

SUSQI PROJECT REPORT

Basingstoke Critical Care: Feed smart, treat better, waste less

Recycling NG feed bottles and reducing wastage, switching from IV to NG medications and recycling where possible.

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Introduction:

Modern healthcare contributes significantly to global greenhouse gas emissions and waste production. In 2020, the NHS became the first health system in the world to commit to achieving net zero and reducing the environmental impact of healthcare. The NHS has set two main targets:

- **Net zero by 2040** for emissions that are directly controlled by the NHS, with an 80% reduction targeted between 2028 and 2032.
- **Net zero by 2045** for emissions that the NHS can influence, with an 80% reduction targeted between 2036 and 2039.

Intensive Care Units (ICUs) are particularly resource-intensive areas of healthcare and generate significant amounts of waste and greenhouse gas emissions. Due to the clinical urgency and complex nature of critical care, waste segregation can sometimes be overlooked, resulting in recyclable materials being disposed of in clinical waste streams.

This project follows the principles of sustainable healthcare by looking at ways to reduce waste and use lower-carbon alternatives in everyday critical care practice, while maintaining safe and effective patient care.

Background:

Basingstoke Hospital (BNHH) Critical Care is an 18-bed intensive care unit divided across two areas; CCA primarily cares for patients following cytoreductive surgery for peritoneal malignancy, while CCB admits patients with a range of medical and surgical conditions. Across both areas, there are approximately 840 admissions each year. Around 34% of the admissions to BNHH critical care are elective surgical patients that require high levels of post operative care. 66% of admissions are due to cardiac arrest, respiratory conditions, trauma, re-patriation and a variety of other conditions, including emergency surgery, who have been transferred from the emergency department or from general wards due to their increased need for care.

With the average carbon footprint of an ICU bed day estimated at around 140 kgCO₂e, it became clear that there was an opportunity to reduce the environmental impact of our unit.

Waste segregation:

Initially, waste segregation was identified as an area for improvement. All waste within Critical Care was being disposed of in infectious clinical waste, with no dedicated bins for offensive, general or recyclable waste. This not only increased the amount of waste being sent for clinical treatment but also increased costs, as treating infectious waste is more expensive. Introducing appropriate waste streams and encouraging staff to dispose of waste correctly therefore presented a relatively simple opportunity to reduce both the environmental impact and cost of waste disposal.

Enteral feeding:

A further area identified was enteral feeding waste. Many patients in Critical Care receive enteral nutrition through a nasogastric (NG) tube. The feed is supplied in single-use plastic containers, which were routinely being disposed of directly into clinical waste rather than being appropriately emptied, rinsed and segregated for recycling. This contributed to unnecessary plastic waste and increased disposal costs.

Sterile plastic water bottles:

Sterile plastic water bottles were also routinely used for patients receiving enteral feeding and for mouthcare for ventilated patients. These were similarly being disposed of in clinical waste, either infectious or offensive, rather than being segregated for recycling. Introducing the correct recycling process could therefore reduce the amount of plastic entering clinical waste while also reducing unnecessary waste disposal costs.

IV medications:

Opportunities to review the route of medication administration were also identified. Many patients were receiving intravenous (IV) paracetamol, often due to established staff practice and misconceptions around the treatment of pain and fever.

Evidence suggests that oral paracetamol provides comparable analgesic effectiveness to intravenous paracetamol for most patients who can tolerate oral medication (NICE, 2020) Mallama et al.(2021) also found no clear difference in postoperative pain outcomes between IV and oral paracetamol, while also highlighting the higher cost of IV administration.

The HEAT trial (2015) did not demonstrate a clinical benefit from routinely treating fever with paracetamol in critically ill patients with suspected infection. Thus, where clinically appropriate, oral or enteral paracetamol provides a lower-carbon alternative to IV administration. IV paracetamol involves not only the manufacture and packaging of the drug itself, but also additional consumables such as IV bags or bottles, administration sets, flushes and alcohol wipes. Therefore, IV paracetamol could be reserved for patients who are unable to receive medication via the oral or enteral route.

A similar opportunity was identified with IV pantoprazole, which is routinely prescribed as part of the ventilator care bundle to reduce the risk of stress-related ulcers. As part of reviewing IV paracetamol use, it was also considered whether IV pantoprazole could be replaced with enteral lansoprazole where appropriate. This could reduce the use of IV consumables and associated waste.

In addition, the long-term use of proton pump inhibitors in critically ill patients is an area that warrants further consideration, particularly whether treatment can be reviewed and rationalised in patients who are tolerating and absorbing enteral nutrition.

Figure 1 below shows the principles of sustainable healthcare that were followed in the project. Figure 2 is the sustainable value equation which demonstrates the importance of environmental, social and financial sustainability.



Figure 1. Four principles of sustainable healthcare



Figure 2. Sustainable Value equation

The projects above relate to sustainable value by streamlining care activities and using low carbon alternatives. The outcomes on patients and the impact on the environment, social and financial impact will be discussed below.

Specific Aims:

1. Introduce black bins (domestic waste), tiger stripe (offensive waste) and recycling bins and ensure proper waste segregation of general and clinical waste and achieve a 100% compliance within 12 months.
2. Reduce plastic and feed waste by 50% by using 500mls nasogastric (NG) feed bottle instead of the 1000mls NG feed bottles, for patients on low-rate enteral feeding regime (days 1 and 2) and introduce 100% compliance of recycling of NG feed bottles.
3. Achieve 100% compliance with recycling empty sterile water bottles.

4. Encourage and increase the use of NG/oral administration of paracetamol over intravenous paracetamol (IV) and achieve an 85% switch based on 555 admissions for year (excluding elective and emergency bowel surgery patients) within 12 months
5. Achieve 50% switch from intravenous pantoprazole to oral/enteral lansoprazole administration within 12 months.

These specific interventions offer a practical pathway towards a greener, more cost-effective clinical practice without compromising patient safety and care. We will measure outcomes by collecting data and compliance and reauditing at the end of the year.

Methods:

Once the above issues were identified, several audits were conducted and collected data to understand the scale of the problem and the potential impact of making these changes.

Studying the system – The following was reviewed:

The amount of sterile water bottles used for oral and NG medications, as well as for mouth care. These bottles were changed every 24 hours. This allowed an estimate of the number of bottles used each year to calculate the waste using the current waste stream (infectious waste) and therefore calculate the potential cost associated with this.

The use of IV paracetamol within the unit was audited. At the time of the audit, six out of seven patients were receiving IV paracetamol. Of these, five patients were receiving IV paracetamol QDS for a temperature and one was receiving it QDS for pain. All six patients were receiving NG feed, absorbing, and there was no clear clinical reason identified for them to require the IV route. This highlighted a potential opportunity to review the route of administration and consider NG paracetamol where appropriate. It also allowed reviewing the reasons for administration and discussions around developing an SOP, based on literature reviewing paracetamol for fever and pain in ICU patients.

The ICNARC team, provided data on Critical Care admissions including the annual number of admissions (840 patients per year), average length of stay (>5 days) and the number of patients receiving NG feeding (10 patients per week average). They also provided data on the number of patients undergoing bowel surgery (285 patients annually). These patients were excluded from predicted calculations, as they were less likely to be suitable for conversion from IV to NG medication. This information, together with an audit, allowed an estimate to be made of how many patients could potentially be switched from IV to NG

The cost of consumables was obtained from the Stores Manager, who provided the current costs of consumables. The potential financial and environmental impact of reducing unnecessary consumables was then calculated.

The domestics team were engaged with, who provided information on how frequently the different bins were changed. The waste management team provided information on the cost of waste disposal per tonne. Both teams were supportive of the proposed changes and helped us to understand the potential impact of improving waste segregation within Critical Care.

Stakeholder engagement and implementing change

Once areas for improvement were identified, the ideas were discussed with the Critical Care Matron, the Medical Lead and the operations manager who were supportive of the proposed changes and the overall aims of the project.

The waste reduction project was initiated by speaking to the waste management team who were able to provide signs for the bins. The trial of changing the waste over from infectious (orange bins) to offensive (tiger stripe) and domestic (black bins) was implemented only in CCB (10 beds). With bin labels and education at the pre-shift huddles over the month and posters on the cost of the bins (Appendix A) This was then rolled out to CCA.

Training has been provided across all six teams during team days on climate change, global warming and the proposed projects and changes. Appendix B (presentation).

Oral paracetamol vs IV was discussed and a questionnaire conducted, asking ICU staff when they would give IV paracetamol for fever. The results ranged from 37.8-38.1 degrees. Therefore, after a literature review, the information in appendix C was provided to staff and by the end of November, members of the Critical Care team undertaking the experienced nurse programme as part of their development, will write an SOP and flow chart on fever management of ICU patients.

Reducing the use of alginate bags for linen and using the standard white bags for non-contaminated items was also considered. However, there was some resistance to this change, and as waste accounts for only around 1% of carbon emissions, the focus was initially on areas with a potentially greater environmental impact, particularly medicines and the other projects outlined above. There is hope to revisit the use of linen bags in the future as part of further sustainability work within Critical Care and continue to identify other opportunities for improvement.

The costs of the medicines used were provided by the pharmacist, and assistance was requested during ward rounds to facilitate the implementation of the prescribing changes. As new ICU doctors are starting in August, the medical lead has also been provided with relevant information and posters. (Appendix A, B and C).

Originally, NG waste going into clinical waste was not considered, however after conducting an audit and asking 26 members of staff, it was identified that a significant amount of unused NG feed was being discarded. In Critical Care, feeds often start at 10 mL/hour for the first 24 hours, increasing to 20 mL/hour and then to 40 mL/hour from day three, depending on the patient's clinical condition. As the feed containers hold 1000 mL, a considerable amount of unused feed can remain in the container and is subsequently discarded into the infectious waste bags, with the giving sets still attached. This highlighted another opportunity to reduce avoidable waste and avoid the sharps going into the waste bins.

Measurement:

The initial audit will be repeated following the implementation of the above changes to calculate the actual savings. The predicted savings have been calculated based on retrospective data from the last 12 months to make modelled assumptions.

Patient outcomes:

Due to the limited project timeframe, direct evaluation of patient outcomes is outside the scope of this work. However, a review of existing evidence will be utilised to infer and explain the potential patient-focused benefits of the project:

- By looking at the rationale for IV paracetamol in temperature management, this project has explored that there could be a potential benefit to the patient in terms of a reduction in line infections, by minimising access of the IV cannula site/CVC line. See appendix D for current line blood stream infections in BNHH ICU. There are no negative outcomes for patients.
- By evaluating national evidence for paracetamol for fever we are ensuring that we are being guided by relevant evidence-based practice (HEAT 2015)
- Due to the predictions in the reduction in nursing time for double checking of IV medication, there may be a benefit to the patient relating to the added time to care for the patient, perform mouthcare, haircare, passive range of movements, massage. (See Appendix E and F) for breakdown on nursing time and consumable costs).
- Direct measures for patient outcomes will be measured by incident reports on IV drug errors for paracetamol and measuring the IV contamination rates. Literature suggests there is no risk of increased length of stay by withholding paracetamol for patients that do not have affected vital signs or are required to have specific aims for their temperature. (HEAT 2015).
- The intention is to maintain the same high standard of patient care while reducing environmental impact and financial costs and simultaneously delivering wider social value.
- There are no anticipated adverse impacts on patient outcomes associated with this project. It aims to deliver equivalent levels of safe and effective care, while achieving reductions in environmental and financial costs and contributing positively to social value.

Environmental sustainability:

The carbon footprint (expressed in Carbon Dioxide Equivalents, or CO₂e) is a common measurement used to show environmental impact.

All patients that were admitted and likely to be NG fed and receive IV paracetamol and pantoprazole based on historical ICNARC data on patient admissions and LOS were included. The PMI patients or bowel surgery patients were not included as they cannot receive medications via the enteral route. All patients have sterile water used for mouthcare and or enteral feed, therefore the predicted reduction in clinical and domestic waste was calculated based on this.

All items used in administering 1 dose of IV pantoprazole and NG lansoprazole daily were listed, in addition to 1g IV paracetamol and 1g NG. This included the actual drug cost, syringes, needles diluents, flushes and cleaning wipes. Using the cost per item and the weight an emissions factor was applied to identify the total CO₂e attributed to each administration method.

A cradle-to-grave hybrid approach carbon footprint analysis was used to estimate the items greenhouse gas (GHG) emissions. The inventory provided for IV, oral and NG administration of medication, the NG feeds and sterile water bottles were carbon footprinted using a process- based carbon footprint analysis. Items were weighed by the team and materials identified.

Data was obtained from previous studies by the Centre for Sustainable Healthcare and other references. Where data was not available, calculations were made based on the weight and material

of the product. Material weights were converted into GHG emissions using emission conversion factors taken from the Department of Energy Security and Net Zero (DESNZ)'s Greenhouse Gas Reporting Conversion Factors 2026 database, ICE V4.0 database, and [Climatiq](#) and primary research papers and LCAs. The analysis included GHG emissions associated with primary materials production, transport, and disposal.

Materials

Material emissions are calculated by the weight of the material, emission factor of the material and number of items.

*Total emissions = weight of material * material emission factor*

Transport

Transport emissions per journey are calculated by weight of product, distance travelled and emissions per tonne.km travelled.

*Total emissions = Weight in tonnes per delivery*distance in km*emission factor*

The emission factor for average laden, non-refrigerated HGV is 0.127 kgCO₂e per tonne.km. Emission factor for shipping travel is 0.0198 kgCO₂e per tonne.km.

Waste

Waste emissions are calculated by amount of waste (tonnes) and the UK emission factor of average emissions by waste stream

*Total emissions = volume of waste * waste stream emission factor*

The emission factor for clinical waste is 1074 kgCO₂e, infectious waste is 569 kgCO₂e, dry mixed recycling is 172 kgCO₂e and domestic waste is 21 kgCO₂e.

Activity data

Data provided on number of patients who would be appropriate for each project:

- Number of admissions per year - 840
- Number of patients per year receiving sterile water - 840
- Number of appropriate patients to include (post op patients excluded) - 555
- Percentage of patients receiving IV medication that could be NG/oral - 85%
- Number of patients who receive IV medication - 472.
- Number of patients on NG feed - 260.

Economic sustainability:

Financial costs for consumables and equipment were obtained from the store's manager. Costs for the waste were calculated based on costs from the waste management team on the cost per tonne of clinical and domestic waste.

Some other organisations such as Northampton have adapted a review approach to proton pump inhibitors such as pantoprazole and lansoprazole (PPI's) due to the risk of clostridium difficile infection (CDI/C-diff). Northampton estimated a reduction in carbon emissions by 414.263kgCO₂e annually. This has been brought up for an area of discussion at the Band 6/7 day in BNHH and will be reviewed at the clinical governance meeting.

Social sustainability:

Questionnaires to gauge engagement in the projects have been conducted and the team will continue to provide education to staff.

Results:

Patient outcomes:

Potential for the benefit of patient outcomes by a reduction in infection rates (not quantifiable) and also an increase in time spent with patients due to reduction in double checking required for NG medications and disposal of waste.

Environmental sustainability:

IV delivery

The inventory for each piece of kit and equipment used to deliver medication by the IV route is shown in Table 1 including the emission factors for each material or piece of equipment and for waste disposal. The carbon footprint for each item was calculated, then combined for the total emissions. It is assumed all equipment is disposed of via the clinical waste route.

Table 1. Inventory for equipment to deliver IV medication and their carbon footprints.

Items used	Carbon emission factor for raw materials (kgCO ₂ e /item use)	Carbon emissions for item (kgCO ₂ e)	Waste disposal method	Carbon emission factor for waste (kgCO ₂ e /tonne)	Carbon emissions for disposal (kgCO ₂ e)	Carbon emissions per item (kgCO ₂ e)	Reference
<i>Sterile gloves (one pair)</i>	0.102	0.102	<i>Clinical waste</i>	1074	0.0421	0.1439	Rizan
<i>10ml saline flush</i>	0.047	0.047	<i>Clinical waste</i>	1074	0.0107	0.0573	Rizan
<i>Syringe (10 ml)</i>	0.024	0.024	<i>Clinical waste</i>	1074	0.0076	0.0313	Rizan
<i>Intravenous infusion giving set</i>	0.091	0.091	<i>Clinical waste</i>	1074	0.0481	0.1394	Rizan
<i>Alcohol wipes - single packet</i>	0.033	0.033	<i>Clinical waste</i>	1074	0.0048	0.0376	Rizan
<i>Sodium chloride 0.9% infusion (100 ml)</i>	0.128	0.128	<i>Clinical waste</i>	1074	0.1289	0.2569	Rizan

Total emissions are 0.67 kgCO₂e per dose for IV administration.

Oral delivery

The inventory for each piece of kit and equipment used to deliver medication by the oral route is shown in Table 2 including the emission factors for each material or piece of equipment and for waste disposal. The carbon footprint for each item was calculated, then combined for the total emissions. It is assumed all equipment is disposed of via the domestic waste route.

Table 2. The equipment used and carbon emissions for oral delivery

Oral medication	Carbon emissions for item (kgCO ₂ e)	Waste disposal method	Carbon emission factor for waste (kgCO ₂ e /tonne)	Carbon emissions for disposal (kgCO ₂ e)	Carbon emissions per item (kgCO ₂ e)
Sterile water bottle (*)	0.238	<i>Domestic waste</i>	172	0.0001	0.2384
Medicine cup	0.035	<i>Domestic waste</i>	172	0.0016	0.0365

(* these emissions are for one 1l bottle of sterile water. If used for additional purposes, emissions per delivery of dose of medication will be lower.)

Total emissions are 0.27 kgCO₂e per dose for oral administration.

NG delivery

The inventory for each piece of kit and equipment used to deliver medication via the NG route is shown in Table 3 including the emission factors for each material or piece of equipment and for waste disposal. The carbon footprint for each item was calculated, then combined for the total emissions. It is assumed all equipment is disposed of via the clinical waste route.

Table 3. The equipment used and carbon emissions for NG delivery

NG medication	Carbon emissions for item (kgCO ₂ e)	Waste disposal method	Carbon emission factor for waste (kgCO ₂ e /tonne)	Carbon emissions for disposal (kgCO ₂ e)	Carbon emissions per item (kgCO ₂ e)
Sterile water bottle (*)	0.238	<i>Clinical waste</i>	1074.0	0.0001	0.2384
50 ml syringe	0.117	<i>Clinical waste</i>	1074.0	0.0373	0.1545

(* these emissions are for one 1l bottle of sterile water. If used for additional purposes, emissions per delivery of dose of medication will fall)

Total emissions are 0.39 kgCO₂e per dose via NG administration.

Emissions associated with moving from IV to oral or NG administration.

Currently, there are 472 patients receiving medication via the IV route annually. 100% of them could be switched from IV paracetamol to oral or NG administration and 50% of those on IV PPIs could switch.

Table 4. Number of patients currently receiving medication via the IV route annually, and number of patients after proposed changes

Drug	% of patients on IV	Number of patients currently on IV	% of patients that could be switched to NG or oral	Number of patients on IV	Number of patients on oral or NG
Paracetamol	85%	472	100%	0	472
PPI	85%	472	50%	236	236

Paracetamol

If a switch was made for paracetamol with 100% changing to oral or NG administration, the results are shown in Table 5. If patients receive an average of 20 doses while on ITU (4 times per day, for five days), a total 9,440 doses would be delivered annually. If 100% of patients moved from IV to oral administration for paracetamol, emissions would reduce by 3,776 kgCO₂e. If changed to NG route, **emissions would reduce by 2,643 kgCO₂e.**

Table 5. Emissions for each route of administering paracetamol with emissions calculated for current practice and after proposed changes.

Paracetamol	Emissions per administration kgCO ₂ e	Number of patients	Current emissions kgCO ₂ e	% swapping from IV to oral/NG	Number of patients	number of doses per stay	Proposed emissions kgCO ₂ e
Emissions per IV administration	0.67	472	6325	0	0	20	0
Emissions per oral administration	0.27	0	0	100	472	20	2549
Emissions per NG administration	0.39	0	0	100	472	20	3682

PPI

The baseline data demonstrated 472 patients received IV PPI per year, equating to 2,360 doses (one dose per day for five days), generating 1,581 kgCO₂e per year. Converting 50% of IV doses to oral administration would reduce emissions to 1,110 kgCO₂e (791 kgCO₂e IV + 319 kgCO₂e oral), **saving 471 kgCO₂e per year.** Converting 50% to NG administration would reduce emissions to 1,251 kgCO₂e (791 kgCO₂e IV + 460 kgCO₂e NG), **saving 330 kgCO₂e per year (see Table 6.)**

Table 6. Emissions for each route of administering PPIs with emissions calculated for current practice and after proposed changes.

Route of administration	Emissions per dose (kgCO ₂ e)	Patients (n)	Doses per patient	Total doses	Total emissions (kgCO ₂ e)
Current practice					
IV	0.67	472	5	2,360	1,581
Scenario A: 50% switched to oral					
IV	0.67	236	5	1,180	791
Oral	0.27	236	5	1,180	319
Total		472		2,360	1,110
Scenario B: 50% switched to NG					
IV	0.67	236	5	1,180	791
NG	0.39	236	5	1,180	460
Total		472		2,360	1,251

Summary for emissions

IV to NG:

For paracetamol, converting 100% of administrations from IV to nasogastric (NG) administration would reduce emissions from **6,325 kgCO₂e to 3,682 kgCO₂e**, giving an annual carbon saving of **2,643 kgCO₂e** (42% reduction).

For PPIs, converting 50% of administrations from IV to NG administration would reduce emissions from 1,581 kgCO₂e to 1,251kgCO₂e, resulting in an annual carbon saving of **330 kgCO₂e** (21% reduction).

Overall, implementation of the proposed oral conversion strategies for both paracetamol and PPIs would deliver a **combined oral annual carbon saving of 4,247 kgCO₂e**. If NG administration were used instead, the **combined annual carbon NG saving would be 2,973 kgCO₂e**.

Reducing the volume of NG feeds in the first two days of admission

The volume of NG given increases over the first three days as per Table 7.

Table 7. Increases to NG feeding rates from day one to three.

Day	Feed volumes:	Total feed per day (ml)
Day 1	Start at 10 ml per hour	240
Day 2	Then 20 ml	480
Day 3	Then 40 ml by day 3 if absorbing	960

The emissions associated with NG feeds consist of the feed itself, the feed bottle and delivery box, transport and waste disposal.

NG feed emissions

There is not an emission factor for NG feeds however, there are three possible methods.

a) Pharmaceutical preparations as the emission factor: 0.581 kgCO₂e /£ spent (Methodology for the NHS Carbon Footprint Plus)

b) Dairy products: 0.969 kgCO₂e /£ spent: UK and England's carbon footprint to 2021 - GOV.UK (www.gov.uk).

c) Estimates using proxy sources. A typical litre of standard enteral feed based on a dairy based, energy-dense feeds (1.5–2 kcal/mL) is likely in the range ~1.5 to 3.5 kgCO₂e per litre.

Based on cost

Nutrison 1 litre costs £2.97. emissions factors would range from 1.73 to 2.88 kgCO₂e per litre for method a) and b) respectively. Nutrison 500ml costs £1.69. emissions factors would range from 1.96 to 3.28 kgCO₂e per litre for method a) and b) respectively.

Emissions of 2 kgCO₂e per litre were used for the calculations. This is towards the lower end of the range.

Additional emissions from transport and waste disposal of unused feed

Currently, 260 feeds waste 75% of the 1l feed (day 1) and 260 feeds waste 50% of their 1l feed (day 2). The total volume of wasted liquid feed is:

$(750\text{ml} \times 260) + (500\text{ml} \times 260) = 325 \text{ litres of feed per year}$

At an assumed density of 1kg/l, 325 kg of feed is transported and wasted inappropriately.

Waste emissions

The excess NG feed (0.325t) is currently disposed of via the clinical waste stream. Using the emissions factor for clinical waste 1074 kgCO₂e /tonne, emissions from waste are from unused feed is 349 kgCO₂e.

Summary of Avoidable Emissions from Feed Waste

The annual carbon emissions associated with unused feed comprise 551 kgCO₂e from product and packaging, 26.6 kgCO₂e from transporting unused feed, and 349 kgCO₂e from waste disposal.

Together, these sources account for 926.6 kgCO₂e per year. Therefore, eliminating avoidable feed waste could **save approximately 927 kgCO₂e annually**.

The largest quantified environmental benefits came from changing medication administration routes and reducing avoidable enteral feed waste. Converting IV paracetamol to NG administration could **reduce annual emissions by approximately 2,643 kgCO₂e (42%)**. A 50% conversion of IV PPIs to enteral administration could **save a further 330 kgCO₂e (21%)**. Overall, the proposed NG conversion strategies were estimated to provide a combined annual saving of **2,973 kgCO₂e**.

Reducing avoidable NG feed waste was estimated to save a further **927 kgCO₂e per year**, through reductions in product and packaging, transport and waste disposal emissions.

Financial savings:

The project identified financial benefits through reducing clinical waste disposal, unnecessary consumables and the use of IV medication.

Waste segregation:

By changing the bins from the orange (infectious waste) to the tiger stripe (offensive) and also adding in black bins for packaging will have an annual cost of **£10,896** which is a 59.75% reduction (Appendix G).

Sterile water recycling:

Waste disposal reduction by changing the waste stream of sterile water bottles and promoting recycling instead of being disposed of in clinical waste could save £120 per year.

NG feed 1L to 500mls and waste streams:

Switching eligible patients to a reduced feeding volume could also generate financial savings. If 520 feeds were changed from 1 litre to 500 mL on days 1 and 2, using Nutrison products, the cost per feed would decrease from £2.97 for a 1-litre feed to £1.69 for a 500 mL feed. This represents a saving of £1.28 per feed, **resulting in a total annual saving of £665.60.**

There would also be a reduction in waste disposal costs. The estimated volume of feed waste is 0.325 tonnes per year. Based on an offensive waste disposal cost of £442 per tonne, the annual cost associated with this waste **avoided is £143.65.**

Overall, the combined savings from reduced feed costs and lower waste disposal costs are estimated at **£809.25 per year.**

IV to NG medications:

The predicted savings by changing IV paracetamol to NG is **£107,872- £151,020** (Appendix E) Along with the conversion to NG lansoprazole from pantoprazole **£2,250.4** (Appendix F).

Totalling £110,122-£153,270 annually.

This combined with the staff financial efficiencies and a reduction of 2808 hours to 330.4 hours per year equate to a reduction of cost from £78,624 for a nurse at £28 per hour to £9,251.2. (Appendix E and F)

Table 8 below shows predicted cost and kgCO₂e savings from the projects:

Project change	Basis of projected saving	Projected annual cost saving	Projected annual carbon saving (kgCO ₂ e)
IV medications	Switching IV paracetamol to NG administration and converting eligible patients from IV pantoprazole to NG lansoprazole	£110,122.00 to £153,270.00	2,973
Improved waste segregation	Replacing the exclusive use of orange infectious-waste bins with appropriate offensive tiger-stripe and black-bin waste streams	£10,896.00	Not calculated
Enteral feeding	Using 500 mL rather than 1-litre feed bottles for eligible patients during days 1 and 2, alongside reduced waste-disposal costs	£809.25	927
Sterile plastic water bottles	Recycling empty bottles instead of disposing of them through clinical waste streams	£120.00	Not calculated

Total estimated annual financial saving	Combined projected savings across all four interventions	£121,947.25 to £165,095.25	3,900
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Social sustainability:

Some staff at the beginning were resistant to change but gradually as the project has progressed staff have been thinking of their own ideas to help reduce carbon emissions. Now we have a team of 8 people we can hopefully plan further projects over the next couple of years and can re-audit and survey staff to provide feedback in relation to the changes.

Calculations on the time spent on checking IV medication accounts for **2808 hours per year** based on a two person check for both IV paracetamol and IV pantoprazole compared to NG paracetamol and NG lansoprazole at **330.4 hours per year**. Meaning a total of **2478 hours saved** by giving the NG alternative equating to **103.25 days a year**.

The negative impact of the project was the underestimation of the undertaking of this project and the time and dedication it would take. Despite having 8 members in the team, this has been an incredibly hard project to undertake as we are on different schedules, with no management time to be able to carry out audits, surveys, and obtain data. All the data collection and write up has been carried out in the team's own time, with the sustainability lead in ICU producing 90% of the work, meaning that there has been increased stress factors to be able to achieve the project within the timeframe.

Anecdotally, there was witnessed behaviour change in colleagues prior to full implementation of any changes. As awareness of the audit and projects grew, it was noted that NG bottles and sterile bottles were being recycled more. In addition, PPIs and IV doses are being reviewed and a new SOP guideline is to be produced (By 1st Dec) on the assessment and guide to fever management in ICU. The project has also been presented as part of a Band 6/7 study day, providing an opportunity to share ongoing actions and projects within critical care. This generated meaningful discussion and encouraged the sharing of ideas for improving sustainability across other aspects of care.

Discussion:

The project identified potential benefits across clinical, population, environmental, financial and social sustainability, although some of the savings are modelled estimates and will require re-audit to confirm the actual impact.

Clinical savings/benefits:

The project aimed to maintain safe and effective patient care while reducing unnecessary IV medication use and associated consumables. Using oral/NG administration where clinically appropriate may reduce unnecessary IV access and associated infection risk, while reducing the nursing time required for IV medication preparation and double-checking. **The project calculated a potential reduction in medication-checking time from 2,808 hours to 330.4 hours per year, representing approximately 2,478 hours (103 days) of nursing time saved annually.**

Population savings:

The project focused on appropriate patient selection, excluding patients who were unlikely to be suitable for conversion from IV to enteral medication, such as patients undergoing bowel surgery

and the specialist PMI patients. The wider population benefit is therefore through maintaining safe care while reducing unnecessary resource use across Critical Care.

Environmental savings:

The largest environmental benefits came from changing medication administration routes and reducing avoidable enteral feed waste. Converting IV paracetamol to NG administration could reduce annual emissions by approximately 2,643 kgCO₂e (42%). A 50% conversion of IV PPIs to enteral administration could save a further 330 kgCO₂e (21%). Overall, the proposed conversion strategies were estimated to provide a combined **annual saving of 2,973 kgCO₂e** if NG administration were used instead.

Reducing avoidable NG feed waste was estimated to save a further **927 kgCO₂e per year**, through reductions in product and packaging, transport and waste disposal emissions.

Financial savings:

The project identified annual savings through improved waste management, reduced feed volumes, and increased use of NG medications. Waste segregation changes could save **£10,896**, while recycling sterile water bottles could save **£120** per year. Reducing eligible NG feeds from 1L to 500mL could generate savings of **£809.25** annually through lower feed and waste disposal costs. Converting IV paracetamol to NG administration and switching pantoprazole to NG lansoprazole could save **£110,122 to £153,270** per year. **Total estimated annual savings are £121,947 to £165,095.**

Social savings:

The project has generated potential social value through releasing nursing time for direct patient care. The estimated **2,478 hours of nursing time saved per year** could provide additional capacity for activities such as mouth care, personal care, rehabilitation and time spent with patients.

Summary:

The project also increased staff awareness and engagement with sustainability, with evidence that staff began identifying their own opportunities for reducing carbon emissions.

Overall, the findings suggest that sustainability improvements in Critical Care can provide multiple benefits simultaneously. The strongest quantified environmental opportunity is through changing medication administration routes, while reducing feed waste provides an additional carbon saving. The potential release of nursing time is also an important benefit, as it could allow staff to spend more time on direct patient care.

The project demonstrates that sustainability does not necessarily require major changes to clinical practice. Instead, reviewing established practices and choosing lower-carbon alternatives where clinically appropriate can generate environmental and financial benefits while maintaining patient safety. However, there are several important limitations to the findings. Firstly, many of the reported savings are predicted rather than measured actual savings. The carbon and financial calculations were based on retrospective data, audits and modelled assumptions, and therefore require repeat measurement following implementation.

Secondly, the project timeframe was too short to directly measure patient outcomes. The clinical benefits are therefore based on existing evidence and anticipated benefits rather than demonstrated changes in patient outcomes within this project.

Finally, delivery was constrained by limited protected time for the project team. Despite having eight team members, much of the data collection and project work was undertaken alongside normal duties, which limited the time available for auditing, surveys and implementation.

Conclusions:

This project has demonstrated that there are practical opportunities to reduce the environmental and financial impact of critical care without compromising patient safety or quality of care. By auditing current practice, the project identified avoidable waste and opportunities to use lower-carbon routes of medication administration. The work has also increased staff awareness of sustainability and encouraged colleagues to identify further opportunities for improvement. The potential environmental impact is significant with **combined annual savings of 3,900kgCO₂e**.

The project has therefore been useful not only in identifying measurable environmental and financial opportunities, but also in demonstrating how sustainability can be incorporated into everyday clinical decision-making.

Several factors contributed to the successes and learning from the project:

- **Auditing current practice:** Initial audits provided evidence of the scale of unnecessary waste and inappropriate use of IV medication, helping to identify areas where change could have the greatest impact.
- **Use of local data:** Working with ICNARC, Stores, Domestic and Waste Management teams enabled the project team to understand patient numbers, waste volumes, consumable costs and disposal costs. This strengthened the case for change.
- **Multidisciplinary engagement:** Support from the Critical Care Matron, Medical Lead, Operations Manager, pharmacists and waste management teams helped facilitate implementation.
- **Staff education and communication:** Education during pre-shift huddles, team days, posters and presentations helped increase awareness and support behaviour change.
- **Evidence-based practice:** Reviewing evidence around IV versus oral/NG paracetamol and fever management provided a clinical rationale for changing established practice rather than pursuing sustainability at the expense of patient care.
- **Linking sustainability to financial and clinical benefits:** Demonstrating potential carbon, cost and staff-time savings helped make sustainability relevant to day-to-day clinical practice. The modelling suggested that changing IV medication administration could save approximately **2,478 nursing hours per year**, equivalent to around **103 days**.

A key learning point was that changing established clinical and operational behaviour takes time. There was initial resistance to some changes, particularly where staff were accustomed to existing processes and questioned why these should change. Providing evidence from audits, alongside information about potential carbon and financial savings, helped to challenge these perceptions and increase engagement.

The project also highlighted the importance of having protected time and sufficient resources for sustainability work. Although the project involved eight team members, different working patterns and the lack of dedicated management time made auditing, data collection and project delivery challenging. A significant proportion of the work was undertaken in staff members' own time, creating additional workload and pressure.

Another important learning was the need to prioritise interventions according to their potential impact. For example, there was resistance to changing linen bag use, and the team recognised that waste contributes only around 1% of carbon emissions. Consequently, attention was redirected towards medicines and other interventions with potentially greater environmental impact. The project has taken several steps to plan to embed the changes into routine practice. These include introducing appropriate waste streams and signage, providing staff education, engaging teams through pre-shift huddles and team days, and planning to develop an SOP and flow chart for fever management and appropriate use of paracetamol.

The pharmacy team were also involved and sought to incorporate medication-route review into ward rounds. Information and posters have been provided to support new ICU doctors, helping to ensure that sustainability considerations are communicated when new staff join the unit. The plan is to repeat the audits following implementation to establish actual environmental and financial savings rather than relying solely on modelled predictions.

The project has demonstrated that interventions are more likely to gain support when their environmental benefits are accompanied by evidence of clinical, financial or workload benefits. There is also evidence that the initiative is beginning to spread beyond the immediate project. The work was presented at a **Band 6/7 study day**, generating discussion and encouraging staff to consider sustainability opportunities in other aspects of critical care.

Overall, the project demonstrates that small changes in everyday critical care practice can generate meaningful environmental benefits while also supporting financial sustainability, staff time and patient-centred care. The most important longer-term outcome may be the development of a culture in which staff routinely consider environmental impact alongside clinical and financial considerations when making decisions.

References and Resources

- **National Institute for Health and Care Excellence (NICE) (2020, updated 2024)** *Perioperative care in adults*. NICE guideline NG180. London: NICE. Available at: [NICE guideline NG180](#) (Accessed: 1st August 2026).
- **Mallama, M., Valencia, A., Rijs, K., Rietdijk, W.J.R., Klimek, M. and Calvache, J.A. (2021)** 'A systematic review and trial sequential analysis of intravenous vs. oral peri-operative paracetamol', *Anaesthesia*, **76**(2), pp. 270–276.
- **Prasad, P.A., Joshi, D., Lighter, J., McComas, M. and Hoang, H. (2021)** *Environmental footprint of regular and intensive inpatient care in a large US hospital*. Journal of Life Cycle Assessment. Available at: [Environmental Footprint of Regular and Intensive Inpatient Care in a Large US Hospital](#) (Accessed: 13 August 2026).
- **Young, Paul et al. (2015)** HEAT Study 'Acetaminophen for Fever in Critically Ill Patients with Suspected Infection.' *The New England journal of medicine* vol. 373,23 (2015): 2215-24.

Appendices

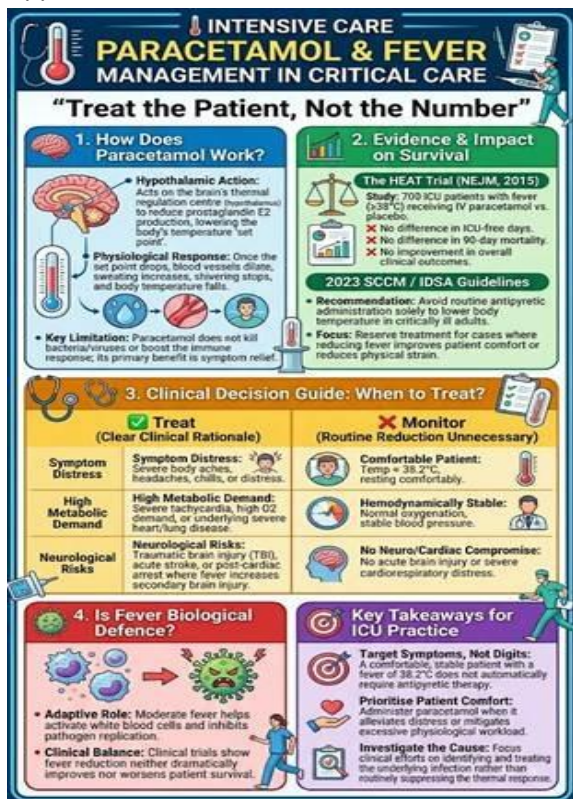
Appendix A: poster re waste segregation



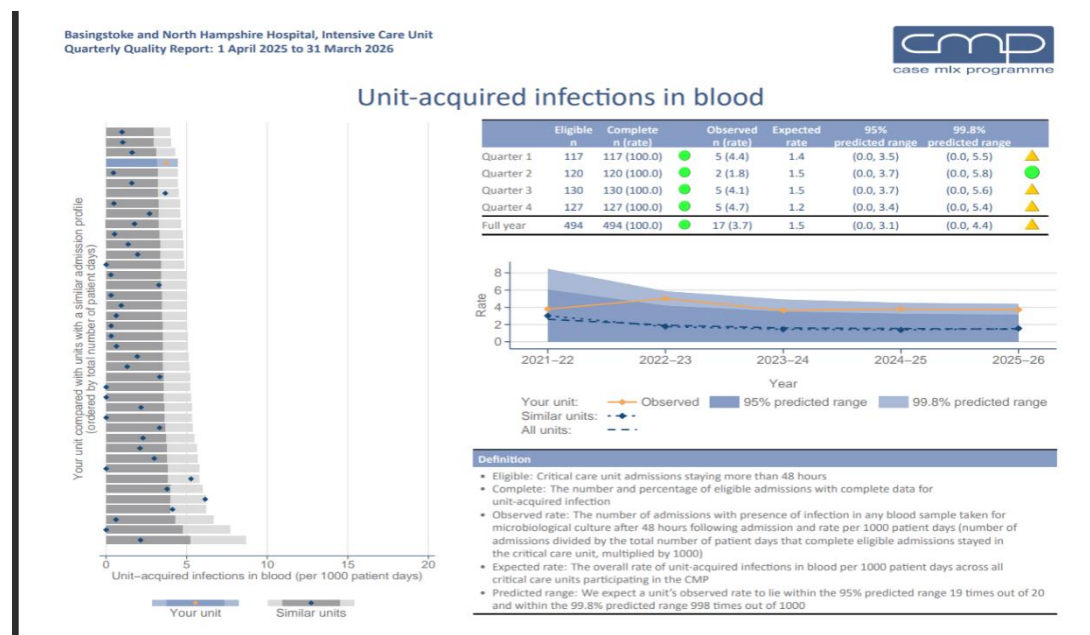
Appendix B

https://docs.google.com/presentation/d/1ET_lkz9rqEr8ynqJRJ5vX7RIMBB6XVm/edit?usp=sharing&ouid=100524543978078228413&rtpof=true&sd=true

Appendix C: Paracetamol use in ICU for fever



Appendix D: Unit acquired infections in blood



Appendix E: Financial costs for IV and NG administration for paracetamol

Component	IV Paracetamol	NG Paracetamol
Medication Cost	0.80	£0.015- £0.115
Primary Nurse Time	15 minutes (administration & documentation)	2 minutes (administration and aspiration prior to feeding)
Primary Nurse Cost	£7	£0.93
Second Nurse Check	2 minutes (£0.93)	Not required
Total Nursing Cost	£7.93	£0.93
IV Access Cannula/CVC	£0.56	Not required
Vygon (bionector)	0.37	Not required
Infusion Set – gravity giving set	£2.04	Not required
Cannula dressing	0.14	Not required
Alcohol Swab	£0.018	Not required
50 mL Normal Saline flush	0.50	Not required
Sterile gloves (for CVC)	£0.20	Not required
Gloves	0.017	0.017
Aprons	0.020	0.020
Enteral syringe	Not required	0.1914
Plastic cup	Not required	£0.0095

Clinical Waste Disposal – yellow sharps bin for IV, tiger stripe for NG pot	472 per ton – weight tbc	472 per ton weight tbc (slightly less as only NG syringe/med pot
Estimated Total Cost (<i>excluding clinical waste</i>)	12.595	1.1679
Total estimated at 181.5-254 doses per week (based on audit)	£2286-£3199	£211.98- £296.65
Total estimated at 9440-13,216 doses per year (based on audit)	£118,897-166,455	£11,025- £15,435

Appendix F: **Financial costs for IV Pantoprazole to change to and NG lansoprazole.**

Component	IV Pantoprazole	NG lansoprazole
Medication Cost	£0.70	£0.156
Primary Nurse Time	15 minutes (diluting, administration & documentation)	2 minutes (administration and aspiration prior to feeding)
Primary Nurse Cost	£7	0.93
Second Nurse Check	2 minutes (£0.93)	Not required
Total Nursing Cost	£7.93	£0.93
IV Access Cannula/CVC	0.56	Not required
Vygon (bionector)	0.37	Not required
Red drawing up needle	0.0145	Not required
Cannula dressing	0.14	Not required
Alcohol Swab	0.018	Not required
Posiflush	0.59	Not required
0.9% saline 10mls	0.30	Not required
Sterile gloves	£0.20	Not required
Gloves	0.017	0.017
Aprons	0.020	0.020
Enteral syringe	Not required	0.1914
Plastic cup	Not required	0.0095
Clinical Waste Disposal – yellow sharps bin for IV, tiger stripe for NG pot	472 per ton – weight tbc	472 per ton weight tbc (slightly less as only NG syringe/med pot

Estimated Total Cost (<i>excluding clinical waste</i>)	£10.8595	£1.3239
Total based on 472 patients (based on admissions over last year) 100% dose	£5125.684	£624.88

Appendix G: Financial costs for waste segregation

	10 bins – 16.5kg (CCA) 10 bins 13.5 (CCB)	Total	Total	Per day	Weekly	Yearly
Orange bins (515)	1.5	32	24.72	74.16	519.12	27068.4
Tiger stripe (442)	1.5	18	11.934	35.802	250.614	13067.73
Black bin (135)	1.5	14	2.835	8.505	59.535	3104.325
Old cost				74.16	519.12	27068.4
New cost				44.307	310.149	16172.055
Savings				£29.853	£209	£10896
Savings in percentage				59.75%		

Critical success factors

Please select **one or two** of the below factors that you believe were most essential to ensure the success of your project changes.

People	Process	Resources	Context
☐ Patient involvement and/or appropriate information for patients - to raise awareness and understanding of intervention ☐ Staff engagement ☐ MDT / Cross-department communication ☐ Skills and capability of staff X Team/service agreement that there is a problem and changes are suitable to trial (Knowledge and understanding of the issue) ☐ Support from senior organisational or system leaders	☐ clear guidance / evidence / policy to support the intervention. ☐ Incentivisation of the strategy – e.g., QOF in general practice ☐ systematic and coordinated approach X clear, measurable targets ☐ long-term strategy for sustaining and embedding change developed in planning phase ☐ integrating the intervention into the natural workflow, team functions, technology systems, and incentive structures of the team/service/organisation	☐ Dedicated time ☐ QI training / information resources and organisation process / support ☐ Infrastructure capable of providing teams with information, data and equipment needed ☐ Research / evidence of change successfully implemented elsewhere ☐ Financial investment	☐ aims aligned with wider service, organisational or system goals. ☐ Links to patient benefits / clinical outcomes ☐ Links to staff benefits ☐ 'Permission' given through the organisational context, capacity and positive change culture.