Design for Life Pilot Project

Northampton General Hospital NHS Trust

The Centre for Sustainable Healthcare in collaboration with the Design for Life team and key partners, is working with pilot sites in the NHS to explore the potential for switching from single-use to reusable medical products. This initiative aims to identify barriers, opportunities, and the benefits of such a transition, focusing on sustainability, cost savings, and improving healthcare efficiency. By quantifying these benefits, the project supports the NHS's broader goal of reducing waste and promoting a circular economy in medical technologies.

Contributors

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Background:

Patient warming is a critical aspect of surgical procedures, as maintaining a stable body temperature is essential to prevent complications such as hypothermia, which can lead to longer recovery times, increased risk of infection, and poor surgical outcomes. In operating theatres, warming devices, such as forced-air warming systems, are commonly used to regulate patient temperature. A widely used system is the Bair Hugger, which consists of a reusable warming unit and single-use, non-sterile disposable warming blankets for use before, during and after surgery. There have been some concerns raised that the use of forced air warming, which blows warm air through a hose into a blanket, could increase the risk of infection by the circulation of bacteria and also by interrupting the controlled flow of air above the operating table. However, a review of the literature looking at Surgical Site Infections (SSIs) has proved inconclusive so far; increased bacterial load has been shown in some cases, including within the hose and filters, but this has not been proven to cause any increase in infections. One paper, however, does suggest avoidance in orthopaedic theatres. Bair Huggers also increase the noise and temperature in theatres in which they are used.

Whilst effective, the single-use nature of Bair Hugger blankets contributes significantly to medical waste, raising environmental and financial concerns within healthcare settings. Reusable warming options, such as the "Hot Dog" system, have been introduced as a more sustainable alternative. These reusable devices consist of wipe clean conductive polymer fabric that are used multiple times, significantly reducing the waste generated by disposable systems. Other reusable options, including heated mattress pads and circulating water-based systems, also offer more environmentally friendly and cost-effective solutions. By shifting from single-use Bair Huggers to reusable warming devices,

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healthcare settings can reduce waste, lower costs, and promote more sustainable practices without compromising patient care.

Northampton General Hospital (NGH) is a large district general hospital servicing a population of 426,500 people living in West Northamptonshire. There are some cancer services which are provided to the wider population of 880,000 who live in Northamptonshire. There are 6 main operative theatres, two of which are operational with robotic urological and colorectal cases. These main theatres were the site for this review. However, there are also orthopaedic, obstetric and day surgery theatres (a total of 9 additional theatres) on site which also use the Bair Hugger system.

In main theatres we have been using the Bair Hugger™ (3M ™) for many years, however six reusable Hot Dogs were purchased at the end of the 23/24 financial year with the units placed in the main theatres. The Hot Dogs were initially trialed in February 2023 following comments from surgeons in the Sustainable Surgery group who found Bair Huggers noisy and intrusive. Positive feedback was received during the trial from Main Theatre staff and the business case was made to purchase one set for each of the theatres. Prior to implementation of the trial the required documentation (Master Indemnity Agreement and Pre-Acquisition Questionnaire) and one of the units was sent to the Trust's Medical Engineering Department for sign off. From the start of the project to the final implementation took approximately two years.

The aims of this report are to explore challenges and opportunities for use of reusable warming and quantify the impact of using Hot Dogs instead of Bair Huggers.

Process and approach taken to support transition:

The supplier of the Bair Hugger provides the forced air generation equipment for free provided a level of consumable supply is purchased. The Bair Hugger name and brand has now been sold to Solventum and they have reduced the amount of maintenance that may be carried out internally by the Trust, the financial impact of this is not yet known.

Six reusable Hot Dogs were purchased at the end of the 23/24 financial year with the units placed in the main theatres. Prior to the initial trial the supplier provided the following information:

- Cleaning guidelines
- Training competency matrix
- Short training guide
- Quality and conformity certificates
- User and technical manuals

Transitioning to use them in place of single use started gradually, but there have been concerns about improper usage, such as only placing them under patients instead of using them above and below, as required. Temperature monitoring for patients that are warmed for more than one hour has shown reduced temperatures when the Hot Dog is used beneath the patient only compared with the Bair Hugger system. Temperature monitoring of the system being used correctly was not performed as the instances where both top and bottom blankets were applied were infrequent. More training is being arranged to address this issue. Hot Dogs may also be appropriate for usage in other surgical

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departments such as Orthopedics, Gynecology, and Day Case, but these areas currently use single-use items.

Numbers of consumables procured in Northampton General Hospital 23/24 and 24/25 for Main Theatres, and the theatres solely using Bair Huggers are shown below.

	Main Theatres 2023/24	Main Theatres 2024/25	Other theatres 2023/24	Other theatres 2024/25
Number of Items	4046	1572	4004	3740

Currently, there is a mix of single use Bair Huggers and reusable Hot Dogs being used in theatres. Some staff prefer one or the other, and some staff are using both Bair Huggers and Hot Dogs. Kettering General Hospital (also part of University Hospitals of Northamptonshire) has continued to use only single-use disposable warming blankets and has not yet adopted the Hot Dog system.

Perceived barriers to the transition.

In the past there has been anaesthetic department hesitancy regarding Hot Dog warming following their own patient warming audit which found a decline in core body temperature for patients who had a Hot Dog. However, a confounding factor in the results was that patients only had an under Hot Dog applied, which skews the results as the manufacturer recommends under and over warming. The reason for this has been cited as difficulty using the Hot Dog, not being suitable for various positions, and potentially not having the correct sizes of Hot Dog for the top.

Despite training sessions, reusable Hot Dogs have not been used consistently or correctly (only placed under patients instead of under and above). Further staff training regarding the application of the over Hot Dog in major abdominal operations would be required to see an improvement in sustainable practice. Further training is yet to be arranged with the Company Representative.

Perceived change to patient experience or safety (including infection prevention and control considerations).

Clinical audit

We conducted a new audit in surgery to confirm current practice in NGH and compare usage of single use and reusable options. An online questionnaire was designed using Jotform and circulated amongst Operating Department Practitioners (ODP's) for 5 days. They completed the questionnaire for each case in theatre. Data was analysed by one individual in the team.

Hypothermia prevention and management in adults having surgery was used as the standard. Document referenced CG65. This guideline suggests the use of patient warming if any of the following:

- Anaesthetic >30 minutes
- Anaesthetic <30 minutes but "high risk" of hypothermia
- High risk: ASA 2-5, pre-operative temperature <36.0, combined regional and general anaesthesia, major or intermediate surgery of risk of cardiovascular complications

The NICE guidance for temperature monitoring suggests that warming is only required for patients in surgery longer than 30 minutes.

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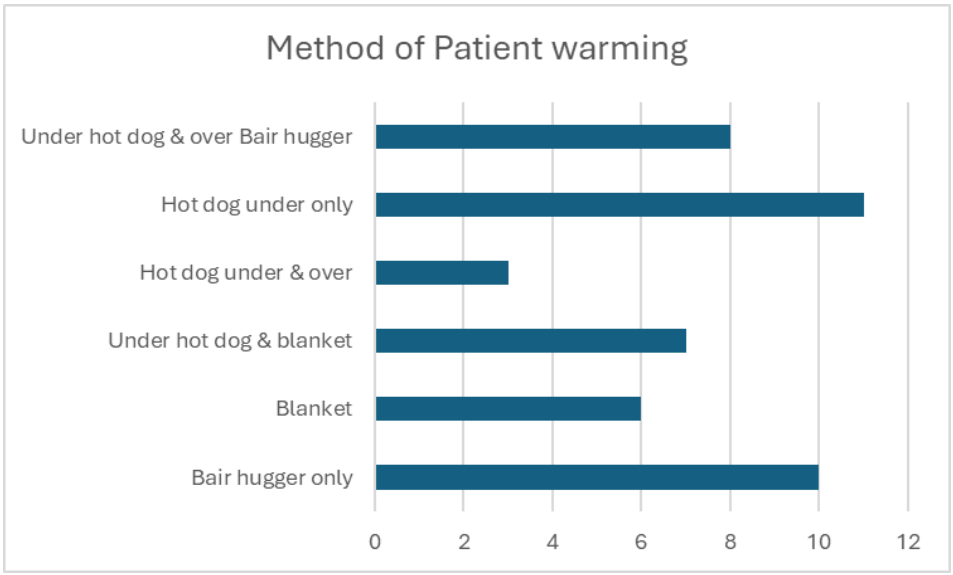
Results:

There were a total of 45 procedures undertaken during the audit. 39 elective cases and 6 emergency cases. 100% of the patients had warming.

Speciality	
GI	20
Urology	6
H&N	7
Breast	3
Vascular	5
Gynaecology	4

The most used modalities of patient warming were under Hot Dog only, Bair Hugger only and under Hot Dog with over Bair Hugger. Interestingly, there is very limited use of both under & over Hot Dog; which would be the recommended way of using the product as per manufacturer.

Method of patient warming:



For procedures lasting less than 30 minutes (15 total) the Hot Dog was the most used method of warming. For procedures lasting greater than 30 minutes the Bair Hugger™ was frequently used, either on its own or in conjunction with other warming devices.

Warming device by operation duration:

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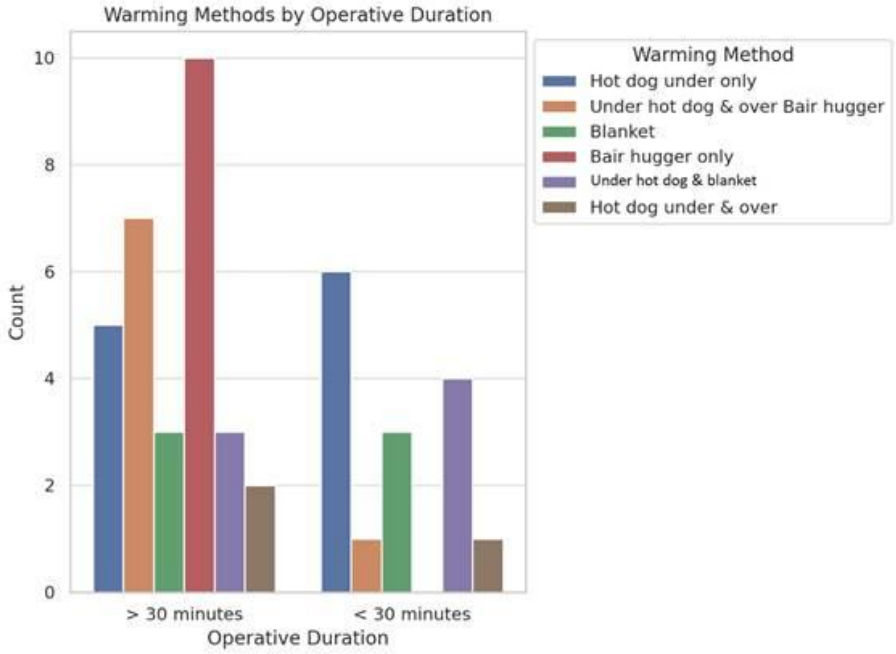

There is very limited use of under and over Hot Dogs for patient warming. Anecdotally this seems to be due to staff uncertainty about how best to place the top warmer, particularly in open abdominal cases. Due to this uncertainty, staff tend to adopt a combination of under Hot Dog and over Bair Hugger™. It is pleasing to see that there is avoidance of Bair Hugger™ use in breast and head & neck surgeries, where a large continuous body surface area is available for warming.

It would be useful to know the exact anticipated duration of the operation to better compare warming modalities, as all patients are being warmed. There were only 3 cases where warm blankets were used where the anticipated operative duration was greater than 30 minutes. We do not know what the actual operative duration was, and if it was a little over 30 minutes then the blanket only may have been appropriate. Additionally it would be beneficial to know if it was an open or laparoscopic case, to provide more informed analysis.

There was concern raised by Infection Prevention and Control about both the potential for surgical site infections following a change to the warming regime, but also with regards to the cleaning of the items between uses. All the information from the supplier was sent to IPC and approval received to undertake the trial so all the evidence presented could be evaluated. The trial was also approved by anaesthetists who were concerned about the ease of use of the Hot Dog when compared to the Bair Hugger.

There is a theoretical risk that patients may have a skin reaction to the glue on the Bair Hugger, used to secure it to the patient. Additionally, those patients with friable skin may be at risk of shearing injury when removing the Bair Hugger at the end of the operation. The Bair Hugger can also affect the space surrounding the operative field once inflated, moving operative adjuncts secured to the drapes and providing some minor obstruction. These risks would be reduced with the use of the Hot Dog.

A move towards reusable patient warming provides an opportunity to reduce background noise in the operating theatre. Excessive noise in the operating theatre has been shown to have a detrimental effect on communication and surgical performance. This leads to a rise in total errors and time to task completion.

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Ultimately, the modality of patient warming will not have any direct significant implications for patients. However, ineffective warming for patients resulting in peri-operative hypothermia places patients at risk of cardiovascular, infectious or haemorrhagic complications. Thus the current anaesthetic department hesitancy to use the Hot Dog alone in longer operations is justified as a drop in core temperature has been recorded. However, further data collection regarding the impact of under and over Hot Dog use in longer cases is required.

Perceived change to staff experience or safety (including infection prevention and control considerations).

A survey was undertaken in March 2025. 47 responses were received to the survey from Surgeons (8), Anaesthetists (6), and Operating department practitioners (33). 89% (42) respondents had experience of using both Hot Dogs (reusable) and Bair Huggers (single use). 38% reported a preference for Hot Dogs and 13% a preference for the Bair Huggers. The remaining had no preference or did not have experience of using both.

Free text comments were mixed in terms of preference and included

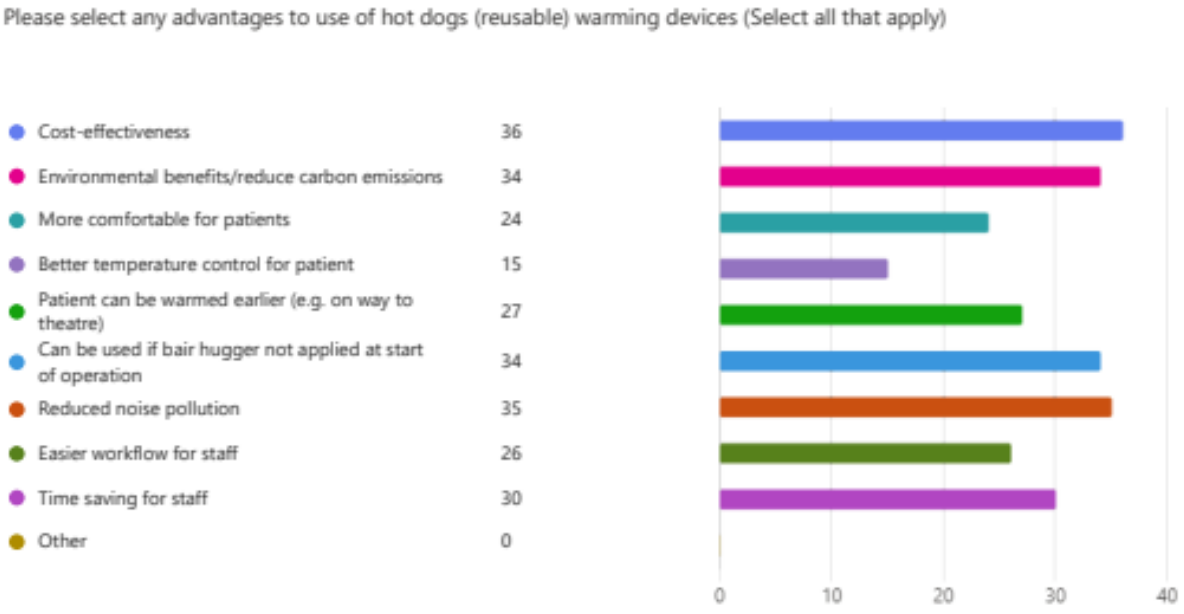
Bair Hugger tend to take up space and effect operative field

Re Hot Dogs: ease of use, time saving, less space comparatively, Bair Huggers can break/flimsy reusable, avoiding plastic was mentioned by several staff

Bair Hugger better for warming

Patients on Hot Dogs need to be lifted rather than being slid over to adjust position which can be challenging.

There were several advantages to using the Hot Dogs summarised in the graph below. These benefits cover clinical, social, environmental and financial considerations.



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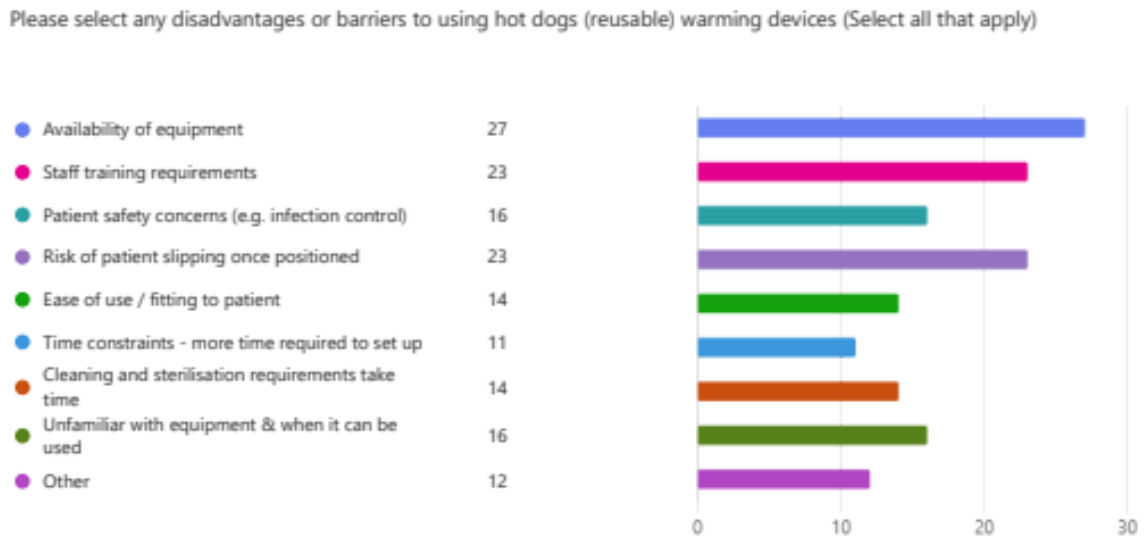
However, there were also several perceived disadvantages to using the Hot Dogs. This included some clinical concerns such as infection control and ease of use, concern over increased staff time requirements, and challenges around implementation such as comprehensive staff training.



When asked specifically about training, 70% (33) staff felt they had received adequate training. 6% (3) would benefit from a refresher, and 19% (9) said they were not confident in use.

Open text comments

need of over warmer to maintain temperature. further staff training required.

unable to maintain temperature over longer operations

I like them. top hotdog concerns therefore end up using Bair Hugger

72% (34) and 74% (35) reported reducing the environmental impact and financial impact of patient warming through use of Hot Dogs would benefit their job satisfaction. 19% (9) and 17% (8) had not considered the environmental impact and financial impact before. The project and survey may raise their awareness and consideration of these factors. The remaining responders did not feel changes from an environmental or financial perspective would impact them.

Carbon emission cost/saving of the proposed change.

Carbon footprint information for the consumables was calculated by weighing the card used to affix the hose, the packaging, and also a small piece of the Bair Hugger blanket as it is composed of two types of material. This was then used to calculate an approximate density to allow calculation of a carbon footprint for the different sizes used within the Trust.

Conversion factors were taken from Defra for the following materials: Card, LDPE and PP (it is assumed that spun PP is the material used and the same conversion factor as PP is used).

Waste disposal conversion factors were taken from The carbon footprint of waste streams in a UK Hospital, Rizan et al 2021.

Carbon footprints for the Bair Hugger consumables were calculated to be as shown below (units of kgCO2e):

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	Main Theatres 2023/24	Main Theatres 2024/25	Other theatres 2023/24	Other theatres 2024/25
Consumables	1559.2	626.2	1253.0	1213.2
Disposal	330.0	132.6	265.8	257.3
Total	1889.2	758.7	1518.8	1470.5

These are for the material production only, and do not include the transport from Germany, their country of manufacture.

It has been impossible to ascertain the actual composition of the Hot Dog material. A set of the blankets was weighed at 2.46 kg and therefore, using an assumption that 3% of this weight was due to the attached cables and that the rest was due to an unknown polymer a carbon footprint of 10.3 kgCO2e per warming blanket set was calculated. Therefore the CO2e per year for main theatres (6 theatres) would be 30.9 kgCO2e. At the end of their life the disposal may involve both domestic and WEEE waste streams.

GHG emissions for raw materials for main theatres 23/24 only

	Item	Clinell wipes (2 per use)	Total
Bair hugger	1,889.2	0	1,889.2
Hot dog	30.9	166.7	197.6
Saving			1,691.6

Electrical consumption of the two items are shown below with the caveat that data is taken from the Hot Dog manufacturer's website which claims a reduction of 0.9 kW per hour of electrical consumption difference. Calculations are based on Forced-air MFR listed average power consumption of 800 watts and HotDog Conductive fabric warming steady state power consumption of 150 watts. Air conditioning power needed to offset waste heat from one Forced-air warming unit is 248 watts (ref Environmentally Friendly Patient Warming: Go Green with HotDog).

Although the Trust generates a small amount of energy from solar PV, and the majority from a CHP engine, there is always a degree of generation from the grid and therefore these are the conversion factors used.

Activity	Country	Unit	Year	kg CO_2e
Electricity generated	Electricity: UK	kWh	2024	0.20705

T&D- UK electricity	Electricity: UK	kWh	2024	0.01830

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Assumptions have been made using the number of items bought as a proxy for the number of operations carried out. It has also been assumed that the control unit / forced air warming generator are operational for 2 hours per surgery.

Energy saving based on 23/24 figures: 4046 operations at a total of 8092 hours. Carbon saving per annum = 1823.5 kgCO2e

Total GHG emission savings from raw materials and energy = 3,515.1 kgCO2e.

Financial cost/saving of the proposed change.

	Main Theatres 2023/24	Main Theatres 2024/25	Other theatres 2023/24	Other theatres 2024/25
Cost of Consumables	28,293.69	11,071.85	19,174.81	17,607.46
Number of Items	4046	1572	4004	3740

The Hot Dog patient blankets have a two year warranty, with the control units having a three year warranty.

- Cost of control unit + cables + one mattress + one blanket per year = approximately £3300.00 incl. VAT
- Cost for 6 theatres per year = approximately £20,000.00

(note, this is not the price paid as a discount was negotiated by the procurement department for the trials carried out, but the standard price is quoted for comparison) per year (cost of blankets / 2 and cost of control unit / 3).

The actual energy consumption of the Hot Dog vs the Bair Hugger is not known and has been estimated using the information on the Hot Dog supplier's website which states a difference of 0.9kW per hour of surgery. With an assumed saving above of 16,100kWh at an average cost of £0.26 this is a financial saving of £2,103.92 per year.

As there is no indication of the cost of maintenance packages for either of the two products under consideration this cannot be calculated.It is also assumed that there is only one size of blanket purchased for theatres and one size of mattress, which is not necessarily the case.

The annual cost saving should the Bair Hugger be removed from use in the Main Theatre suite would be in the region of £10,276. However, due to the cost of the equipment and the lower use of consumables in the other theatre suites, there would be an annual cost increase of £8,925.51 if the system was put in all theatres. It would therefore only make financial sense to put the system into the orthopaedic theatres which are the second highest user of consumables.

Discussion and conclusion:

After assessing all studies performed at NGH it appears the Hot Dogs are not being used as per manufacturer's recommendations. Despite there being frequent use of the Hot Dog for shorter cases (< 30 minutes), alone or in combination with warmed blankets. There seems to be infrequent use of

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under & over Hot Dogs in longer cases. In these operations with an anticipated duration of > 30 minutes, staff still tend to prefer using the Bair Hugger. This may be historical due to having more experience of using Bair Huggers or due to the anaesthetic department study which concluded that under Hot Dog warming was ineffective for longer cases.

The main objective for the use of patient warming is to reduce the incidences of hypothermia in patients and therefore the risk of surgical site infection and prolonged length of stay. NICE guidance states that patient warming should be used for procedures where the patient will be anaesthetised for more than 30 minutes or where patients are at risk of hypothermia. The review of patient warming did highlight some warming occurring when the procedure was less than 30 minutes but this could be due to the risk presented by the patient.

A review of literature did not show any difference in the efficacy of the two methods of heating. There is a consensus growing that preoperative patient warming will help maintain the patient's core temperature, which may improve patient outcomes for longer procedures. It has been stated by anaesthetists that this presents more of a difficulty if the Hot Dog is used.

Whilst most staff who responded to the survey saw a need for more sustainable way to carry out the patient warming, there was an additional training need in order to ensure that the Hot Dog was placed above and below the patient as many were using it as an extra warming device in addition to the Bair Hugger.

Calculation of cost savings and environmental savings can only be approximate as there is no definite energy consumption data available for either system, there has been a reduction in the consumables purchased within main theatres. The calculation of the footprint of the consumables and the Hot Dog have had to be approximated. Disposal of the Hot Dog would also have to be taken into account as it is only guaranteed for two years.

Some of the implementation issues may have been due to the number of staff that work in Main Theatres compared to e.g. orthopaedic theatres. There was a year between the trial and the implementation during which period there may have been a change in personnel. It is suggested that a champion for the project is found in both sets of theatres to ensure that full use is made of the product whilst it is still in warranty.

The next steps will be to ask the company representative to return and carry out more training, trial the Hot Dog in one of the orthopaedic theatres and collect more patient warming data for correct use of the Hot Dog so a better comparison can be made with the Bair Hugger.

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