

Guidelines for Syringe Driver Management in Palliative Care

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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 (syringe driver) management.

Scope

Component One:

Literature Review & Development of Draft Clinical Practice Guidelines

A literature review was undertaken to identify the most current evidence regarding syringe driver management. The following databases were searched for the purposes of these guidelines: CINAHL, Medline, PsycArticles and PsycInfo. The review of the literature was limited to adult patients and the English language, and covered a ten year period from 1995-2005. Search terms included: syringe drivers; subcutaneous infusions, end-of-life care, Graseby and palliative care. 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 Evidence¹ 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 syringe driver devices identified as relevant to the project were examined. A total of 43 published and unpublished papers were considered for inclusion in the guidelines; 24 were included. 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 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 were prepared in two formats: A formal report providing a detailed summary of the evidence, and a summary card for wider distribution to clinicians. The guidelines were also made available on the CPCRE web site to enhance accessibility.

In addition, a workshop was held involving a cross section of professionals involved in the provision of palliative care. The aim of the workshop was to raise awareness of the guidelines as well as to identify strategies for implementation.

Guidelines Summary

Section One: The patient experience

- Health care professionals should consider a syringe driver 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 the syringe driver as an invasion of their body privacy, and may perceive the device as an indicator of a poor prognosis³.

Section Two: Equipment guidelines and principles

- The most common syringe drivers in clinical use are the SIMS Graseby® MS16A and the MS26³⁻⁵;
- The organisation's protocol regarding the preparation and set-up for changing the device should always be used to guide practice;
- The syringe driver is normally used to deliver medications over a 24 hour period to reduce the risk of errors in setting up the device^{3,5-8};
- A 10 ml⁹ Luer-Lock® syringe, to prevent risk of disconnection⁶, should be used if volume/concentration permits; 20 and 30 ml syringes can be used, but may not fit as well⁹;
- The same brand of syringe should be used each time to minimise errors in setting up the syringe driver and calculating the rate^{6,9};
- The syringe should be measured every time the device is set up, as different brands of syringes have different diameters and lengths⁹;
- 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 to the appropriate length in the syringe^{2, 7-9, 11}. After priming the line, measure the syringe and document the line change 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}.

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.
- 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;
- 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, semi-occlusive dressing to cover the site, as this permits inspection of the site by the caregiver^{8,9};
- Factors that cause site reactions include the tonicity of the medication, the pH of the solution, infection and prolonged presence of a foreign body¹²;
- 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;

Section Four: Drugs and diluents

- Syringe drivers 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 syringe for a subcutaneous infusion (occasionally up to 4 drugs^{6, 10});
- If compatibility is an issue, the use of two syringe driver 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} and check with hospital pharmacists;
- Use of the boost facility is not recommended because it rarely provides enough analgesia to cover uncontrolled pain, and if other drugs are being infused, overdosing could occur of the other drug(s)⁶.
- 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 less commonly used in Australia⁸.

Section Five: Patient/family education needs

- Patient and family education promotes safety and acceptance of the syringe driver 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 guidelines⁹.

Section Six: Patient assessment and troubleshooting guidelines

- 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 syringe driver is set-up¹⁷;
- Use only one type of syringe driver in each setting to prevent confusion which may lead to errors^{6,8,10,18};
- 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 9 volt battery 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:

- 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;
- 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?;
- Documentation of symptom control and efficacy of interventions;
- 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}.

Syringe Driver Guidelines

Background

Syringe drivers are defined as power driven devices that drive the plunger of a syringe at an accurately controlled rate to deliver medications¹⁰. Their use as a method of drug delivery to control symptoms in palliative care is a common and accepted practice. They provide symptom control via subcutaneous infusion of drugs to treat pain and other distressing symptoms when other routes are inappropriate or ineffective. However, their clinical use has evolved rather than being subject to close multiprofessional scrutiny and guideline formation²⁰.

Many of the medications used in syringe drivers 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 safety¹⁷.

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 syringe driver 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 may perceive the device as an indicator of a poor prognosis³. They may also restrict the person's daily activities.

Syringe drivers should be used when it is determined that improved symptom control will result from the continuous delivery of medication, and that other less invasive routes for administering medication are not possible².

Summary of the patient experience guidelines

- Health care professionals should consider a syringe driver 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 the syringe driver as an invasion of their body privacy, and may perceive the device as an indicator of a poor prognosis³.

SECTION TWO

Equipment guidelines and principles

Summary Statement

- The most common syringe drivers in clinical use are the SIMS Graseby® MS16A and the MS26³⁻⁵;
- The organisation's protocol regarding the preparation and set-up for changing the device should always be used to guide practice;
- The syringe driver is normally used to deliver medications over a 24 hr period to reduce the risk of errors in setting up the device^{3,5-8};
- A 10 ml⁹ Luer-Lock® syringe, to prevent risk of disconnection⁶, should be used if volume/concentration permits. 20 and 30 ml syringes can be used, but may not fit as well⁹;
- The same brand of syringe should be used each time to minimise errors in setting up the syringe driver and calculating the rate^{6,9};
- The syringe should be measured every time the device is set up, as different brands of syringes have different diameters and lengths⁹;
- 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 to the appropriate length in the syringe^{2,7-9,11}. After priming the line, measure the syringe and document the line change 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}.

There are several types of syringe drivers available for use in palliative care. It is important to verify the equipment that is used within the specific organisation, as all syringe drivers work quite differently. The most common syringe drivers identified in clinical use in Queensland are the SIMS Graseby® MS16A and the MS26, which are electronic, battery driven syringe drivers. This equipment is summarised in Table 1.

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 the same for both the MS16A and the MS26 syringe drivers and include:

- The syringe driver should be used for the delivery of drugs over a 24 hour period, reducing the risk of errors in setting up the device;
- 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 the syringe driver is set up;
- A Luer-Lock® syringe⁶ is recommended to prevent accidental disconnection of the tubing from the syringe;
- 10 ml syringes are recommended unless there are drug concentration and/or volume issues. A 10 ml syringe rests securely in the device, whereas a 30 ml syringe is more difficult to secure firmly onto the syringe driver;
- 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. It is possible that a tamper-proof box is mandatory within an individual organisation as a risk management stipulation;
- Employ an aseptic technique when changing the device and resiting the cannula⁷;
- When changing the extension set and/or cannula, prime the line after drawing up the prescribed medications to the appropriate length in the syringe. After priming the line, measure the syringe and document the line change and the time the syringe is calculated to finish;
- Ensure that the patient and the family have received a full explanation of how the syringe driver works, and its indications for use⁷.

Regardless of which model Graseby® battery driven device is used, the size and brand of the syringe used is an important variable. It is important to note that different brands of syringes have different diameters and lengths. This

will impact 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.

The simplest way to overcome any error in relation to syringe type is to measure the syringe against the scale on the syringe driver every time it is changed. Another important consideration when selecting syringe type is to ensure it is a Luer-Lock® syringe^{6,12}. Luer-Lock® syringes are commonly recommended as they prevent accidental separation of the syringe from the infusion set¹⁰.

A piece of equipment that should be considered is a tamper-proof box, or a 'lock-box'. These lockable clear plastic covers have been devised to place over the driver 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 syringe driver. These covers simply provide protection for the device, but are not 'tamper proof'.

Management Guidelines

Table 1: General principles and assembly of Graseby® syringe drivers

Graseby MS16A principles	Graseby MS26 principles
<ul style="list-style-type: none"> • Blue colour plate, delivers dose in mm/hr. 	<ul style="list-style-type: none"> • Green colour plate, delivers dose in mm/24 hrs.
<ul style="list-style-type: none"> • To calculate rate take the length of the fluid in mm and divide it by the delivery time required in hours to arrive at a rate in mm/hr. For example, 48 mm of fluid divided by 24 hours will equal a rate of 2 mm per hour⁷. 	<ul style="list-style-type: none"> • To calculate rate take the length of the fluid in mm and divide it by the delivery time in days to give the rate in mm/24 hours. For example, 48 mm divided by one day equals 48 mm in 24 hours⁷.

Principles for both the MS16A and MS26

- Measured in length per time rather than volume per time – in millimetres, not millilitres^{6,7}.
- Use of the boost facility is not advocated because it lacks a lock-out period. If the boost is continually depressed, it will deliver 8 boluses before an alarm will sound. In theory, this could occur until the syringe is empty, resulting in the patient being over-medicated, and a shortened infusion time⁹.

- The boost dose rarely provides enough analgesia to cover uncontrolled pain, and if other drugs are being infused overdosing could occur of the other drug(s) concurrently. It is better to use breakthrough medication to treat uncontrolled symptoms than the boost facility¹⁴. 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 syringe driver.
- Take care to identify the device that is being used to avoid calculation errors^{7, 9}. In 1994 the UK Department of Health issued a hazard warning about the possible confusion between the Graseby® MS16A and MS26¹⁸ syringe drivers.
- The front panels of both drivers are similar, each having a length ruler, a start/test button, rate setting dials and a flashing indicator. Note: there is no 'off' button, the battery needs to be removed to turn the driver off.

Assembling the Graseby® syringe driver	
The Graseby MS16A	The Graseby MS26
Fill syringe with drugs prescribed, dilute to a maximum length of 48 mm—use millimetre scale on the device as reference (Note that this is different to the MS26).	Fill syringe with drugs prescribed, dilute to a maximum length of 60 mm ⁶ —use millimetre scale on the device as reference (Note that this is different to the MS16A).

Assembling the Graseby® syringe driver

The Graseby MS16A	The Graseby MS26
Each time a new line is used, prime the line prior to the connection ⁹ .	Each time a new line is used, prime the line prior to the connection ⁹ .
Set delivery rate, obtained by dividing the length of the barrel by the required infusion time - <i>calculated in hours.</i>	Set delivery rate. This is obtained by dividing the length of the barrel by the required infusion time - <i>calculated in days.</i>
Connect syringe to driver by sliding the actuator up towards the plunger of the syringe by pressing and holding the button on the side.	Connect syringe to driver by sliding the actuator up towards the syringe plunger by pressing and holding the button on the side.
Secure syringe into position using the rubber securing strap.	Secure syringe into position using the rubber securing strap.
Insert battery into device. An audible alarm should sound. This is the same sound heard if the infusion has ended, or the line is occluded.	Insert battery into the device. An audible alarm should sound. This is the same sound heard if the infusion has ended, or the line is occluded.

Assembling the Graseby® syringe driver

The Graseby MS16A

Pressing the 'start' button will silence the alarm, and activate the driver. The green light on the driver should flash every second^{6,8}. If this doesn't occur, the battery should be changed. The battery used is an alkaline 9V; each battery should deliver up to 50 daily infusions⁶. The green light will cease flashing approximately 24 hours before the battery is fully depleted⁶.

The Graseby MS26

Pressing the 'start' button will silence the alarm, and activate the driver. The green light on the driver should flash every 25 seconds^{6,8} – if this doesn't occur, the battery should be changed. The battery used is an alkaline 9V; each battery should deliver up to 50 daily infusions⁶. The green light will cease flashing approximately 24 hours before the battery is fully depleted⁶.

SECTION THREE

The selection, preparation and maintenance of the site

Summary Statement

The selection, preparation and maintenance of the site:

- General principles for appropriate site selection include⁶:
 - 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, semi-occlusive dressing to cover the site, as this permits inspection of the site by the caregiver^{8,9};
- Factors that cause site reactions include: the tonicity of the medication, the pH of the solution, infection and prolonged presence of a foreign body¹²;
- 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;
- The site should be inspected regularly. Four hourly is recommended, or more frequently if indicated, to identify early and reduce the risk of site related complications;
- 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}.

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 infusions via a syringe driver 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 axilla¹¹. This site is preferred because it is easily accessible, rarely oedematous, and permits easy inspection by the caregiver¹¹. 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 bruising⁶. 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 there is broken skin;
- 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 of the medication, the pH of the solution, infection and prolonged presence of a foreign body¹². Specific drugs used in palliative care that may cause site irritation include cyclizine^{6,10}, levomepromazine, methadone, promethazine, morphine tartrate and ketamine¹¹. 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 syringe⁹. 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 Teflon® or Vialon® cannulas reduces site inflammation^{6,8}.

One study from the UK suggests that 1500 units of hyaluronidase can be injected into the site prior to the infusion commencing if the skin is not already irritated. Hyaluronidase acts to macerate the subcutaneous tissue, thereby increasing drug absorption⁹. The injection only needs to be given once per site, not daily⁶. Hyaluronidase usage is uncommon within Australia for subcutaneous drug administration, being more commonly used for more rapid subcutaneous fluid administration for rehydration. This low dose of hyaluronidase is also contraindicated in patients with asthma⁹.

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 practice⁹.

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 cannula¹¹.

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): is their pain and other symptoms controlled?
- Ensuring that the light on the syringe driver is flashing, and a 'whirring' sound can be heard as the device delivers the infusion;
- 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, which is one of the preferred cannulas when using a syringe driver in clinical practice¹¹.

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 syringe driver are immuno-compromised. Ensure hands are washed thoroughly⁷.
- In consultation with the patient and family, select a suitable site⁷. Choose the site using the guidelines (see preferred sites).
- Select and use sites on a rotating basis².
- Prepare the skin using an alcohol swab, and wait for skin to dry.
- 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 BD Saf-T-Intima® is not being used, place the bevel of the metal device 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 pulled⁹. Use a transparent, semi-occlusive dressing to cover the site, as this permits inspection of the site by the caregiver^{8,9}.
- Connect the syringe to 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

Drugs and diluents

- Syringe drivers 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 syringe for a subcutaneous infusion (occasionally up to 4 drugs^{6,10});
- If compatibility is an issue, the use of two syringe driver 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} and check with hospital pharmacists;
- Use of the boost facility is not recommended because it rarely provides enough analgesia to cover uncontrolled pain, and if other drugs are being infused overdosing could occur of the other drug(s)⁶.
- 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 less commonly used in Australia⁸.

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 patient⁹. Pain is the most common symptom for which control is sought, but the use of syringe driver 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 syringe².

Commonly, two–three drugs and occasionally up to four drugs¹⁰ may be mixed in a syringe for a subcutaneous infusion. The maximum number of drugs that most clinicians are prepared to mix in a single syringe is four⁵. The more drugs that are mixed together, the greater the risk of precipitation and reduced efficacy⁹. It has been reported that a wide variety of drugs can be used in different combinations with no clinical evidence of loss of efficacy¹³. If compatibility is an issue, the use of two syringe driver 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 medications²³.

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}. 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 syringe driver device is placed on top of bed clothes and outside of clothing, rather than beneath them⁶.

Medications contraindicated for use in syringe drivers:

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 cyclizine⁶.

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 reactions¹¹. 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 precipitation¹⁶.

There is a need for ambiguities to be addressed by further research, given the lack of clinical evidence or recommendations regarding diluents¹⁵.

SECTION FIVE

Patient/family education needs

Summary Statement

Patient/family education needs

- Patient and family education promotes safety and acceptance of the syringe driver 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 guidelines⁹.

Careful explanation and education about what the device will do, and its advantages and possible disadvantages is required⁸. Patient and family education guidelines are outlined in Table 3.

Management Guidelines

Table 3: Patient and family education

Information about the device itself

- Syringe driver devices are very reliable.
- It is normal for the 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.
- It is normal for a green light to flash on the right hand side of the machine. If this light stops, the battery needs to be changed. Instruct the patient that it is a good idea to keep a spare 9 volt battery.
- Encourage the patient to get into the habit of checking that the light is flashing and the “whirring” sound is coming from the machine, but encourage them not to worry about checking it overnight.
- The machine has an alarm which is a constant piercing sound. Eventually the alarm will turn itself off. Instruct the patient not to panic if it alarms. It will alarm if the syringe is empty, or there is a blockage in the tubing.

Activities of daily living	
Carrying the syringe driver	Purchasing a belt bag to conceal and carry the device discreetly may be useful.
Showering	<p>The syringe driver must not be immersed in water and can be damaged by steam.</p> <p>Although it is possible to disconnect the driver for a short duration, disconnection from the syringe driver is not encouraged.</p> <p><i>If disconnection does occur:</i></p> <ul style="list-style-type: none"> • The patient does not need to turn off the syringe driver. It is important to inform the patient that they are unlikely to be affected in terms of worsening symptoms for the brief period that the syringe is disconnected from the device, but should also be informed that they will not receive any medication from the syringe driver while it is disconnected. • Once the syringe is replaced into the syringe driver the patient or family will need to press the start/boost button to recommence the infusion.

<p>Extra pain or breakthrough of unrelieved symptoms</p>	<p>The patient may require reassurance that although they may continue to experience some pain, breakthrough medication can be given on these occasions¹⁴. (*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 syringe driver).</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 syringe driver, or if the alarm sounds, reassure them that it is likely to be an easy problem to rectify. • 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. • If the alarm is sounding, take out the battery as that is the only way to stop the noise. <p><i>Check:</i></p> <ul style="list-style-type: none"> • If there is a kink in the tube - untwist it. • If the syringe is disconnected from the machine, attach it again with the black strap. Replace the battery and press the “start” button. • 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.

SECTION SIX

Patient assessment and troubleshooting guidelines

Summary Statement

Patient assessment and troubleshooting guidelines

- 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 syringe driver is set up;
- Use only one type of syringe driver in each setting to prevent confusion which may lead to errors^{6,8,10,18};
- 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 9 volt battery 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:
 - 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;
 - 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 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 an intermittent ‘whirring’ sound;
- There is a flashing light which indicates that the syringe driver is functional.

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.
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-Lock® syringes; • Carefully inspect tubing, at least 4 hourly, and document findings.

<p>4) Inappropriate dosages being delivered due to:</p> <ul style="list-style-type: none"> • Confusion over the type of syringe driver device • Device running too fast/ too slow • Incorrect setting or setting moved • Confusing millimetres with millilitres • Different policies/practices regarding priming of the line 	<ul style="list-style-type: none"> • Ensure only one type of syringe driver is used in each setting to prevent confusion; • Always measure the syringe 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. • Ensure only one type of syringe driver is used in each setting to prevent confusion. • Ensure that organisational protocol is followed regarding priming of the line (refer to Section One of these guidelines).
<p>5) Calculation errors</p>	<ul style="list-style-type: none"> • Ensure that all drug calculations are checked according to legislative requirements and organisational policy and protocols when the syringe driver is set up.

<p>6) Tampering with boost button facility or syringe driver settings</p>	<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.
<p>7) Battery running flat</p>	<ul style="list-style-type: none"> • Ensure that a spare 9 volt battery is always available; • Ensure that the light is flashing on the syringe driver.

Management Guidelines

Table 5: Troubleshooting		
Clinical situation	Possible cause(s)	Suggested solution(s)
<p>Pump alarms (long, continual 'beep' which will stop after a while)</p>	<ul style="list-style-type: none"> • The syringe may be empty; • Tubing is kinked, needle is blocked, plunger is jammed; • Battery is flat. 	<ul style="list-style-type: none"> • Re-fill syringe; • Un-kink tubing; check plunger is not sticking; • Change battery.
<p>Infusion has not run to time</p>	<ul style="list-style-type: none"> • Rate set incorrectly, or has been altered; • Scale length measured incorrectly; • Pump has been immersed in water. 	<ul style="list-style-type: none"> • Set correct rate—consider tamper-proof box; • Re-measure syringe—check measurement; • Instruct that pump should not be immersed.

<p>Infusion has ended too early</p>	<ul style="list-style-type: none"> • Boost button may have been activated; • Rate could be set incorrectly, or it has been altered; • Check the scale length has been measured correctly. 	<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; • If rate has been incorrectly set, recalculate; • Remeasure the scale length to ensure accuracy.
<p>Infusion has yet to be completed</p>	<ul style="list-style-type: none"> • Pump has been stopped; • Actuator may not have been flush against the plunger when infusion commenced; • Scale length measured incorrectly; • Rate setting is incorrect. 	<ul style="list-style-type: none"> • Check why the pump may have stopped. Flat battery? Syringe empty? Occlusion? – implement corrective action; • Check actuator is flush against the plunger; • Remeasure scale length to ensure accuracy; • Repeat rate calculation.

Clinical situation	Possible cause(s)	Suggested solution(s)
<p>The infusion has stopped (i.e. the light is not flashing)</p>	<ul style="list-style-type: none"> • Infusion has finished; • Line is blocked, or cannula is blocked; • Possible battery problem; • Drugs have precipitated; • Inflammation at the site; • Syringe incorrectly fitted; • Mechanical malfunction. 	<ul style="list-style-type: none"> • Reload syringe 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. • If the drugs precipitate (crystallise) in the syringe, discard the mixture. To prevent this happening again, you could 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 simplified, or two pumps used⁷. • Change site; • Continue to observe site for resolution of inflammation. • Recheck set-up of driver. • Send for maintenance.

Clinical situation	Possible cause(s)	Suggested solution(s)
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 (http://www.amh.net.au); • Possibility of terminal delirium; • Pain—check bladder, bowel etc. 	<ul style="list-style-type: none"> • Treat the underlying cause as appropriate. • Consider re-siting 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, eg. insert an IDC if necessary.

Clinical situation	Possible cause(s)	Suggested solution(s)
<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 syringe causing irritation; • The site is infected; • Syringe contains drugs not appropriate for subcutaneous infusions; • Shallow cannula insertion. 	<ul style="list-style-type: none"> • Resite the needle, and observe for abscess formation. • Resite to area not previously treated. • Dilute the concentration using a larger syringe - i.e. change from 10 to 20/30ml syringe. • Remove cannula, and observe for clinical signs of infection • Ensure that drugs are suitable for the subcutaneous route; • Adding 1mg of dexamethasone to the syringe may reduce site irritation. • Remove and resite the cannula, and observe the old site for signs of infection.

Clinical situation	Possible cause(s)	Suggested solution(s)
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.
Patient reports unrelieved pain and control of symptoms	<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"> • Ensure syringe connections are secure—use Luer Lock® device; • Check all connections, changing components as necessary. • Consult medical staff to review medications; • Give available breakthrough doses until optimal symptom control is achieved.

Clinical situation	Possible cause(s)	Suggested solution(s)
<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 syringe drivers in palliative care to achieve symptom control is standard and accepted practice. There are many benefits that syringe drivers present to the patient in terms of convenience and effective management of symptoms. However use of this device has not been without its risks and limitations, including the inflexibility of prescription, technical problems, safety issues and skin reactions at the site of the infusion.

Syringe drivers may also cause concerns and fears for some patients and their families because they are associated with disease progression.

The guidelines presented in this report 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	<ul style="list-style-type: none">• Systematic Review (with homogeneity) of Experimental studies (eg. Randomised Control Trial with concealed allocation);• Or 1 or more large experimental studies with narrow confidence intervals.
2	Quasi-experimental studies (eg. without randomisation).
3	3a. Cohort studies (with control group); 3b. Case-controlled; 3c. Observational studies without control groups.
4	Expert opinion without explicit critical appraisal, or based on physiology, bench research or consensus.

1. Joanna Briggs Institute. Levels of Evidence. Joanna Briggs Institute. Available at <http://www.joannabriggs.edu.au/pubs/best_practice.php>. Accessed April 18th, 2005.

Appendix B - Literature Summary

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
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
Dickman A, Littlewood C, Varga J. The Syringe Driver. Oxford: Oxford University Press; 2002.						
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
<p>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.</p>						
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.
<p>Flowers C, McLeod F. Diluent choice for subcutaneous infusion: a survey of the literature and Australian practice. <i>International Journal of Palliative Nursing</i> 2005;11(2):54-60.</p>						
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 contra-indicated. 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, Habegger L., Wade M, Fisher J, Ashby M. Evaluation of training on the use of Graseby syringe drivers for rural non-specialist 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

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
<p>Lichter I, Hunt E. Drug combinations in syringe drivers. The New Zealand Medical Journal 1995;108(1001):224-226.</p>						
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 the 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 patients in whom continuous subcutaneous infusion was used, was recorded. The incidence of skin reactions with the different drugs was noted. The efficacy of combinations used was assessed clinically	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 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

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
McNeilly P, Price J, McCloskey S. The use of syringe drivers: a pediatric perspective. International Journal of Palliative Nursing 2004;10(8):399-404.						
3	N/A	Examine specific issues concerning the use of SD when caring for children and young people	N/A	Evidence based guidelines	N/A	N/A
McQuillan R, Finlay I. The utilization of syringe drivers at a teaching hospital. Palliative Medicine 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 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.

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
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 SD, & discusses a range of potential problems & 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
<p>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. Palliative Medicine 2001;15:149-154.</p>						
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%).
<p>Ratcliffe N. Syringe drivers. Community Nurse 1997;3(6):25-26.</p>						
4	N/A	N/A	N/A	Instruction guidelines	N/A	N/A

Level of Evidence	Sample (if applic)	Setting	Aims	Design	Methods	Results
<p>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.</p>						
3	Seventy-six palliative patients requiring subcutaneous infusions were involved; a total of 217 syringe driver days	Hospital in South-east 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, post-intervention it 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, double-blind 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 through 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.
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
PalliativeDrugs.com. 'Syringe drivers.' < www.palliativedrugs.com >. Accessed 25th January, 2005.						
4	N/A	N/A	N/A	Drugs used in palliative care website	N/A	N/A

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

DRUG	INDICATION	COMMON DOSAGE	VOLUME
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 oral morphine. Morphine is physically compatible with the 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) 120mg/1.5ml; 400mg/5ml
hyoscine hydrobromide (Hyoscine)	Antimuscarinic useful for drying secretions (e.g. sialorrhoea, drooling, death rattle), intestinal colic, inoperable bowel obstruction.	200-400 microgram SC stat 600-1200microgram per 24 hours.	400 microgram and 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
hydromorphone (Dilaudid)	Opioid for pain control. Often used when morphine is not effective, or tolerated, in an attempt to control symptoms.	There is no maximum dosage of hydromorphone. Usual starting dose is 2-4 mg per 24 hours, can be increased if pain uncontrolled.	2mg/ml; 10mg/ml as 1 & 5ml 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, 1.5-5 mg over 24 hours. To control delirium associated agitation, 5-20 mg over 24 hours.	5mg/ml

DRUG	INDICATION	COMMON DOSAGE	VOLUME
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.	5-60 mg over 24 hours.	5mg/ml
metoclopramide (Maxolon)	An antiemetic and gastro kinetic, indicated when nausea is associated with gastric/ bowel stasis.	30 –120 mg over 24 hours. Occasional extrapyramidal side effects.	10mg/2ml
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/2ml
fentanyl	An opioid for pain control. Not commonly given in the community as not PBS listed.	600 mcg/24 hours in a subcutaneous infusion equivalent to a 25 mcg/hr fentanyl patch.	500 mcg in 10 ml 100 mcg in 2 ml 50 mcg in 1 ml

* This appendix is intended as a guide only²³. It is important to refer to Hospital guidelines and onsite Pharmacist support.

Please refer to the Disclaimer on Pg 2. To determine drug incompatibilities, you should refer to your Pharmacy Manual, or refer to your onsite Pharmacist¹⁹.

Acknowledgements

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References

1. Joanna Briggs Institute. Levels of evidence. Joanna Briggs Institute. Available at: http://www.joannabriggs.edu.au/pubs/best_practice.php. Accessed April 18th, 2005.
2. Gomez Y. The use of syringe drivers in palliative care. *Australian Nursing Journal* 2000;2(suppl 1-3).
3. Coleridge-Smith E. The use of syringe drivers & Hickman lines in the community. *British Journal of Community Nursing* 1997;2(6):292, 294, 296.
4. McQuillan R, Finlay I. The utilization of syringe drivers at a teaching hospital. *Palliative Medicine* 1996;10(1):52.
5. 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 Ireland. *Palliative Medicine* 2001;15:149-154.
6. Dickman A, Littlewood C, Varga J. The syringe driver: continuous subcutaneous infusions in palliative care. Oxford: Oxford University Press; 2002.
7. Ratcliffe N. Syringe drivers. *Community Nurse* 1997;3(6):25-26.
8. PalliativeDrugs.com. 'Syringe drivers.' <www.palliativedrugs.com>. Accessed 25th January, 2005.
9. Mitten T. Subcutaneous drug infusions: a review of problems and solutions. *International Journal of Palliative Nursing* 2001;7(2):75-85.
10. McNeilly P, Price J, McCloskey S. The use of syringe drivers: a paediatric perspective. *International Journal of Palliative Nursing* 2004;10(8):399-404.
11. Dickman A, Schneider J, Varga J. The syringe driver: continuous subcutaneous infusions in palliative care. 2nd ed. Oxford: Oxford University Press; 2005.
12. 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.
13. Lichter I, Hunt E. Drug combinations in syringe drivers. *The New Zealand Medical Journal* 1995;108(1001):224-226.

14. Lloyd-Williams M, Rashid A. An analysis of calls to an out-of-hours palliative care advice line. *Public Health*. 2003;117(2):125.
15. Flowers C, McLeod F. Diluent choice for subcutaneous infusion: a survey of the literature and Australian practice. *International Journal of Palliative Nursing* 2005;11(2):54-60.
16. British National Formulary. 'Syringe drivers.' <www.bnf.org>. Accessed 26th January, 2005.
17. 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.
18. 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.
19. Palliative Care Matters. <www.pallcare.info>. Accessed September, 2005.
20. Dunne K, Garvey A, Kernohan G, Diamond A, Duffy C, Hutchinson J. An audit of subcutaneous syringe drivers in a non-specialist hospital. *International Journal of Palliative Nursing* 2000;6(5):214, 216-219.
21. Hayes A, Brumley D, Habegger L, Wade M, Fisher J, Ashby M. Evaluation of training on the use of Graseby syringe drivers for rural non-specialist nurses. *International Journal of Palliative Nursing* 2005;11(2):84-92.
22. Reymond L, Charles MA, Bowman J, Treston P. The effect of dexamethasone on the longevity of syringe driver subcutaneous sites in palliative care patients. *Medical Journal of Australia* 2003;178:486-489.
23. Joint Therapeutics Commission. A survey of doctors on their preferred medications for various symptoms in palliative care. Brisbane: Unpublished data; 2005.