Injection technique & needle length recommendations for children and adolescents

Prof Paul Hofman
Liggins Institute
University of Auckland, New Zealand

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The FITTER Review and Recommendations[1]

Frid AH, Kreugel G, Grassi G *et al.* New injections recommendations *Mayo Clin Proc.* September 2016:91(9):1231-1255.

Goal of Insulin Injections[2]

- Reliable deposition of insulin into the subcutaneous tissue
- No leakage
- Minimisation intramuscular injections
- Minimisation of injection induced pain

Image Source: http://isabelhome.com/tests/type-1-diabetes-patch.htm (Accessed April 2017)

2. Frid A, Hirsch L, Gaspar R, et al. Diabetes Metab. 2010; 36(suppl 2):S3-S18.

Needle length & technique are important!

- Risk of intramuscular (IM) injection is relatively high with both 12.7mm and 8mm needles in children.[3]
  - Tubiana-Rufi et al. (1999)
  - 86% with 12.7mm
  - 38% with 8mm
- Changes in pharmacokinetics of NPH, Regular and Glargine insulin when injected IM.[2]
- Variations in insulin absorption with increased risk of hypoglycaemia when injected IM prior to exercise.[4]

2. Frid A, Hirsch L, Gaspar R, et al. Diabetes Metab. 2010; 36(suppl 2):S3-S18.
3. Tubiana-Rufi N, et al. Diabetes Care 1999; 22(10):1621.
4. Frid A. Diabetes Care. 1990; 13(5):473.

Intramuscular injections

- Increased risk with:
  - Younger age
  - Male gender[5,6]
  - Lower body mass index[5]
  - Smaller skinfold thickness[5]
  - Injection technique[7]

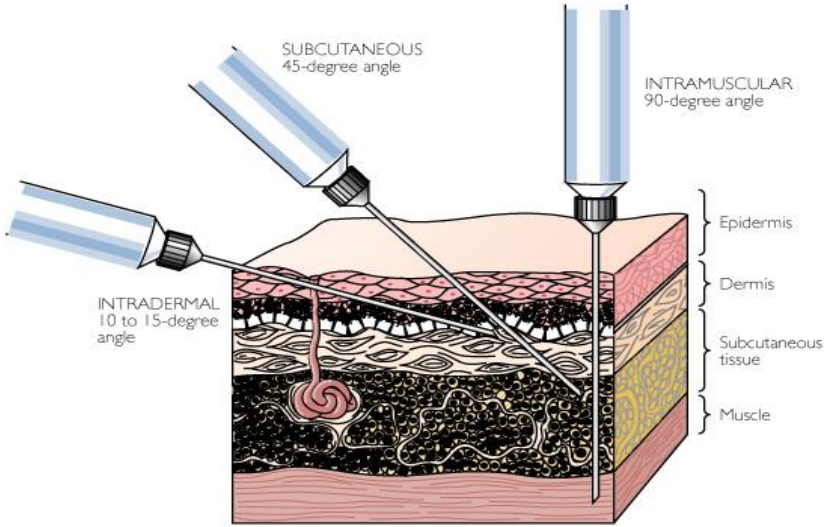


Image Source: https://www.quora.com/Why-are-subcutaneous-injections-given-at-a-45-degree-angle (Accessed April 2017)

5. Birkebaek NH, et al. Diabetic Medicine. 2008; 15: 965.
6. Polak M, *et al. Diabetes Care* 1996, 19: 1434-1436.
7. Hofman P, *et al. Diabet Med.* 2007; 24(12):1400.

Intradermal injections

- May be increased by shorter needle length and angled insertion[8]
- Intradermal injection may alter insulin pharmacokinetics[9]

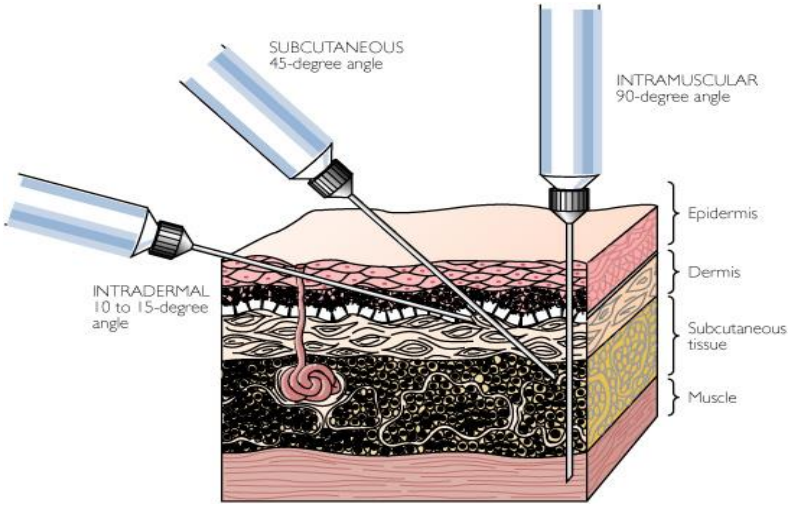


Image Source: https://www.quora.com/Why-are-subcutaneous-injections-given-at-a-45-degree-angle Accessed April 2017)))

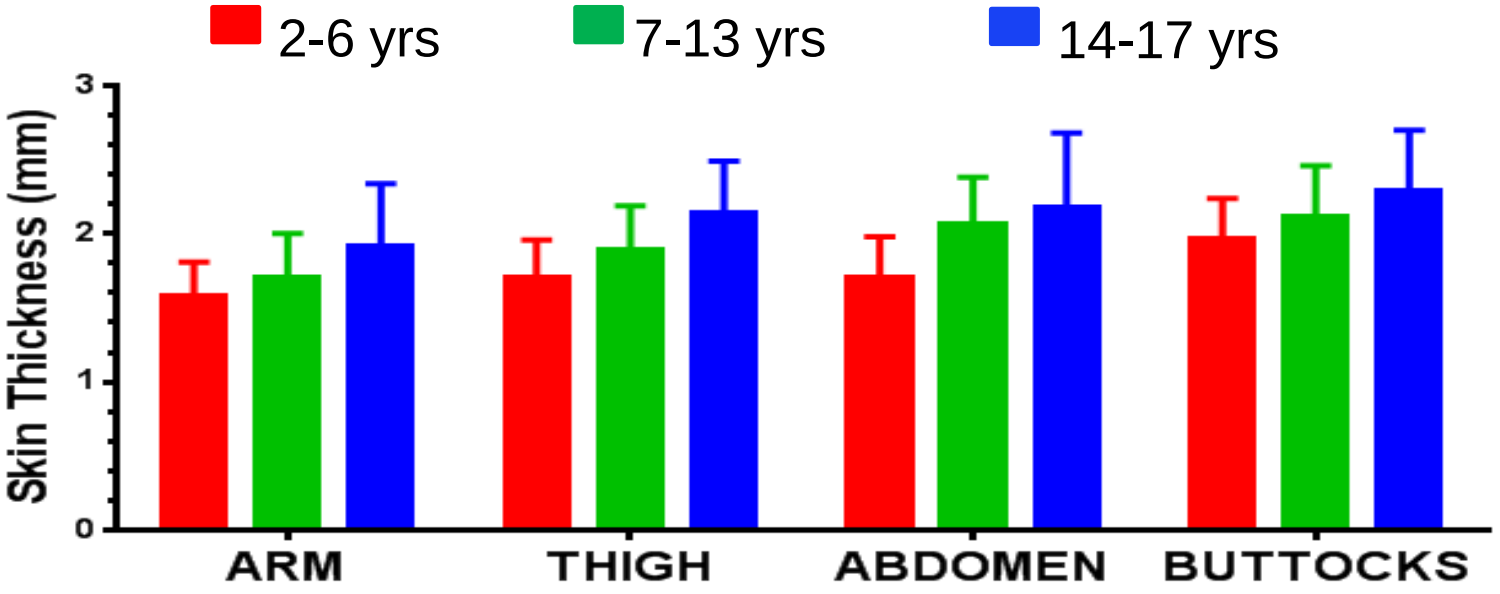
8. Kreugel G, *et al. Europ Diab Nursing* 2007;4:1-5.
9. Strauss K *et al. Practical Diabetes International* 1998, 15: 181-184.

Needle length and injection depth

Needle Length	45^{o} angle
4mm	3.1mm
5mm	3.5mm
6mm	4.2mm
8mm	5.7mm
12.5mm	8.8mm

Figures calculated mathematically based on 45^{o} insertion.

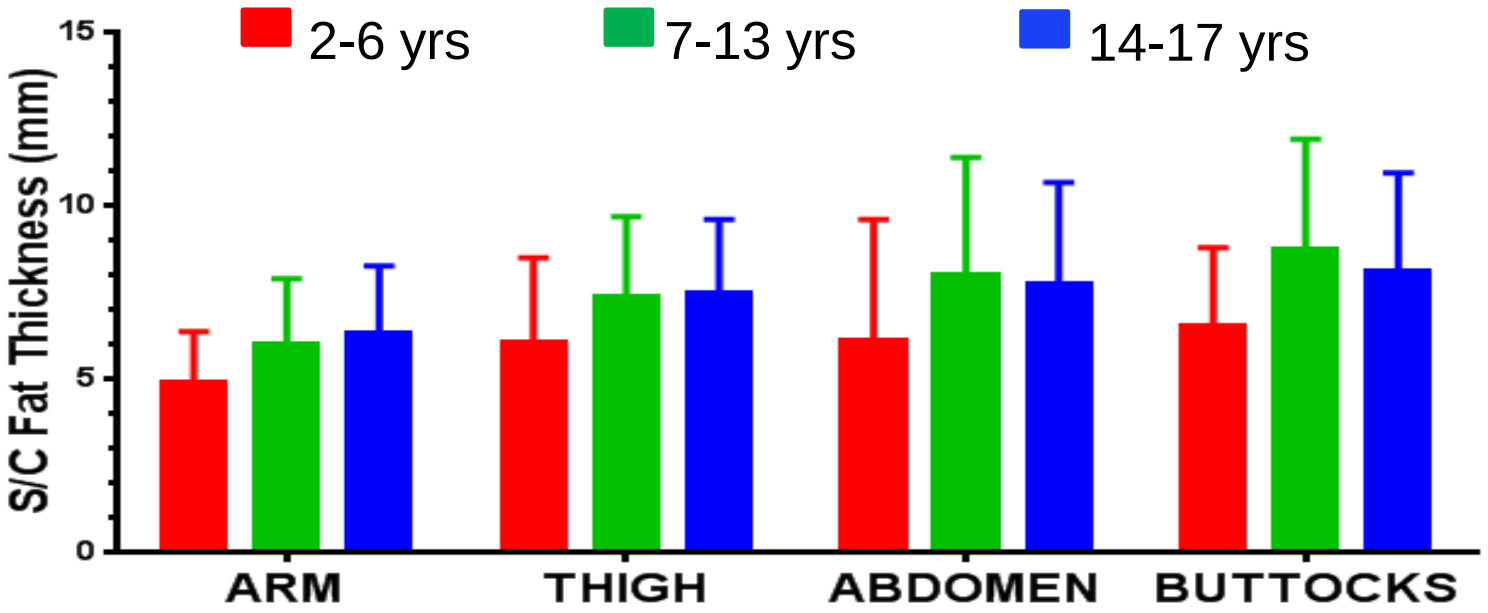
Skin thickness according to site & age in children/adolescents[10]



N=101
56% Male

10. Lo Presti *et al. Pediatric Diabetes* 2012: 13: 525–533.

S/C fat thickness according to site & age in children/adolescents[10]



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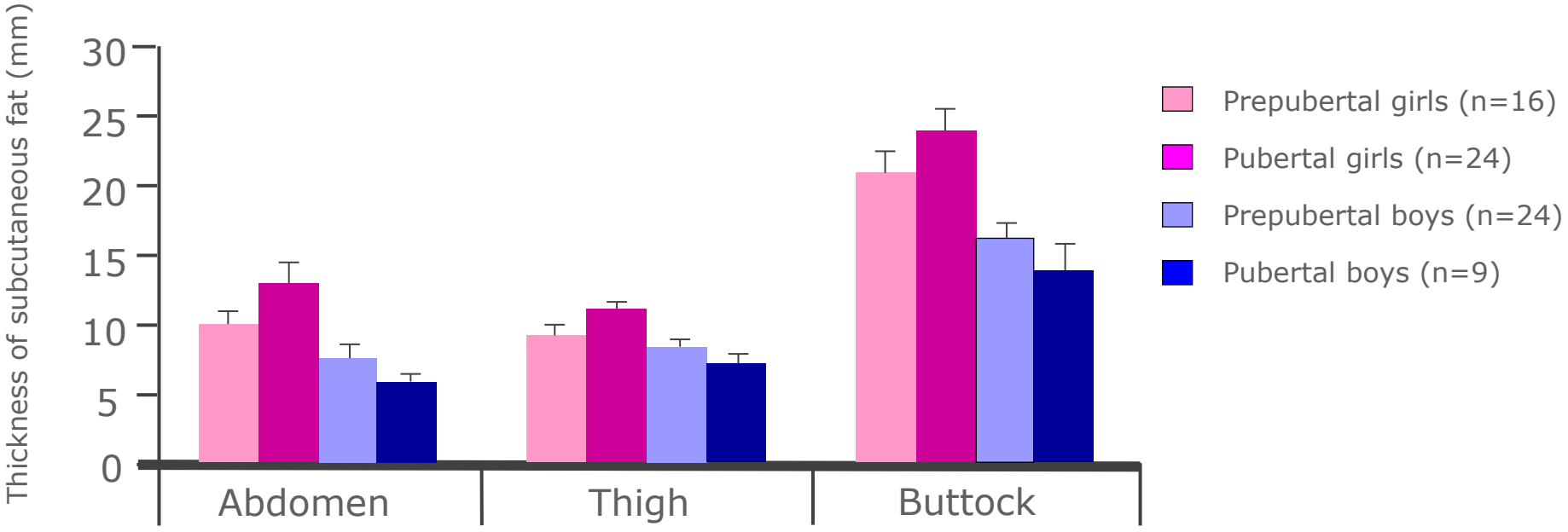
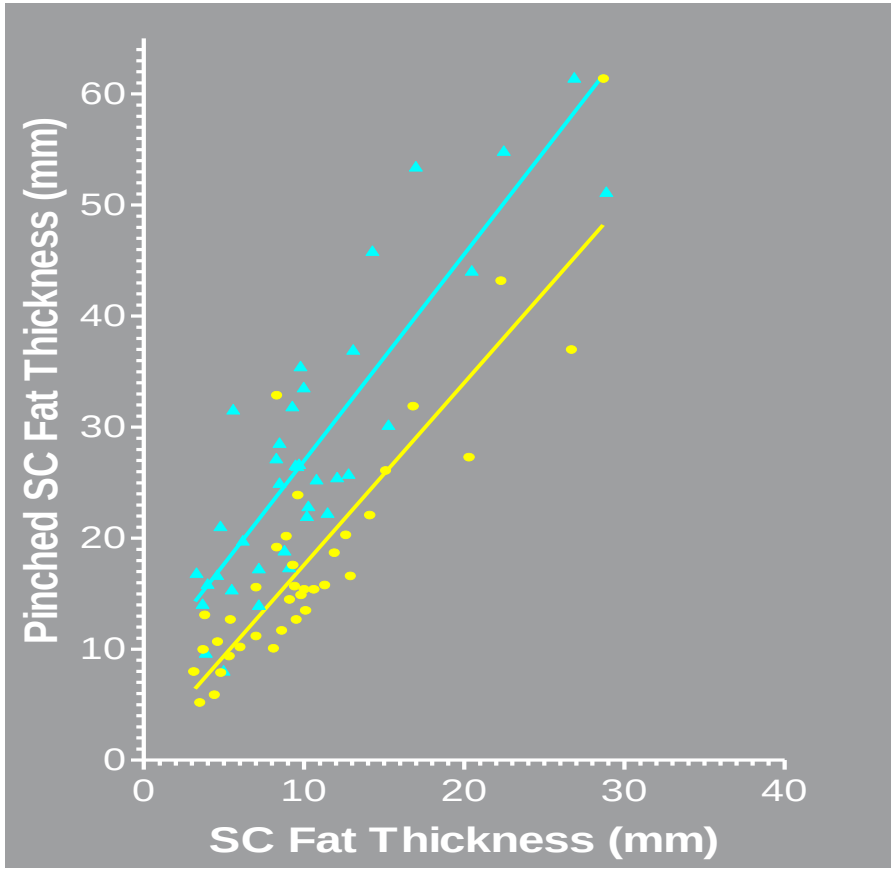
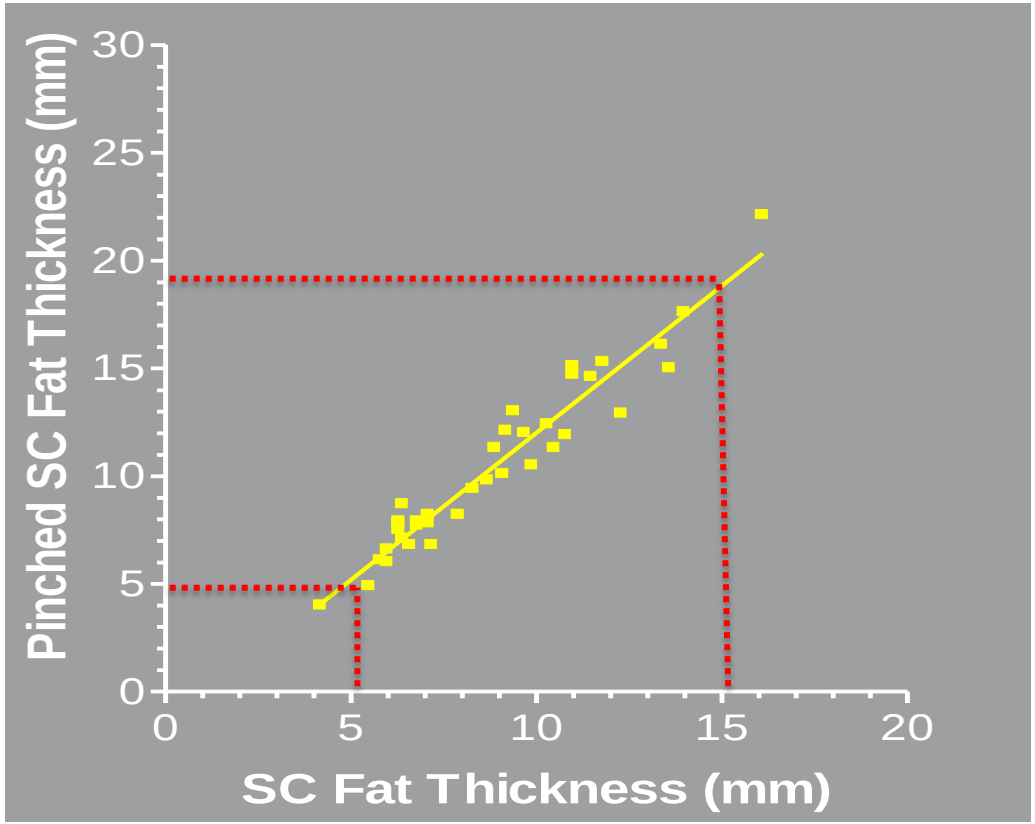


Unpublished data courtesy of P. Hofman.



Unpinched versus pinched (lifted) abdominal S/C fat thickness[7]

Unpublished data courtesy of P. Hofman.



Unpinched versus pinched (lifted) thigh S/C fat thickness

Unpublished data courtesy of P. Hofman.

Injection technique

Involves three main variables[2]

1. Injection with or without a lifted skinfold
2. Angle of insertion
3. Time needle is left in the skin after injection

2. Frid A, Hirsch L, Gaspar R, et al. Diabetes Metab. 2010; 36(suppl 2):S3-S18.

Injection technique – evidence in children

Three studies

1. Comparison of 8mm pen needles to 6mm pen needles using either angled or perpendicular injection into abdomen or thigh.[7]
2. Comparison of 4mm needles to 6mm needles using perpendicular injection into abdomen and thigh.[5]
3. 5mm needles using direct or lifted skinfold and angled or perpendicular injections into abdomen or thigh.[11]

5. Birkebaek NH, et al. Diabetic Medicine. 2008; 15: 965.
7. Hofman P, *et al. Diabet Med.* 2007; 24(12):1400.
11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

6mm versus 8mm needles[7]

n=73, Age 10.7 ± 2.1, BMI 18.7 ± 2.7, 44% pubertal, 45% male

	6mm vertical insertion	6mm angled insertion	8mm angled insertion
Percentage IM Injections	42%	5%	24%
Percentage Dermal	3%	2%	3%

7. Hofman P, *et al. Diabet Med.* 2007; 24(12):1400.

4mm versus 6mm needles[5]

21 lean children (16 male)
32 lean adults (23 male)
BMI *Z* score <0

- 19/21 (90%) of children and 100% adults had subcutaneous fat injections with 4 mm needles.
- IM injections were significantly more common with 6mm needles in abdomen ($p<0.03$) and thigh ($p<0.001$).

5. Birkebaek NH, et al. Diabetic Medicine. 2008; 15: 965.

5mm needles[11]

- Involved abdomen and lateral thigh injections
- Lifted or no skin fold
- Angled or perpendicular injection
- Total of 8 injections
- 20U air injected and visualised on ultrasound
- 123 children (and 138 adults)

11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

5mm needles[11]

No technique difference with the majority of injections into the subcutaneous fat (>95%)

- <1% of injections dermal
- <5% (children) of injections were intramuscular
- 1-2% IM were angled and 7-8% IM were vertical

IM injections were much more likely in leaner individuals.

However, no factor including subcutaneous fat thickness reliably predicted risk of an IM injection

11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

Injection pain

Important to patients!

- May be important to long-term compliance.[13]
- Related to both the needle and injected compound.[13]
- Needle pain predominantly reflects diameter[13] with no evidence that technique (angled versus perpendicular) makes a difference.[7]

7. Hofman P, *et al. Diabet Med.* 2007; 24(12):1400.

13. Arendt-Nielsen L. *et al. Somatos Mot. Res*. March-June 2006;23(1/2):37-43.

Pain with injections – Based on analogue pain scale[11]

	Pain (cm)
5mm 32G	1.51±0.5
6mm 31G	2.51±1.2
8mm 30G	2.85±1.6

Range from 0 (no pain) to 10 (worst pain ever experienced)

$p < 0.001$

NB: intraperitoneal injections hurt!

Data on file courtesy of P. Hofman.

11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

Adults perceive less pain than children[11]

5mm Needles – a mean of all 8 injection techniques

Pain in Children	Pain in Adults	P Value
1.51 ± 1.55cm	1.0 ± 1.11mm	<0.0001

No difference between angled and vertical injections or S/C/ IM injections

11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

Insulin leakage[11]

- Hypothesised to be greater given shorter needles.

- Angled and vertical injections in abdomen and thigh tested (all pinched).

11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

4mm, 5mm and 6mm needles[11]

Irrespective of technique used, backflow/ insulin leakage from all needles was minimal.

Based on:

- 10 and 40 unit injections using 4 and 6mm needles.
- 20, 40 and 60 unit injections using 5mm needles.

11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

Insulin leakage 5mm needles (units)[11]

Units Injected	Pinched Abdo Angled	Pinched Abdo Vertical	Pinched Thigh Angled	Pinched Thigh Vertical
20	0.019	0.020	0.041	0.067
40	0.019	0.014	0.033	0.072
60	0.02	0.029	0.053	0.062

11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.

Conclusions

- Shorter needles (4mm and 5mm {6mm for insulin syringes}) reliably inject into subcutaneous fat in most patients.
- In very thin subjects consideration should be given using the shortest needle available.
- An angled approach using a pinched skinfold will reduce IM injections in very thin subjects using 5 or 6mm injections.
- Pain is reduced with thinner/ shorter needles.
- Backflow/ leakage is negligible up to 60units.

FITTER Recommendations[1]

- The safest pen needle for all patients is 4 mm in length inserted perpendicularly.
- The 4 mm needle may be used safely and effectively in all obese patients.
- Young children (6-years old and under) and extremely thin youth should use the 4 mm needle **by lifting a skin fold** and injecting into it.
- All others may inject using the 4 mm needle without lifting a skin fold.

1. Frid AH, Kreugel G, Grassi G et al. Mayo Clin Proc. September 2016:91(9):1231-1255.

FITTER Recommendations[1]

- The safest currently-available syringe needle for all patients is 6 mm (8mm in Australia & New Zealand).
- When any syringe needle is used in children or slim to normal weight adults, injections should always be into a lifted skin fold.
- Use of syringe needles should be prohibited in young children (6-years old and under) and extremely thin youth even if they use a raised skin fold because of the excessively high risk of IM injections.

1. Frid AH, Kreugel G, Grassi G et al. Mayo Clin Proc. September 2016:91(9):1231-1255.

Thank You!

Reference List:

1. Frid AH, Kreugel G, Grassi G et al. Mayo Clin Proc. September 2016:91(9):1231-1255.
2. Frid A, Hirsch L, Gaspar R, et al. Diabetes Metab. 2010; 36(suppl 2):S3-S18.
3. Tubiana-Rufi N, et al. Diabetes Care 1999; 22(10):1621.
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5. Birkebaek NH, et al. Diabetic Medicine. 2008; 15: 965.

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6. Polak M, *et al. Diabetes Care* 1996, 19: 1434-1436.
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8. Kreugel G, *et al. Europ Diab Nursing* 2007;4:1-5.
9. Strauss K *et al. Practical Diabetes International* 1998, 15: 181-184.
10. Lo Presti *et al. Pediatric Diabetes* 2012: 13: 525–533.
11. Hofman PL *et. al. Diabetes Care.* 2010 Sep;33(9):1940-4.
12. Chantelau E *et al. Br Med J* 1991; 303: 26–27.
13. Arendt-Nielsen L. *et al. Somatos Mot. Res*. March-June 2006;23(1/2):37-43.

BD Medical - Diabetes Care Australia: Becton Dickinson Pty Ltd, 4 Research Park Drive, Macquarie University Research Park, North Ryde, NSW. 2113. ABN 82 005 914 796. Toll free telephone: 1800 656 100.

BD Medical - Diabetes Care New Zealand: Becton Dickinson Limited, 14b George Bourke Drive, Mt Wellington Auckland 1060, New Zealand, Toll Free: 0800 572 468