



Optimizing Insulin Delivery: Best Practices for Needle Selection and Injection Techniques

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Disclosures



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Learning Objectives



By the end of this session, participants will be able to:

1. Describe the connection between needle length and the risk of intramuscular (IM) injection.
2. Identify needle and pen needle characteristics that can affect the injection experience.
3. Discuss the impact of pen needle hub design on the depth of needle penetration.



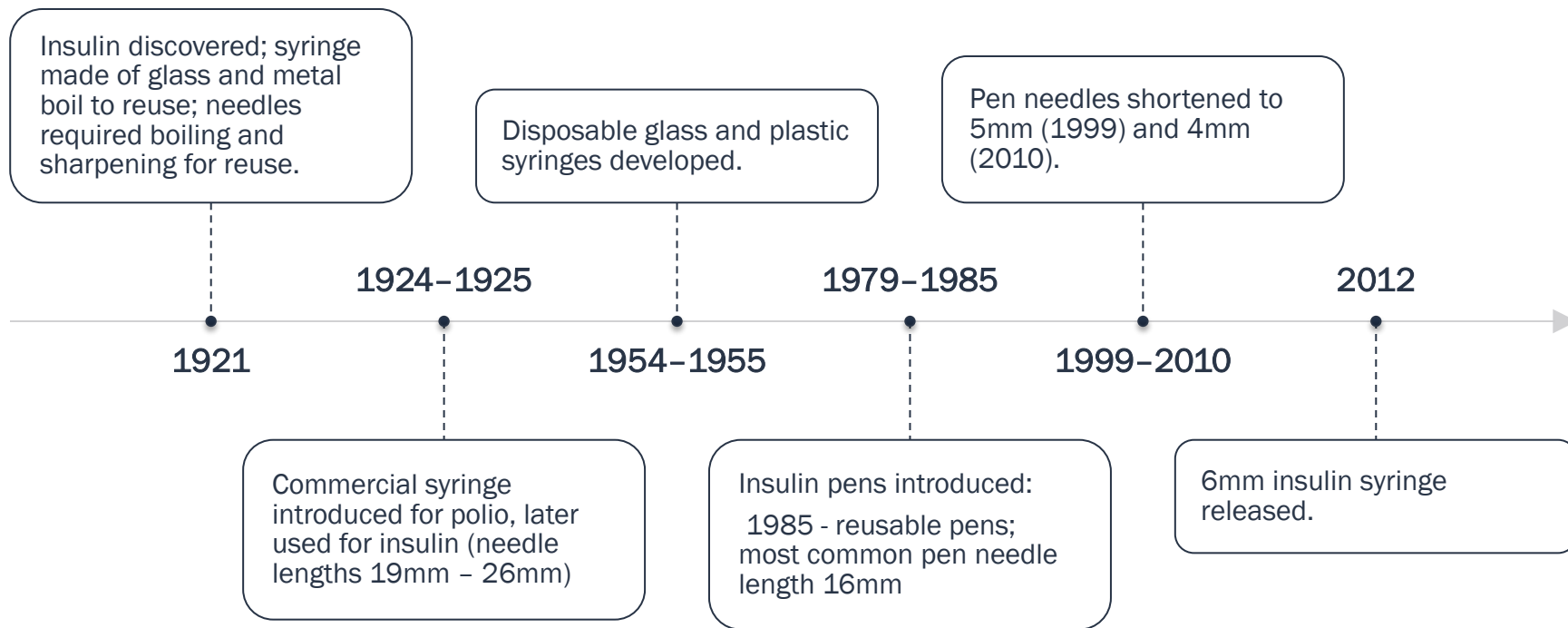
Introduction



- Patient administered insulin is a mainstay of diabetes management.
- Much attention is given to the dosing, pharmacokinetic and pharmacodynamic properties of insulin.
- The correct administration of insulin is just as relevant.
- This presentation explores best practices in needle selection and injection techniques to improve insulin injection experience.



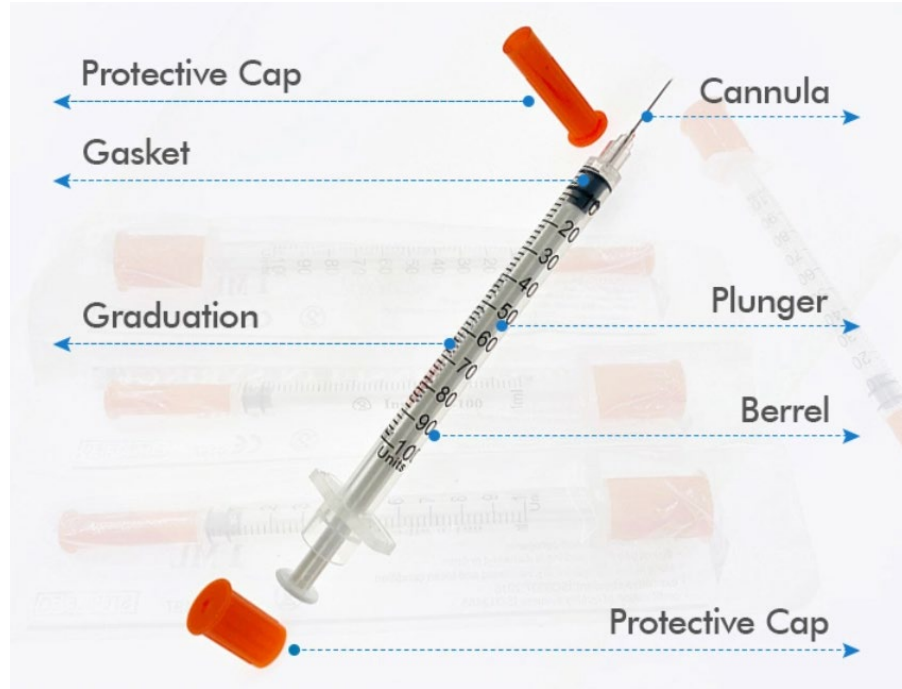
Brief Evolution of Insulin Needle Length



(Heinemann et al., 2023)



Insulin Syringe Components

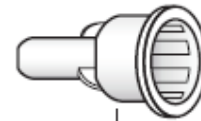
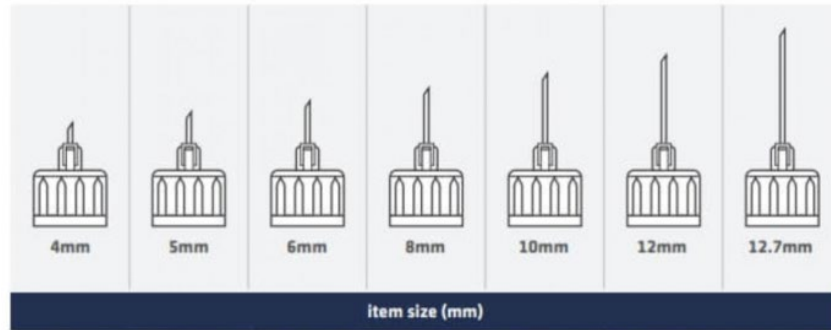


(teamstandardmedical.com)



Pen Needle Lengths and Components

Needle length



Outer
needle cap



Inner
needle cap



Needle



Protective
tab

(Sarahhormachea.com & MSKC.com)



Needle Gauge

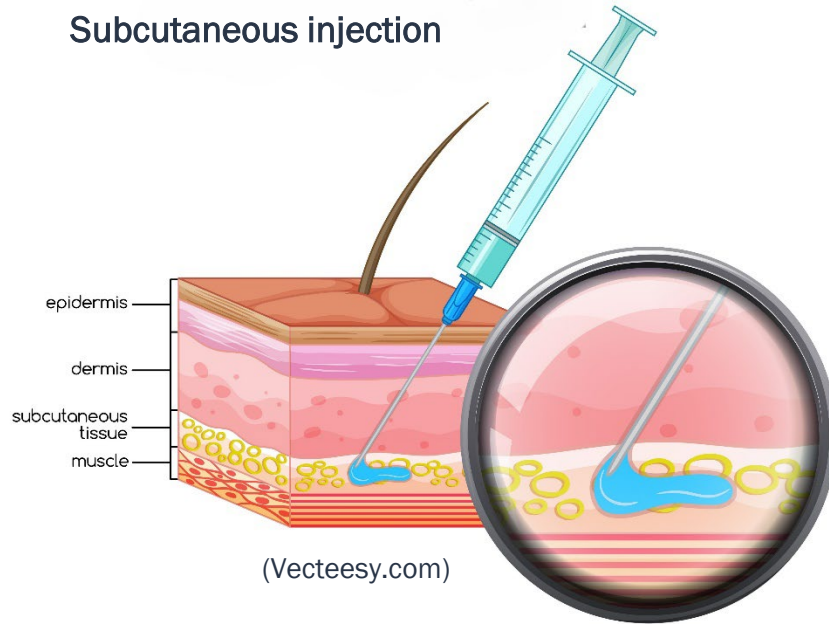


(Care Touch)



Goals of Insulin Injection

Subcutaneous injection



- Reliable deposition into the subcutaneous (SC) tissue.
- Minimize risk of Intra-muscular (IM) injection.
- Minimize injection site pain.
- Minimize leakage.
- Minimize injection site complications.



Knowledge Check #1

What is the primary goal of insulin injection?

- A. To ensure reliable deposition into the SC tissue.
- B. To increase insulin absorption speed.
- C. To reduce the need for frequent injections.



Why worry about an IM insulin injection?

- IM delivery results in variably faster insulin activity
 - Wider glycemic variability
 - Sudden, unpredictable hypoglycemic events



Needle Length and Risk for IM Injection

Intramuscular Risk at Insulin Injection Sites—Measurement of the Distance from Skin to Muscle and Rationale for Shorter-Length Needles for Subcutaneous Insulin Therapy (Hirsch et al., 2014)

- IM risk directly related to needle length.
- 8mm and 12.7mm needles have relatively high risks.
- Estimated IM risk inversely related to body mass index (BMI).



Estimated Intramuscular Injection Risk 90°



Needle length	Thigh	Abdomen
4mm	1.6%	0.3%
6mm	10.0%	2.8%
8mm	25%	9.7%
12.7mm	63%	38%

(Hirsch et al., 2014)



BMI and Estimated Intramuscular Injection Risk 90°



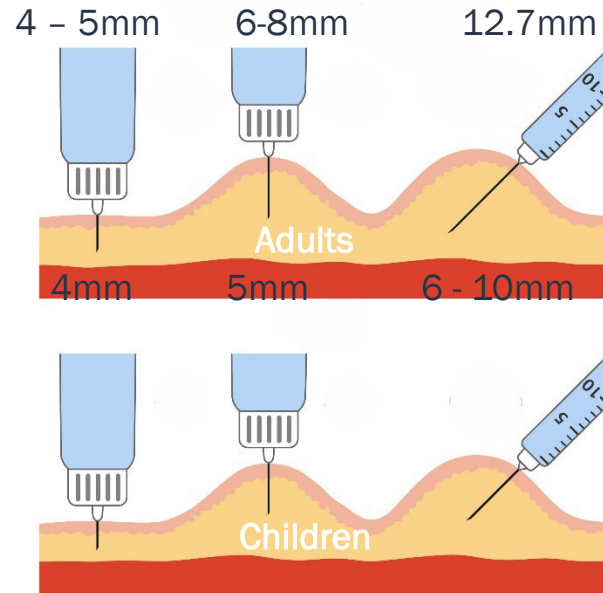
Needle length	BMI (kg/m ²)	Thigh	Abdomen
8mm	≤ 25*	41.4%	
8mm	≥ 30 [#]	14.0%	
12.7mm	≤ 25*	77.9%	55.5%
12.7mm	≥ 30 [#]	46.2%	23.4%

(Hirsch et al., 2014)

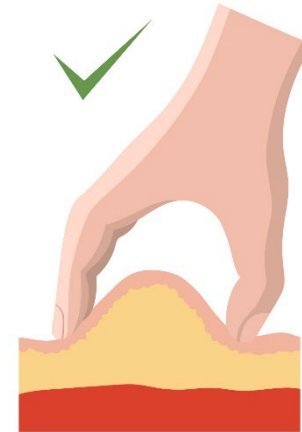
*normal weight; [#]obese



Injection Angle & Skin Fold



Increases distance
from skin to muscle



(Shutterstock.com, n.d.)



Estimated Intramuscular Injection Risk 90° & 45°



Needle Length	Thigh 90°	Thigh 45°	Abdomen 90°	Abdomen 45°
6mm	10%	2.2%	2.8%	0.4%
8mm	25%	8.0%	9.7%	2.1%
12.7mm	63%	34%	38%	14.6%

(Hirsch et al., 2014)



Who May Benefit From Use of a Skin Fold

- Older adults
- BMI < 19
- Pregnant women
- Children



Skinfold Pearls

Thigh: sometimes difficult to lift a skinfold.

Thin patients: skinfold may decrease distance to muscle.

Buttocks: skinfold is rarely needed.

Arm: skinfold must be performed by a third party.

Do not release the skinfold until the injection is completed.



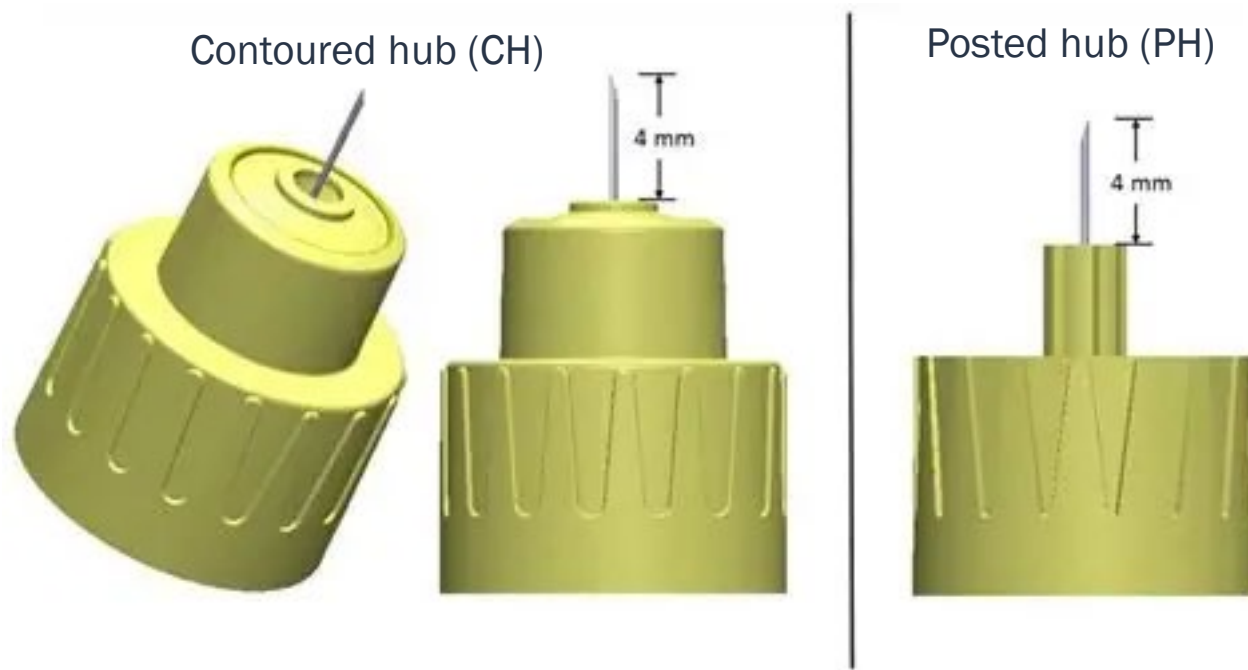
Knowledge Check #2

Which combination of needle length and injection angle minimizes the risk of IM injection of insulin?

- A. 8mm needle at a 45° angle
- B. 4mm at a 90° angle
- C. 12.7mm at a 45° angle



Hub Design and Risk for IM Injection



(Heinemann et al., 2021)



Reducing IM Injection Risk: CH vs PH

(Rini et al., 2019)

Compare hub design

- NPD and IM injection risk
- Four types of 32G x 4mm; PH x 3 & CH x 1

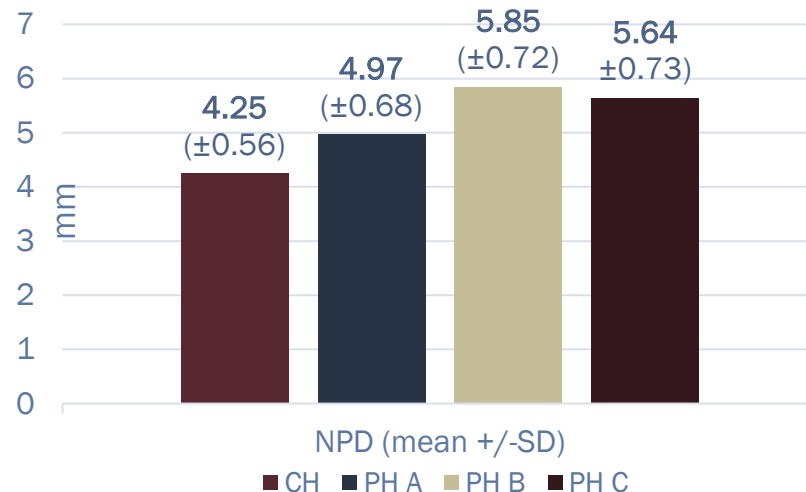
Lab based contrast injection

- Fluoroscopic imaging measured NPD
- Varied injection force into flank of swine

IM Risk

- Calculated using published human skin thickness data

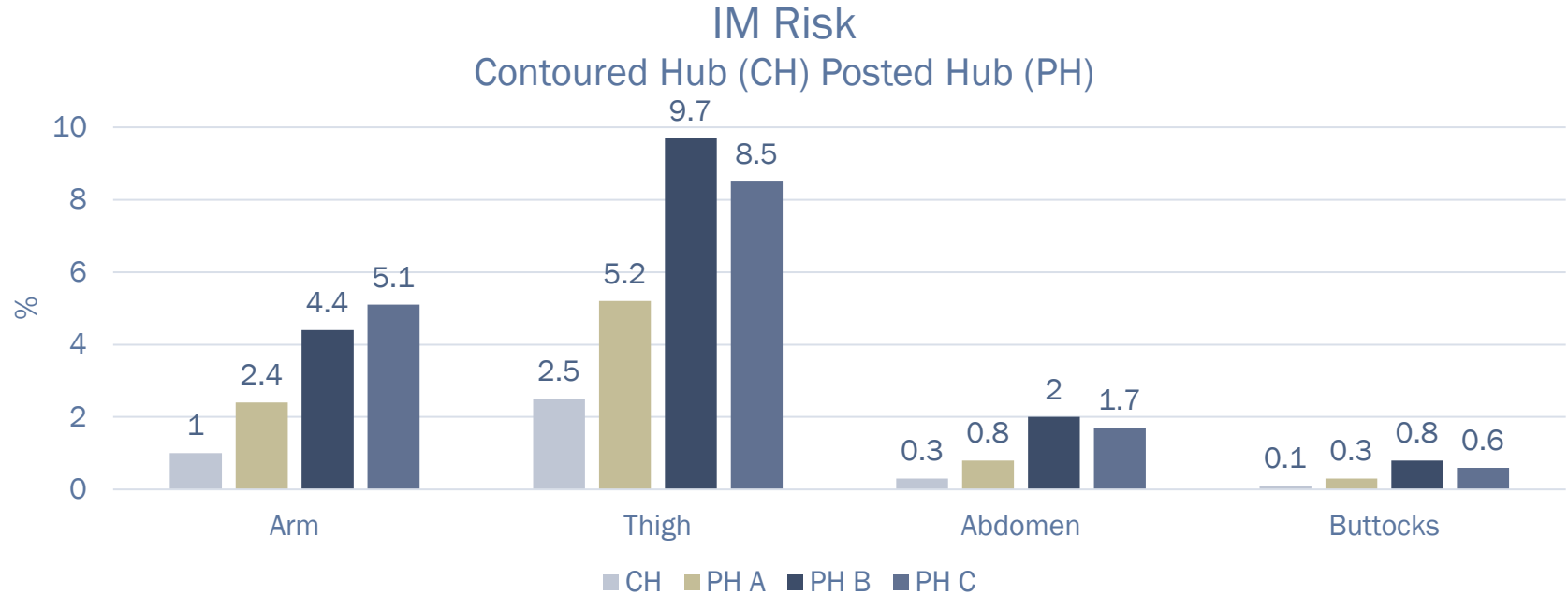
Needle Penetration Depth (NPD)



(Rini et al., 2019)



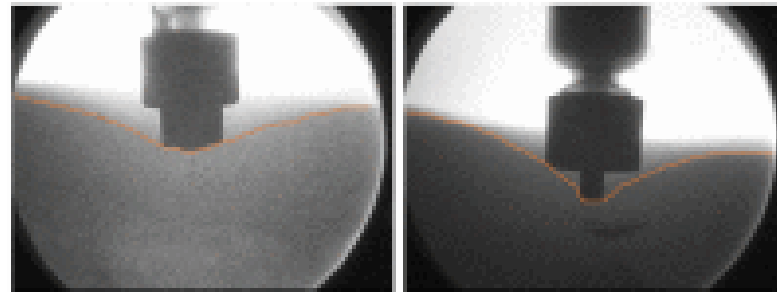
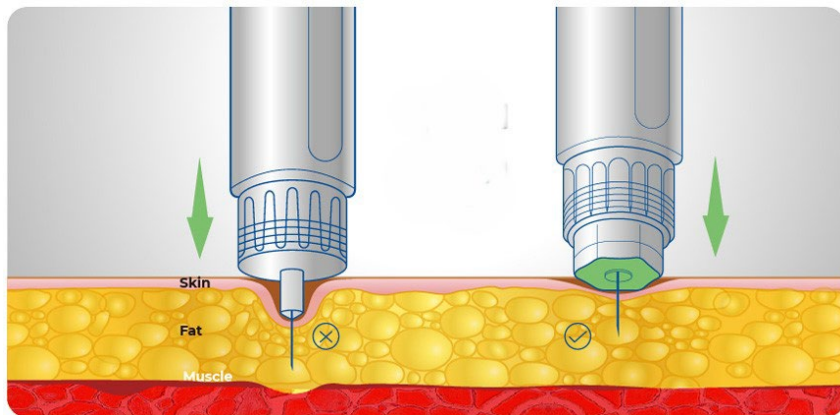
IM Injection Risk



(Rini et al., 2019)



Needle Penetration Depth: Illustration of Contoured and Posted Hub



(Sandstone Med; Rini et al., 2019)

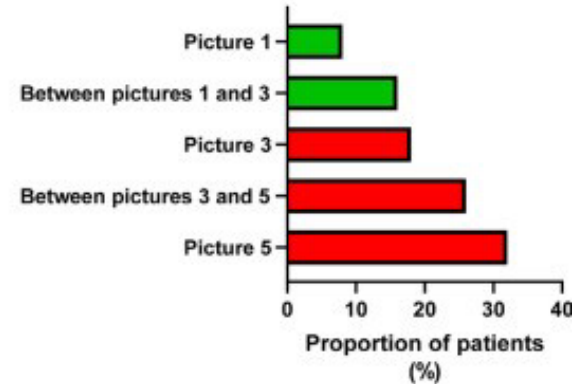
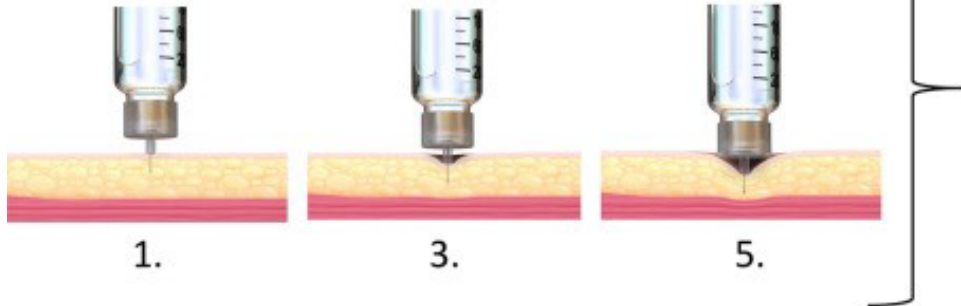


Observational Study: Force of Injection

(Bari et al., 2020)



Which of these pictures represent how your skin looks when you are pushing the pen button as you are injecting your insulin?



(Bari et al., 2020)



Knowledge Check #3

How does the use of pen needles (PN) with contoured hubs (CH) compare to a posted hub (PH) in terms of IM injection risk with applied force of injection?

- A. CH reduces IM injection risk more effectively than PH under all laboratory applied injection forces.
- B. PH reduces IM injection risk more effectively than CH under higher applied injection force.
- C. CH and PH have the same IM injection risk regardless of applied injection force.
- D. IM injection risk is not influenced by the type of PN hub used.



International Regulations Related to Pen Needles



(Tommasi & Silvestri, 2024)



Injection Site Pain



Injectons are generally painless, except when hitting a nerve.

Pain perception is influenced by:

- Needle length.
- Needle diameter.
- Injection force.
- Insulin temperature.
- Injection context (environment, needle appearance, and anxieties).

Shorter (4mm) needles are often reported as less painful.



Innovations in Needle and Pen Needle Technology



- Notable advancements
 - Shorter and thinner needles have been demonstrated to be effective and are preferred over longer and thicker needles.
 - Ultrasound research indicates that using shorter needles decreases the likelihood of IM injections.
- The subsequent section reviews further developments.



Purpose of Needle Characteristics on Injection Experience

Large Gauge

- Small diameter reduce penetration force

Short Length

- Reduce penetration depth

Contoured hub

- Reduce penetration force

Thinner wall

- Reduce injection force

Geometry of needle tip

- Reduce penetration force

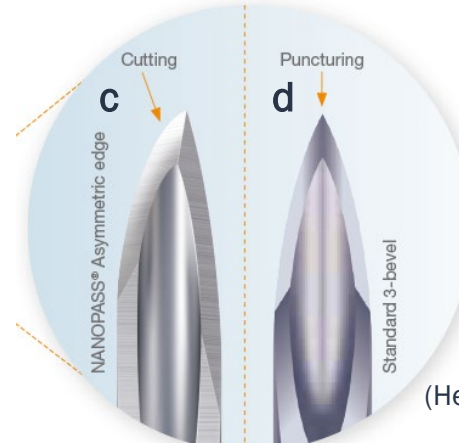
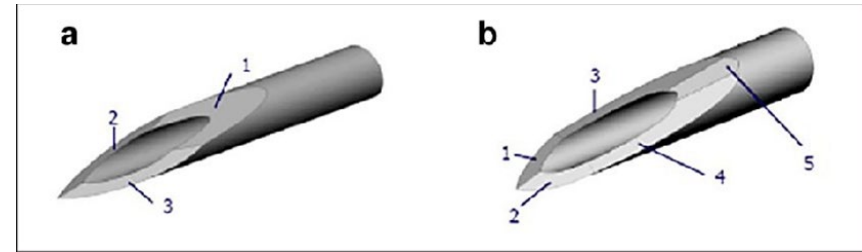
Silicone coating

- Reduce penetration force



Pen Needle Bevel and Lubrication

- More bevels or cuts in the tip geometry improve the sharpness and reduces injection force. (b)
- Asymmetrical edge reduces injection force. (c)
- Silicone lubrication of the needle surface reduces injection force.
- Needle reuse reduces the surface lubrication and the sharpness.

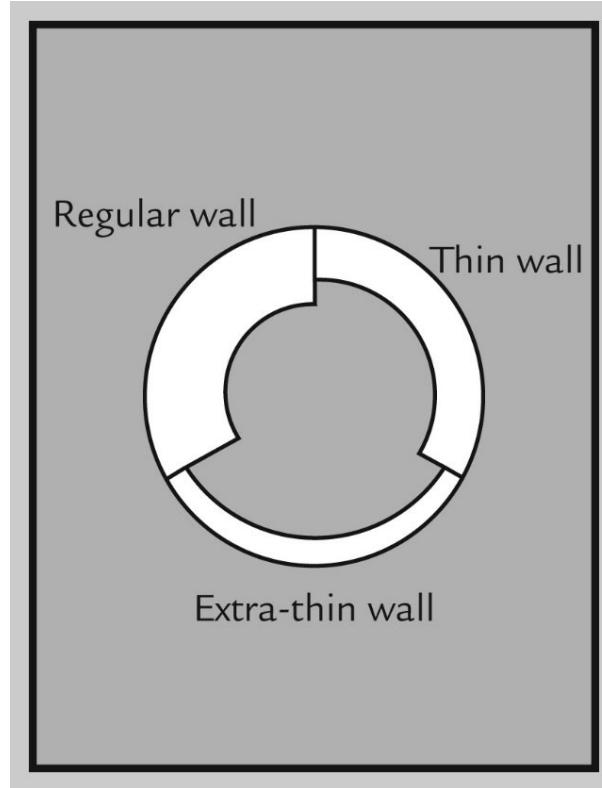


- a. 3-bevel
- b. 5-bevel
- c. Asymmetrical edge
- d. Standard bevel

(Heineman et al., 2021 and Nanopass®)



Needle Wall Thickness and Flow Rate



(Aronson et al., 2013)



Needle Characteristics and Injection Experience

(Mannucci et al., 2025)



Systematic review

- Included 22 studies
- Needle diameter (ND): 11 studies
 - ND Small (33G-34G): 6 studies
 - ND Traditional(29G-32G): 5 studies
- Other Features: 11 studies
 - ND small: 2 studies
 - ND Traditional: 9 studies

Purpose: Evaluate pen needle design and patient insulin injection experience

- Gauge (diameter)
- Length
- Wall thickness
- Tip geometry
- Coating



Needle Characteristics and Injection Experience (cont.)



Discomfort stems from both physical and psychological factors

- Smaller needles (32G–34G) reduce pain
- Penetration & injection force correlates with perceived pain— **but individual variability remains significant**

Higher skin blood perfusion (SBP), a marker of trauma, correlate with increased perceived pain

- Larger diameter, obtuse or damaged tip, & lack of lubrication increase SBP



Some Strategies to Reduce Pain/Fear of Pain



Key needle characteristics

- Use short, thin needles, consider a 5-bevel tip.
- Always use a new needle for each injection.
- Select contoured hub.

Additional strategy

- Use insulin at room temperature.

Possible technique error

- If pain continues, evaluate injection technique.



Knowledge Check #4

Which of the following pen needle characteristic is more effective in reducing injection site pain?

- A. Longer needle length with larger diameter.
- B. Shorter needle length with a smaller diameter.
- C. Needles with fewer bevels and no lubrication.



Injection Site Insulin Leakage

- Incidence of injection site reflux is variable.
- Volumes of leakage is usually clinically insignificant.
 - Volume of leakage is generally <0.1 units or $<1\%$ of total.
- Leakage is not related to needle length.
- Higher injection volumes have higher absolute volume of leakage, but percentage of dosage leaked does not increase.
- Reuse of needles may increase risk of leakage, bruising, bleeding.



Strategies to Reduce Leakage

- After fully depressing the plunger/autoinjector, count to 10 before removing the needle.
 - Allows time for insulin flow and spread through tissue.
 - Allows time for tissue to expand and stretch.
- Split larger doses (>60 units) to deliver a smaller volume.
- New needle with each injection.
- If frequent leakage occurs evaluate injection technique.



Needle Reuse and Injection Related Complications

(Sharma et al., 2022)



- A total of 121 pediatric patients with Type 1 diabetes
- Frequency of daily needle reuse:
 - 3 times or fewer: 29%
 - 4 to 6 times: 49%
 - 7 to 9 times: 19%
 - 10 times or more: 10%

Outcomes observed following three months of single-use needles

	Baseline 3 months	3 months single use	
	n = 102 Number (%)	n = 91 Number (%)	<i>P</i>
Leakage	27 (26.4%)	1 (1.09%)	0.003

(Sharma et al., 2022)



Knowledge Check #5

How does needle reuse impact the risk of injection site leakage?

- A. It has been shown to increase the risk of injection site leakage.
- B. It has no impact on leakage risk.
- C. It reduces leakage risk by improving tissue penetration.



Another Injection Risk Factor has Come to Light



Temperature of injected insulin



Injection Site Selection

Site must have sufficient SC fat to reduce the risk of IM injection.

- Abdomen
- Thighs
- Buttocks
- Upper arms

Site should be clean and intact.

- Avoid injecting into scars, stretch marks, or tattoos.
- Never inject into areas with signs of edema, infection, inflammation, ulceration, or Lipohypertrophy (LH)

Avoid injection through clothing

- Prevents examination of injection site and needle penetration verification.

(Klonoff et al., 2025)



Lipohypertrophy

- Enlargement of adipocytes that present as swelling or induration of fat tissue.
- Can arise from repeated injection or infusion into one skin site.
- Injection into LH sites may cause erratic insulin absorption and:
 - unexplained hypoglycemia
 - Uncontrolled glycemia
 - Unknown glycemic variability
 - Need for higher insulin doses



(Makta et al., 2013)



Injection Technique Specific Risk Factors for LH

(Gentile et al., 2020)

- Determine frequency of and risk factors for insulin related LH.
- 1245 adult Type 2 DM duration ≥ 5 years
 - Using insulin pens
 - 3 - 4 injections/day
- Assessments
 - Questionnaire for demographics, insulin usage habits
 - Standardized exam and ultrasound detection of LH.

Results

Factor	RR
Needle reuse	4.43
Failure to rotate sites	5.11
Iced-cold insulin injections	3.06
Post-injection leakage from needle	1.68

RR: relative risk

(Gentile et al., 2020)



Knowledge Check #6

Which injection technique specific factors increases risk for development of lipohypertrophy?

- A. Use of long needles.
- B. Use of short needle and 45° angle of injection.
- C. Needle reuse and injecting cold insulin.
- D. Failing to keep needle inserted to count of 10 and noting pain of injection.



Key Components of Insulin Injection

Patient directed

- Site rotation
- Needle reuse
- Temperature of injected insulin
- Angle of insertion
- Use of skinfold (usually not necessary with 4mm needle)
- Injection force
- Time needle remains inserted after injection

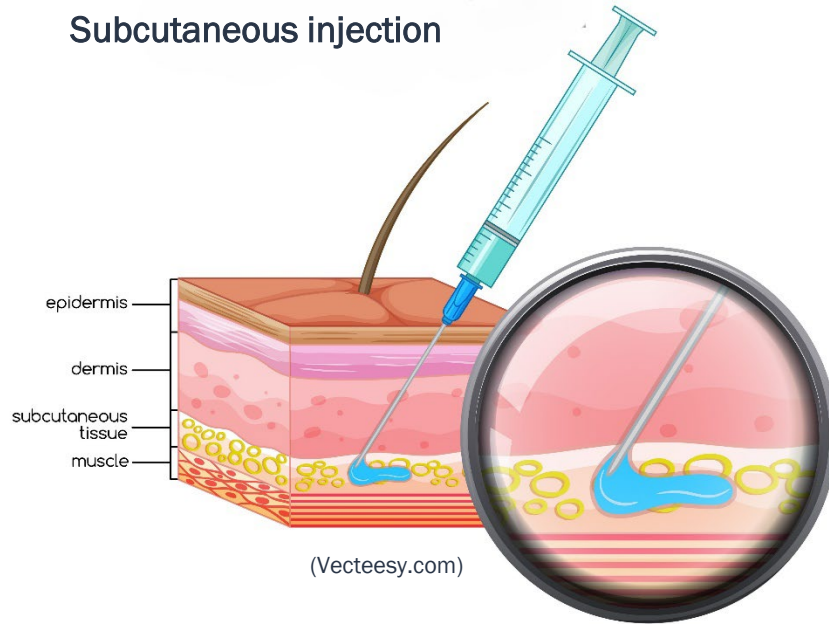
Prescriber directed

- Needle length
- Needle tip geometry
- Pen needle hub
- Patient education and training



Goals of Insulin Injection

Subcutaneous injection



- Reliable deposition into the subcutaneous (SC) tissue.
- Minimize risk of Intra-muscular (IM) injection.
- Minimize injection site pain.
- Minimize leakage.
- Minimize injection site complications.



Goals of Insulin Injection with Key Characteristics

Reliable deposition into the subcutaneous tissue.

- 4mm needle
- Contoured needle hub

Minimize risk of Intramuscular injection.

- 4mm needle
- Contoured needle hub
- Site with adequate SC tissue

Minimize injection site pain.

- Small needle diameter
- Contoured needle hub

Minimize leakage.

- Avoid needle reuse

Minimize injection site complications.

- Avoid needle reuse
- Rotate site
- Insulin room temperature



Patient Case



- 75y/o male with T2DM for decades.
- Has been on insulin for over 15 years.
- On long-acting insulin and is prescribed vials - he has run out of insulin syringes.
- Prescription profile with previous orders for 8mm needle insulin syringe.
- Patient is adamant that he wants the 8mm needles and will not take anything other than the 8mm needles.
- What do you do?



Polling Question #1



What do you do?

- A. Prescribe the 8mm needle insulin syringe
- B. Prescribe the 6mm needle insulin syringe
- C. Prescribe the 8mm needle insulin syringe and teach the patient how to perform a skinfold for injection
- D. Switch the patient to an insulin pen of the same insulin and prescribed 4mm pen needles



Polling Question #2

My pharmacy stocks a 4mm, contoured hub pen needle.

- A. Yes
- B. No
- C. I don't know





Polling Question #3

I plan to speak with my pharmacist or pharmacy supply technician about obtaining the 4mm, contoured hub, pen needle.

- A. Yes
- B. No
- C. We already carry the product
- D. I am not presently in a position to engage in discussions regarding formulary product issues



Key Takeaways



- Using shorter needles (4mm) decreases the likelihood of intramuscular injections.
- Correct injection technique, especially injection force, site rotation, and insulin temperature, influences both efficacy and potential injection site complications.
- A contoured hub design enhances safety and comfort by reducing needle penetration depth and minimizing IM injection risks.
- Reusing needles is discouraged to prevent injection related complications.
- Educating patient on proper site rotation, using room temperature insulin, and avoiding needle reuse is essential in minimizing injection-related complications.



References (1 of 4)

- Aronson, R., Gibney, M. A., Oza, K., Bérubé, J., Kassler-Taub, K., & Hirsch, L. (2013). Insulin Pen Needles: Effects of Extra-Thin Wall Needle Technology on Preference, Confidence, and Other Patient Ratings. *Clinical Therapeutics*, 35(7), 923-933.e4. <https://doi.org/10.1016/j.clinthera.2013.05.020>
- Bari, B., Corbeil, M.-A., Farooqui, H., Menzies, S., Pflug, B., Smith, B. K., Vasquez, A., & Berard, L. (2020). Insulin Injection Practices in a Population of Canadians with Diabetes: An Observational Study. *Diabetes Therapy*, 11(11), 2595–2609. <https://doi.org/10.1007/s13300-020-00913-y>
- De Tommasi, F., & Silvestri, S. (2024). Influence of Insulin Pen Needle Geometry on Pain Perception and Patient's Acceptability: A Review. *Technologies*, 12(11), 233. <https://doi.org/10.3390/technologies12110233>
- Gentile, S., Guarino, G., Corte, T. D., et al. (2020). Insulin-Induced Skin Lipohypertrophy in Type 2 Diabetes: a Multicenter Regional Survey in Southern Italy. *Diabetes Therapy*, 11(9), 2001–2017. <https://doi.org/10.1007/s13300-020-00876-0>



References (2 of 4)

Heinemann, L., Nguyen, T., Bailey, T. S., Hassoun, A., Kulzer, B., Oliveria, T., Reznik, Y., de Valk, H. W., & Mader, J. K. (2021).

Needle technology for insulin administration: a century of innovation. *Journal of Diabetes Science and Technology*, 17(2), 193229682110595. <https://doi.org/10.1177/19322968211059564>

Hirsch, L., Byron, K., & Gibney, M. (2014). Intramuscular Risk at Insulin Injection Sites—Measurement of the Distance from Skin to Muscle and Rationale for Shorter-Length Needles for Subcutaneous Insulin Therapy. *Diabetes Technology & Therapeutics*, 16(12), 867–873. <https://doi.org/10.1089/dia.2014.0111>

Klonoff, D. C., Berard, L., Franco, D. R., et al. Gentile, S., Gomez, O. V., Hussein, Z., Jain, A. B., Kalra, S., Anhalt, H., Mader, J. K., Miller, E., O'Meara, M. A., Robins, M., Strollo, F., Watada, H., & Heinemann, L. (2025). Advance Insulin Injection Technique and Education With FITTER Forward Expert Recommendations. *Mayo Clinic Proceedings*, 100(4), 682–699. <https://doi.org/10.1016/j.mayocp.2025.01.004>



References (3 of 4)

Mannucci, E., Pintaudi, B., Lunati, M. E., & Fiorina, P. (2025). Needle characteristics and the insulin injection experience in patients with diabetes. *Acta Diabetologica*. <https://doi.org/10.1007/s00592-025-02538-8>

Præstmark, K. A., Jensen, M. L., Madsen, N. B., Kildegaard, J., & Stallknecht, B. M. (2016). Pen needle design influences ease of insertion, pain, and skin trauma in subjects with type 2 diabetes. *BMJ Open Diabetes Research & Care*, 4(1).
<https://doi.org/10.1136/bmjdr-2016-000266>

Rini, C., Roberts, B. C., Morel, D., Klug, R., Selvage, B., & Pettis, R. J. (2019). Evaluating the Impact of Human Factors and Pen Needle Design on Insulin Pen Injection. *Journal of Diabetes Science and Technology*, 13(3), 533–545.
<https://doi.org/10.1177/1932296819836987>



References (4 of 4)



Sharma, M., Kumar, R., Latika Rohilla, et al. (2022). Effect of reuse of insulin needle on glycaemic control and related complications in children with type 1 diabetes mellitus: A prospective observational study. *Indian Journal of Endocrinology and Metabolism*, 26(2), 167–167. https://doi.org/10.4103/ijem.ijem_407_21



Questions?



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