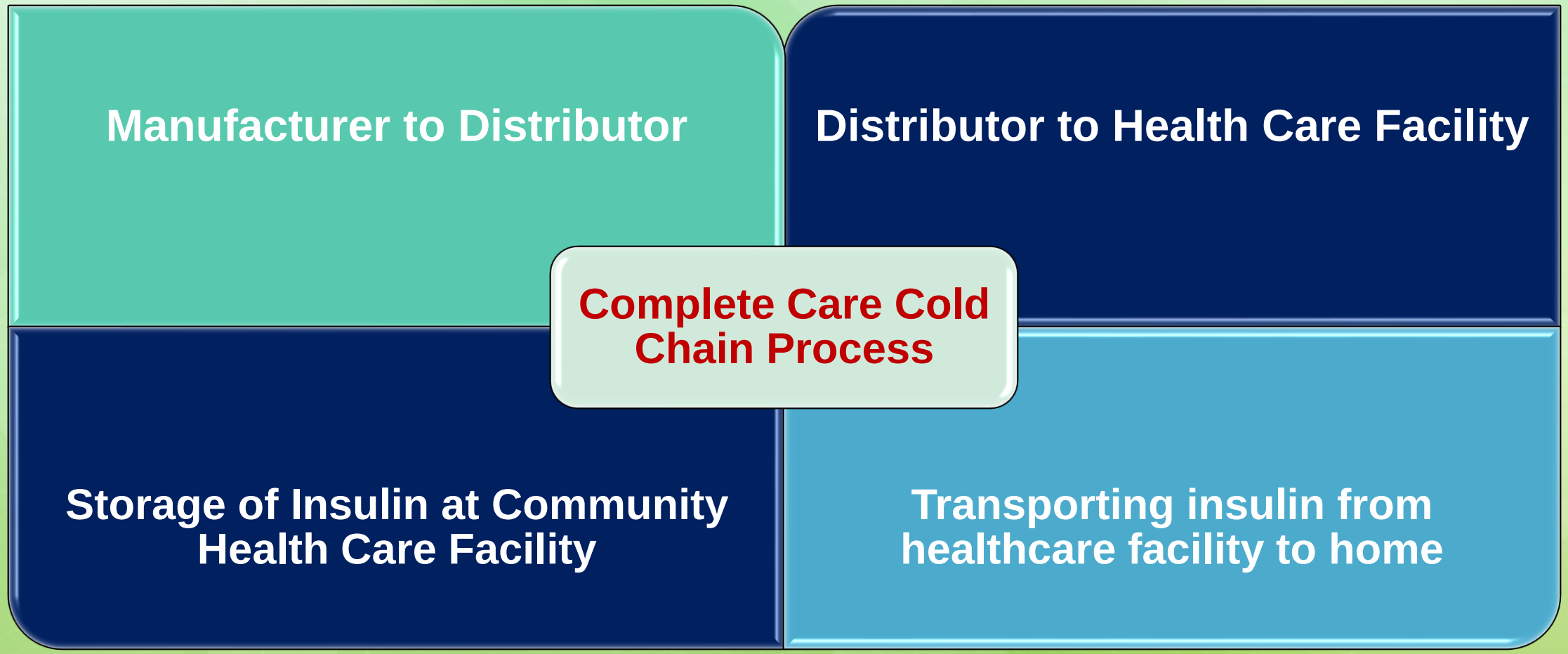
| Insulin | Before opening | After opening | Shelf life |
|---|---|---|---|
| Apidra | 2 °C-8 °C up to expiry date<br>-at room temperature for 4 weeks | Refrigerated or room temperature(below 25 °C ) for 4 weeks<br>- within pen device at room temperature (below 25 °C ) for 4 weeks | |
| Basaglar | 2 °C-8 °C up to expiry date<br>-at room temperature for 4 weeks | Do not refrigerate, below 30 °C for 4 weeks | |
| Insugen 50/50 (Biocon) | 2 °C-8 °C up to expiry date<br>-at room temperature (below 25°C) for 6 weeks | Do not refrigerate, below 25 °C for 42 days | 36 months |
| Eglucent | 2 °C-8 °C up to expiry date | -within pen device at room temperature (below 30 °C ) for 4 weeks | 36 months |

Factors affecting Insulin action

# Storage of insulins: Recommendations

| Insulin | Before opening | After opening | Shelf life |
|---|---|---|---|
| Lupisulin | 2 °C-8 °C up to expiry date | room temperature(between 15 °C-25 °C ) for 2 weeks | |
| Insuman vials & cartridge (Sanofi) | 2 °C-8 °C up to expiry date | Vails can be refrigerated or room temperature (below 25 °C ) for 4 weeks<br>-within pen device at room temperature (below 25 °C ) for 4 weeks | 24 months |

# Factors affecting Insulin action
# Maintenance of cold chain




Last Mile Delivery of Cold Chain Medicines – Challenges and Recommendations. Indian J. Pharm. Biol. Res.2018; 6 (1):34-41.

# Insulin should never be kept in the freezer or placed directly on ice

**In the *top part*, the insulin bottles are still in their cardboard box and in the *lower one*, the insulin bottles have been removed from the packaging**

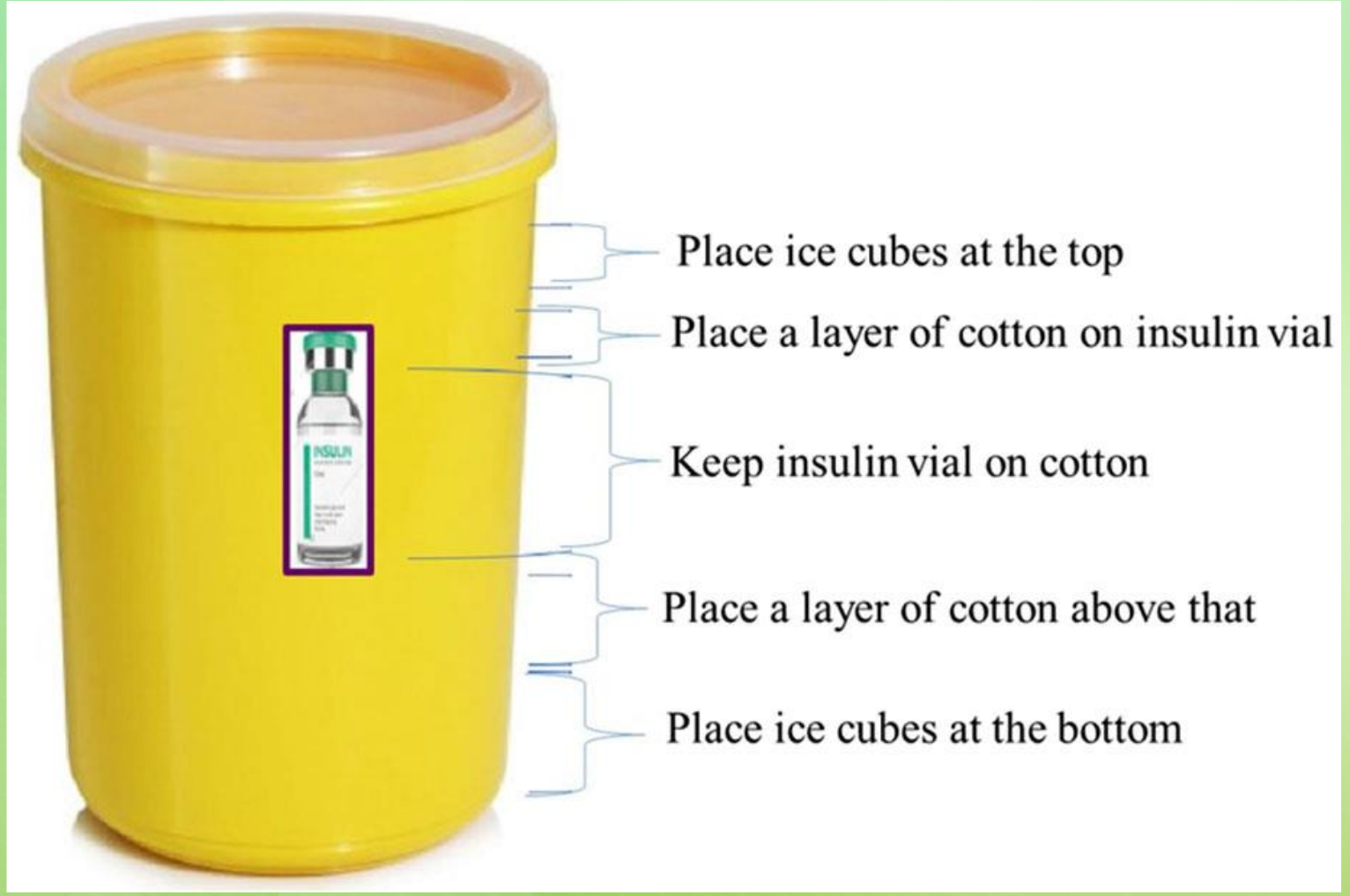
**In both cases the method of keeping insulin cool is not recommended as it may result in the insulin freezing. Moreover, the melting water will destroy the labels on the insulin bottles**

**Common mistake of placing insulin directly on ice, usually during transportation.**
**<u>This should be avoided</u>**

Last mile delivery of cold chain medicines— challenges and recommendations. Indian J Pharm Biol Res. 2018;6(1):34–41.

# A suggested improvised box for transportation of insulin from the health facility or pharmacy to home

- The ice will keep the temperatures favourable for transportation even in the heat of the sun.
- Furthermore, the cotton layers ensure that the melting ice will not spoil the labels on the insulin
- It act as cushions against undue shaking of insulin during transportation




EADSG Guidelines: Insulin Storage and Optimisation of Injection Technique in Diabetes Management. Diabetes Ther (2019) 10:341–366

# Plastic containers with cotton

- An improvised way of keeping insulin and syringes at room temperature (20 – $30^0$ C)
- Insulin and syringes may be transported to work and to school in the same plastic containers

Last mile delivery of cold chain medicines— challenges and recommendations. Indian J Pharm Biol Res. 2018;6(1):34–41.

# Storage of insulins: Evidence - Without refrigerator

Research: Care Delivery

## Insulin storage in hot climates without refrigeration: temperature reduction efficacy of clay pots and other techniques*

G. D. Ogle[1,2], M. Abdullah[3], D. Mason[1,4], A. S. Januszewski[5] and S. Besançon[6]

[1]International Diabetes Federation Life for a Child Program, Sydney, NSW, Australia, [2]Diabetes NSW, Glebe, NSW, Australia, [3]Sudan Childhood Diabetes Centre, Khartoum, Sudan, [4]Macquarie University, Sydney, NSW, Australia, [5]NHMRC Clinical Trials Centre, University of Sydney, Sydney, NSW, Australia and [6]Santé Diabète, Bamako, Mali

*Accepted 26 July 2016*

**Fifteen cooling techniques were studied:**

- **Clay pots from Sudan (three types), Pakistan, Tanzania, Ethiopia, India, Haiti and Mali (two types)**
- **A vegetable gourd from Sudan**
- **An animal skin from Sudan**
- **A sand-filled bucket from Ethiopia & two cooling wallets**

## Factors affecting Insulin action

# Storage of insulins: Evidence

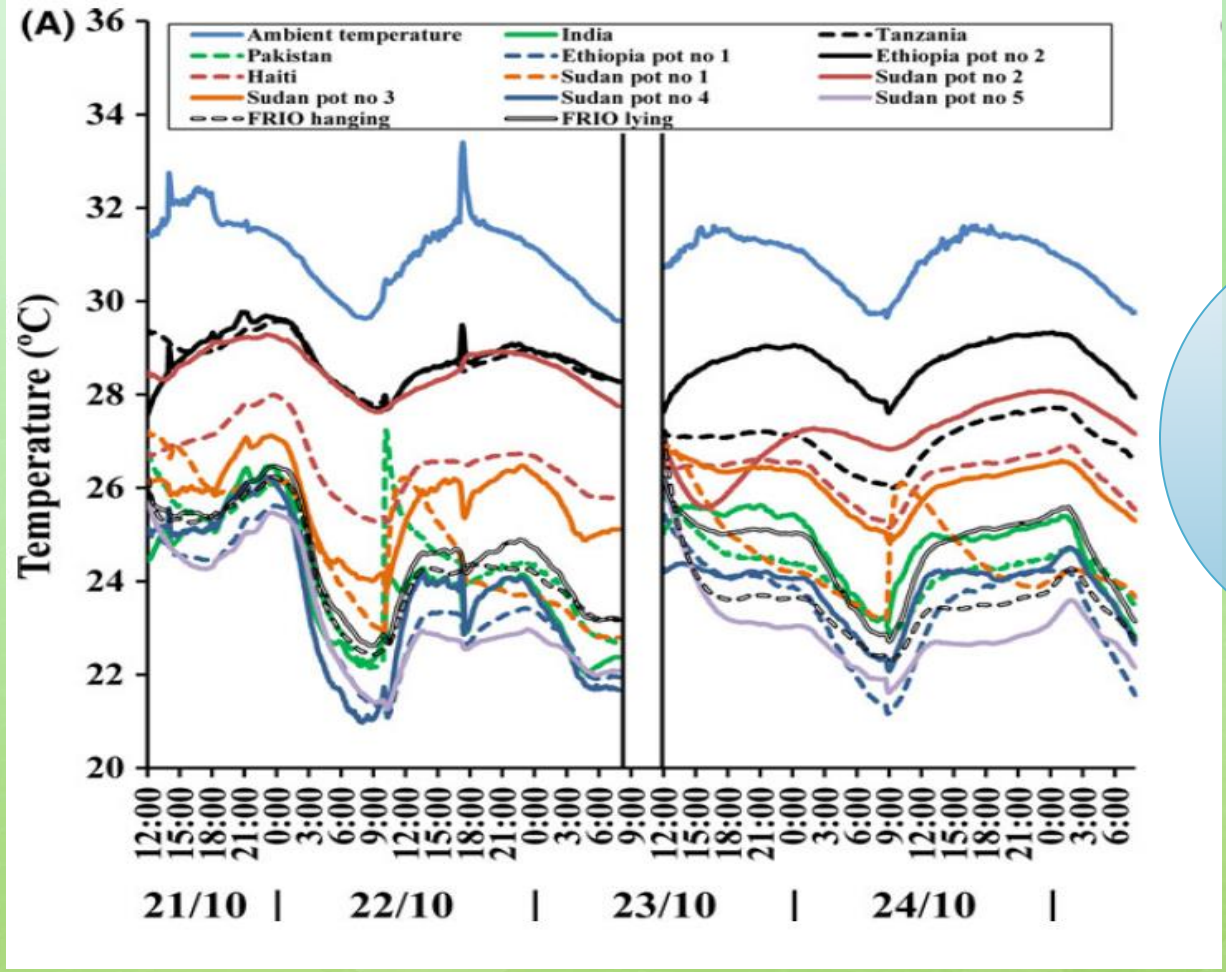
**Devices studied in Khartoum except for Ethiopia 2, Sudan 5, and the cooling wallets**


**The goat skin freshly filled with water**


**The goat skin in use**


Diabet. Med. 33, 1544–1553 (2016)

# Storage of insulins: Evidence - Without refrigerator




**Low-cost devices used in less-resourced countries reduce storage temperatures. With more efficacious devices, average temperatures at or close to standard room temperature (20–25°C) can be achieved, even in hot climates.**

Diabet. Med. 33, 1544–1553 (2016)

## Factors affecting Insulin action

# Improvised practical methods of storage in India –Rural With limited facilities

- Insulin can be stored in a small bowl of water
- Remember not to keep this container in direct sunlight

- Keeping a cool wet cloth around insulin helps to preserve insulin potency
- Insulin vial cap should not be submerged, & the labels with insulin name, date of opening, & expiry be preserved


- If available, a small clay pot or earthenware pitcher is a perfect storage utensil for the drug
- Reduces an exposure to external temperature variations

The water level should be below the neck of the vial, to prevent possible leakage into, and contamination of, insulin supply

Kalra S, Kalra B. Storage of insulin in rural areas. J Acad Med Sci 2012;2:88-9

## Factors affecting Insulin action

# Improvised methods of storage in India – Rural With some facilities

- **Keeping insulin in clay pots is likely to cause contamination as it is difficult to keep** EADSG Guidelines 2018
  - **Clay pots have been previously recommended**

Diabet Med. 2016 Nov;33(11):1544-1553. doi: 10.1111/dme.13194. Epub 2016 Aug 28.

**Insulin storage in hot climates without refrigeration: temperature reduction efficacy of clay pots and other techniques.**

Ogle GD[1,2], Abdullah M[3], Mason D[4,5], Januszewski AS[6], Besançon S[7].

# Practical methods of insulin storage in rural setting

Storing insulin in a small bowl of water protected from exposure to direct sunlight and wetting of the label using a water-proof tape

Using a small clay pot or earthenware pitcher to reduce an exposure to external temperature variationswith insulin vial cap is not submerged

Using thermo cool boxes, with ice packs inside them or a good insulated extra vaccination boxes

Keeping a cool wet cloth around insulin to preserve insulin potency

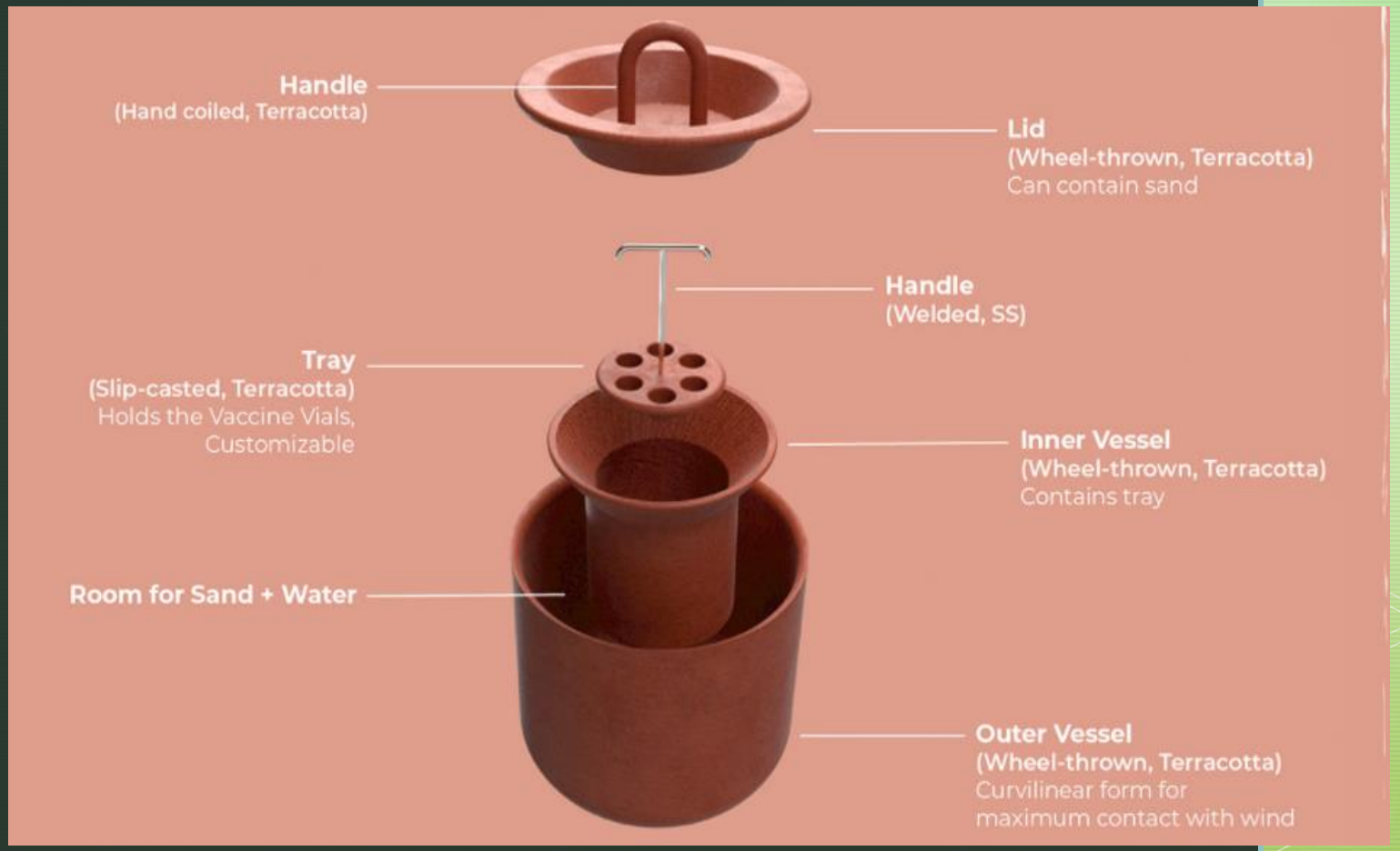
Storing insulin in a small bowl of water protected from exposure to direct sunlight and wetting of the label using a water-proof tape

# Practical methods of insulin storage in rural setting

- Using thermo cool boxes, with ice packs inside them (replaced by frozen ones on weekly basis), as effective refrigeration devices for insulin that would keep the temperature within acceptable limits for many days.
- Using a good insulated extra vaccination boxes that can keep insulin stable for many days.
- Keeping a cool wet cloth around insulin to preserve insulin potency

# Practical methods of insulin storage in rural setting

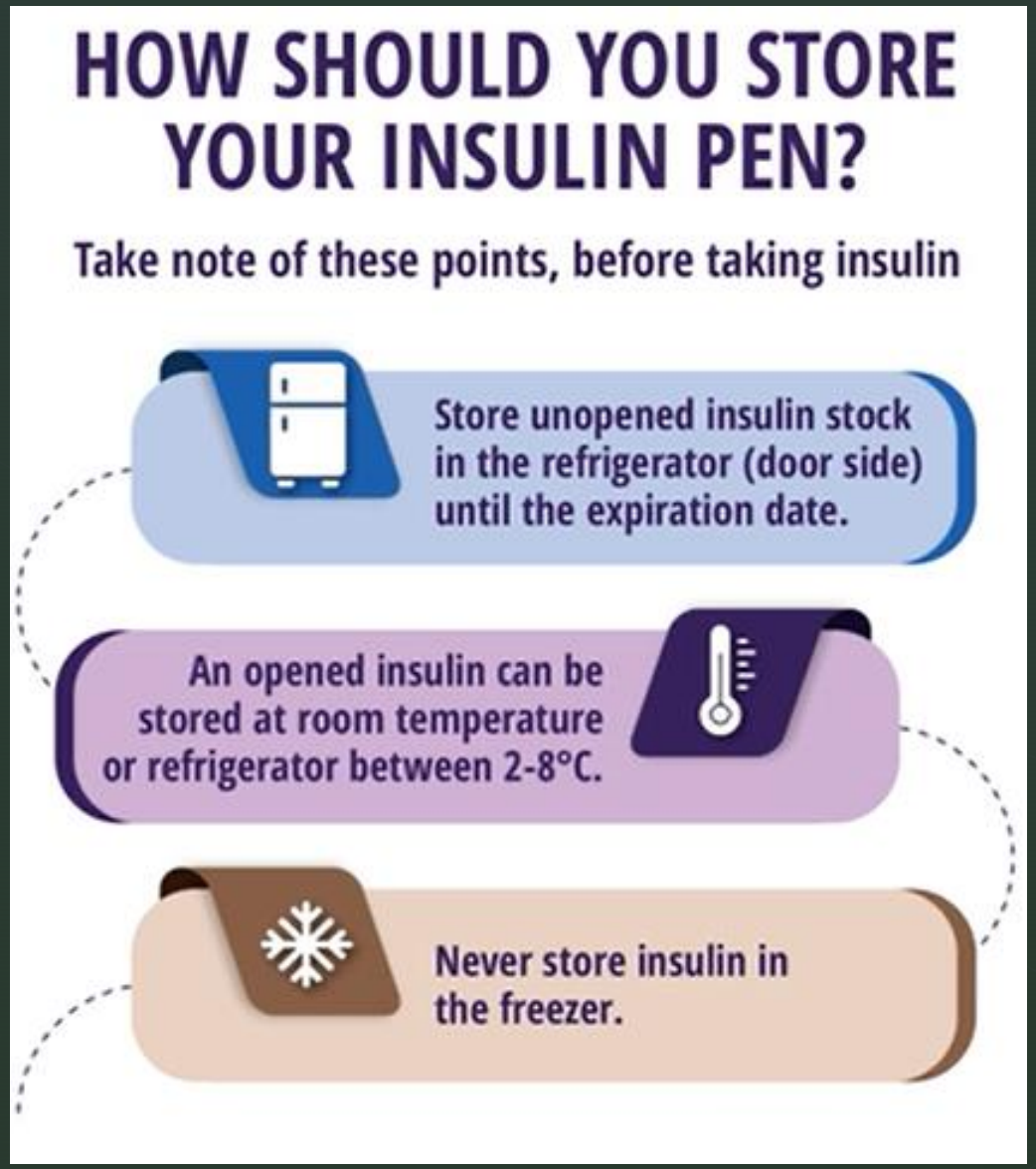
Using a small clay pot or earthenware pitcher to reduce an exposure to external temperature variations with insulin vial cap is not submerged, and the labels with insulin name, date of opening, and date of expiry are preserved.



# Miniature version of “Zeer pot” for insulin storage:

Outer chamber is filled up with water or wet sands and the inner chamber contains insulin

# Storage of insulin pen



## Factors affecting Insulin action

# Improvised methods of storage in India – Rural With some facilities

- Use thermo cool boxes, with ice packs inside them, as effective refrigeration devices for insulin
- The temperature will remains within acceptable limits for many days and can be monitored using a room thermometer


- Ice packs can be replaced by frozen ones on weekly basis
- Extra vaccination boxes, used for storing and transporting vaccines, can be utilized, if available, for keeping insulin


- A good insulated vaccination box can keep insulin stable for many days
- As the label tends to peel off when wet, one should use waterproof tape to stick a label with the name of the insulin, its expiry date, and its date of opening


- In a hospital ward where insulin vials of more than one patient are stored together, the name and bed number of the patient should be mentioned clearly

Kalra S, Kalra B. Storage of insulin in rural areas. J Acad Med Sci 2012;2:88-9

## Factors affecting Insulin action

# Using a Refrigerator

- A refrigerator is the best place to store insulin
- Insulin should never be frozen as this will make it lose its potency

- Unopened insulin is best kept at 2-8°C temperature
- This temperature is maintained below the freezer or in the butter compartment of most fridges

- Opened insulin may be kept at room temperature, or in the vegetable compartment, where temperature is maintained at a stable 14°C
- Avoid keeping insulin in the door of the fridge, as this area is most prone to temperature fluctuations

Kalra S, Kalra B. Storage of insulin in rural areas. J Acad Med Sci 2012;2:88-9

# Storage of insulin in cold climate – current practice

Patients are advised by health workers to store insulin vials and pens by wrapping them in two to three layers of warm woolen cloths, made of sheep wool, in wooden or steel cupboard

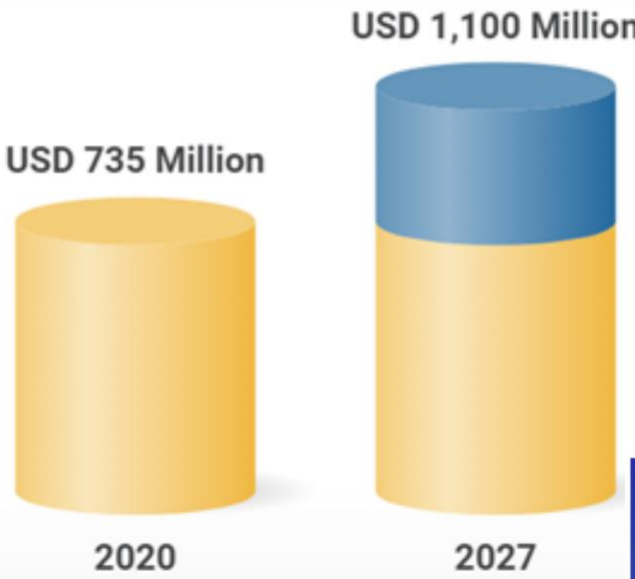
This widespread approach, termed 'commonsense life style solution' in local parlance, is based upon the local method of storing foodstuffs

While no data have been colligated so far to validate this methodology, Most persons with diabetes maintain good glycaemic control, thus supporting the rationale for such insulin storage practices

JK Mokta , S Kalra. Insulin storage in the Upper Himalayas. Rural and Remote Health 14: 2983. (Online) 2014

## Global Market for Insulin Storage Devices

Market forecast to grow at CAGR of 6.6%






# Final Point

## Did I talk about BIG CONCEPT ?

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