



**Queensland
Government**

**Centre for Palliative Care
Research and Education**

Queensland Health


Guidelines for

Subcutaneous Infusion Device Management in Palliative Care

Second Edition

**Funded by the Australian Government
Department of Health and Ageing**

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First published in 2006 as
'Guidelines for syringe driver management in palliative care'.
Reprinted 2007

Second edition 2010

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ISBN 978-1-921707-07-0

Printed by Herston Multimedia Unit

Guidelines for Subcutaneous Infusion Device Management in Palliative Care - Second Edition

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Disclaimer

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Aims

These guidelines are intended to provide clinicians and palliative care services with guidelines to inform practice, the development of policy and procedures, and associated training and education programs in relation to portable subcutaneous infusion device management.

Scope

Component One:

Literature Review & Development of Clinical Practice Guidelines

This revised edition of the 'The Guidelines for Subcutaneous Infusion Device Management in Palliative Care' takes account of the October 2007 withdrawal from sale in Australia of the Graseby syringe driver, a subcutaneous infusion device that was the major focus of the first edition. Information about possible alternatives to the Graseby is offered in this document, as well as on the Palliative Care Australia¹ and CPCRE² websites. However because the Graseby syringe driver is still widely used, information relevant to that device will continue to be included in this document.

It should be noted that the Graseby device was withdrawn from the market in a context of concern regarding the level of user error. Many services have now purchased alternative devices. Also important in the Graseby's removal from sale was the Therapeutic Goods Administration's aim of having Australia align with international best practice regarding the licensing and use of medical devices. While the distributors of the Graseby within Australia are required by law to continue to service it until October 2012, it is not known whether they will continue to do so beyond that date. For all these reasons, continued use of Graseby devices could be problematic.

A literature review was undertaken in 2009 to identify current evidence regarding subcutaneous infusion device management and update the previous review.

¹<http://www.palliativecare.org.au>

²<http://www.health.qld.gov.au/cpcrc>

The CINAHL and PubMed databases were searched for the purposes of the review (CINAHL, Medline, PsycArticles and PsycInfo were searched for the original review). The review of the literature was again limited to adult patients and the English language, and covered a ten year period from 1999-2009 (original review 1995-2005). Search terms originally included: syringe drivers, subcutaneous infusions, end-of-life care, Graseby and palliative care. For the 2009 review, the original search terms were used as well as: Alaris AD; Niki T34; McKinley T34; and CADD. The Alaris AD has since been withdrawn from the Australian market. An internet search using the Google search engine was also undertaken using the same search terms. This identified relevant websites relating to syringe driver management.

The literature was rated for its level of evidence using the Joanna Briggs Levels of Evidence chart (Appendix A). All abstracts identified during the search were assessed by two reviewers, and articles were retrieved for all papers that were identified by the project officer as being of relevance to the review topic.

In addition, clinical notes, websites and books about subcutaneous infusion devices identified as relevant to the project were examined. A total of 43 published and unpublished papers were considered for inclusion in the original guidelines; 24 were included. A further 14 papers are included in this second edition.

A summary of the literature used to develop these guidelines is presented in Appendix B.

Component Two:

Multidisciplinary Expert Review of Draft Guidelines

An Expert Multidisciplinary Review Panel consisting of individuals working in relevant clinical areas was assembled. Panel members included palliative care nurses, physicians, a Congress of Aboriginal and Torres Strait Islander Nurses representative and a pharmacist with expertise in palliative care medications. The Multidisciplinary Review Panel was asked to review the evidence available and the draft guidelines and to provide feedback on their quality and relevance. The Review Panel also provided comments on the format for presenting, disseminating and promoting uptake of the guidelines.

Component Three:

Dissemination of Final Guidelines

The guidelines have been prepared as a formal report providing a detailed summary of the evidence. They are also available on the CPCRE web site³ to enhance accessibility.

³<http://www.health.qld.gov.au/cpcre>

Guidelines Summary

Section One: The patient experience

- Health care professionals should consider a subcutaneous infusion device as a means of providing symptom control via subcutaneous infusion of drugs to treat unrelieved pain and other distressing symptoms when other routes are inappropriate or no longer effective²;
- Some patients may view infusion devices as an invasion of their body privacy, and may perceive the device as an indicator of a poor prognosis.³

Section Two: Equipment guidelines and principles

- The most common infusion devices in clinical use in Australia, until their withdrawal from sale in 2007, were the SIMS Graseby® MS16A and the MS26³⁻⁵;
- Alternatives to the Graseby include the Niki T34®, CADD Legacy®, WalkMed 350LX® and GemStar® infusion devices;
- For further information about alternative infusion devices, see Palliative Care Australia's 'Syringe driver report' at www.palliativecare.org.au
- The organisation's protocol regarding the preparation and set-up for changing the device should always be used to guide practice;
- Subcutaneous infusion devices have traditionally been used to deliver medications over a 24 hour period to reduce the risk of errors in setting up the Graseby,⁵⁻⁸; microbiological stability and physical and chemical compatibility data most commonly relate to a 24 hour period and it is for this reason that a 24 hour infusion period is still recommended³²;

- Use only one type of infusion device in each setting to prevent confusion which may lead to errors^{6,8,10,18};
- Where more than one device is used in a particular setting, it is recommended the service provider implement strategies to manage potential risks regarding the need for staff to be competent with a number of devices;
- Where a syringe is necessary, a Luer-Lok® syringe should be used to prevent risk of disconnection^{6,9}; 20 ml is the recommended minimum syringe size¹¹ to reduce the risk of incompatibility and adverse site reactions and minimise the effect of priming the line;
- The same brand of syringe should be used each time to minimise errors in setting up the device and calculating the rate^{6,9} (Graseby only);
- The syringe should be measured every time the device is set up, as different brands of syringes have different diameters and lengths⁹ (Graseby only);
- An aseptic technique should be used when preparing and setting up the infusion⁷;
- A minimum volume extension set should be used to minimise dead-space in the line¹¹;
- When changing the extension set and/or cannula, prime the line after drawing up the prescribed medications.^{2,7-9,11} After priming the line, measure the syringe and document the line change, syringe volume and the time the syringe is calculated to finish;
- Teflon® or Vialon® cannulas are associated with less risk of site inflammation than metal butterfly needles.^{8,9,11,12,26,27}

Section Three: The selection, preparation and maintenance of the site

- General principles for appropriate site selection include:
 - ▶ Using an area with a good depth of subcutaneous fat;
 - ▶ Using a site that is not near a joint;
 - ▶ Selecting a site that is easily accessible such as the chest or the abdomen
- Select and use sites on a rotating basis²;
- Site selection will be influenced by whether the patient is ambulatory, agitated and/or distressed;
- The chest or abdomen are the preferred sites⁶, specifically the upper, anterior chest wall above the breast, away from the axilla. If the patient is cachectic, the abdomen is a preferred site⁶;
- When the tubing is placed against the skin, form a loop to prevent dislodgement if the tubing is accidentally pulled⁹. Use a transparent, semi-occlusive dressing to cover the site, as this permits inspection of the site by the caregiver^{8,9};
- The longevity of the site can vary considerably from 1–14 days. Many variables influence the longevity of the site, such as the type of medication and type of cannula used;
- Factors that cause site reactions include the tonicity of the medication, the pH of the solution, infection and prolonged presence of a foreign body.¹²

Section Four: Drugs and diluents

- Anecdotal evidence suggests some clinicians are not adding diluent to medications to be infused subcutaneously. The evidence indicates site longevity is likely to be reduced by such practices^{11,12};
- Subcutaneous infusion devices can be used to deliver drugs to treat a variety of symptoms. Common symptoms include pain, nausea, vomiting, breathlessness, agitation, delirium and ‘noisy breathing’;
- A wide variety of drugs can be used together in different combinations with no clinical evidence of loss of efficacy^{11,13};
- The more drugs that are mixed together, the greater the risk of precipitation and reduced efficacy⁹;
- 2–3 drugs may be mixed for a subcutaneous infusion (occasionally up to 4 drugs^{6,10,11});
- If compatibility is an issue, the use of two infusion devices³ or regular or prn subcutaneous injection should be considered;
- Before mixing any drugs together in a subcutaneous infusion, check for stability information^{3,6,9,11,28,29} and check with hospital pharmacists;
- Use of the boost facility, where available, is not appropriate; breakthrough medication should be used to treat uncontrolled symptoms. A boost dose rarely provides sufficient analgesia to relieve uncontrolled pain, and may lead to overdosing of other drugs being infused^{6,14} such as metoclopramide, an overdose of which could trigger extrapyramidal symptoms such as an oculogyric crisis;
- Normal saline is the most commonly used diluent in Australia¹⁵;
- The use of water for injection has been linked to pain due to its hypotonicity (having a lower osmotic pressure than body fluids), although normal saline may be more likely to cause precipitation¹⁶;
- 5% dextrose is used only occasionally as a diluent⁶, and is not commonly used in Australia.⁸

Section Five: Patient/family education needs

- Patient and family education promotes safety and acceptance of the subcutaneous infusion device as a means to providing improved symptom control¹²;
- Patient and family education includes:
 - ▶ Explanation and education about what the device will do, and its advantages and possible disadvantages;
 - ▶ Safety aspects;
 - ▶ Ways to incorporate a subcutaneous infusion into everyday life;
 - ▶ Troubleshooting guidelines.⁹

Section Six: Patient assessment and troubleshooting guidelines

- When troubleshooting the equipment used in subcutaneous infusions, it is important to understand the usual functioning of the device⁹;
- Ensure that drug calculations are checked according to best practice, legislative requirements and organisational policy and protocols when the infusion device is set-up¹⁷;
- Use only one type of infusion device in each setting to prevent confusion which may lead to errors^{6,8,10,18};
- Where more than one device is used in a particular setting, it is recommended the service provider implement strategies to manage potential risks regarding the need for staff to be competent with a number of devices;
- Ensure that the organisational protocol is followed regarding priming of the line^{2,6-9};
- Ensure that drugs being delivered are compatible^{3,19};

- Ensure that a spare battery, where relevant, is always available^{5,6,8};
- Thorough patient assessment is important when caring for patients with a subcutaneous infusion^{7,12};

Principles to include in patient assessment, recording and documentation include:

- Asking the patient how they feel (or family member/carer, if the patient is unable to comprehend): for example, are their pain and other symptoms controlled? (this should not replace clinical assessment/responsibility);
- Documentation of symptom control and efficacy of interventions;
- Careful inspection of site, at least 4 hourly, for signs of inflammation and site reaction, and documentation of findings¹⁷;
- Careful inspection of syringe volume remaining⁶, at least 4 hourly, and documentation of findings;
- Careful inspection of tubing for patency^{8,9} at least 4 hourly and documentation of findings;
- Site inspection should be performed as part of routine care and includes principles such as checking for: tenderness at the site, presence of a haematoma and leaking at the insertion site.^{3,7,9}

Subcutaneous Infusion Device Guidelines

Background

Subcutaneous infusion devices are commonly used for symptom management in palliative care to treat pain and other distressing symptoms when other routes are inappropriate or ineffective. These devices are power driven devices that deliver medications at a controlled rate, providing symptom control via continuous subcutaneous infusion of drugs. However, their clinical use has evolved rather than being subject to close multiprofessional scrutiny and guideline formation.²⁰

Many of the medications used in subcutaneous infusion devices have narrow margins of error, so any errors that occur during prescription, preparation, administration and documentation of these infusions can result in adverse drug events and present an on-going risk for patient safety.¹⁷

There is evidence that such adverse incidents arise as a result of:

- Errors in drug calculations²⁰;
- Drug incompatibilities and instabilities²⁰;
- Equipment failure (including disconnection)²⁰;
- Incorrect rates of infusion²⁰;
- Inadequate user training^{9,21};
- Inadequate documentation and record keeping²⁰;
- Poor servicing of equipment.^{4,9}

The guidelines presented in this report have been developed in consultation with an Expert Multidisciplinary Review Panel in response to a lack of standardised information about subcutaneous infusion device management in contemporary practice. The guidelines are intended to avoid duplication of information and support primary care and specialist providers in palliative

care who may not use such devices on a regular basis.

The Guidelines are presented in six sections:

- The patient experience;
- Commonly used equipment;
- The selection, preparation and maintenance of the site;
- Drugs and diluents;
- Patient/family education; and
- Patient assessment and troubleshooting guidelines.

SECTION ONE

The patient experience

Although some studies report that subcutaneous infusions are well accepted and can achieve almost 100% compliance amongst people with life limiting illnesses¹², some people may view the device as an invasion of their body privacy, and/or may perceive the device as an indicator of a poor prognosis.³ They may also restrict the person's daily activities.

Subcutaneous infusion devices should be used when it is determined that improved symptom control will result from continuous medication delivery, and that other less invasive routes for administering medication are not possible.²

Summary of the patient experience guidelines

- Health care professionals should consider a subcutaneous infusion of drugs to treat unrelieved pain and other distressing symptoms when other routes are inappropriate or no longer effective²;
- Some patients may view an infusion device as an invasion of their body privacy³;
- Patients and carers may perceive an infusion device as an indicator of a poor prognosis.³

SECTION TWO

Equipment guidelines and principles

Summary Statement

- The most common syringe drivers in clinical use in Australia, until their withdrawal from sale in 2007, were the SIMS Graseby® MS16A and the MS26³⁻⁵;
- Alternatives to the Graseby® include the Niki T34®, CADD Legacy, GemStar and WalkMed 350LX® infusion devices;
- Use only one type of infusion device in each setting to prevent confusion which may lead to errors^{6,8,10,18};
- Where more than one device is used in a particular setting, it is recommended the service provider implement strategies to manage potential risks regarding the need for staff to be competent with a number of devices;
- The organisation's protocol regarding the preparation and set-up for changing the device should always be used to guide practice;
- A Luer-Lok® syringe, where relevant, should be used to prevent risk of disconnection^{6,9}; 20 ml is the recommended minimum size¹¹;
- The same brand of syringe should be used each time to minimise errors in setting up the device and calculating the rate^{6,9} (Graseby® only);
- The syringe should be measured every time the device is set up, as different brands of syringes have different diameters and lengths⁹ (Graseby® only);
- An aseptic technique should be used when preparing and setting up the infusion⁷;
- A minimum volume extension set should be used to minimise dead-space in the line¹¹;
- When changing the extension set and/or cannula, prime the line after

drawing up the prescribed medications in the syringe^{2,7-9,11}; after priming the line, document the line change, syringe volume and the time the syringe is calculated to finish;

- Teflon® or Vialon® cannulas are associated with less risk of site inflammation than metal butterfly needles^{8,9,11,12,26,27};
- Subcutaneous infusion devices have traditionally been used to deliver medications over a 24 hour period to reduce the risk of errors in setting up the Graseby,⁵⁻⁸; microbiological stability and physical and chemical compatibility data most commonly relate to a 24 hour period and it is for this reason that a 24 hour infusion period is still recommended.³²

There are several types of subcutaneous infusion devices available for use in palliative care. It is important to verify the equipment that is used within the specific organisation, as the various infusion devices work quite differently. The most common subcutaneous infusion devices identified in clinical use in Queensland have been the SIMS Graseby® MS16A and the MS26, which are electronic, battery driven syringe drivers. Alternatives to the Graseby include the Niki T34®, CADD Legacy®, GemStar® and WalkMed 350LX® devices.

Further information about the devices can be found on the Palliative Care Australia and CPCRE websites (see page 3).

Management Principles

When setting up the equipment for a subcutaneous infusion, it is important to verify with the individual organisation's protocol regarding the preparation and set-up for changing the device. The management principles are essentially the same for all subcutaneous infusion devices and include:

- Ensure that the patient and the family have received a full explanation of how the infusion device works, and its indications for use⁷;
- The infusion device should be used for the delivery of drugs over a 24 hour period, reducing the risk of errors in setting up the device;

- Employ an aseptic technique when changing the device and resiting the cannula⁷;
- A Luer-Lok® syringe^{6,10,12} is recommended to prevent accidental disconnection of the tubing from the syringe;
- A 20ml syringe is the recommended minimum size to reduce the risk of adverse site reactions and incompatibility, as well as the effect of priming the line¹¹;
- The Niki T34® detects the syringe size and brand; it works with syringes up to 50 ml in volume. An electronic menu guides setting up the infusion;
- The CADD Legacy®, GemStar® and WalkMed® devices do not use a syringe;
- When changing the extension set and/or cannula, prime the line after drawing up the prescribed medications in the syringe. After priming the line, measure the syringe and document the line change and the time the syringe is calculated to finish;
- Consider using a tamper-proof ‘lock-box’⁶ if there is a possibility of the patient or others tampering with the infusion device, or using the boost facility. It is possible that a tamper-proof box is mandatory within an individual organisation as a risk management stipulation;
 - These lockable clear plastic covers have been devised to place over the device to prevent accidental, or intentional, activation of the boost button or tampering with the rate control. They should not be confused with the Perspex cover provided with the Graseby® syringe driver. These covers simply provide protection for the device, but are not ‘tamper proof’.
- For the Graseby, it is the length of the solution within the syringe—not the volume—that will determine the rate, i.e. the syringe driver delivery rate is a measure of distance, not a measure of volume administered;
- It is important to always measure the syringe prior to determining the rate each time a Graseby® syringe driver is set up;

- Regardless of which model Graseby® battery driven device is used, the size and brand of the syringe used is an important variable. Different brands of syringes have different diameters and lengths, which impacts upon the preparation of the medications used. Therefore, care needs to be taken when considering syringe types, because each syringe may have a different barrel length for the same volume⁹, for example:
 - ▶ Terumo® brand 10 ml syringe: 9.4 ml = stroke length of 48 mm;
 - ▶ BD® brand 10 ml syringe: 7.8 ml = stroke length of 48 mm;
 - ▶ Terumo® & BD® brand 20 ml syringe: 15 ml = stroke length of 48 mm;
 - ▶ Terumo® brand 30 ml syringe: 20 ml = stroke length of 48 mm;
 - ▶ BD® brand 30 ml syringe: 18 ml = stroke length of 48 mm.

NB: BD ‘Plastipak’ syringes are a different diameter to other BD syringes, emphasising the importance of measuring the syringe against the scale on the Graseby when using that device, to ensure the volume to be infused is equal to the relevant length e.g. 48mm for a 24 hour infusion at 2mm/hour.

The simplest way to overcome any error in relation to syringe type when using the Graseby is to measure the syringe against the scale on the Graseby every time it is changed.

In the case of the Niki T34® the device itself detects the parameters of the syringe, and seeks confirmation during the setting up phase that the syringe it has detected is the correct one.

Management Guidelines

Table 1: General principles - subcutaneous infusion devices

- Various infusion devices are now available for subcutaneous infusion.
 - Any device should be used according to your organisation's policies and guidelines.
 - With any device, each time a new line is used, prime the line before connecting it to the patient.⁹
 - Devices such as the Niki T34 have a sensor system which automatically detects the size and make of syringe.
 - The Niki T34 detects the syringe size and make and then asks the operator for confirmation.
-
- Use of the boost facility, where available, is not advocated. A boost dose rarely provides sufficient analgesia to relieve uncontrolled pain, and may lead to overdosing of other drugs being infused.⁶
 - The use of prescribed prn (breakthrough) medication is recommended to treat uncontrolled symptoms.¹⁴ Breakthrough medication is defined as extra medication that may be required for symptoms that are not controlled by the medications prescribed for continuous delivery via the subcutaneous infusion device.
-
- Information about specific devices is available as follows:
- Niki T34: www.mckinleymed.co.uk/online-training/ (Step by step online training)
 - CADD Legacy: www.smiths-medical.com
 - GemStar: www.hospira.com
 - WalkMed: www.msa.com.au/ambulatory_drug_infusion_pump
 - Graseby: www.health.qld.gov.au/cpcrc
(General principles from first edition of these Guidelines)

SECTION THREE

The selection, preparation and maintenance of the site

Summary Statement

- General principles for appropriate site selection include⁶:
 - ▶ Assessing whether the patient is ambulatory, agitated and/or distressed;
 - ▶ Using an area with a good depth of subcutaneous fat;
 - ▶ Using a site that is not near a joint;
 - ▶ Selecting a site that is easily accessible—such as the chest or the abdomen;
- The longevity of the site can vary considerably from 1–14 days. Many variables influence the longevity of the site, such as the type of medication and type of cannula/needle used;
- Select and use sites on a rotating basis²;
- When the tubing is placed against the skin, form a loop to prevent dislodgement if the tubing is accidentally pulled⁹. Use a transparent, semiocclusive dressing to cover the site, as this permits inspection of the site by caregivers^{8,9};
- Factors that cause site reactions include: the tonicity (concentration) of the medication, the pH of the solution, infection, and prolonged presence of a foreign body (the cannula)¹²;
- The chest or abdomen are the preferred sites⁶, specifically the upper, anterior chest wall above the breast, away from the axilla. If the patient is cachectic, the abdomen is a preferred site⁶;
- The site should be inspected regularly. Four hourly inspection is recommended, or more frequently if indicated, to identify early and reduce the risk of site related complications;

- Site inspection for adverse reactions or other issues should be performed as part of routine care. Signs and symptoms to assess for include:
 - ▶ tenderness at the site;
 - ▶ presence of a haematoma;
 - ▶ leaking at the insertion site.^{3,7,9}

Site problems will cause the patient discomfort and may interfere with drug absorption, thus compromising effective symptom control. The selection of an appropriate site for subcutaneous infusion can help to avoid site problems, and minimise restrictions on the patient's normal functioning.

Site selection:

General principles for appropriate site selection include¹¹:

- Use an area with good depth of subcutaneous fat;
- Use a site that is not near a joint;
- Select a site that is easily accessible such as the chest or abdomen.

Site selection will depend upon whether the patient is ambulatory, agitated and/or distressed. The chest or abdomen is generally the preferred site⁶, specifically the upper, anterior chest wall above the breast, but away from the axilla.¹¹ This site is preferred because it is easily accessible, rarely oedematous, and permits easy inspection by the caregiver.¹¹ If the patient is cachectic, the abdomen may be a more appropriate site. The upper arm can be used, but it makes it difficult for the patient to lie on their side and may lead to problems such as bruising.⁶ If the patient is distressed or agitated, using the area around the scapula may be useful to prevent dislodgement.^{6,9} The insertion technique is summarised in Table 2.

Inappropriate site selection includes¹¹:

- Lymphoedematous areas;
- Areas where the skin is broken;
- Skin sites that have recently been irradiated;
- Sites of infection;
- Bony prominences;
- In close proximity to a joint;
- Sites of tumour;
- Skin folds;
- Inflamed skin areas;
- Wherever ascites or pitting oedema are present;
- Where scarring is present;
- Areas where lymphatic drainage may be compromised², for example in women who have had a mastectomy.

Reducing site irritation:

Many factors contribute to site reactions such as the tonicity (concentration) of the medication, the pH of the solution, infection and prolonged presence of a foreign body (the cannula).¹² Specific drugs used in palliative care that may cause site irritation include cyclizine^{6,10}, levomepromazine, methadone, promethazine, morphine tartrate and ketamine.¹¹ Techniques that may be considered in consultation with the treating physician to minimise site irritation include:

- Diluting the medications by using a larger syringe size⁶;
- Using normal saline (0.9%) if applicable, instead of water for injection⁶;

- Adding 1 mg of dexamethasone to the syringe.⁹ One Australian trial found that the addition of 1 mg of dexamethasone to syringe drivers can significantly extend the longevity of the subcutaneous infusion site²²;
- The use of a Teflon® or Vialon® cannula reduces site inflammation.^{6,8,26,27}

In the context of subcutaneous fluid administration for rehydration, a UK study suggests absorption is increased by injection of 1500 units of hyaluronidase into the site prior to the infusion commencing, if the skin is not already irritated.⁹ The injection is given once per site, not daily.⁶ This low dose of hyaluronidase is contraindicated in patients with asthma.⁹

The longevity of the site can vary considerably from 1–14 days. Many variables influence the longevity of the site, such as the type of medication and cannula/needle used. Rather than relying on a time-frame for resiting the infusion, the onset of a site reaction should dictate this practice.⁹

Site inspection

Meticulous site inspection is integral to early identification and prevention of site related complications, and should be performed as part of routine care.^{3,7,9} Any site problems can potentially cause patient discomfort. They also interfere with drug absorption and compromise effective symptom control. When inspecting the site, check for:

- Tenderness or hardness at the site;
- Presence of a haematoma;
- Leakage at the insertion site;
- Swelling—a sterile abscess can occur at the insertion site, causing local tissue irritation⁷;

- Erythema (redness);
- The presence of blood in the tubing;
- Displacement of the cannula.¹¹

In addition to checking the site regularly (4 hourly is recommended), other important patient checks include:

- Asking the patient how they feel (or family member/carer, if the patient is unable to comprehend): are their pain and other symptoms controlled?
- **Ensuring that the infusion device is working e.g.**
 - **Niki T34: LED light flashes green;**
 - **GemStar: arrows progress across the screen;**
 - **WalkMed: squares progress along the screen which states 'infusing';**
 - **Graseby: light flashes green and a 'whirring' sound is heard;**
- Checking the volume remaining in the syringe, and that the device is running to time;
- Ensuring there are no leakages, and that the connections to the syringe and the cannula are firm.

Management Guidelines

Table 2: Site preparation and insertion

The BD Saf-T-Intima® has a Vialon® cannula, and is used commonly in clinical practice in Australia.^{11,26,27}

It is important to refer to the protocols for site preparation and insertion used within individual organisations.

Principles for preparing the site and inserting the cannula include:

- An aseptic technique must be employed, as many patients who require a subcutaneous infusion are immuno-compromised. Ensure hands are washed thoroughly⁷;
- In consultation with the patient and family, select a suitable site.⁷ Choose the site using the guidelines (see preferred sites);
- Select and use sites on a rotating basis²;
- Prepare the skin using an antiseptic with residual activity, such as a solution containing 0.5% to 2% chlorhexidine gluconate, and wait for the skin to dry³¹;
- The point of the cannula should be inserted just beneath the epidermis. For thin people the angle of the cannula on insertion may need to be less (30 degrees) than for a person with more subcutaneous tissue (45 degrees). A deeper infusion may prolong the life of the infusion site.

To insert:

- Grasp the skin firmly to elevate the subcutaneous tissue. Insert the cannula and release the skin;

- Remove the stylet if using a BD Saf-T-Intima® and take care to hold the device in situ when removing the stylet so that the entire device is not accidentally removed from the patient;
- **Note:** If a metal needle is used, place the bevel of the needle downwards to deliver the drugs more deeply into the skin, and minimise irritation;
- The extension tubing is changed when the cannula is changed.
- When the tubing is placed against the skin, form a loop to prevent dislodgement if the tubing is accidentally pulled.⁹ Use a transparent, semi-occlusive dressing to cover the site, as this permits inspection of the site by the caregiver^{8,9};
- Where relevant, place the syringe in the syringe driver;
- Record and document that the infusion has been commenced as per local drug administration policies.

SECTION FOUR

Drugs and Diluents

Summary Statement

- Subcutaneous infusion devices can be used to deliver drugs to treat a variety of symptoms. Common symptoms include pain, nausea, vomiting, breathlessness, agitation, delirium and ‘noisy breathing’;
- A wide variety of drugs can be used together in different combinations with no clinical evidence of loss of efficacy¹³;
- The more drugs that are mixed together, the greater the risk of precipitation and reduced efficacy⁹;
- 2–3 drugs may be mixed in a subcutaneous infusion (occasionally up to 4 drugs^{6,10});
- If compatibility is an issue, the use of two subcutaneous infusion devices³ or regular or prn subcutaneous injection should be considered;
- Before mixing any drugs together in a subcutaneous infusion, check for stability information^{3,6,9,28,29} and check with hospital pharmacists;
- Use of the boost facility, where available, is not advocated. A boost dose rarely provides sufficient analgesia to relieve uncontrolled pain, and may lead to overdosing of other drugs being infused⁶.
- It is better to use breakthrough medication to treat uncontrolled symptoms than the boost facility¹⁴;
- Normal saline is the most commonly used diluent in Australia¹⁵;
- The use of water for injection has been linked to pain due to its hypotonicity, although normal saline may be more likely to cause precipitation¹⁶;
- 5% dextrose is used only occasionally as a diluent⁶, and is not commonly used in Australia.⁸

Drugs

Subcutaneous infusion of drugs is a commonly used method for delivering a wide range of medication, particularly when other drug routes are no longer available, or are unacceptable to the patient.⁹ Pain is the most common symptom for which control is sought, but the use of subcutaneous infusion devices is not limited to analgesic administration. Drugs to control other symptoms, such as nausea, vomiting, dyspnoea, agitation, delirium and terminal phase ‘noisy breathing’ can also be prescribed for continuous subcutaneous infusions and administered in the same syringe or cassette.²

Commonly, two–three drugs and occasionally up to four drugs¹⁰ may be mixed in a syringe/cassette for subcutaneous infusion. The maximum number of drugs that most clinicians are prepared to mix in a single infusion is four.⁵ The more drugs that are mixed together, the greater the risk of precipitation and reduced efficacy.⁹ It has been reported that a wide variety of drugs can be used in different combinations with no clinical evidence of loss of efficacy.¹³ If compatibility is an issue, the use of two infusion devices³ may be considered.

In the Australian context, symptoms that are encountered at the end of life are generally well controlled by the use of nine commonly used medications.²³ These include:

- morphine sulphate/tartrate (an opioid);
- hydromorphone (**Dilaudid**, an opioid);
- haloperidol (**Serenace**, an antipsychotic/antiemetic);
- midazolam (**Hypnovel**, a short acting benzodiazepine);
- metoclopramide (**Maxolon**, an antiemetic);
- hyoscine hydrobromide (**Hyoscine**, an antimuscarinic /antiemetic);
- clonazepam (**Rivotril**, a benzodiazepine);
- hyoscine butylbromide (**Buscopan**, an antimuscarinic); and
- fentanyl (a narcotic).

An important safety consideration, before mixing any drugs together in a subcutaneous infusion, is to check for stability information.^{3,6,9} Detailed drug compatibility tables have been prepared showing compatibility data for various combinations of drugs.¹¹ Check with hospital pharmacists to confirm information or clarify any questions regarding stability. Temperature may affect the stability of drugs. This can be overcome by ensuring the infusion device is placed on top of bed clothes and outside of clothing, rather than beneath them.⁶

Medications contraindicated for use via subcutaneous infusion:

Drugs such as prochlorperazine (an antiemetic), diazepam (an anxiolytic) and chlorpromazine (an antipsychotic) are specifically contraindicated for use in subcutaneous infusions due to severe localised reactions.^{9,16}

There are several drugs that have also been linked to abscess formation when used in subcutaneous infusions. These include pethidine (pethidine hydrochloride—an analgesic), prochlorperazine (Stemetil—an antiemetic) and chlorpromazine (Largactil—an antipsychotic).¹¹

Diluents

The choice between water for injection and 0.9% saline (normal saline) as a diluent is a matter of debate. The literature is divided with some recommending water for injection as the diluent^{6,8,9,15}, and recent literature recommending normal saline¹¹ as the diluent. Normal saline can be used for most drugs, the main exception being cyclizine.⁶

Normal saline is most commonly used within Australia for two reasons¹¹:

- Firstly, the majority of drugs can be diluted with normal saline with only two exceptions: cyclizine and diamorphine (neither of which are commonly used in Australia);
- Secondly, normal saline is isotonic, as are most injectable formulations. By diluting with normal saline, the tonicity of the solution is unaltered.

Water for injection is hypotonic. Using this as a diluent will potentially produce a hypotonic solution. The literature suggests that hypotonicity can contribute to the development of site reactions.¹¹ For example, the use of water for injection has been linked to pain due to its hypotonicity, although normal saline is more likely to cause precipitation.¹⁶

The first edition of this publication indicated a need for ambiguities to be addressed by further research, given the lack of clinical evidence or recommendations regarding diluents.¹⁵ The literature review for this edition found no further research in this context.

SECTION FIVE

Patient/family education needs

Summary Statement

- Patient and family education promotes safety and acceptance of the subcutaneous infusion device as a means to providing improved symptom control¹²;
- Patient and family education includes:
 - ▶ Explanation and education about what the device will do, and its advantages and possible disadvantages;
 - ▶ Safety aspects;
 - ▶ Ways to incorporate a subcutaneous infusion into their everyday life;
 - ▶ Troubleshooting guidelines.⁹

Careful explanation and education about what the device will do, and its advantages and possible disadvantages is required.⁸ Patient and family education guidelines are outlined in Table 3.

Table 3: Patient and family education

Information about the device itself	<ul style="list-style-type: none">• Infusion devices are generally very reliable.• It is normal for the Graseby syringe driver to make a 'whirring' noise every few minutes. It should not be loud enough for others to hear or to keep them awake at night.• A green light normally flashes on the front of the Niki T34 and Graseby.• When the GemStar is working, arrows run constantly across the screen.• The CADD Legacy makes an audible noise when delivering the medication.• Instruct the patient that it is a good idea to keep a spare 9 volt battery (or other relevant size battery).• Encourage the patient to get into the habit of checking the device to ensure it is working normally, but encourage them not to worry about checking it overnight.• Infusion devices generally will alarm if the reservoir, such as syringe or cassette, is empty, or there is a blockage or air in the tubing. Instruct the patient/carer not to panic if it alarms and how to contact the relevant health professional.• Provide written troubleshooting guidelines for the patient and carer.
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Activities of daily living	
Carrying the infusion device	Purchasing a belt bag to conceal and carry the device discreetly may be useful.
Showering	<p>Infusion devices must not be immersed in water and may be damaged by steam.</p> <ul style="list-style-type: none"> • Patients and carers should be given clear written instructions regarding disconnection from the infusion device for the purpose of showering and reconnection afterwards. The period of disconnection should be as brief as possible.
Extra pain or breakthrough of unrelieved symptoms	<p>The patient and their carer may require reassurance that although the patient may continue to experience some pain or other symptoms, breakthrough medication can be given on these occasions.¹⁴</p> <p>(*Breakthrough medication is defined as extra medication that may be required for symptoms that are not controlled by the medications prescribed for continuous delivery via the subcutaneous infusion device).</p>

<p>Troubleshooting</p>	<p>If the patient is concerned that the device is not functioning properly, the following guidelines for patient and family can assist:</p> <ul style="list-style-type: none"> • If the patient believes there is something wrong with the infusion device, or if the alarm sounds, reassure them that it is likely to be an easy problem to rectify. • Graseby only: Check that the light on the right hand side of the device is flashing. If not, change the battery and press the button labelled ‘start/boost’ and the light should begin to flash. • Refer the patient/carer to the written troubleshooting guidelines you have left with them, which will hopefully cover common issues likely to arise. <p>Check: If there is a kink in the tube - untwist it.</p> <p>Graseby only: If the syringe is disconnected, attach it again with the black strap. Replace the battery and press the ‘start’ button.</p> <p>Syringe reconnection to other devices will require assistance from a health professional.</p> <p>If the syringe is empty or the cannula has come out, if the cannula site is swollen, or if there is pain at the site of the cannula, the patient will need to contact their healthcare provider.</p>
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SECTION SIX

Patient assessment and troubleshooting guidelines

Summary Statement

- When troubleshooting the equipment used in subcutaneous infusions, it is important to understand the normal functioning of the device⁹;
- Ensure that drug calculations are checked according to legislative requirements and organisational policy and protocols when the subcutaneous infusion device is set up;
- Use only one type of subcutaneous infusion device in each setting to prevent confusion which may lead to errors^{6,8,10,18};
- Where more than one device is used in a particular setting, it is recommended the service provider implement strategies to manage potential risks regarding the need for staff to be competent with a number of devices;
- Ensure that the organisational protocol is followed regarding priming of the line^{2,6-9};
- Ensure that drugs being delivered are compatible^{3,19};
- Ensure that a spare battery is always available for battery-driven devices^{5,6,8};
- Thorough patient assessment is important when caring for patients with a subcutaneous infusion^{7,12};
- Principles to include in patient assessment, recording and documentation include:
 - Ask the patient how they feel (or family member/carer, if the patient is unable to comprehend): for example, are their pain and other symptoms controlled?;
 - Document symptom control and efficacy of interventions;

- ▶ Careful inspection of site, at least 4 hourly, for signs of inflammation and site reaction, then documentation of findings¹⁷;
- ▶ Careful inspection of syringe volume remaining⁶, at least 4 hourly, and documentation of findings;
- ▶ Careful inspection of tubing for patency^{8,9} at least 4 hourly and documentation of findings;
- Site inspection should be performed as part of routine care and includes principles such as checking for tenderness at the site, presence of a haematoma and leaking at the insertion site.^{3,7,9}

Section Six of the guidelines addresses patient assessment and troubleshooting. When troubleshooting any equipment, it is important to understand the normal functioning of the device.

These principles include ensuring that:

- There is a flashing light which indicates that the syringe driver is functional (Niki T34, Graseby);
- There is an intermittent ‘whirring’ sound (Graseby, WalkMed);
- Arrows are running constantly across the screen (GemStar).

Patient assessment recommendations are presented in Table 4. A comprehensive troubleshooting guideline is presented in Table 5.

Management Guidelines

Table 4: Patient Assessment guidelines	
Potential problem	Reducing potential problems
1) Site inflammation, infection and/or abscess development	<ul style="list-style-type: none"> Carefully inspect site, at least 4 hourly and document findings. If site becoming red or patient reports tenderness at site, change site.
2) Precipitation/ crystallising in tubing	<ul style="list-style-type: none"> Ensure that the drugs being delivered are compatible¹⁹; Carefully inspect tubing, at least 4 hourly, and document findings.
3) Disconnection of tubing	<ul style="list-style-type: none"> Use Luer-Lok® syringes; Carefully inspect tubing, at least 4 hourly, and document findings.
4) Inappropriate dosages being delivered due to: <ul style="list-style-type: none"> Confusion over the type of subcutaneous infusion device Device running too fast/too slow Incorrect setting or setting moved 	<ul style="list-style-type: none"> Ensure only one type of subcutaneous infusion device is used in each setting to prevent confusion; Always document the syringe volume each time the device is set up. Carefully inspect infusion and syringe volume, at least 4 hourly, and document findings. Carefully inspect the syringe volume remaining, at least 4 hourly, and document findings.

<ul style="list-style-type: none"> • Different policies/ practices regarding priming of the line • Confusing millimetres with millilitres 	<ul style="list-style-type: none"> • Check rate setting on device and document. • Ensure that organisational protocol is followed regarding priming of the line (refer to Section One of these guidelines).
5) Calculation errors	<ul style="list-style-type: none"> • Ensure that all drug calculations are checked according to legislative requirements and organisational policy and protocols when the subcutaneous infusion device is set
6) Tampering with boost button facility or syringe driver settings	<ul style="list-style-type: none"> • Consider using a tamperproof ‘lock-box’⁶ if there is a possibility of the patient or others tampering with the device, or using the boost facility. • Use key-pad lock if this function is available
7) Battery running flat	<ul style="list-style-type: none"> • Ensure that a spare battery is always available (9 volt for Niki T34, WalkMed and Graseby, 2x AA for GemStar and CADD); • Ensure that the light is flashing on the device.

Management Guidelines

Table 5: Troubleshooting		
Clinical situation	Possible cause(s)	Suggested solution(s)
Device alarms	<ul style="list-style-type: none"> • Reservoir may be empty; • Tubing is kinked, needle is blocked, plunger is jammed; • Battery is flat • Air in line 	<ul style="list-style-type: none"> • Re-fill reservoir; • Un-kink tubing; check plunger is not sticking; • Change battery; • Remove air per workplace or manufacturer guidelines.
Infusion has not run to time	<ul style="list-style-type: none"> • Rate set incorrectly, or has been altered; • Scale length measured incorrectly • Device has been immersed in water 	<ul style="list-style-type: none"> • Set correct rate – consider tamperproof box; • Re-measure syringe – check measurement; • Instruct that device should not be immersed

Infusion has ended too early	<ul style="list-style-type: none"> • Boost button may have been activated; • Delivery rate could be set incorrectly, or it has been altered; 	<ul style="list-style-type: none"> • Consider using a tamper-proof 'lock-box'⁶ if there is a possibility of the patient or others tampering with the device, or using the boost facility; • Check rate set on device to ensure correct delivery over 24 hours; • Remeasure the Graseby scale length to ensure accuracy; • Ensure Graseby perspex shield is in place.
Infusion has yet to be completed	<ul style="list-style-type: none"> • Device has been stopped; • Rate setting is incorrect. • Graseby actuator may not have been flush against the plunger when infusion commenced; 	<ul style="list-style-type: none"> • Check why the device may have stopped. Flat battery? Reservoir empty? Occlusion? – implement corrective action; • Check rate set on device to ensure correct delivery over 24 hours; • Check Graseby actuator is flush against the plunger;

	<ul style="list-style-type: none"> • Graseby scale length measured incorrectly; 	<ul style="list-style-type: none"> • Check Graseby scale length, repeat rate calculation
<p>The infusion has stopped (e.g. light is not flashing or arrows not running across screen)</p>	<ul style="list-style-type: none"> • Infusion has finished; • Line is blocked, or cannula is blocked; • Possible battery problem; • Drugs have precipitated; 	<ul style="list-style-type: none"> • Reload reservoir as per medical order. • Check extension set not kinked, or clamp in place. • Check battery is inserted correctly; • If battery is flat, change; • Check START button not depressed sufficiently (Graseby). • If the drugs precipitate (crystallise) in the syringe, discard the mixture. To prevent this happening again, increase the dilution, change the syringe line and re-site the cannula. If drugs mixed in the syringe precipitate, check their compatibility. The medication regimen may need to be reconsidered, or two devices used.⁷

	<ul style="list-style-type: none"> • Inflammation at the site; • Syringe/cassette incorrectly fitted; • Mechanical malfunction. 	<ul style="list-style-type: none"> • Change site; • Continue to observe site for resolution of inflammation. • Recheck set-up of device. • Send for maintenance.
Limited cannula access sites	<ul style="list-style-type: none"> • Oedema/infection or patient may be cachectic. 	<ul style="list-style-type: none"> • Confer with experienced colleagues; • Consider if a subcutaneous infusion is appropriate; • Refer to 'site selection' area of these guidelines.
Patient is restless and/or confused	<ul style="list-style-type: none"> • Delirium (reversible) see Australian Medicines Handbook 'Drug Choice Companion: Aged Care' 2003 pp 9-12 (www.amh.net.au). 	<ul style="list-style-type: none"> • Treat the underlying cause as appropriate/able.

<p>Patient is restless and/or confused</p>	<ul style="list-style-type: none"> • Possibility of terminal delirium • Pain – check bladder, bowel etc 	<ul style="list-style-type: none"> • Consider resiting the cannula around the scapula; • Consider giving a breakthrough dose of an antipsychotic agent such as haloperidol¹¹ • Check if the bladder is full, and implement appropriate management strategies, e.g. insert an IDC if necessary.
<p>Cannula site inflamed after only 24-48 hours</p>	<ul style="list-style-type: none"> • Skin reaction at the site; • Patient has had previous radiotherapy to the site; • High drug concentration in reservoir causing irritation; • The site is infected; 	<ul style="list-style-type: none"> • Resite the needle and observe for abscess formation. • Resite to area not previously treated. • Dilute the concentration by using a larger reservoir – e.g. change from 20 to 30 ml syringe. • Remove and resite the cannula, and observe the old site for signs of infection.

	<ul style="list-style-type: none"> • Infusion contains drugs not appropriate for subcutaneous infusion • Shallow cannula insertion 	<ul style="list-style-type: none"> • Ensure that drugs are suitable for the subcutaneous route. • Adding 1 mg of dexamethasone to the syringe may reduce site irritation • Consider whether a subcutaneous infusion is appropriate where there is repeated site inflammation.
The patient experiences pain at the insertion site	<ul style="list-style-type: none"> • Shallow cannula insertion; • Inflammation. 	<ul style="list-style-type: none"> • Remove and resite cannula; • See previous page
Leakage at the insertion site	<ul style="list-style-type: none"> • Cannula position is not stable. 	<ul style="list-style-type: none"> • Remove and resite cannula.
Bleeding at the insertion site	<ul style="list-style-type: none"> • Trauma or coagulation problem 	<ul style="list-style-type: none"> • Remove cannula and apply pressure at old site; when resited, observe site for further bleeding.

<p>Patient reports unrelieved pain and control of symptoms</p>	<ul style="list-style-type: none"> • Leakage from the device; • Therapeutic dose has not been achieved in serum levels >24 hours after commencement of infusion. 	<ul style="list-style-type: none"> • Remove cannula and apply pressure at old site; when resited, observe site for further bleeding. • Check all connections, changing components as necessary. • Consult medical staff to review medications; • Give available breakthrough doses until optimal symptom control is achieved.
<p>Patient reports unrelieved pain and/or poor control of symptoms</p>	<ul style="list-style-type: none"> • Medication order is inappropriate; • Inappropriate dose of medication prepared. 	<ul style="list-style-type: none"> • Assess the patient, confer with medical staff to adjust dosage. • Recheck the medication order, and draw up the correct dose; • Complete an incident form and notify the correct persons.

Please note: If any of the above cannot be explained, the device may be faulty and should be checked by a medical engineer.

Conclusion

The use of subcutaneous infusion devices in palliative care to achieve symptom control is standard and accepted practice. There are many benefits that subcutaneous infusion devices present to the patient in terms of convenience and effective management of symptoms. However use of such devices has not been without its risks and limitations, including inflexibility of prescription, technical problems, safety issues and skin reactions at the site of the infusion.

Subcutaneous infusion devices may also cause concerns and fears for some patients and their families because they are associated with disease progression.

The guidelines presented in this document are intended to promote a standardised approach to clinical care, thereby minimising practice errors that can result in serious adverse events that present an on-going risk for patient safety.

Appendix A – Levels of Evidence¹

Level of Evidence	Effectiveness
1	Meta-analysis (with homogeneity) of experimental studies (eg Randomised Control Trial with concealed randomisation) OR One or more large experimental studies with narrow confidence intervals
2	One or more smaller RCTs with wider confidence intervals OR Quasi-experimental studies (without randomisation)
3	3a. Cohort studies (with control group); 3b. Case controlled; 3c. Observational studies(without control group)
4	Expert opinion, or physiology bench research, or consensus.

¹Joanna Briggs Institute. Levels of Evidence. Joanna Briggs Institute. Available at <<http://www.joannabriggs.edu.au/pdf/about/Approach.pdf>>. Accessed June 24th, 2009.

Appendix B – Literature Summary

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Abbas S, Yeldham M, Bell S. The use of metal or plastic needles in continuous subcutaneous infusion in a hospice setting. American Journal of Hospice and Palliative Medicine 2005;22(2):134-138.						
4	40 patients	UK hospice	N/A	Retrospective clinical audit	Clinical audit methodology	Mean survival of plastic cannula 4.03 days cf 1.8 days for metal needle. Kinking was not a problem; no needlestick injuries were reported.
British National Formulary. 'Syringe drivers.' <www.bnf.org>. Accessed 26th January, 2005						
4	N/A	N/A	N/A	British National Formulary website	N/A	N/A
Coleridge-Smith E. The use of syringe drivers & Hickman lines in the community. British Journal of Community Nursing 1997;2(6):292, 294, 296.						
3	N/A	N/A	N/A	Evidence based guidelines	N/A	N/A
Curtis S, Douglas I. Pyoderma gangrenosum in a syringe driver site of a patient with non-Hodgkins's lymphoma. Palliative Medicine 2006;20:113-114.						
4	Case study	Not specified	N/A	Case Study	N/A	When faced with rapidly growing ulcer at site of skin trauma, early involvement of dermatologist can help establish diagnosis of pyoderma gangrenosum.
Dickman A, Schneider J, Varga J. The Syringe Driver (2nd ed). Oxford: Oxford University Press; 2005.						
3	N/A	N/A	N/A	Reference book about syringe drivers	N/A	N/A

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Donald AI, Chinthamunedi MP, Spearritt D. Effect of changes in syringe driver height on flow: a small quantitative study. <i>Critical Care and Resuscitation</i> 2007;9(2):143-147.						
4	N/A	Bench experiment	To quantify flow irregularities in drug delivery caused by syringe pump vertical displacement.	Bench experiment	A standard syringe pump and line set with dye solution was run through a graduated length of tubing. The effect of changing pump height was quantified by measuring progress down the tubing over time.	A 30cm elevation produced significant drug delivery boluses – up to seven times programmed rate at 2mL/hr. Lowering the pump 30cm resulted in no-flow times of up to 180 seconds at 2mL/hr.
Dunne K, Garvey A, Kernohan G, Diamond A, Duffy C, Hutchinson J. An audit of subcutaneous syringe drivers in a non-specialist hospital. <i>International Journal of Palliative Nursing</i> 2000;6(5):214, 216-219.						
3	13 cases of palliative care patients	Not specified	To establish the standard of current practice in wards where syringe drivers were being used.	Clinical audit (retrospective study)	Clinical audit methods.	Highlighted many areas of unregulated practice with regard to setting up, monitoring & maintenance of syringe drivers.
Dunne K, Garvey A, Kernohan G, Diamond A, Duffy C, Hutchinson J. An audit of subcutaneous syringe drivers in a non-specialist hospital. <i>International Journal of Palliative Nursing</i> 2000;6(5):214, 216-219.						
3	N/A	Australian practice settings (and national and international literature search).	To determine diluent choice for subcutaneous infusions in the literature and in Australian practice.	Survey of clinical practice settings; literature search.	Literature review considered existing literature, drug databases & directories; involved a survey of palliative care services to examine evidence & experience relating to diluent choice.	With the exception of five drugs for which saline was recommended, there was an inclination to use water unless contraindicated. More research is needed to address formal clinical evidence & ambiguities.

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Gomez Y. The use of syringe drivers in palliative care. Australian Nursing Journal 2000;(2):suppl 1-3.						
3	N/A	N/A	Outlines application of syringe drivers, in particular the Graseby MS16A in a palliative care setting	Evidence based instruction guide	N/A	N/A
Hayes A, Brumley D, Habeggar L., Wade M, Fisher J, Ashby M. Evaluation of training on the use of Graseby syringe drivers for rural nonspecialist nurses. International Journal of Palliative Nursing 2005;11(2):84-92.						
3	270 non-specialist nurses	Rural Grampians Health Region in Victoria, Australia	To assess the impact of a training programme on nurse confidence in setting up and explaining the Graseby syringe driver.	Training program	Pre-training post-training and follow up questionnaires	Increases in confidence levels were found in participating nurses in relation to each of the four confidence parameters
Herndon C. Continuous subcutaneous infusion practices of United States hospices. Journal of Pain and Symptom Management 2001;22(6):1027-1034.						
3	3762 US hospice facilities.	N/A	To determine subcutaneous infusion practices in US hospices.	Survey of hospices	Questionnaire	907 respondents; 73% used CSCI to administer medications and/or fluids. Most commonly used drugs: morphine (97%), hydromorphone (60%), haloperidol (14%), midazolam (9%), metoclopramide (8%). Over 75% used normal saline as diluent.

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Koshy R, Kuriakose R, Sebastian P, Koshy C. Continuous morphine infusions for cancer pain in resource-scarce environments: comparison of the subcutaneous and intravenous routes of administration. Journal of Pain & Palliative Care Pharmacotherapy 2005;19(1):27-33.						
2	Thirty terminally ill patients.	Cancer Centre Pain Clinic in southern India	To determine most cost effective method of parenteral morphine administration for cancer pain management.	Prospective randomised controlled trial	Patients with pain >8/10 on a visual analogue score were randomised to receive continuous morphine infusion either IV or SC. Gravity dependent drip method was used for all infusions because staff trained to use infusion pumps are often not available in outlying centres in developing countries.	Morphine administered by SC and IV routes produced similar favourable effects on vital parameters and for analgesia.
Lichter I, Hunt E. Drug combinations in syringe drivers. The New Zealand Medical Journal 1995;108(1001):224-226.						
2	One hundred consecutive patients in a palliative care setting.	New Zealand	To record the combinations of drugs in SD's that were found to be compatible.	Experimental	Case series. Because of widely differing views on drugs that can be administered in combination, a study was undertaken to record the combination of drugs in syringe drivers that were found to be compatible. The content of syringe drivers in 100 consecutive	It was found in this study that a wide variety of drugs were used in many different combinations, with no clinical evidence of loss of efficacy. Some drug combinations were incompatible. Drugs known to cause skin reactions were not administered. In this study skin reactions depended on the number of

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
					patients in whom CSCI was used was recorded. The incidence of skin reactions with the different drugs was noted. The efficacy of combinations used was assessed clinically.	drugs used in combination. The study concluded that the array of medications that can be used together in syringe drivers enable this method of drug administration to be used successfully in the control of the diverse symptoms that may arise in terminal illness.
McLeod F, Flowers C. A practical guide for nurses in diluent selection for subcutaneous infusion using a syringe driver. <i>International Journal of Palliative Nursing</i> 2006;12(12):558-565.						
4	N/A	N/A	To develop an instructional guide to assist nurses select an appropriate diluent for SC infusions in order to standardise practice.	Literature review and consensus of expert group of palliative care nurses.	Literature review and consensus of expert group of palliative care nurses.	Authors recommend that manufacturers specify diluent to be used with their drugs in instructions for use in product packaging.
McQuillan R, Finlay I. The utilization of syringe drivers at a teaching hospital. <i>Palliative Medicine</i> 1996;10(1):52.						
4	N/A	University Hospital of Wales	Correspondence about utilisation of syringe drivers at a teaching hospital in Wales	Correspondence	N/A	The most common types of syringe driver used in Britain are the Graseby MS16A and MS26 machines; approx. 2500 of these are sold annually in the UK and a similar number sold abroad. The simple Graseby syringe drivers cost about £600 each; the manufacturer does not recommend

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
						routine maintenance. In theory a syringe driver could be in use 100% of the time, but because of loss and under-usage of syringe drivers, they are not used efficiently at some centres.
Mitten T. Subcutaneous drug infusions: a review of problems and solutions. International Journal of Palliative Nursing 2001;7(2):75-85.						
3	N/A	N/A	Reviews general issues with the operation of portable syringe drivers and discusses a range of potential problems and solutions.	Evidence based guidelines	N/A	N/A
Morgan S, Evans N. A small observational study of the longevity of syringe driver sites in palliative care. International Journal of Palliative Nursing 2004;10(8):405-412.						
3	27 Palliative Care patients examining 86 syringe driver sites	UK hospice Setting	To establish the rate of SD reactions, duration of sites and to determine whether a predictable relationship existed between the number of days on a SD and number of sites used consecutively.	Observational study	A proforma was designed to collect information. Data collected included: date and time of set-up; medication doses; date & time site discontinued; presence of site reaction; body site used.	44% discontinued due to site reactions; Location of SD site appeared to be an important factor; Dislodgement 3 x more prevalent from chest wall than upper arm; Sites must be inspected regularly; There is no evidence base - more research is needed.

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Negro S, Salama A, Sanchez Y, Azuarat M, Barcia E. Compatibility and stability of tramadol and dexamethasone in solution and its use in terminally ill patients. <i>Journal of Clinical Pharmacy and Therapeutics</i> 2007;32:441-444.						
4	Six terminally ill patients		To study compatibility and stability of tramadol (100-400mg/day) and dexamethasone (4-40mg/day) combined in solution.	Bench test of solutions. Retrospective study with prospective clinical validation of six terminally ill patients in the home setting.	Twelve different solutions were prepared in saline and stored in polypropylene syringes for 5 days at 25 °C. Clinical performance was assessed retrospectively in 6 terminally ill patients.	Tramadol (100-400mg/day) and dexamethasone (4-40mg/day) are stable for at least 5 days when combined in saline and stored in polypropylene syringes at 25 °C.
O'Doherty C, Hall E, Schofield L, Zeppetella G. Drugs and syringe drivers: a survey of adult specialist palliative care practice in the United Kingdom and Eire. <i>Palliative Medicine</i> 2001;15:149-154.						
3	Palliative care specialists	UK	The aim of the present study was to reassess practice in the field of SD management and to enquire more specifically about newer drugs.	Survey	Survey methods	The maximum number of drugs that respondents were prepared to mix in a single syringe was usually three (51%) or four (35%). In the UK, all units used diamorphine in doses from 2.5mg/24h upwards. All respondents also used haloperidol, in doses from 0.5 to 60mg/24 h. A total of 28 different drugs were used in syringe drivers. The most common combinations were diamorphine and midazolam (37%), diamorphine and levomepromazine (35%), diamorphine and haloperidol (33%), and diamorphine and cyclizine (31%).

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
PalliativeDrugs.com. 'Syringe drivers.' <www.palliativedrugs.com>. Accessed 17th May, 2010.						
4	N/A	N/A	N/A	Drugs used in palliative care website	N/A	N/A
Peterson G, Miller K, Galloway J, Dunne P. Compatibility and stability of fentanyl admixtures in polypropylene syringes. Journal of Clinical Pharmacy and Therapeutics 1998;23:67-72.						
4	N/A	Bench test	To study stability of fentanyl with midazolam combined with metoclopramide or hyoscine butylbromide.	Bench test of fentanyl alone or combined with metoclopramide or hyoscine butylbromide, in polypropylene syringes at 32 °C.	High-performance liquid chromatography was used to assess stability of the infusions.	All drugs maintained over 90% of initial chemical potency for at least 1 week.
Pickard J, Mitchell K, Roberts D. Syringe driver site reactions: a review of the literature. European Journal of Palliative Care 2008;15(3):125-131.						
4	N/A	N/A	To provide insight into the size and complexity of the issue of subcutaneous infusion site reactions.	Literature search	Literature review	More specific guidelines needed to aid assessment of whether site reaction has occurred, and if action is required. Studies to provide evidence regarding the benefit of one diluent over another are needed.
Ratcliffe N. Syringe drivers. Community Nurse 1997;3(6):25-26.						
4	N/A	N/A	N/A	Instruction guidelines	N/A	N/A

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Reymond E, Charles M. An intervention to decrease medication errors in palliative patients requiring subcutaneous infusions: Brisbane South Palliative Care Service and Adverse Drug Event Prevention Program; unpublished report presented to Clinical Services Evaluation Unit, Princess Alexandra Hospital, Brisbane, Australia; 2005.						
3	Seventy-six palliative patients requiring subcutaneous infusions were involved; a total of 217 syringe driver days.	Hospital in Southeast Qld, Australia	To improve the standard of care for palliative patients with the implementation of a quality improvement intervention, namely a new subcutaneous infusion proforma, and to evaluate the outcome in terms of infusion errors and staff feedback.	Clinical Audit	NUMs, from wards that manage palliative patients, nominated 60 nurses interested in becoming 'staff champions' for subcutaneous infusions. 25 nominees attended one of five 3-hour workshops, facilitated by a specialist palliative care nurse, concerning education strategies for the administration and management of subcutaneous infusions incorporating the new proforma. After the workshops were completed the new proformas were introduced to the wards and all previously used forms removed. One month later the audit was repeated.	The most frequently occurring errors that compromised patient symptom control were those relating to operational checks. Pre-intervention this occurred due to the use of non-standardised forms, many of which did not prompt nursing staff to check subcutaneous infusions four hourly. According to feedback from staff, postintervention errors occurred because the checking documentation is on the reverse of the new proforma. According to staff feedback, if four hourly operational checks were routine then the audited equipment malfunctions or errors would have been detected earlier.

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Reymond L, Charles MA, Bowman J, Treston P. The effect of dexamethasone on the longevity of syringe driver subcutaneous sites in palliative care patients. MJA 2003;178:486-489.						
1	38 palliative care patients	Two Australian inpatient units at two hospitals	To assess the effect of adding 1mg of dexamethasone to SD on the viability time of subcutaneous sites in palliative care patients.	Prospective, doubleblind randomised controlled trial	Patients received their daily infusion medication plus 1mg dexamethasone in 1ml saline through one sc test site, and other received their medications plus 1ml saline though symmetrically placed site (control site).	Of 38 participants, 20 did not complete as site broke down; Remaining 18 either partially completed, or fully completed. Test sites lasted 3.6 days longer than control sites. The addition of 1mg dexamethasone significantly extended the viability time of SC cannulations in palliative care patients.
Ross JR, Saunders Y, Cochrane M, Zeppetella G. A prospective, within-patient comparison between metal butterfly needles and Teflon cannulae in subcutaneous infusion of drugs to terminally ill hospice patients. Palliative Medicine 2002;16:13-16.						
3	Thirty hospice inpatients	Hospice	To determine difference in time from needle insertion to site reaction using metal needles vs Teflon cannulae for sc administration of drugs in terminally ill patients.	Prospective study of hospice inpatients.	Patients were used as their own control. Prescribed medications were divided equally between two syringe drivers and delivered over 24 hours.	Teflon cannulae had a median life span twice that of metal butterfly needles, making them a cost effective alternative for sc administration of medications in terminally ill patients.
Smith J, Karthikeyan G. Foreign body occlusion of syringe driver mechanism (Correspondence). European Journal of Anaesthesiology 2007;24:1063-1064.						
4	N/A	Operating Theatre	N/A	Correspondence	N/A	To reduce chances of foreign body occlusion, it is recommended there be a thorough check of all equipment to be used before any procedure;

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
						immediately after removal, IV set protective caps be disposed of in an appropriate container; infusion devices to include a cover for moving parts.
Stuart P, Lee J, Arnold G, Davis M. A centralized storage system for the delivery of subcutaneous infusions. British Journal of Nursing 2008;17(8):512-516.						
4	30 inpatients	30 inpatients of a large acute NHS Trust	To identify whether introduction of a centralised storage system of set boxes containing all relevant equipment would resolve delays in obtaining the correct equipment and patients being given drugs prescribed.	Staff surveys	Questionnaires for palliative care team and ward staff.	A centralised storage system of syringe drivers enhanced practice by ensuring a standardised approach to initiation and care of syringe drivers.
Torre M. Subcutaneous infusion: non-metal cannulae vs metal butterfly needles. British Journal of Community Nursing 2002;7(7):365-369.						
1	N/A	N/A	To evaluate the effectiveness of non-metal cannulae compared to metal butterfly needles in maintaining s/c infusion sites in patients receiving palliative care.	Meta-analysis	A mini-review of 5 RCTs was conducted.	One study was excluded. It appears that non-metal cannulae are more effective in maintaining s/c infusion sites than butterfly needles. There is no basis to recommend Vialon rather than Teflon cannulae.

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
Wilcock A, Jacob JK, Charlesworth S, Harris E, Gibbs M, Allsop H. Drugs given by a syringe driver: a prospective multicentre survey of palliative care services in the UK. Palliative Medicine 2006;20:661-664.						
4	18 pharmacists, 2 medical practitioners	15 palliative care services covering 22 inpatient units	To obtain a recent snapshot of practice to aid revision of the syringe driver drug compatibility charts in the UK Palliative Care Formulary.	Prospective survey	Questionnaire administered to pharmacists and medical practitioners regarding drugs, doses, diluent, volume, duration of administration, visual compatibility and site reaction, for every syringe driver in use by palliative care services on 4 separate days.	98% of syringe drivers were for s/c use; 2% for intrathecal/epidural. The majority of s/ drivers contained 2 or 3 drugs. 20% contained only 1 drug. Median volume of infusions: 15ml. Duration of infusion 24 hours in 98% of cases. Reports of syringe driver site reactions in 4% of cases.
Wilson V. Clinical guidelines for use of the MS26 daily rate syringe driver in the community. British Journal of Community Nursing 2000;5(4):162-168.						
4	N/A	N/A	N/A	Guidelines for use of the Graseby MS26 in the community.	N/A	N/A

Appendix C - Commonly Used Drugs in Syringe Drivers^{6,8}

Drug	Indication	Common Dosage	Injection Strength
morphine sulphate/tartrate (tartrate is used rather than sulphate for larger doses as it is more soluble).	Opioid for pain control. Morphine is 2-3 times more potent when given parenterally than orally. Morphine is physically compatible with most other drugs commonly used in syringe drivers.	There is no maximum dosage of morphine. Usual starting dose is 10-20 mg per 24 hours, which can be increased if pain is uncontrolled.	(as sulphate) 5mg/ml; 10mg/ml; 15mg/ml; 30mg/ml (as tartrate) 80mg/ml
hyoscine hydrobromide (Hyoscine)	Antimuscarinic useful for drying secretions (e.g. sialorrhoea, drooling, death rattle), intestinal colic, inoperable bowel obstruction.	200-400 microgram SC stat 600-1200 microgram per 24 hours	400 microgram/ml 600 microgram/ml
clonazepam (Rivotril)	A benzodiazepine derivative with antiepileptic properties. Several indications in palliative care: terminal agitation, anxiety, myoclonus, seizures, and neuropathic pain.	Usual dose is 1-4 mg per 24 hours.	1mg/ml

Drug	Indication	Common Dosage	Injection Strength
hydromorphone (Dilaudid)	Opioid for pain control, five times more potent than morphine. Often used when morphine is not effective or not tolerated.	There is no maximum dosage of hydromorphone. Usual starting dose is 2-4mg/24 hours; can be increased if pain uncontrolled.	2mg/ml; 10mg/ml as 1 & 5 ml ampoules
haloperidol (Serenace)	An antipsychotic agent and antiemetic. Used in low doses to control nausea and vomiting, and has minimal sedative properties at this dosage. Higher doses may control agitation and confusion.	As an antiemetic, 0.5-5 mg over 24 hours. To control delirium associated agitation, 1-20mg over 24 hours.	5mg/ml
midazolam (Hypnovel)	A short acting benzodiazepine, used to control seizures, anxiety and terminal agitation. Tolerance can develop and the dose may need to be increased.	2.5-60 mg over 24 hours.	5mg/ml

Drug	Indication	Common Dosage	Injection Strength
metoclopramide (Maxolon)	An antiemetic and gastrokinetic, indicated when nausea is associated with gastric/bowel stasis.	30-120 mg over 24 hours. Occasional extrapyramidal side effects.	5mg/ml
hyoscine butylbromide (Buscopan)	An antimuscarinic used mainly for the treatment of intestinal colic. Often used to dry terminal secretions. Not directly an antiemetic, but does reduce gastrointestinal secretions.	60-180 mg over 24 hours.	20mg/ml
fentanyl	An opioid for pain control. Not commonly given in the community as not PBS listed.	600 mcg/24 hours in a subcutaneous infusion is equivalent to a 25 mcg/hr fentanyl patch.	50microgram/ml

Please refer to the disclaimer on page 2.

This appendix is intended as a guide only.²³ It is important to refer to hospital guidelines and onsite pharmacist support.

To determine drug incompatibilities, you should refer to your pharmacy manual, or refer to your onsite pharmacist.

Acknowledgements

We would like to acknowledge the expertise and support of our Expert Panel: Professor Janet Hardy (Director of Palliative Care, Mater Health Services, Brisbane), Linda Barrett (Nurse Unit Manager, Metro South Palliative Care Service, Brisbane South), Assoc Prof Rohan Vora (Medical Director, Palliative Care Services, Gold Coast Hospital), Anthony Hall (Senior Lecturer, School of Pharmacy, Griffith University), Sally Pike (Nurse Unit Manager, Royal Brisbane and Women's Hospital Palliative Care Service), Karen Mitchell (Project Officer/Research Officer, Congress of Aboriginal and Torres Strait Islander Nurses), Jennifer Rowe (Palliative Care Coordinator, Community and Allied Health, Roma Hospital), Georgi Slade (Educator, St Vincent's Brisbane), Toni Bradley (Nurse Unit Manager, The Prince Charles Hospital Palliative Care Unit), and Jill Sanders (Clinical Nurse, Karuna).

Funding for the initial project was generously provided by the Queensland Health Central Zone Management Unit, Brisbane, Australia, and for the revision by the Australian Government Department of Health and Ageing.

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