Buyers’ guide

Intravenous fluid warming devices

CEP10013

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CEP buyers’ guides are intended to provide prospective purchasers of healthcare products on the UK market with general guidance on the technical, operational, and economic considerations to be taken into account in selecting the most appropriate product where a range of similar products exists. They do not include product-specific information, which is published separately via market reviews (which contain product specifications and expert commentary) or evaluation reports (which contain additional technical and / or user evaluation data). Readers are encouraged to check CEP’s web site for updates.

Scope

Intravenous (IV) fluid warming is a method of raising the temperature of fluids administered to a patient, to maintain normal body temperature. IV fluid warming devices are used in operating theatres and recovery rooms or the critical care environment. The clinical staff that use IV fluid warming devices are those who care for patients in these settings, including nurses, operating department practitioners, anaesthetic assistants and anaesthetists.

This buyers’ guide applies to intravenous (IV) fluid warming devices that:

- are routinely used in operating theatres, post anaesthetic recovery rooms, Intensive care units and the emergency unit
- are available in the UK and are CE marked.

All devices for warming blood that meet the above criteria are also included in the report. Warming cabinets are excluded, since these are not recommended by NICE for warming IV fluid or blood for use during surgical procedures.

There is a large variation in the design of IV fluid warming devices, and the intended uses and capabilities of the devices. It is important that the specification of the device used meets clinical requirements for each scenario. If flow rates are used exceeding the specification of the device, the fluid may not be adequately warmed.

Inadvertent perioperative hypothermia

Inadvertent perioperative hypothermia is a common and preventable complication of surgery. Hypothermia is defined as a drop in core body temperature below 36°C and is associated with poor outcomes for patients as outlined below[1].

Inadvertent perioperative hypothermia is distinguished from the deliberate induction of hypothermia for medical reasons eg during cardiac surgery [1]. In this document ‘hypothermia’ refers to inadvertent perioperative hypothermia as defined above.
Causes of inadvertent perioperative hypothermia

During the first 30 to 40 minutes of anaesthesia, a patient’s temperature can fall below 35ºC. The reasons for hypothermia include [1]:

- loss of the body’s normal response to cold due to anaesthetic drugs
- dilation of peripheral blood vessels (also due to anaesthetic drugs) causing redistribution of core heat and heat loss
- patients getting cold while waiting for surgery
- exposure of the body during surgery
- fluid deprivation before anaesthesia
- the use of unwarmed intravenous (IV) or irrigation solutions.

The degree of heat loss is also influenced by operating theatre air temperature, airflow and skin preparation [1].

Consequences of inadvertent perioperative hypothermia

The possible consequences of hypothermia are [1]:

- increased risk of wound infection
- increased blood loss during and after surgery
- longer recovery from anaesthesia
- shivering and feeling cold after surgery
- heart problems during and after surgery
- altered drug action
- reduced patient satisfaction
- longer hospital stay.

Prevention of inadvertent perioperative hypothermia

Simple measures before and after surgery, such as wearing warm clothing and using a duvet or blankets on the hospital ward can help to prevent hypothermia [1].

There are also several types of active patient warming device that have been designed for use in the operating theatre and critical care environment [1]. These include:

- electric (including carbon polymer) blankets and mattresses
- heated fluid filled mattresses and garments
- electric radiant heaters
Introduction

- intravenous fluid warmers
- forced air warming devices [2-4].

These technologies, other than IV fluid warmers, have not been assessed as they are outside the scope of this Buyers Guide. Information on forced air warming devices is available in CEP publications [2-4].

National guidance

The National Institute for Health and Clinical Excellence (NICE) recommends that all intravenous fluids (500 ml or more) and blood products should be warmed to 37°C using a fluid warming device (not in a warming cabinet) [1]. NICE also suggest that service managers ensure that there is an adequate provision of fluid warming devices in theatres [5].

These recommendations apply to healthcare providers in England, Wales and Northern Ireland, and health professionals (and the organisations who employ them) are expected to take them fully into account when deciding what treatments to provide [6].

The NICE guideline included a systematic literature [1] of clinical evidence and constructed economic models. The findings included:

- “for all scenarios modelled, fluid warming was cost effective compared with usual care (unwarmed fluids)”. They also noted that fluid warming on its own may be unreliable since a patient requiring few fluids may not be adequately warmed. Forced air warming plus warmed fluids option is likely to be the most cost effective strategy.

- only one report of adverse effects of IV fluid warmers was found.

- no comparison was made between different types of IV fluid warmer.

- warming cabinets and IV fluid warming devices were compared. This resulted in weak evidence to show no significant difference between these methods, but there was insufficient information on the volume of fluids and the method of significance testing. After discussion, the use of fluid warming devices, was therefore recommended.

Warming of intravenous fluids is an integral component of the strategy to maintain body temperature perioperatively, and therefore reducing the risk of hypothermia. Maintaining normal body temperature is also widely recognised as an important
factor in reducing wound infections[1]. Patient warming is included in the World Health Organisation (WHO) surgical safety checklist adapted for England and Wales by the National Patient Safety Agency (NPSA) [7]. The reduction of wound infections by maintenance of normal body temperature is promoted as a key factor in the Patient Safety First campaign in England [8] and the 1000 lives campaign in Wales [9].

The Association for Perioperative Practice (AfPP) states as a standard that there should be a system in place for managing the risk of perioperative hypothermia for patients undergoing a clinical intervention [10]. The recommendations for achieving this include IV fluid warming using a fluid warming device fit for the purpose and used in accordance with the manufacturer’s instructions [10].

The Medicines and Healthcare products Regulatory Agency (MHRA) provides general guidance on the purchasing, deployment, maintenance, repair and disposal of all medical devices [11]. They also publish medical device alerts and field safety notices on all medical devices, including fluid warmers [12-22].

The British Committee for Standards in Haematology (BCSH) [23] has published guidelines for blood transfusion that include infusion devices, administration sets and fluid warming. They state that blood should only be warmed using approved, specifically designed and regularly maintained blood warming equipment with a visible thermometer and audible warning. They require that any blood administration set should have an integral mesh filter (170-200 micron) and that the set should be changed at least every 12 hours (or in accordance with manufacturer’s instructions).

Standards for Infusion Therapy is published by the Royal College of Nursing (RCN) [24] and contains guidance on the whole process of infusion including the use of fluid warmers, filters and other components of administration sets.

A technical evaluation for the Welsh Assembly Government has been completed by another independent test body (Surgical Materials Testing Laboratory, Bridgend, South Wales) and results will be published on at a later date. [25]

Scale of use

All intravenous fluids (500 ml or more) and blood products should be warmed to 37°C [1]. NICE found only limited data on the number of patients who currently receive warmed IV fluids and blood products, and therefore used a conservative estimate of 30% of all patients undergoing general anaesthetic of greater than 30 minutes, which is equivalent to over 600,000 uses per year, in England, for 2006/7 [5]. Following the NICE recommendation to warm all IV fluids over 500ml it is likely that most procedures involving general anaesthetic for greater than 30 minutes will require IV
fluid warming. This is used for estimating numbers, however iv fluid should still be warmed if required for procedures of less than 30 minutes. This results in the proposed number of fluid warming instances growing to over 1.7million per year, an increase of 1.1 million from that estimated in 2006/7.
Technical Overview

To deliver warmed blood or IV fluids to the patient, the fluid must first travel from its origin, generally a fluid bag, or less commonly a fluid reservoir, then through the tubing of the disposable administration set before passing through the patient’s cannula. If the fluid is blood, then the administration set should include a blood filter [23]. The fluid is warmed in the device’s heat exchanger which may cause air to bubble out of solution. An air trap or an air detector may be included in the system to capture any escaping gas before the fluid passes through the cannula and into the patient. This is shown schematically in the diagram below (figure 1). The precise arrangement of components varies between devices. Devices may require the use of a specific administration set that is designed only for that device. Alternatively some devices allow the use of a standard administration set.

Figure 1 Schematic representation of fluid flow through a typical IV fluid warming device

The method of warming fluid is variable. All devices are powered by electricity (mains or battery), and apply heat to the fluid, normally through the wall of the administration set, as the fluid passes through a heat exchanger. The temperature of the heated fluid at the point where it enters the patient depends on many factors, including:

- the starting temperature of the ‘cold’ fluid
- temperature setting of the heat source and the device having sufficient power to maintain this temperature, as the fluid absorbs heat.
- the period of time the fluid spends in the heat exchanger, longer times allow greater heating. This depends on the fluid flow rate, exchanger volume and device design.
the surface area of the heat exchanger, larger surfaces allow greater heating.

the amount of heat lost through the tubing wall when fluid exits the heat exchanger and travels to the patient; this depends on the length, and degree of insulation provided by this section of tubing, air temperature and flow rate.

Fluid warming devices are designed to overcome the issues outlined above and maintain fluid temperature close to that set by the operator of the device. This has led to different specifications and functionality of devices which can be viewed in the market review accompanying this buyers’ guide [26].

In devices where the reference point is close (eg within a few cm) to the patient the problem of heat loss is minimised, meaning that the operator has more accurate information on the temperature of the fluid entering the patient. In these devices the heat output adjustment is based on the fluid temperature at the point it enters the patient, rather than the temperature within the device.

Manufacturer supplied specifications for device performance are not provided in a consistent format, and therefore, to understand the heating performance of specific devices, the following specification information should be considered:

- output fluid temperature at different flow rates, with a known input temperature
- where the temperature measurement is taken (reference point)
- flow rates at different cannula sizes.

**Warming methods**

**Plate warmer**

**Overview:** Plate warmers heat either one or more large flat metal plates to the desired temperature to heat the fluid.

**Administration sets:** Plate warmers require a device specific administration set with a flat section in contact with the heated plate.

**Benefits and issues:** The shape of the plates allows a large area for heat exchange.
Drum warmer
Overview: Drum warmers use a heated metal drum, which is either cylindrical or cone shaped. The IV line is wound multiple times around grooves in the drum allowing time and contact area for heat exchange.

Administration sets: Drum warmers generally allow for the use of a standard IV line, rather than requiring a device-specific administration set. The grooves may be appropriate for a specific diameter IV line.

Benefits and issues: In some devices more than one IV line may be wrapped around the drum, but with each having fewer turns around the drum. This allows two fluids to be warmed at the same time, but reduces the time and area for heat exchange for each fluid, meaning that the maximum flow rates for effective heating are reduced.

Counter current warmer
Overview: The warmer heats a recirculating fluid. This fluid passes in the counter direction to the IV fluid, with both contained in separate tubes or channels. The arrangement for the flow varies between devices.

Administration sets: A device specific administration set is normally used.

Benefits and issues: There is a small risk that if the tubing is pierced or damaged there may be cross contamination between the fluids [1]. This could lead to loss of sterility of the IV fluid and the introduction of undesirable fluid into the patient.

Induction warmer
Overview: Induction warmers operate in a similar way to an induction hob cooker – an electromagnetic field induces heat in a metal component of the administration set, and this metal component heats the IV fluid.

Administration sets: These devices require device-specific administration sets, since the set must contain a conductive material in which heat can be induced.

Benefits and issues: All heat is generated within the administration set.

Infra red warmer
Overview: Infrared radiation is part of the same energy spectrum as visible light, but with a longer wavelength that causes heating. In infrared warmers, halogen lamps are used to emit infrared radiation, and thus heat the IV fluid.

Administration sets: A device-specific set may be required.
Warm air

**Overview:** Warm air devices warm fluid via an accessory to a forced warm air device. The warm air that is generated for patient warming heats the IV fluid circulating through the accessory.

**Administration set:** A device-specific set may be required.

**Benefits and issues:** Warm air devices are typically only suitable for low flow rates.

Sleeve on patient line

**Overview:** A heated sleeve around the patient line can be used either to warm the fluid at low flow rates, or to maintain the warmth between a warming device and the patient. The sleeve may be heated electrically or by using a heated recirculating fluid.

**Administration set:** A standard administration set can normally be used.

**Benefits and issues:** The fluid is heated right up to delivery to the patient, minimising heat loss. This is particularly important at low flow rates.

Temperature measurement

The purpose of temperature measurement in IV fluid warming devices is to indicate to the operator the temperature of the warmed fluid entering the patient. Temperature measurements either record the temperature of the IV fluid itself, the heating element or recirculating fluid. They may be taken within the device, or close to the point of administration to the patient.

In order to have the most accurate temperature measurement of the fluid entering the patient, measurements should be ideally be taken within the IV line as close to the patient as possible. An inherent problem in measuring the temperature of the sterile fluid in the administration set is that sterility will be compromised if a temperature probe is introduced into the IV line.

Measuring temperature at the device rather than the patient does not indicate the amount of heat lost between the device and the patient, or indicate if the desired fluid temperature was achieved at the device. There can be a significant difference between the desired temperature and that achieved due to heat loss at low flow rates, and inadequate heating at high flow rates. The practical implications are that:

- the operator believes the fluid to be warmed to the set temperature, when it is in reality at a lower temperature
Technical considerations

- the device receives feedback that the set temperature is reached, leading to a reduction in heating effort.

This discrepancy explains why devices may use temperature settings higher than normal body temperature.

Flow control

The simplest form of flow control is to use gravity to drain fluid from a bag, with a roller clamp to control the flow. Some devices are suitable for use with fluid under pressure (up to 300 mmHg) resulting in an increase to fluid flow rates. Increased pressure may be achieved using a separate fluid pump, which can be attached to the fluid warming device, or using a pump that is integral to the warming device itself.

Air detection and removal

Warming the IV fluid may cause air to be released from solution, forming bubbles. Air may also enter the system during setting up or in use, although the risk is reduced by following recommended procedures. If air is delivered to the patient in the IV line it can have very serious implications and therefore must be removed beforehand. Where the fluid is pressurised, or the warming device includes a fluid pump, the need for air detection and removal is greater.

Bubble trap: This term often indicates a simple drip chamber, but may be used by some manufacturers for a more sophisticated design. It may occur before or after the warming device.

Gas venting membrane: This is a semi-permeable membrane that allows gas to pass through it whilst being an impermeable barrier to the infused liquid.

Air detection systems: Typically these use ultrasound to detect small bubbles in the fluid. When air is detected the device stops fluid flow and warns the user. The bubbles may then be removed manually.

Most standard IV administration sets contain a bubble trap, in the form of a drip chamber. Device specific sets may already include a bubble trap or gas venting membrane. Both of these methods seek to remove air from the system automatically, they do not warn the user of the presence of air, or stop fluid flow.

Where present, air detection will not automatically remove gas, but will stop the fluid flow and warn the user so that bubbles may be removed manually. It may be that an air detection system is used in conjunction with a bubble trap or venting membrane.
If the air detector is electrically operated, it requires power to function. The operator should be aware that there will be no air detection in the event of a power failure, any air in the system would be delivered to the patient. There are also alternative systems that can stop fluid flow in the presence of air without power.

Over temperature setting

Devices use temperature measurement to control heating and have an over temperature limit at which heating stops. Generally the device must be switched off before the alarm is reset.

Devices may use several sensors to trigger a cut-off in addition to the normal temperature control. This will switch off the heating mechanism, but will not normally interrupt fluid delivery. Since heat will be retained in the device (eg in the heating plates, or circulating fluid) the IV fluid will still be heated to some extent.

Heat loss

Ideally all the heat generated by the warming device would be used to heat the IV fluid and would remain in the fluid all the way to the patient. In practice heat may be lost through:

- heat transfer to the device components as well as fluid
- heat loss from the device, to air
- heat loss from the IV line between patient and device to air.

The first issue may partially be addressed by the heating technology itself, for instance in an induction heater, all the heating will be within the administration set.

The second and third issues may be addressed through adequate insulation. Where the administration set is inserted into the device, heat losses to air will be minimised. On a drum heater however, the IV line is exposed to air, and there will be some heat losses even as it is being heated. This does not stop the fluid warmer from working successfully, but may mean that increased energy is required to achieve a given temperature and flow rate. Heat loss will be reduced if the device has an insulating cover.

Finally, the line between the patient and device should not be longer than necessary. The cooling effect is significantly higher for slower flow rates with uninsulated IV lines. Some devices offer an insulation sleeve as an accessory, others offer a sleeve
that actively heats the fluid. This may be as the main means of warming, or as an additional accessory.

Filter

BCSH [23] requires that all blood administration sets should contain an integral mesh filter (170-200 micron). This may be included in a standard blood administration set, or in some device specific administration kits.

RCN guidance is that all infusions sets should contain in-line filtration appropriate to the solution being administered. For example, 15 micron or less for clear fluid, 170-200 micron for blood components.
Operational considerations

Staff training

BCHS states that individuals using any type of infusion device should be able to demonstrate competency in their use [14]. The same document also outlines procedures to ensure the safe transfusion of blood with which staff should be familiar and which should be included in operational procedures.

Where a hospital uses several types of fluid warmer, there is an increased risk of user errors when staff move between areas, potentially using different types of devices. In these situations operators should ensure that they are competent with each device that they use, and be aware of differences in operation.

Temperature settings

Staff must be aware that the temperature displayed on the device may need to be higher than the optimum temperature for fluid delivery. This is to allow for cooling between the device and the patient. The user should know where the display temperature is measured and the effect that this, combined with the flow rate, have on the delivery temperature. This is also important when the user is able to choose the temperature setting on the device.

Device mounting

Warming devices are typically set up on IV poles which may become unstable if the device is placed too high on the pole. Manufacturer instructions on the correct positioning the device should be followed. Some devices may be mounted in different orientations; on bed rails, table tops, or alternative positions.

Standardisation

Limiting the variety of devices and consumables within and across NHS organisations can both improve safety and reduce costs. Scope for human error is reduced if there are fewer different set up procedures, or administration sets. Costs are reduced by reducing the complexity of stock control and storage and increasing orders with one supplier which may allow a discount to be negotiated. This has to be balanced with different clinical needs for different cases, given the variety in flow rates that are achieved at a given temperature by various devices.

Standard vs device specific administration sets

Using a standard IV set can reduce the variety of stock used and improve standardisation. It may also reduce the cost of consumables. The user may need to add components such as filters or bubble traps, the cost for which should be included in any financial considerations. It also limits the design of the warming device to one
that accepts a standard IV set. Typically this means a drum warmer, however there are some alternative devices available.

A device-specific IV set is likely to be more complex and may be more expensive. It may include additional functionality, and will generally allow for greater variation in the device design, which has the potential to give improved heating performance and ease of set up.
Cost effectiveness

NICE evaluated the overall cost information, together with published studies of outcomes with and without active patient warming, to look at the cost effectiveness, and economic case for adoption. The normal measures adopted by NICE for such equations are the cost per quality adjusted life year (QALY). NICE found the purchase and use of IV fluid warming devices on administering quantities of fluids of 500ml or more, to be cost-effective, even for short, low risk procedures. The benefits were calculated using a threshold of £20,000 per QALY. They also found that the most cost-effective procedure was to use IV fluid warming in conjunction with forced warm air.

NICE estimated that fluid warming devices should be used in over 1.7million procedures in England, after full implementation of the guideline [5]. Their estimation of the total costs associated with the implementation of this guideline is based on the cost of disposable administration sets, since many fluid warming devices are leased or loaned free of charge with an agreement to purchase disposables. NICE highlighted a large variation in the prices of these disposable sets (£4.16 to £21.48 per set although it was noted that lower prices may be available). Estimated costs for implementation in England are shown in Table 1 for three prices of disposable set[5].

Table 1. Costs of implementing NICE recommendations

<table>
<thead>
<tr>
<th>Estimated incidences of general anaesthetic &gt;30 mins</th>
<th>Estimate of percentage warmed (%)</th>
<th>Occurrences of warming</th>
<th>Estimated cost for varying disposable set costs (£000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,087,727</td>
<td>30</td>
<td>626,318</td>
<td>£2,605 £6,300 £13,453</td>
</tr>
<tr>
<td>2,087,727</td>
<td>85</td>
<td>1,774,568</td>
<td>£7,382 £17,852 £38,118</td>
</tr>
<tr>
<td>1,148,250</td>
<td>85</td>
<td>1,774,568</td>
<td>£4,777 £11,551 £24,664</td>
</tr>
</tbody>
</table>

Some of this cost is offset by potential savings. NICE only considered the cost of surgical site infections (SSI). They estimated that there were potential savings of £21 million annually from using active patient warming (including the use of both forced air warming and IV fluid warming) in England. Inclusion of potential savings from avoidance of other complications further supports the financial argument to introduce IV fluid warming in peri-operative hypothermia avoidance.

Whole life costs

The bulk of the cost will be from consumables List prices for consumables in 2010 are in the market review that accompanies this buyers’ guide [26].
IV fluid warming devices can be bought outright, or it may be possible to lease the device. Maintenance costs, energy consumption and disposal costs are a very small proportion of the overall lifetime cost, but should be allowed for.

Device specific administration sets may be more expensive, but they may offer specifications that other devices using standard administration sets cannot as outlined earlier in this report. Purchasers need to take into account both the full lifetime cost and clinical performance of devices when selecting the most suitable device for their requirements.

**Worked example for cost calculation**

An example calculation is shown below. Figures for device costs, power used and weight and cost of administration sets will vary widely depending on the choices made locally. Disposal costs and utility costs will also vary locally. The scale of use is based upon Cardiff and Vale University Health Board (UHB), a large, tertiary care and teaching centre with two surgical hospitals, twenty five operating theatres and a critical care department, assuming full implementation of the guidelines.

Cardiff and Vale UHB performs an estimated 32,000 surgical procedures each year under general or spinal anaesthesia [27]. This example assumes that 85% of these patients receive IV fluid warming. In reality, some patients may not require IV fluid warming. The number of devices required has been estimated from this figure, rather than the number actually in use.

**Cost estimation for purchase of disposable IV fluid administration sets**

Applying a price of £10 per administration set to 27,000 unit creates an annual administration set purchase cost of £270,000. Any additional items (such as filters, if required) should be added to the cost of the set if not included.

<table>
<thead>
<tr>
<th>No. of sets used per year</th>
<th>Cost per set (£)</th>
<th>Total cost of sets per year (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27,000</td>
<td>10</td>
<td>270,000</td>
</tr>
</tbody>
</table>

**Maintenance**

Most devices require little maintenance. It may be necessary to check or calibrate temperature sensors, and for counter current devices it will be necessary to change the recirculating fluid. The cost of maintenance will vary according to local policy. Assumptions are:

- annual cost for servicing medical equipment using internal clinical engineering staff of 7.5% of the device’s capital value [28].
- capital value per device of £2200 [1].
Economic considerations

### Cost estimation for IV fluid warmers

<table>
<thead>
<tr>
<th>No. of IV fluid warmers</th>
<th>Capital value of each warmer (£)</th>
<th>Annual service cost of 7.5%</th>
<th>Total servicing cost per year (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>2200</td>
<td>0.075</td>
<td>9,570</td>
</tr>
</tbody>
</table>

### Cost estimation for disposal of administration sets

Both the device and the disposable administration sets must be disposed of at the end of their life. The volume of sets will normally be much greater and therefore be most of the cost. The sets will be disposed of as clinical waste. Local policies will determine the appropriate disposal cost, however it may be possible to shred and heat treat plastic sets. Sets that contain metal require incineration which is more expensive. Assumptions are:

- weight of 170g per set
- clinical waste haulage, processing and disposal fee of £280 per tonne

<table>
<thead>
<tr>
<th>No. of sets used per year</th>
<th>Weight of each set (g)</th>
<th>Total weight of sets (g)</th>
<th>Conversion factor, grams to tonnes</th>
<th>Total weight of sets (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27,000</td>
<td>170</td>
<td>4,590,000</td>
<td>1,000,000</td>
<td>4.59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total weight of sets (t)</th>
<th>Waste disposal charge per tonne (£)</th>
<th>Cost of set disposal per year (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.59</td>
<td>280</td>
<td>1,285</td>
</tr>
</tbody>
</table>

### Cost estimation for energy use

IV Fluid warming devices consume energy as electricity. The market review lists the maximum power consumption for devices. Where devices are designed for high fluid flows this figure will be correspondingly high. The actual power used may be much lower at low flow rates. Assumptions are:

- 27,000 sets represent surgical patients each receiving warm IV fluids for one hour
- devices operate at 800 W during operation
- an electricity charge of £0.0872 per kWh [29].
## Economic considerations

<table>
<thead>
<tr>
<th>No. of sets used per year</th>
<th>Device operating time per use (h)</th>
<th>Total device operation time per year (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27,000</td>
<td>1</td>
<td>27,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total device operation time per year (h)</th>
<th>Device power (W)</th>
<th>Conversion factor, Watts to Kilowatts</th>
<th>Electricity used per year (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27,000</td>
<td>800</td>
<td>1000</td>
<td>21,600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electricity used per year (kWh)</th>
<th>Electricity charge per kWh (£)</th>
<th>Electricity cost per year (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21,600</td>
<td>0.0872</td>
<td>1,884</td>
</tr>
</tbody>
</table>

### Capital cost

In some cases the equipment is purchased, and the capital cost must be considered. This is calculated by dividing the cost over the expected lifetime of the equipment. This cost does not apply where equipment is loaned on the basis of consumable sales. Assumptions are:

- capital value per device of £2200 [1]
- expected lifetime of 5 years

<table>
<thead>
<tr>
<th>Cost of equipment</th>
<th>Expected lifetime (years)</th>
<th>Annual cost of equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>£2200</td>
<td>5</td>
<td>£440</td>
</tr>
</tbody>
</table>

The costs are summarised in table 2 which shows that the vast majority of the cost is from the administration sets, even when these prices are varied.
Table 2 Summary of estimated costs for worked example

<table>
<thead>
<tr>
<th>Costs with an administration set price of</th>
<th>£2 per set</th>
<th>£10 per set</th>
<th>£21 per set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual cost of equipment</td>
<td>£440</td>
<td>£440</td>
<td>£440</td>
</tr>
<tr>
<td>Total cost of sets per year</td>
<td>£54,000</td>
<td>£270,000</td>
<td>£567,000</td>
</tr>
<tr>
<td>Total servicing cost per year</td>
<td>£9,570</td>
<td>£9,570</td>
<td>£9,570</td>
</tr>
<tr>
<td>Cost of set disposal per year</td>
<td>£1,285</td>
<td>£1,285</td>
<td>£1,285</td>
</tr>
<tr>
<td>Electricity cost per year</td>
<td>£1,884</td>
<td>£1,884</td>
<td>£1,884</td>
</tr>
<tr>
<td><strong>Total Annual Cost</strong></td>
<td><strong>£67,179</strong></td>
<td><strong>£283,179</strong></td>
<td><strong>£580,179</strong></td>
</tr>
</tbody>
</table>

*These costs are estimated for a particular set of circumstances and would need to be recalculated to reflect any real situation.*
Purchasing procedures

The Trust Operational Purchasing Procedures Manual provides details of the procurement process [30].

European Union procurement rules apply to public bodies, including the NHS, for all contracts worth more than £90,319 (from January 1st 2008) [31] (appendix 2). The purpose of these rules is to open up the public procurement market and ensure the free movement of goods and services within the EU. In the majority of cases, a competition is required and decisions should be based on best value.

NHS Supply Chain (www.supplychain.nhs.uk), a ten year contract operated by DHL on behalf of the NHS Business Services Authority, offers OJEU compliant national contracts or framework agreements for a range of products, goods and services. Use of these agreements is not compulsory and NHS organisations may opt to follow local procedures.

Sustainable procurement

The UK Government launched its current strategy for sustainable development, Securing the Future [32] in March 2005. The strategy describes four priorities in progressing sustainable development:

- sustainable production and consumption – working towards achieving more with less
- natural resource protection and environmental enhancement – protecting the natural resources and habitats upon which we depend
- sustainable communities – creating places where people want to live and work, now and in the future
- climate change and energy – confronting a significant global threat.

The strategy highlights the key role of public procurement in delivering sustainability.

Consumables

All products use considerable amounts of disposable items. This is a necessity given the need for sterile administration sets. The sets will be disposed of as clinical waste. Depending on local policy, plastic sets may be shredded and heat treated. Sets that contain metal require incineration, with a greater energy and monetary cost.

Power consumption

Devices have very varied power consumption. This is a factor of both the required performance and the efficiency of the technology used in heating. Ensure that the device chosen meets the required flow rate and heating specification.
End-of-life disposal

Consideration should be given to the likely financial and environmental costs of disposal at the end of the product’s life. Where appropriate, suppliers of equipment placed on the market after the 13th August 2005 should be able to demonstrate compliance with the UK Waste Electrical and Electronic Equipment (WEEE) regulations (2006) [33]. The WEEE regulations place responsibility for financing the cost of collection and disposal on the producer. Electrical and electronic equipment is exempt from the WEEE regulations where it is deemed to be contaminated at the point at which the equipment is scheduled for disposal by the final user. However, if it is subsequently decontaminated such that it no longer poses an infection risk, it is again covered by the WEEE regulations, and there may be potential to dispose of the unit through the normal WEEE recovery channels.
We should like to thank the following for their contribution to this buyers’ guide.

Peggy Edwards, Patient Safety Manager (South East Wales), National Patient Safety Agency

Joanna Ford, Surgical Materials Testing Laboratory (SMTL)

Mark Harper, Consultant Anaesthetist, Royal Sussex County Hospital

Surgical Materials Testing Laboratory

Gavin Hughes, Technical Manager, Surgical Materials Testing Laboratory (SMTL)

Richard Hughes, Consultant Anaesthetist, Cardiff and Vale University Health Board

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Peter Robinson, Buyer, NHS Supply Chain

Janice Sharp, Media Resources, School of Medicine, Cardiff University

John Andrzejowski, Consultant Anaesthetist, The Royal Hallamshire Hospital
<table>
<thead>
<tr>
<th><strong>Administration set</strong></th>
<th>The tubing from the fluid bag through to the patient, including any additional components that may be device specific.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cannula</strong></td>
<td>Hollow tube inserted into a blood vessel</td>
</tr>
<tr>
<td><strong>Catheter</strong></td>
<td>Tube for injecting or evacuating fluids [24]</td>
</tr>
<tr>
<td><strong>Hypothermia</strong></td>
<td>A core body temperature less than 36.0°C</td>
</tr>
<tr>
<td><strong>Perioperative</strong></td>
<td>Including preoperative, intraoperative and postoperative time. From preparation for surgery through to 24 hours after surgery.</td>
</tr>
<tr>
<td><strong>QALY</strong></td>
<td>Quality adjusted life years. An outcome measure that captures both quality and quantity elements in a single measure.</td>
</tr>
<tr>
<td><strong>Warming cabinet</strong></td>
<td>A heated container in which fluid bags are placed to warm before use.</td>
</tr>
</tbody>
</table>


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(29) McGarringle J, On behalf of Cardiff and Vale University Local Health Board. Personal communication from Energy Advisor, Cardiff and Vale University Local Health Board to CEDAR, Cardiff and Vale University Local Health Board re: charge per kWh electricity at the University Hospital of Wales site and the carbon dioxide produced per kWh electricity. (2008).


Lease options

National frameworks are in place for operating leases to help the NHS procure leases more cost efficiently and effectively. Further details are available from the PASA website [34].

EU procedures

The Public Sector Directive (2004/18/EC) has been transposed into UK law via the following statutory instruments:

- the Public Contracts Regulations SI 2006 No.5 (the regulations)
- the Utilities Contracts Regulations SI 2006 No. 6 (not relevant to this guide).

The regulations apply to contracts worth more than £90,319 (from January 1st 2008) [31] over their whole life, and specify the procedures to be followed for public sector contracting, including adherence to strict timetables, requirements for advertising, invitation to tender and the award of contract. Organisations undertaking a procurement exercise covered by the regulations must give all suppliers an equal opportunity to express an interest in tendering for the contract by placing a contract notice in the Official Journal of the European Union (OJEU).

At all stages of the procurement process, the purchaser must be demonstrably fair, as any decision made can be challenged by the unsuccessful suppliers.

Establishing a procurement strategy

To achieve a successful outcome, decisions need to be made on:

- whether an existing contract/agreement can be used
- the need to consider sustainable development issues
- whether EU directives apply
- the type and form of contract
- sourcing potential suppliers
- duration of contract and opportunity to review/extend
- payment schedules
- how to minimise any risks with the chosen strategy, including supplier appraisal and evaluation/clarification of suppliers’ bids.
Preparing a business case

A business case should be drafted and approved before conducting any procurement exercise. Further guidance on preparing business cases is available from the Office of Government Commerce [35] and an illustrative example is provided in the NHS PASA Operational Purchasing Procedures Manual, Procedure 1-01 [36].

The EU tendering exercise

EU procurements usually take between 4 and 6 months to complete. This needs to be taken into account in the planning stages. The length of the exercise depends on the chosen procedure (open or restricted). Further information is available from the Department of Health [37].

The procurement panel

A multidisciplinary team should be selected to guide the purchase. Representatives from clinical, user, technical, estates and financial areas should be considered.

Identifying potential suppliers

Criteria for supplier selection must be established. A pre-qualification questionnaire, seeking background information (eg on the skills and experience of the service engineers) may be employed as an initial screen to exclude unsuitable suppliers.

Evaluation criteria

Performance specifications should be derived from local operational requirements, and agreed by the procurement panel. They will form the basis for assessing the adequacy of suppliers’ technical specifications, provided in response to the technical specification questionnaire.

It is important to have agreed on the performance specifications of the product as they will be used in the adjudication against company specifications.

Requests for features which are supplier-specific are not permitted under the regulations. Very specific features which are not supported by operational requirements are also not allowed.

Award of contract

Following award of the contract to the successful supplier; unsuccessful suppliers may need to be debriefed. This is at the supplier’s request.
Buyers must be aware of the ‘Alcatel’ procedure (see the Trust Operational Purchasing Procedures Manual [30], Procedure No.T-08, section 6 - Mandatory Standstill Period).

For more information on procurement please refer to the Department of Health Website [38].
Buyers’ guide:
Intravenous fluid warming devices

Andrew Cleves, Megan Dale, Grace Carolan-Rees

Clinical Engineering Device Assessment and Reporting (CEDAR) Cardiff Medicentre Cardiff CF14 4UJ

Tel: 029 2068 2120
Email: cedar@wales.nhs.uk
www.cedar.wales.nhs.uk

About CEP

The Centre for Evidence-based Purchasing (CEP) is part of the Policy and Innovation Directorate of the NHS Purchasing and Supply Agency. We underpin purchasing decisions by providing objective evidence to support the uptake of useful, safe and innovative products and related procedures in health and social care.

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Centre for Evidence-based Purchasing Room 152C Skipton House 80 London Road SE1 6HL

Tel: 020 7972 6080 Fax: 020 7975 5795 Email: cep@pasa.nhs.uk
www.dh.gov.uk/cep

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