

Clinical Guiding Principles for Subcutaneous Injection Technique

Technical Guidelines



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Clinical Guiding Principles for Subcutaneous Injection Technique

Technical guidelines

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The Guiding Principles have been developed with financial support from BD Diabetes Care and Novo Nordisk Pharmaceuticals Pty Ltd.



Disclaimer

These clinical guiding principles form an acceptable basis for working with children and adults with diabetes mellitus who require injectable medicines, however there may be sound clinical reasons for different strategies initiated for an individual. The complexity of clinical practice requires that, in all cases, users understand the individual clinical situation, and exercise independent professional judgment within the scope of practice of their specific discipline when basing therapeutic intervention on this document. The information set out in this publication is current at the date of first publication. It is not exhaustive of this subject matter. Compliance with any recommendations cannot by itself guarantee discharge of duty of care owed to patients and support people.

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About ADEA

The Australian Diabetes Educators Association (ADEA) is the peak national organisation for multidisciplinary health professionals who are committed to the provision and excellence of quality, evidence-based diabetes education, care and management with over 2,100 members working in all sectors and across all locations.

ADEA aims to improve the health and wellbeing of people with diabetes by:

1. Assessing diabetes educators based on their qualifications, skills, knowledge and experience through the credentialling program
2. Supporting multidiscipline health professionals through its various programs, including mentoring, education and research
3. Developing and updating relevant policies, standards of practice and clinical guidelines

For more information, visit our website at www.adea.com.au.

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Glossary

Continuous subcutaneous insulin infusion (CSII). The use of a portable electromechanical pump to deliver short-acting insulin into the subcutaneous tissue at preselected rates, via a needle or soft cannula under the skin.

Dermis + Subcutis. Describes the depth of the tissue from skin surface to muscle, i.e. epidermis, dermis and subcutaneous. This term is used to estimate the risk of intramuscular injections and the importance of choosing the correct needle length.

GLP-1 Mimetic: GLP-1 mimetics (exenatide[®], liraglutide[®]) can only be administered using a disposable pen device or syringe (weekly exenatide[®] preparation) which requires a subcutaneous injection technique into the abdomen, thigh or arm, using the principles of subcutaneous injection.

Intradermal (ID): The skin layer: used to describe the action of injecting into skin (dermis).

Intramuscular (IM): The layer under the subcutis: used to describe the action of injecting into muscle.

Lifted skin fold. A lifted skin fold is made using the thumb and index or middle finger to gently lift subcutaneous tissue away from the muscle layer [2]. It is used to reduce the risk of intramuscular injection. Care should be taken not to pinch the skin and inadvertently also lift muscle tissue.

Lipoatrophy (LA) is a breakdown (atrophy) of the subcutaneous fat tissue. It is thought to be immunological in nature and probably results from impurities or other components in some insulin preparations [1]. Due to the availability of purified human and analogue insulins, it is now less commonly seen, estimated to affect only 1-2% of those injecting insulin [1].

Lipodystrophy is one of the most common complications of subcutaneous insulin injection and may present as either lipoatrophy or lipohypertrophy [1].

Lipohypertrophy (LH) is an area of thickened subcutaneous tissue which may be hard or scar like, or soft like a rubber ball [2]. LH is associated with repeated injection into the same sites, inadequate site rotation and the reuse of needles, and incidence is increased with duration of diabetes, duration of insulin use and number of injections per day [1-4]. LH is common, with studies finding that between 29 and 64% of insulin users are affected [1, 3-5].

Subcutaneous (SC). The layer between the skin (epidermis + dermis) and muscle which contains the fatty tissue which is ideal for the absorption of insulin and GLP-1 mimetics. Also called the subcutis.

Background

The Australian Diabetes Educators Association (ADEA) promotes evidence-based practice in all aspects of diabetes education and care.

The teaching of subcutaneous injection technique (SCIT) is a fundamental role of the diabetes educator [2]. As such, ADEA recognises the need for diabetes educators to possess evidence-based knowledge and skills in relation to SCIT. This ensures the correct instruction and education regarding injectable medicines for people with diabetes, including the self-administration of insulin and GLP-1 mimetics.

These clinical guiding principles have been developed from the “ADEA Clinical Recommendations for Subcutaneous Injection Technique for Insulin and Glucagon-Like Peptide 1” (ADEA 2011). This expanded and updated technical document was developed from a literature search and review, and a stakeholder consultation period to ensure current evidence is included and the guideline

is relevant for diabetes educators and other health care professionals responsible for administering or teaching SCIT.

The guiding principles provide an evidence base for the injection of SC diabetes medicines for health care professionals involved in the administration and teaching of SCIT for diabetes therapies in various clinical settings. They include information about the principles of SCIT, education of individuals in safe and accurate injection technique (IT), evaluation of IT, and specific issues for health care settings and carers.

This document does not address the administration of glucagon, an injectable medicine for the treatment of severe hypoglycaemia, nor technical issues associated with continuous subcutaneous infusion devices (insulin pumps), however it does include a small section on CSII where principles of SCIT apply.

Introduction

An increasing number of Australians are injecting diabetes medicines. This is due to an increasing prevalence of diabetes, the move to earlier insulin use in type 2 diabetes and the newer classes of non-insulin injectable medicines for type 2 diabetes.

Insulin therapy is essential for the management of type 1 diabetes. It is also increasingly being used in those with type 2 diabetes to achieve optimal glycaemic control. It is estimated that around 50% of people with type 2 diabetes will require insulin within 10 years of diagnosis and this increases with duration of diabetes [6]. Insulin may also be required for women with gestational diabetes mellitus (GDM) who are unable to maintain blood glucose levels in the recommended range for pregnancy with dietary modification and exercise alone [7]. According to the National Diabetes Services Scheme (NDSS), in January 2017 almost 391,500 Australians with diabetes were registered as requiring insulin [8], representing 32% of all people registered with diabetes. Of these, 31% were identified as having type 1, 66% as having type 2 and 3% as having GDM. The number of people with diabetes using CSII was recorded as being 20,265. Another 25,659 individuals were registered as using non-insulin injectable medications.

Proper IT by individuals using injectable diabetes medicines is essential to reduce absorption variability, optimise the drug effect and in turn achieve target glycaemic goals [2]. Health care professionals, and particularly diabetes educators, play a crucial role in the education of individuals with diabetes regarding correct IT [2].

Despite the availability of IT guidelines, large studies of individuals with diabetes found that many are not following evidence-based recommendations for the administration of insulin [3, 4]. The most recent survey (injection technique questionnaire [ITQ]) was conducted in 2014-2015 with 13,289 insulin injecting patients from 423 centres in 42 countries taking part, including Australia for the first time [9]. Since the release of TITAN [2], the main change in injection technique measured was the increased use of smaller length needles. For example, the use of 8mm length needles had reduced from 48.6% to 16%, whilst one in five respondents were now using 4mm needles (not available in 2009). However the ITQ 2014-2015 sought more clinical information and diabetes self-management information from respondents compared to the previous ITQ 2009. This, plus an expanded methodology, has produced a set of recommendations, titled the Forum for Injection Technique and Therapy: Expert Recommendations (FITTER) [10]. The FITTER recommendations were published in 2016, with two additional publications focusing on the ITQ data and implications for health care professionals.

Summary of Recommendations:

- People with diabetes, their carers and health care professionals require high quality education and training from diabetes educators that encompasses current evidence and consensus-based principles of SCIT.
- Diabetes health care professionals require knowledge of the factors affecting the efficacy of injectable diabetes medicines.
- The choice of injection site should take into consideration the requirements of different injectable medicines. However the abdomen is the preferred injection site for most people due to its convenience, consistency and reproducible rates of absorption of injectable medicines.
- Shorter length pen needles (4 and 5mm) are recommended for the initiation of SC injectable medicines in children, adolescents and adults of all sizes. There is no medical rationale for use of longer needles for SC diabetes medications.
- When using a syringe, needle length no longer than 6mm is recommended, however the shortest syringe needle length in Australia at time of publication is 8mm.
- The size and angle of insertion of the needle used for injection, and the need for a lifted skinfold, should be determined according to clinical examination and consideration of the likely composition of skin and SC tissue.
- Injections should not be administered through clothing.
- Regular review of SC injection technique and inspection of sites used for injection is an integral part of the education of SCIT.
- Review of SCIT should be completed at least annually for adults and at each visit for children and adolescents, or when lipodystrophy has been identified.
- Diabetes educators must document all components of the assessment and education for the administration of injectable diabetes medicines, including a review of technique and injection sites.

Objectives:

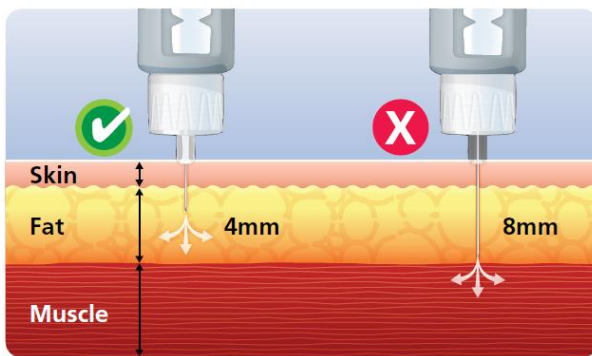
The objectives of these clinical guiding principles are to:

1. Identify and promote the quality framework required for the safe delivery of injectable diabetes medications.
2. Support evidence-based decision making for clinicians providing education for people who require injectable diabetes medicines.
3. Identify the appropriate injection sites, needle length, insertion angle, and need for a lifted skin fold for the administration of diabetes medicines to adults and children/adolescents.
4. Outline the principles required for the teaching, review and evaluation of the injection of insulin and GLP-1 mimetics for people with diabetes, carers and health professionals.
5. Highlight the potential impact of incorrect injection technique on blood glucose variability in those injecting diabetes medications.
6. Articulate and reinforce requirements for documentation of teaching of injection technique and review.
7. Minimise adverse outcomes caused by incorrect SC injection technique.
8. Reduce the risk of needle stick injury to family members, carers and healthcare professionals.

Guidelines

Principles of subcutaneous injection technique for insulin and GLP-1 mimetics

Correct SCIT can be defined as one that consistently delivers injected medicine into the SC space with minimal discomfort [11]. The SC tissue has relatively poor blood supply, prolonging the absorption time of injected medicines, resulting in a more consistent absorption rate. This is advantageous for drugs that cannot be ingested, such as insulin, or drugs which require a slower, more predictable absorption rate. A network of blood vessels lie between the dermis and subcutaneous layer and serve as the site of absorption for medicines [12].



Correct SC administration of diabetes injectable medications requires consideration of the following:

- Injection site.
- Needle length
- Use of a lifted skinfold.
- Angle of injection.

Choice of injection site

The most commonly recommended site for SC injections is the abdomen due to its convenience and tendency to more rapid and reproducible insulin uptake [2, 13]. The buttocks, thigh and upper arms may also be used, however the risk of IM injection is higher with the thighs and arms, and the difference in absorption between sites needs to be considered for some types of insulin (older human insulins, eg Regular, NPH) [2,14]. When using the abdomen, injections should be given at least 1cm above the symphysis pubis, 1cm below the lowest rib and 1cm away from the umbilicus [10].

The posterior lateral aspects of the buttocks offer the slowest rate of absorption, and have a higher SC tissue depth, so injecting with a skin fold is generally not required [13]. If the person is able to reach this part of the anatomy for self-injection, SC injections can be safely performed with the correct needle length using a single handed technique [2, 12].

Injection into the upper third anterior lateral aspects of both thighs is the preferred region to reduce inadvertently injecting IM [10]. The risk of IM injections into the thigh ranges from 6.7% in obese females to 58.1% in males with a body mass index (BMI) < 25kg/m² when an 8 mm needle is used without a lifted skin fold [17]. This is reduced with shorter needles, but remains a risk, particularly for slimmer individuals. Even with 4mm needles, it is estimated that 10.1% of injections into the thigh for males with a BMI < 25kg/m² will be given IM [17]. Due to vascularisation of the area, there is also a risk of rapid absorption of insulin from the thigh where exercise is performed shortly after injection [18,19].

The arms also have a reduced depth of subcutis, increasing the risk of IM injection even with very short (4 mm) needles and a lifted skin fold is recommended for children and slim adults [12, 16, 17, 20]. However it is almost impossible to perform this technique properly in those who are self-injecting [2]. There is also difficulty consistently locating the injection into the correct part of the arm to ensure SC injection (middle third posterior aspect) [10]. The risk of IM injection at 90 degrees with a 4mm needle without a skinfold lift is estimated to range from 0.1% for obese females to 7.1% for males with a BMI <25kg/m² [17]. This risk increases progressively with increasing needle length and is 50.5% in males with a BMI < 25kg/m² with 8mm needle lengths [17].



Modern insulins/Insulin analogues

Modern analogue insulin (rapid – lispro, aspart and glulisine, long acting – glargine and detemir and premix – insulin aspart, insulin lispro) can be given SC at any site as absorption rates do not appear to be site-specific [2]. However long-acting analogues can cause severe hypoglycaemia if inadvertently injected IM [21].

Human insulins

Human insulin is more variable in its absorption and pharmacodynamics. The abdomen is the preferred injection site for soluble human insulin (regular), due to the faster absorption from this area [2]. It is also the preferred site for morning doses of mixed human insulin due to increased absorption of the short-acting insulin to cover glycaemic excursions with breakfast [2]. IM administration of neutral protamine Hagedorn (NPH) should be absolutely avoided due to the increased risk of hypoglycaemia. It is preferable that NPH (when given alone) be injected at bedtime rather than earlier in the evening in order to reduce the risk of nocturnal hypoglycaemia [10]. The thigh and buttocks are the preferred injection sites for NPH due to slower absorption from these sites which can help to reduce the risk of nocturnal hypoglycaemia [2]. Similarly, an injection of mixed insulin containing NPH should be given in the thigh or buttocks in the evening if there is a risk of nocturnal hypoglycaemia [10].

GLP-1 Receptor Agonists

There are few studies investigating the optimal injection technique for GLP-1 receptor agonists but their absorption does not appear to be site specific and injections into the abdomen, thigh or upper arm are recommended [2, 22]. Pending further studies, patients using non-insulin injectable therapy should follow the established recommendations for insulin injections regarding needle length, site selection and rotation.

Injection sites during pregnancy

During pregnancy women with GDM or pre-existing type 2 diabetes may require insulin therapy to achieve glycaemic targets. Women with type 1 diabetes will continue to inject but may require different insulin preparations. GLP-1 receptor agonists are not currently approved or indicated for use in pregnancy.

While there is a lack of research into the optimal injection technique during pregnancy, the following recommendations are made [2, 10]:

- Shorter needles are preferred (pen: 4 or 5mm length, syringe: 6mm) when injecting into the abdomen due to the thinning of abdominal fat from uterine expansion.
- First trimester: Women should be reassured that no change in insulin site or technique is needed.
- Second trimester: Insulin can be injected over the entire abdomen as long as properly raised skinfolds are used. Lateral aspects of the abdomen can also be used when not using a skinfold.
- Third trimester: Injections can be given into the lateral abdomen using a correct skinfold technique. Apprehensive clients may use their thigh, upper arm or buttock instead of the abdomen.

Women can be reassured that insulin needles are not long enough to penetrate the uterine wall if insulin is injected abdominally.

Injections should not be given through clothing.

Injecting through clothing is discouraged as the person is unable to inspect the site, or properly use a lifted skin fold if required [2]. Further the advent of shorter needles means that the injection may not penetrate the skin sufficiently for correct administration of medicine into the SC space [23].

Choice of needle length

The choice of needle length should be one which will reliably deliver the medicine into the SC space without leakage or discomfort [2].

Various options for pen and syringe needles are available to users of insulin and GLP-1 mimetics in Australia. Pen needles from 4 mm to 12.7 mm in length are currently available and syringes with needles from 8 mm to 12.7 mm.

However needles greater than 6mm are no longer recommended due to the high risk of IM injection [2, 10], so while they are still available on the NDSS, their use should be discouraged.

Studies examining the effect of shorter (4-6mm) needle lengths on glycaemic management, pain, insulin leakage, and other issues have found that shorter needles are safe, effective, and usually better tolerated [2]. Furthermore, the use of 4mm needles for overweight and obese people is efficacious, with no loss of safety, efficacy or tolerability, and no evidence of worsening metabolic management [10, 25-27]. Studies have found no statistically significant difference between the efficacy of injections delivered into deep or shallow subcutis, supporting the fact that longer needles are not necessary for those with a greater amount of SCT [28, 29, 30].

Injections delivered at 90 degrees with a 4mm needle were estimated to deliver insulin to

the subcutaneous tissue > 99.5% of the time with minimal risk of intradermal (ID) injections. Inadvertent intramuscular injections occur more often using longer needles, in slimmer and younger patients, males and in those who use limbs rather than truncal injection sites [10].

Until recently skin thickness (ST) was thought to depend on the weight or race of the individual. Recent studies have demonstrated that there is minimal difference in ST between adults of different age, gender, body mass index (BMI). A variety of studies show the skin varies in thickness from approximately 1.25mm to 3.25mm in 90% of individuals [9]. A study which compared skin and SC adipose tissue thickness in 388 US adults of varying BMI and ethnicities, found the measurement of ST varies only from 1.7 – 2.7 mm (95% CI) and is rarely greater than 3mm [15]. A small difference was found between sites, with thighs having the smallest ST (mean ST 1.9mm), buttocks the largest (mean ST 2.4mm), and the abdomen and arms falling in between (mean ST 2.2mm for both areas). Males were noted to have marginally thicker skin than females, by up to 0.3 mm. However BMI had minimal effect on ST, with a difference of 10kg/m² accounting for less than a 0.2mm change in ST. Children have been shown to have a smaller ST, which increases gradually from birth to adulthood [10, 20, 24].

The thickness of the SC adipose layer (subcutis) is widely variable and women have an approximate 5mm extra SC fat compared with men of the same BMI. In both children and adults, even the shortest needles (4mm) reliably transverse the skin and enter the subcutaneous (SC) fat [10].

In the study above, SC adipose tissue (SCT) layer thickness was found to range from 9.8mm to 16.2mm (95% CI) across all sites, with mean SCT measurements of 10.4mm in the thigh, 10.8mm in the arm, 13.9mm in the abdomen and 15.5mm in the buttocks [15]. Unlike ST, there was a significant impact of BMI on SCT, with a change of 10kg/m² accounting for a 4mm change in SCT. Females also had a greater (5.1mm) mean SCT compared to males.

Combining the measurements of ST and SCT in this study, it was estimated that the majority of injections across the four commonly-used injection sites with a 5mm needle at 90 degrees would be delivered into the SCT, with less than 2% estimated to be IM [15]. For 6mm, 8mm and 12.7mm needles, 5%, 15% and 45% of injections were estimated to be delivered IM. Even when injected at 45 degrees, 21% of injections with a 12.7mm needle were estimated to be IM when injected at 90 degrees.

Injections delivered at 90 degrees with a 4mm needle were estimated to deliver insulin to the subcutaneous tissue > 99.5% of the time with minimal risk of intradermal (ID) injections. Inadvertent intramuscular injections occur more often using longer needles, in slimmer and younger patients, males and in those who use limbs rather than truncal injection sites [10]. The use of shorter needles is particularly important in children. The distance from the skin surface to muscle has been estimated to be less than 4mm in 10% of children, particularly in the 2-6 age group [20]. Without a skinfold lift, it is estimated that 20% of injections would be given IM in this group, even with 4mm needles [20]. This doubles with 5mm and triples with 6mm needles.

Very young children (<6 years old) should use 4mm needles by lifting a skinfold and inserting the needle perpendicularly into it. Older children may inject without a skin fold using a 4 mm needle [10].

The shortest syringe needle length available in Australia is 8 mm at the time of publication. Therefore the use of for very young children (<6 years old) is not recommended due to the higher risk of IM injection [10].

Current guidelines suggest there is no medical reason to recommend pen needles longer than 4-5mm for children and adults [10]. It is recommended that initial therapy should commence with shorter (4-5mm) pen needle lengths or 6mm syringe needle lengths [10]. According to the NDSS, in 2014-2015 almost half (47.9%) of all pen needle users are using needles of 8mm or longer, although the number now using 12mm or longer needles is only 2.8% and has fallen almost 40% since 2013-2014. For syringe users, 30.3% are using needles of 12.7-13mm although these make up only a small proportion of total needle use.

In the 2008-2009 Insulin Injection Technique Questionnaire Survey it was found that 63% of participants had used the same needle length since commencing an injectable medicine [4]. This highlights the importance of accurate initial education on appropriate needle length, and regular evaluation of IT in those administering injectable diabetes medicines.

Recommendations for adults include:

- Use of shorter pen needles (4mm or 5mm) for all adults, including those who are obese.
- Insulin and GLP-1 receptor agonists must be injected into healthy subcutaneous tissue, avoiding lipohypertrophy and scars.
- If 4mm needles are used they should be injected at 90 degrees to the skin surface.
- Very slim adults may need a lifted skin fold at all sites, even with the 4 mm needle.
- Injections into the arm or thigh will require a lifted skin fold with any needle length and are known to increase the risk of unintentional IM injections.
- If needles \geq 6 mm are used, they should be used with a lifted skin fold or injected at 45 degrees to decrease the risk of unintentional IM injections [10].

Recommendations for children include:

- Use of shorter pen needles (4mm or 5mm) for all children commencing insulin therapy although 4mm needles are the safest option, particularly for those aged 2-6 years.
- Children aged under 6 years must use a 4 mm needle with a lifted skin fold.
- The use of syringes in very young children (<6 years old) is not recommended [10].
- Children using a 5mm pen needle or longer should be switched to a 4mm needle if possible and if not should always use a lifted skinfold [10].
- For children using syringes, the shortest available needle (6mm/8mm) must be used and injected using a

lifted skinfold and 45 degree injection angle.

- The need to use a lifted skin fold should be reviewed as the child grows.

GLP-1 receptor agonist devices:

All of the **GLP-1 receptor agonists** currently available in Australia are supplied in disposable injection devices and have specific instructions for their preparation and administration. The recommended needle length is the same as that required to deliver a SC injection of insulin [10], except for Bydureon, the new GLP-1 receptor agonist which has its own specific needle device. Refer to the manufacturer's specific instructions for more information.

Recommended sites for injection are the abdomen, thigh and arms, however the same principles apply for reducing the risk of IM injection as they do for insulin injections [2,22].

Table 1: A guide to needle length

| | | | |
|---|--------------------|--|-------------------------|
| Children | Needle size | Angle of injection (degrees) | Use of skin fold |
| | 4 mm | 90 | May, in 2-6 year olds |
| | 5 mm | 45 or 90 | Yes May |
| | 6 mm | 45 or 90 | Yes |
| | 8 mm | Use not recommended with pen needles but may be used with syringes. If used, inject at 45 degree angle with a lifted skin fold | |
| | 12 mm | Use not recommended | |
| Very slim adults | Needle size | Angle of injection | Use of skin fold |
| | 4 mm | 90 | May |
| | 5 mm | 45 or 90 | Yes |
| | 6 mm | 45 or 90 | Yes |
| | 8 mm | 45 | Yes |
| | 12 mm | Use not recommended | |
| Adults of Normal Weight | Needle size | Angle of injection | Use of skin fold |
| | 4 mm | 90 | No |
| | 5 mm | 90 | May |
| | 6 mm | 90 | Yes |
| | 8 mm | 45 | Yes |
| | 12 mm | Use not recommended | |
| Adults who are overweight or obese | Needle size | Angle of injection | Use of skin fold |
| | 4 mm | 90 | No |
| | 5 mm | 90 | No |
| | 6 mm | 90 | May |
| | 8 mm | 45 - 90 | Yes |
| | 12 mm | Use not recommended | |

Choice of injection device

Insulin pens

Insulin pen devices first became available in 1985 and are now the standard choice for most people with diabetes who inject insulin. GLP-1 receptor agonists only come in a prefilled pen device and new pen device that requires re-constitution before administration.

Studies have shown a number of benefits of insulin pens over syringes, including [31-33]:

- Convenience and ease of use.
- Greater accuracy, particularly at low doses.
- Greater adherence.
- Greater perceived social acceptance.
- Reduced fear of needles.
- User preference over syringes.

There are a number of different brands and models of insulin pens available in Australia (Table 2) and the choice of pen device will depend on a number of factors including:

- Insulin type.
- The maximum dose of insulin that can be given (important for those taking large doses).
- Availability of 0.5 unit or 1.0 unit dosing increments (0.5 unit dosing may be helpful for children and/or those on smaller doses).
- Readability of the numbers for those who are vision impaired
- Audible sound for dialling the dose for those who are vision impaired
- Dexterity in dialling the dose
- The ease of use of the pen.
- Choice of colour.
- Preference for disposable versus non-disposable.
- Additional features such as an inbuilt electronic memory of previous doses and administration times.

Syringes

Insulin syringes were the only method available for the administration of insulin until the 1980's. While they have largely been replaced by insulin pens and insulin pump therapy, some people still choose to use syringes.

They are also still commonly used by healthcare professionals for the administration of insulin. With this method, insulin is drawn up into the syringe from a vial or cartridge, and then injected. Insulin syringes are available in 0.3, 0.5 or 1.0ml sizes depending on the dose of insulin required, and needle length of 8mm, 12.7mm and 13mm. The main advantage of a syringe is the ability to mix two different types of insulin in the one syringe, reducing the number of injections for those who take two different types of insulin at the same time (where the insulin types are compatible). However the drawing up of the insulin is more time consuming and can be difficult when injecting away from home. There is also increased potential for insulin contamination and dose errors if the incorrect syringe size is inadvertently used. Where retractable insulin pen needles are not available in the health care setting, the use of syringes with non-capping technique after use, markedly reduce the incidence of needle stick injuries.

Table 2: A guide to insulin pen devices

| Pen | Insulin types | Disposable or Reusable | Dosing increments | Maximum dose | Colours /other features |
|---------------------|---|------------------------|-------------------|--------------|---|
| Novo Nordisk | | | | | |
| NovoPen® 4 | NovoMix® 30; NovoRapid®; Levemir®; Actrapid®; Protaphane®; Mixtard® 30/70; Mixtard® 50/50 | Reusable | 1.0 | 60 | Silver or Blue |
| NovoPen Echo® | NovoMix® 30; NovoRapid®; Levemir®; Actrapid®; Protaphane®; Mixtard® 30/70; Mixtard® 50/50 | Reusable | 0.5 | 30 | Red or Blue Memory function for last dose |
| InnoLet® | Protaphane®; Mixtard® 30/70 | Disposable | 1.0 | 50 | Beige Large easy to read dial |
| FlexPen® | NovoMix® 30; NovoRapid®; Levemir® | Disposable | 1.0 | 60 | Blue (NovoMix® 30) Orange (NovoRapid®) Green (Levemir®) |
| Lilly | | | | | |
| Humapen® Savvio™ | Humalog®; Humalog® Mix 25®; Humalog® Mix 50®; Humulin® R; Humulin® NPH; Humulin® 30/70 | Reusable | 1.0 | 60 | Grey, Blue, Green, Pink, Red and Graphite |
| Humapen® Luxura HD™ | Humalog®; Humalog® Mix 25®; Humalog® Mix 50®; Humulin® R; Humulin® NPH; Humulin® 30/70 | Reusable | 0.5 | 30 | Green |
| Kwikpen® | Humalog®; Humalog® Mix 25®; Humalog® Mix 50® | Disposable | 1.0 | 60 | Grey |
| Kwikpen®* | Basaglar® | Disposable | 1.0 | 80 | *not yet available at time of publication |
| Sanofi | | | | | |
| | | | | | |
| SoloSTAR® | Apidra®; Lantus®; Toujeo® | Disposable | 1.0 | 80 | Grey (Lantus®); Blue (Apidra®); Grey and Green (Toujeo®) |
| ClikSTAR® | Apidra®; Lantus® | Reusable | 1.0 | 80 | Silver, Blue |
| JuniorSTAR® | Apidra®; Lantus® | Reusable | 0.5 | 30 | Blue, Red, Silver |

Use of Pen Devices

Steps for injecting with an insulin pen [2, 13]:

1. Always follow the manufacturer's instructions to ensure the correct technique.
2. Fit a new needle to the top of the pen.
3. Resuspend cloudy insulin if applicable by gently rolling and tipping. Confirm visually that the resuspended insulin is sufficiently mixed. Avoid vigorous shaking as this produces air bubbles that may affect accurate dosing.
4. 'Prime' the pen to ensure it is working correctly and there are no air bubbles and that pen needle is correctly secured.
5. Dial up the required dose of insulin.
6. Insert the needle and push down the plunger along the axis of the pen to administer the insulin dose.
7. Leave the pen needle *in situ* after injecting the medicine for 10 seconds (or as per the manufacturer's instructions) to allow the medicine to fully inject. Counting past 10 seconds may be needed for higher doses.
8. Remove the pen needle and discard safely. Replace cap on the pen.

Note:

- Pen devices are for individual use only and should not be shared. "Think: One pen, one person" Pens and their cartridges can be contaminated with epithelial cells and blood after a single injection – leading to possible

transmission of blood-borne illnesses if a pen is used in more than one patient [34].

- Durable (reusable) injection devices must be matched with their complimentary insulin cartridge to ensure the injection and dosing is accurate. Each type of insulin cartridge requires a designated pen device.
- Manufacturers of pen devices for insulin and GLP-1 mimetics have different recommendations regarding the priming of a device at the commencement of use, and before each injection. It is generally advised to prime the insulin delivery device prior to each injection by dialling up 1-2 units, inverting the pen so that the needle is facing upwards and pressing the plunger. This is repeated until a few drops of insulin are seen, to check that the pen is working.
- During needle insertion the thumb button should be touched only after the pen needle is inserted to reduce accidental leakage.
- Pressure should be maintained on the thumb button until the needle is withdrawn from the skin to prevent aspiration of patient tissue into the cartridge.
- The pen needle should be removed from the injection device immediately after administration of the medicine to prevent the entry of air, or other contaminants, into the cartridge and to prevent the leaking of medication, which can affect subsequent dose accuracy. A new needle should be attached just prior to the subsequent injection.

Use of Syringes

Steps for injecting with a syringe [2,13]:

1. Prepare syringe - choose the correct size syringe and remove from packaging (eg 0.3ml if taking less than 30 units, 0.5ml if taking less than 50 units and 1.0ml if taking less than 100 units).
2. Resuspend cloudy insulin if applicable by gently rolling vial.
3. For a single insulin dose:
 - a. Inject air at a dose equal to or slightly greater than the desired dose of insulin into the vial
 - b. Draw insulin dose into syringe
 - c. Check for correct number of units and that there are no air bubbles.
4. For a mixed insulin dose:
 - a. Inject air at a dose equal to or slightly greater than the desired dose of cloudy insulin into the vial
 - b. Inject air equal to the dose of clear insulin into the clear vial
 - c. Draw out clear insulin dose
 - d. Check for correct amount and no air bubbles
 - e. Insert needle into cloudy vial and withdraw correct dose
 - f. Ensure total dose is correct
 - g. If the incorrect dose(s) are drawn up the syringe should be discarded and the procedure started again with a fresh syringe.

Note:

- Long-acting insulin analogues (insulin detemir and insulin glargine) should not be mixed with rapid acting insulin due to the blunting of the onset of action of the rapid-acting insulin [13, 35, 36].
- Short-acting and NPH insulins may be mixed and used immediately or stored for future use.
- Rapid-acting insulin can be mixed with NPH. The mixture should be injected within 15 minutes before a meal [13].
- If administering a dose greater than 100 units, 2 separate injections are required.

Other considerations when injecting diabetes medicines

Volume of medicine

There is no consensus regarding the largest volume of medicine that can be delivered subcutaneously in a single injection. Insulin absorption is prolonged with larger doses of insulin and there is also evidence of increased pain and leakage with higher doses [37]. It may therefore be desirable to divide large doses into smaller doses once the insulin dose reaches over 50 units (0.5ml) [37]. Studies into GLP-1 mimetics typically use smaller volumes for injection and have not focussed on the issue of maximum volume for injection.

Use of concentrated insulin

At the time of publication of this document, concentrated insulin (e.g. U-500 Regular) is not used widely in Australia. Evidence indicates that reducing the volume of injection by use of concentrated insulin can improve insulin absorption, reduce the risk of hypoglycaemia, and reduce glucose variability [38-40]. The use of concentrated insulin has proven beneficial for those with extreme insulin resistance and the obese. Use of concentrated insulin may also reduce the frequency of injections and alleviate concerns about large insulin doses [41]. However the onset is delayed and duration of action extended in concentrated insulin formulations caused by slower diffusion of insulin in higher concentrations [29]. Further research is still recommended as two studies have found a slightly higher dose of concentrated insulin was required to achieve glycaemic targets, possibly due to a slight decrease in bioavailability as a result of longer SC residence time [39, 40]. Diabetes educators should be aware that the onset, peak and duration of action of a concentrated insulin

preparation is different than 100 unit/ml preparations.

Leakage

Leakage of insulin may be reported from the injection site, from the tip of the needle or from the pen due to a poor seal between the needle and pen cartridge following injection. If leakage occurs following injection of medicine it is recommended to increase the time the needle is left *in situ* following injection. The most recent global review of injection technique indicated that less than one in three people with diabetes were waiting ten seconds (or longer) from fully depressing the device plunger to removal from the tissue. However there is agreement in the literature that the percentage of medicine lost to leakage is minimal and not clinically significant relative to overall glycaemic management when the correct IT is used; there is also little difference between different needle lengths [25, 42-47]. Leakage can be minimised by:

- Ensuring the pen needle is correctly attached to the pen device.
- Counting ten seconds after the plunger is fully depressed before removing the needle from the skin allows enough time for the injected medicine to spread out through the tissue plains resulting in tissue expansion and stretch – however by trial and error, patients may learn how long they need to hold the device *insitu* prior to removing.
- Using needles that have a wider inner diameter (extra-thin-walled needles) can reduce dripping from the needle and skin leakage.
- Splitting larger doses of insulin.
- Pressure should be maintain on the thumb button of the pen device until it is withdrawn from the skin to

prevent aspiration of patient tissue into the cartridge [10].

Bleeding and Bruising

People with diabetes and caregivers should be reassured that local bruising and bleeding does not adversely affect the clinical outcomes or the absorption of insulin.

However if bleeding and bruising are frequent or excessive, injection technique should be carefully assessed particularly if anticoagulants or antiplatelet agents are currently prescribed. Needle length does not alter the frequency of bleeding or bruising [10].

Storage of injectable medicines

Injectable medicines should be stored according to the manufacturer's instructions, considering required temperature for used and unused medicine, length of time medicine can be stored when open, requirements for protection from light, and the expiry date of the medicine. Insulin should be discarded if [13]:

- It is past the expiry date on the bottle or if the vial has been open for more than a month.
- The insulin is discoloured, lumps or flakes are seen, or clear insulin has turned cloudy.
- Uniform resuspension cannot be achieved.
- The insulin has been frozen or exposed to high temperatures.

Re-suspension of insulin

Cloudy insulin (isophane and mixed insulin) must be resuspended according to individual manufacturers' instructions before each injection. The recommended method is gentle mixing by tipping (rocking) and rolling the insulin 10-20 times until the mixture is even in colour without any visible particles [48].

Vigorous shaking of the preparation is discouraged because it can affect the kinetics

of the preparation. Correct mixing of insulin suspensions reduces the risk of hypoglycaemia and variability in the action of the injected medicine [49]. In the Insulin Injection Technique Questionnaire Survey, of those using a cloudy insulin 35% did not resuspend their insulin prior to injection, and 44 % rolled their insulin less than 10 times [4].

Reducing painful injections

While most insulin injections are not painful, some individuals complain of pain on injecting. The risk of painful injections can be minimised by [2, 13]:

- Injecting insulin at room temperature rather than when cold.
- If using alcohol to clean the skin (although not necessary), injecting only after this has dried.
- Using a new needle for each injection.
- Using needles of shorter length and smaller diameter.
- Penetrating the skin quickly with the needle.
- Injecting the insulin slowly.
- Not changing the direction of the needle during insertion and withdrawal.

Preparation of the skin

If the site requires cleaning, soap and water is adequate. Use of alcohol swabs to cleanse the skin prior to injection is usually not required and increases the risk of toughening the skin. While cleansing with alcohol does reduce bacterial counts, a study in which 13 participants with type 1 diabetes gave more than 1700 injections without skin preparation over a 3-5 month period found no evidence of local or systemic infections [50].

Disposal of sharps

It is essential that people with diabetes are taught about the safe disposal of their used sharps. Evidence suggests that only 33% of

needle users dispose of their sharps in a designated waste unit [4]. Programs for the disposal of sharps vary between states/territories within Australia as well as within various local council areas and both health care professionals and people with diabetes should be aware of their local regulations. Links to current recommendations for each state and territory can be found in Appendix 3.

Site rotation

Site rotation is important for reducing the risk of lipodystrophy [13]. People with diabetes, their carers and health care professionals should be taught an easy-to-follow structured process for site rotation [2]. The rotation regimen used by the individual with diabetes needs to be documented by the diabetes educator. This should also be encouraged in health care facilities and documentation in the drug chart at time of administration will facilitate rotation of sites when injections are given by different staff.

Rotation within one area rather than rotating to a different area for each injection is recommended [13]. Where different sites are used, variations in absorption between sites must be considered, where applicable [13]. One effective method of rotation is to divide the injection site into quadrants (abdomen) or halves (buttock or thigh), using one quadrant per week and moving clockwise around this area [2]. Injections within each area should be spaced at least 1cm apart [2]. Site rotation grids can be useful for people with diabetes who have difficulty remembering where they have injected.



Angle of injection and use of lifted skinfold

Angle of injection

The angle of insertion of the needle used for injection should be determined according to the needle length, injection site and anticipated thickness of SC tissue, and use of a skinfold lift [2, 14]. Needles 8mm or longer should usually be inserted at 45 degrees with a skinfold to reduce the risk of IM injection [2, 14]. Shorter needles can usually be injected at 90 degrees in adults, however for children, slim adults and when injecting into the arms or thigh, a 45 degree angle and/or lifted skinfold may be required to avoid IM injections with 5mm and 6mm needles. A 4mm needle can be injected at 90 degrees in most cases [2, 14].

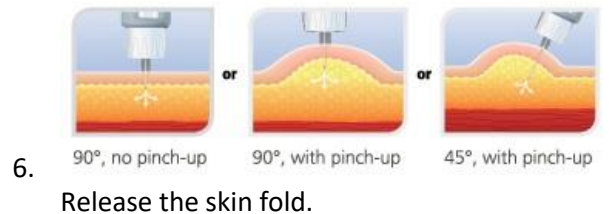
Use of lifted skin fold

The purpose of using a lifted skin fold is to reduce the risk of IM injection by increasing the space between the skin and muscle fascia [14]. The decision to use a lifted skin fold should be assessed individually, taking into account the likely composition of skin and subcutis relative to needle length, injection site, age, size and body composition [2]. Some individuals (particularly young children and lean adults) may require a lifted skinfold for all injection sites and needle lengths, while for others this will only be needed at injection sites with less SC tissue (e.g. thighs and arms) and with longer (≥ 6 mm) needle lengths [12, 14, 17].

All people injecting diabetes medicines should be taught the correct technique for lifting a skin fold. Two fingers should be used to lift the skin away from the muscle fascia. Ideally this should be the thumb and first or second finger [2].

Technique for lifting a skin fold:

1. Use thumb and index finger (or middle finger) to gently lift (not grab) the skin fold and avoid lifting accompanying muscle.
2. Inject into the raised tissue at 90 degrees.
3. Keep the skin fold raised as the medicine is administered.
4. Hold the needle *in situ* for 10 seconds, or as per the manufacturer's instructions (for insulin pens).
5. Withdraw the needle.



Pinch-up method

✓ DO



Correct pinch-up

✗ DON'T



Incorrect pinch-up

A good pinch-up is performed with only 2 or 3 fingers to avoid taking the muscle from underneath.

Teaching subcutaneous injection technique

People with diabetes, family members, carers and health care professionals require detailed education on SCIT from a diabetes educator which reflects evidence-based practice. Consideration is also needed of the many psychological hurdles the person with diabetes, their family, and carers may face, to commencing insulin treatment [51]. The perception that injections will be painful and anxiety are two major factors that often need to be addressed during education of IT.

Teaching IT is a dynamic process. It requires an individualised approach which takes into account the needs of the person with diabetes and/or their carer. Consideration must be given to multiple factors including:

- The person's readiness and ability to learn.
- The person's anxiety around self-injecting.
- Their understanding of diabetes and the reasons injectable medicines are needed.
- Physical or psychosocial factors affecting their ability to safely inject and the availability of support if needed.
- The learning environment, eg, noise level, the presence of other people, anxieties of the healthcare professional and family members. The more apprehensive the family members are, the greater the pain and anxiety felt by the patient.
- Level of confidence and mastery in performing injections with correct technique.
- The type of device and needle length best suited to the individual.
- Willingness to perform other aspects of diabetes self-management related

to injectable diabetes medicines (e.g. blood glucose monitoring).

- Management and prevention of hypoglycaemia.

Support for commencement of an injectable therapy

Initiation of injectable medicines can be overwhelming for many people. People with type 1 diabetes, including children, adolescents and adults, will be required to commence insulin at the time of diagnosis. Those with type 2 diabetes are likely to have had their condition for some time and are often aware of the need to begin insulin treatment for a period of time prior to its commencement. Healthcare professionals should prepare those with type 2 diabetes for the likely future need for insulin treatment, explaining the progressive nature of the condition and making it clear that insulin treatment is not a sign of failure in managing their diabetes [2].

People of any age can struggle with injections and may require support and assistance to develop the skills required for improved diabetes management. Others may need support on an ongoing basis to achieve the required glycaemic management.

Recommendations to support the education process include [10, 49]:

- Show empathy by addressing patients' emotional concerns first by exploring worries and barriers to treatment and acknowledging that anxiety is normal when beginning any new medication, especially insulin.
- Distraction techniques or play therapy for children (e.g. injecting into a stuffed animal).
- Cognitive behaviour therapy techniques for older children (e.g. guided imagery, incentive scheduling).

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- Health care professionals or parents/carers demonstrating and self-injecting saline to help alleviate anxiety.
- Always using positive language to discuss injection of diabetes medicines. It is important to explain that insulin is not a punishment or failure and that improving blood glucose levels will make them feel better.
- Allowing the person with diabetes to be open and honest regarding their feelings and emotions towards injections, including their frustrations and struggles.
- Include caregivers and family members in the planning and education of the patient and tailor the therapeutic needs of the individual.
- Considering that pen therapy may have psychological advantages over syringe therapy.
- Understanding that children have a lower pain threshold than adults, and therefore asking questions regarding pain at each diabetes education review.
- Referral to a psychologist for input if the person with diabetes has significant fear around injections. Consider using devices that hide the needle.
- Fear and anxiety may be substantially reduced by having the person with diabetes or their care giver by having a 'dry run', placing the needle under the skin but not delivering any medication.
- Use of insulin ports may help to reduce anxiety and fear of injections and its associated pain.

Where other carers are involved in the administration of insulin, their involvement in the education process is essential. They should be offered the same education as the person with diabetes and this also requires documented.

Examples of those who may be involved in the administration of an injectable medicine include:

- Family (spouse, children, partners).
- Health care professionals (diabetes educators, general practitioners, practice nurses, domiciliary nurses and community care workers).

Key topics for education

Research has shown that people with diabetes do not always receive education about the injection of diabetes medications, and when they do, not all essential topics are covered [3, 4]. In the 2008-2009 Insulin Injection Technique Questionnaire survey, 25% of participants reported wanting more education regarding IT [4]. While there was some variation between countries, many participants did not recall a number of key topics being adequately covered during their education and training [4]. An earlier study revealed almost 70% were wanting to learn more about insulin IT [3].

Education in correct IT should cover the following essential topics [2]:

- The injection regimen including the timing and action of prescribed medicines and dose(s) required.
- The choice, and training in use of insulin pen device and/or syringe
 - Assembly of the device including loading of insulin cartridge if applicable
 - Preparation of the device for injection, including attaching pen needle and priming
 - Drawing up of insulin for syringes
- Choice of injection site(s) and importance of site rotation. Note that different sites can illicit different rates of insulin absorption.
- Care and self-examination of injection sites.
- Choice of optimal needle length. The recommended needle length should be recorded for the person with diabetes or carer to eliminate confusion when obtaining supplies from NDSS outlets.
- The importance of single use of needles and syringes.
- IT including angle of injection and use of a lifted skin fold, where required.
- Injection complications and how to avoid these.
- Storage of injectable medicines according to the manufacturers' instructions.
- Safe disposal of sharps.
- Preparation of skin prior to injecting. Hands should be washed prior to preparing the device and injecting.
- Structured self-blood glucose monitoring, including appropriate frequency and timing in relation to injection regimen and documentation in a diary/logbook or meter download.
- Hypoglycaemia, including symptoms, prevention and treatment.
- Where required, discussion of the considerations for flying and travelling when taking injectable medicines.
- Sick day management.

Evaluation of injection technique

SCIT requires assessment by qualified and experienced healthcare professionals (e.g. a diabetes educator or endocrinologist) at least annually and ideally at each visit [2]. Review and documentation of injection or infusion insertion technique is pivotal to best practice. Studies have demonstrated that after 12 months the theoretical and practical information taught when initiating injections is not retained. Practical knowledge is more likely to be retained than theoretical knowledge [52]. One study found a significant decrease in glycosylated haemoglobin (HbA1c) in individuals with insulin-treated diabetes who underwent re-education in IT once a month for 4 months. Those who had a poor understanding of IT initially had a higher HbA1c and experienced the greatest reductions in HbA1c with re-education [53].

Review of injection/insertion sites

Along with revision of IT, review of injection sites should occur at least annually and preferably at every diabetes visit [2]. The assessment should include the visual inspection and palpation of injection sites to check for problems related to injections, choice of sites and use of sites [2]. This not only enables the healthcare professional to discover and address injection site problems, but also reinforces to the person with diabetes the importance of correct IT to avoid such problems [4]. Of concern, in the 2014–2015 Insulin Injection Technique Questionnaire survey, 39% of participants could never remember having their injection sites checked [9].

Variable blood glucose levels without obvious explanation should provide the catalyst for sound clinical enquiry to review IT and sites.

Documenting education and evaluation of injection/insertion technique

Teaching of IT and regular review of IT and sites of injection requires documentation reflecting evidence-based recommendations

The entire process of education, including knowledge and competency, must be documented including regular review and assessment of any pre-existing knowledge and self-care practices related to IT [2]. Where family members, carers or other health care professionals are involved in the process, these details should also be recorded.

Documentation should include:

- Understanding of insulin action and the timing of injections.
- Recommended site(s) for injection.
- Recommended site rotation patterns.
- The needle length recommended.
- The angle of insertion recommended.
- Whether use of lifted skin fold is required.
- Demonstration of correct device assembly, following manufacturer's instructions for the device.
- Demonstration of IT.
- Correct dose selection.
- Evidence of damage to injection sites (lipohypertrophy or lipoatrophy), with a description of the size and location of damage, and advice on avoiding these areas for injection.
- Additional issues/barriers to correct IT including physical deficits, psychosocial issues.

Continuous subcutaneous insulin infusion (CSII)

The uptake of continuous subcutaneous insulin infusion (CSII) is increasing in the management of diabetes. The same aims of administering insulin via SC tissue exist for CSII as does an insulin pen device or syringe. Similar criteria for choosing needle length for pen needles should apply for choosing optimal insulin infusion set cannula length. Using fluoroscopy and MRI, Bolick identified that insulin infusion cannula measuring 9mm or more could increase the risk of intramuscular insertion, particularly in body areas of reduced adipose tissue such as the back of the arm or the thigh [54].

Recommendations [10]:

- Cannulation sites should be changed every 48 – 72 hours.
- All people using CSII should be taught to rotate infusion sites along the same principles as people using pen devices and syringes.
- Use of the shortest needle/cannula available should be considered in line with the same principles of people with diabetes using multiple daily injections in order to minimise risk of IM infusion.
- Young children and very thin individuals may need to insert into a lifted skinfold to avoid IM insertion of the cannula.
- The smallest diameter needle/cannula should be considered to reduce pain and occurrence of insertion failure.
- Angled insertion should be considered in patients who experience infusion site complications using a 90 degree insertion technique. Individuals who are lean, muscular or very active have a higher probability of the cannula being dislodged and may benefit from angled (30 – 45 degree) insertion of infusion set.
- Use of alternate infusion sets, tapes or skin barriers should be considered if hypersensitive reactions occur to the cannula material or adhesive.
- Unexplained glucose variability that includes frequent hypo/hyperglycaemia should have their infusion sites checked for LH, nodules, scarring, inflammation or other skin and SC conditions that could affect insulin flow or absorption.
- All people using CSII should have their infusion sites checked regularly (at least annually) for LH by a health care professional.
- If LH is suspected, the individual should be instructed to stop infusing into these lesions and to insert the cannula into healthy tissue.
- Silent occlusion or interruption of insulin flow should be suspected in any person with unexplained glucose variability, unexplained hyperglycaemia, or frequent hypo/hyperglycaemia. If silent occlusion is suspected, an alternative cannula may need to be considered.
- Patients who experience difficulty inserting their infusion sets manually may benefit using a mechanical insertion device.
- Women who become pregnant may need to adjust the type of infusion sets used, infusion site locations and frequency of site changes.

Problems with injection sites

Lipodystrophy

Lipodystrophy is one of the most common complications of SC insulin injection and may present as either lipoatrophy (LA) or lipohypertrophy (LH) [1].

LA is a breakdown (atrophy) of the subcutaneous fat tissue. It is thought to be immunological in nature and probably results from impurities or other components in some insulin preparations [1]. Due to the availability of purified human and analogue insulins, it is now less commonly seen, estimated to affect only 1-2% of those injecting insulin [1].

LH is an area of thickened SC tissue which may be hard or scar like, or soft like a rubber ball [2]. Detection requires both visualisation and palpation of injection sites, as some lesions can be more easily felt than seen [2]. LH is associated with repeated injection into the same sites, poor site rotation and reuse of needles, and incidence is increased with duration of diabetes, duration of insulin use and number of injections per day [1-4]. Unlike LA, LH is commonly seen, with studies showing between 29 and 64% of insulin users being affected [1, 3-5]

Injecting into LH-affected sites may lead to greater variability in blood glucose levels due to delayed or erratic insulin absorption [2]. One observational study of 430 insulin users found a greater glucose variability (49% vs 7%), increased rates of unexplained hypoglycaemia (39% vs 6%) and higher total daily insulin needs (15 IU) in those with LH compared to those without [1]. These results were further supported by a recent crossover study which showed large reductions in insulin uptake, greater variability of insulin uptake and significant hyperglycaemia when injecting into LH-affected sites [55]. These studies verify the findings of a number of

previous studies, although one small clinical trial (N=8) failed to show a significant impact on glycaemic control of injecting into areas of LH versus unaffected areas [56].

Several studies have shown a relationship between site rotation and needle re-use and the presence of LH [1, 3-5]. The importance of these key aspects are highlighted in the study by Blanco et al, in which only 5% of those with correct rotation technique were found to have LH, while 98% of those with LH either did not rotate or rotated incorrectly [1]. There was also a trend towards more LH the more times a needle was reused, which was particularly noticeable when needles were used more than 5 times [1].

Signs of lipohypertrophy include:

- Variable blood glucose levels and hyperglycaemia that does not appear to be explained by factors such as dietary intake, insulin dosing, stress, infection, or use of certain medicines known to increase blood glucose levels.
- Unexplained hypoglycaemia.
- Upon inspection and palpation, a thickened rubbery lesion/nodule that appears in the SC tissue of injection sites.
- Sites which cannot be tightly pinched.

Monitoring for lipodystrophy:

- Visually inspect and palpate injection sites for nodules. Palpation is ideally performed with the patient lying down and on bare skin, however if not possible, it is acceptable with the patient sitting or standing, and being partially clothed.
- Look for multiple needle pricks from injections administered over a small area.
- Ask about the frequency and method of site rotation and reuse of needles.

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- Inspect sites for signs of atrophied or hypertrophied skin at least annually and ideally at each visit. If LH is detected, sites require visual inspection and palpation at each visit.
- Be aware that longer duration of diabetes and insulin use, as well as the frequency of injecting, are associated with a higher risk of LH.
- Documentation should also include location and size of LH and LA. Using a texta, two ink marks at the extreme edges of the affected area can be made to allow for accurate measurement and ongoing future assessment. Clinical photography stored on the client's medical record is also valuable.



Management of lipodystrophy:

- Rest affected sites until tissue changes have returned to normal. This can take months to years [2].
- The person administering the injectable medicines should firstly gently palpate the desired injection area, to identify and thus avoid injecting into areas of lipodystrophy.
- If changing from an affected site, doses of insulin need to be reviewed prior to administration in the new site. Change in insulin needs vary from one individual to another and should be guided by frequent blood glucose monitoring. Dose reductions of 20% are commonly recommended but in more serious incidents may require a 50% insulin dose reduction when changing to a non-affected site [2, 57].

Prevention of lipodystrophy:

The risk of developing lipodystrophy can be reduced by teaching people with diabetes and/or their family member or carers to [2]:

- Rotate injection sites using an easy-to-follow structured process.
- Use a new needle for each injection.
- Inspect their own injection sites and know how to detect LH.

Problems with injection technique

Intramuscular (IM) injections

Researchers have long sought evidence regarding the ideal needle length for SC injections. It has been noted that injections into the IM tissue hasten the absorption of injected medicine by up to 50% due to the vascular nature of muscular tissue, and/or as a result of exercising the relevant muscle tissue [18, 56]. Studies with insulin showed an increased rate of absorption with IM injection and this is thought to increase the risk and severity of hypoglycaemia [19, 21, 59, 60].

Problems caused by IM injection of insulin:

- Hypoglycaemia with rapid onset and/or longer duration.
- Variable insulin uptake and duration - bio-availability of insulin can be double the expected time and duration of action, leading to faster onset and shorter duration of action.
- Unwanted fluctuations in metabolic control.
- Variable insulin absorption between injections.

Clinical Signs of IM injection of insulin:

- Pain occurring whilst injecting.
- Unexplained hypoglycaemia, often in the person who is slim and complains of pain on injection.
- Variable blood glucose levels.
- Bleeding.
- Bruising.

Prevention of IM injection of insulin:

- Inject into the abdomen or buttocks.
- Avoid sites with little SC tissue such as arms and thighs.
- Consider the use of different techniques according to sites chosen including:
 - shorter needle lengths
 - lifted skin fold

- insertion of the needle at 45 degree angle.

Intra-dermal (ID) Injections

Much of the research on the ID administration of insulin is with the use of micro-needles for developing alternative methods of insulin administration including an insulin patch. Micro-needles have hollow cannulae with total lengths of less than 2 mm and are commonly used in dermatology settings. Studies of ID insulin administration using micro-needles show increased bioavailability, more rapid absorption and reduced post-prandial glucose levels [61-64]. However insulin administration using micro-needles is not the same as an ID injection made accidentally using an incorrect SC technique. There is some evidence that this may lead to insulin leakage, higher dose requirements, and increased pain caused by direct nerve stimulation. More rapid absorption of insulin may lead to hypoglycaemia. There have also been case studies reporting localised site reactions, attributed to immunological response [65].

Considerations for Health Care Settings and Carers

People with diabetes may require additional support in administering their injectable diabetes medicines. This can occur in a range of settings that include their own home, school, camp settings, aged and disability care accommodation and support services and during hospitalisation. Those providing this support may include family members or close friends, paid carers, support workers, enrolled and registered nurses.

Organisations providing this support require comprehensive policies and procedures to guide staff in their responsibilities and the processes they are to follow in administering injectable diabetes medications. It is recommended that comprehensive training

and evaluation of health and disability care workers knowledge and skills in this area be undertaken by diabetes educators. This includes the development and ongoing review of appropriate policies and procedures for health care facilities and education programs that are implemented and evaluated to ensure effective care.

Organisations providing support with injectable medicines to individuals with diabetes should have:

- A comprehensive education program.
- Injection technique skills training and evaluation of knowledge and skills.
- Education on safe sharps disposal and occupational health and safety.
- Education on identification, treatment and prevention of hypoglycaemia.
- An individualised written health care plan to guide the expected care for each individual with diabetes being supported, which includes specific requirements such as needle length, administration procedures and additional monitoring required.

Safety considerations for injectable diabetes medicines include:

- Syringes and pen needles are for single use only.
- Pen devices and cartridges or vials are for single person use only, and must never be shared due to the risk of cross contamination [34]. This applies even if a new needle is used for each injection.
- Safe disposal of sharps should be taught to patients and caregivers from the beginning of injection or infusion therapy and be regularly reinforced. Potential adverse events of needle stick injuries should be emphasised to the person and family/caregivers i.e. safe sharps disposal.
- Needle stick injuries are common among health care professionals [66]. One study of nurses in an Australian hospital found that insulin needles were the second most common causative device resulting in needle stick injuries [67]. Recapping of needles should be discouraged and only undertaken by the person with diabetes. Healthcare services should encourage reporting of needle stick injuries and near misses and should establish a blame-free culture. Review of all needle stick injuries and near misses should take place regularly to assess educational needs and allow for policy change.
- Organisations are responsible for protecting the person with diabetes, other individuals being supported within the organisation, the public and staff from blood borne pathogens by ensuring their specific infection control policies reflect current evidence and best practice. Employees require access to training that supports best practice, and

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consideration should be given to the use of insulin pen needles and syringes with inbuilt safety mechanisms [66]. Campaigns to increase needle stick injury awareness should be conducted regularly.

- If the person with diabetes is unable to remove the pen device needle without help, health care professionals should instead administer injections using pen needles and syringes with inbuilt safety mechanisms [2, 66].
- To minimise the risk of a needle stick injury through a skin fold, the use of a

4 or 5mm pen needle or 6 or 8mm insulin syringe needle without a skinfold is recommended. If a lifted skinfold is used, the finger and thumb are approximately 25mm apart and the injection should occur in the centre of the fold.

- Pen device needles and syringes must be disposed of into an approved sharps container and be easily accessible at the point of care or beside the patient.

Appendix 1: Checklist for Education of Initiation of Injectible Therapies

| | |
|-------------------------|--|
| Date: | |
| Name of patient/client: | |
| Name of educator: | |

| | |
|---|--|
| <input type="checkbox"/> Initial education on injection technique | <input type="checkbox"/> Review of injection technique |
|---|--|

| Task | Note |
|---|------|
| <input type="checkbox"/> Timing and action of prescribed medicines | |
| <input type="checkbox"/> Dose of medicine(s) required | |
| <input type="checkbox"/> Assembly of the pen device including loading insulin cartridge if applicable | |
| <input type="checkbox"/> Preparation of the device for injection, including attaching pen needle and priming | |
| <input type="checkbox"/> Drawing up of insulin for syringes | |
| <input type="checkbox"/> Choice of injection site(s) specify | |
| <input type="checkbox"/> Importance of and guidelines for site rotation | |
| <input type="checkbox"/> Preparation of skin prior to injecting | |
| <input type="checkbox"/> Importance of washing hands prior to preparing the device and injecting | |
| <input type="checkbox"/> Choice of optimal needle length | |
| <input type="checkbox"/> Recommended needle length recorded for obtaining supplies from NDSS outlets | |
| <input type="checkbox"/> Importance of single use of needles and syringe | |
| <input type="checkbox"/> Injection technique including angle of injection and use of a lifted skin fold, where required | |
| <input type="checkbox"/> Storage of injectable medicines according to the manufacturers' instructions | |
| <input type="checkbox"/> When to discard medicines | |
| <input type="checkbox"/> Safe disposal of sharps | |
| <input type="checkbox"/> SBGM, including appropriate frequency and timing in relation to injection regimen | |
| <input type="checkbox"/> Hypoglycaemia, including symptoms, prevention and treatment. | |
| <input type="checkbox"/> Check injection sites for signs of lipohypertrophy (LH) | |
| <input type="checkbox"/> Advice on avoiding injecting in areas of LH, if applicable | |
| <input type="checkbox"/> Other | |

Appendix 2: Sharps Disposal

Programs for disposal of sharps vary between states/territories within Australia as well as within the various local council areas. Links to current recommendations for each state and territory can be found below.

| | |
|------------|---|
| NSW | https://www.safesharps.org.au/ |
| QLD | http://www.health.qld.gov.au/qnsp/ |
| VIC | http://www.health.vic.gov.au/aod/about/needle.htm |
| SA | http://www.diabetessa.com.au/health-professionals/do-you-know-how-to-dispose-of-your-sharps.html |
| WA | http://www.public.health.wa.gov.au/3/463/2/safe_disposal_of_needles_and_syringes.pm |
| ACT | http://www.act.gov.au/browse/topics/health/needle-and-syringe-disposal |
| TAS | http://www.dhhs.tas.gov.au/_data/assets/pdf_file/0017/109232/Safe_Sharps_Disposal_Draft_1.0CH.pdf |
| NT | http://www.ntahc.org.au/programs/needle-a-syringe-program |

Appendix 3: Resources

Astra Zeneca

Contact: 1800 805 342

- Byetta Clinicians Guide
- Bydureon Pen Getting Started (Booklet)
- Bydureon Pen Patient Booklet
- Bydureon Pen Instruction Video <https://www.azhealth.com.au/> (Registration required)

BD Diabetes Care

Contact: 1800 656 100

- Think...about injection rotation (Flyer – tear of pad)
- Starting Injectable Diabetes Medication (Booklet)
- Needle reuse and lipohypertrophy (Poster)

Lilly Diabetes

Contact: 1800 023 764

- Lilly Insulin Range (Flyer – tear-off pad)
- KwikPen: A how-to-use guide (Flyer – tear off pad)
- Humapen Savvio Instructions for Use (Flyer – tear off pad)
- Starting premixed insulin therapy for Humalog Mix 25 or Humalog Mix 50 (Booklet)
- Starting Humalog booklet
- Know your insulin resources, poster and flip chart

Novo Nordisk

Contact 1800 668 626

- Product information can be found at www.novonordisk.com.au
- Changing Diabetes Website - <https://www.changingdiabetes.com.au/resources> (information guides, videos and other resources)
- Novo Nordisk Diabetes Treatment Range (Flyer – tear off pad)
- Novofine Patient User Guide (Folded brochure)
- FlexPen How to Use sheet (Flyer)
- NovoPen Echo How to Use sheet (Flyer)
- NovoPen 4 How to Use sheet (Flyer)
- Novorapid Patient User Guide (Booklet)
- Levemir Patient User Guide (Booklet)
- Victoza Patient User Guide (Booklet)

Sanofi

Contact: 1800 818 806

- Sanofi Diabetes & Cardiovascular Website www.CVDiabetesHub.com.au (useful resources)
- Apidra SoloSTAR® Instructions for Use Leaflet
- Lantus SoloSTAR® Instructions for Use Leaflet
- JuniorSTAR® User Guide
- SoloSTAR® & ClikSTAR® Guide
- Toujeo “How to inject video” <http://videos.sanofi.com.au/howtoinjectvideo>
- Toujeo online education resources <https://www.toujeo.com.au/login>
- Toujeo SoloSTAR® Instructions for Use Leaflet

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