SUSQI PROJECT REPORT

REDUCE, RE-USE, RECYCLE: a Trilateral Sustainability Quality Improvement Project by the UHCW Critical Care Team.

Start date of Project:

Date of Report:

Team Members:

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Background:

1) **REDUCE: Reducing unnecessary equipment in central line packs**

A Central Venous Catheter (CVC) is a vascular access device inserted into a large vein to deliver medication, as advanced monitoring, or to permit dialysis. Due to the amount of sterile equipment required to insert one CVC, we have pre-prepared Coventry CVC Insertion Packs. Last year, 1872 packs were used within critical care and theatres. It became evident that several items in this pack were not being used and were thrown away each time. Furthermore, several items could be improved upon, and/or their carbon footprint reduced.

Improving the insertion packs served three purposes. The first is the safety aspect; reducing unnecessary equipment in the pack simplifies the amount of equipment the clinician has to work with and reduces overcomplicating the procedure or increasing the number of steps to perform it. Secondly, an environmental impact; reducing waste means a potential reduction in production, sterilising, packaging and disposal of equipment, as well as a reduction in its overall carbon footprint. Thirdly, staff engagement; it was well recognised amongst clinicians using CVC packs that the packs created unnecessary waste, and this caused moral upset by having to dispose of these items each time. By demonstrating that sustainable change is possible, this will hopefully lead to increased workplace satisfaction and engagement with future sustainability improvements.

2) **REUSE: Investigating the feasibility of reusable gowns and aprons**

Single use, plastic, disposable aprons and gowns are key parts of our Personal Protective Equipment (PPE) used to prevent the transmission of infection from one person to another, in many areas of the hospital including the critical care unit. Based on a Health Innovations North West Coast report, it was identified that gowns are one of the most carbon intensive PPE items to produce and have large potential for carbon- and cost-saving by switching to reusable gowns (which have been shown to be as effective or superior to single use gowns.)

Our aim was to switch to using reusable gowns and aprons on the critical care unit. We were more focussed on aprons as they are a high use item as they are used for any procedure where staff may come into physical contact with a patient, their body fluids, or their bed; to prevent contamination of uniform and spread of infection between patients. This means that a single nurse in a single bed space could use, on average, around 15 aprons over a 12-hour shift, not with counting any used by visiting teams, relatives, etc. Gown use on critical care is more limited to situations where patients are ‘barrier’ or ‘reverse barrier’ nursed, such as those with multi drug-resistant infections. This forms a smaller number of the critical care patient population but involves a higher cost (gowns need to be thicker and use a lot more material, as well as being safely disposed of) and therefore carbon-saving, by switching to reusable ones.

3) RECYCLE: Recycling of nasogastric feed and supplement bottles

In the critical care unit, many patients are unable to eat and drink in the normal way, or need nutritional supplementation. They may be unconscious, under strong sedation, or have medical reasons (such as a recent operation) why they cannot have oral intake. It is very common, therefore, for patients to receive nutrition via a nasogastric (NG) feeding tube. This is a fine tube that is inserted through the nose and down into the stomach and is connected to a bottle of specialised feed to meet a patient’s nutritional requirements. Patients who can take oral nutrition may need extra nutritional support in the form of supplement drinks; used to provide extra protein, calories, fibre or vitamins and minerals. The drinks come in the form of individual plastic 200ml bottles.

We discovered our critical care unit had very limited recycling facilities, and there was a general lack of knowledge on whether NG feed and supplement bottles could be recycled. It was identified that most of these plastic bottles would be thrown in the clinical waste bins after use, meaning they would be incinerated, thus creating a far larger carbon footprint and cost to the NHS than if they were recycled. Furthermore, these feeds are used in many of the areas in the hospital, such as ward environments, and, by implementing recycling of such a common product, we could demonstrate that this was an easily achievable process that could be rolled out across the trust, making an even bigger impact on carbon savings.

UHCW has a large critical care footprint, consisting of a 30-bed general and 16-bed cardiothoracic unit. Once we started researching project ideas and areas where sustainability could be improved on the unit, we found many colleagues who shared our views and were keen for change. Since starting the project, we have developed a multi-disciplinary team, comprising doctors, nurses, and allied health professionals (AHPs), to help us identify areas within their own areas of work that could undergo sustainable change or improvement.

There can often be challenges in implementing sustainability projects in critical care as, by its very nature, critical care is a complex, busy, high workload environment. A multitude of tasks, drugs, procedures, and tests, to name but a few, can be given or performed on just one patient in one day. One of our goals is to show a safe balance between expedience of clinical work and sustainability-optimisation; helping demonstrate that if we can take these steps in critical care then other environments within the hospital will have a strong starting point to achieve more sustainable practices, also.

Specific Aims:

- To remove items that are clinically unnecessary from central line packs to simplify equipment and reduce waste.
- To implement recycling of nasogastric feed bottles and oral supplement bottles to reduce environmental and financial impacts of clinical waste incineration.
- To investigate the feasibility of reusable gowns and aprons, instead of single use items, to reduce the environmental impact of manufacture and disposal of single use materials.

Methods:

1) REDUCE: Reducing unnecessary equipment in central line packs

Data from our procurement process in 2023 showed that 1872 central line packs were used at a cost of £42,251.04. Clinicians from the anaesthetic and critical care teams were invited to complete an anonymous online survey to understand usage of items in the packs. These clinicians were key stakeholders as they were the ones using the packs regularly and could inform us about which equipment, if any, was not used. The survey also helped increase involvement and investment in the SusQI process, aiming to aid acceptance of the new packs, as well as fostering support and interest in improving sustainability in critical care in the future.

Other key stakeholders were the critical care equipment lead and the current pack manufacturer. It was important to involve the equipment lead early on to understand if it was feasible to alter the packs, what changes could and could not be made, current contract end date and ideal costings. He immediately gave the go-ahead and said there were no restrictions other than the price needed to be equal or, ideally, less, than the current price pack. We had lengthy discussions with both our current CVC pack manufacturer, as well as a competitor, to compare pricing, quality and additional plastic involved in a new, slim-line CVC pack. We gave them both a list of our exact requirements and asked for a breakdown of the cost of each product and the total price for this new custom-made pack. Over time we gradually honed our requirements down even further by reducing the size of the tray contained within all packs, to half that of our current size, and made of thinner, lighter plastic. We asked for 'trial' packs to be made up so we could physically compare them side by side and gather opinions and consensus. The final costs for each manufacturer's pack were, obviously, different (by around £3-5 pounds) but the equipment quality also varied a little. We used both cost and quality, as well as colleagues' opinions, to guide our final decision on which competitor's pack to purchase.

2) REUSE: Investigating the feasibility of reusable gowns and aprons

After undergoing training on sustainability in healthcare as part of the SusQI initial slide set, we realised that single-use plastic apron use was something we both felt was a big, but potentially changeable, problem. The use of single-use gowns in side-rooms (for patients with multi drug-resistant infections) was evident too, as clinical waste bins often filled up quickly with such gowns. We felt this issue could also be solved by changing to reusable PPE. Wastage and overuse of plastic gloves was already an ongoing project (the Gloves Off campaign) and so we decided to focus on reusable PPE; aprons and gowns. The first thing we did was a literature search on reusable PPE. Through this we uncovered the Health Innovation North West Coast (2024) report[1] on reusable isolation gowns. This gave three case studies involving NHS trusts that had implemented the switch from single-use to reusable gowns using different models, providing a framework on how we could replicate this with gowns and aprons.

We engaged with staff about current apron usage and what they would want in a new apron. We then reached out to numerous manufacturers to get information on whether they may be able to produce such an item, its cost, carbon foot-printing and method of laundering. We discussed gown and apron usage, quality testing and the practicalities of reusable PPE with the infection prevention and control (IPC) department. Finally**,** we liaised with the hospital's sterile services team about the possibility of on-site laundering or organising transportation for off-site laundering.

3) RECYCLE: Recycling of nasogastric feed and supplement bottles

We surveyed critical care nurses and healthcare assistants, both of whom dispose of nasogastric feed supplement bottles in their everyday work, to understand how they were currently being disposed of (i.e. usual practice), potential barriers to recycling, and any suggestions they would find helpful in increasing the likelihood of recycling of these products.

Survey results demonstrated that pretty much all staff would like to be more sustainable and recycle more on the unit. Practice at the time was to put any feed bottles in a clinical waste bin, as well as supplement bottles, although occasionally supplement bottles did go in a recycling bin. We devised a two-step approach for a targeted recycling initiative, involving both education and addition of recycling bins and signs to clinical areas. Senior staff were informed of the project and recyclability of feed and supplement bottles. They cascaded this information to their teams during daily safety briefs, as well as creating posters which were put up around the unit, including in the coffee room. The estates department added a recycling bin to each sluice room (as we found out during the survey that this is where staff most disposed of these bottles, in clinical waste bins) and created large print infographic signs to go on each bin showing what could be put in them. These were standard hospital bins with standard waste bags so there was no additional cost associated. We then worked with the hospital estates team to devise a short trial to monitor usage of these bins and look in detail at the waste disposed of in them, by sifting through and weighing individual items.

Measurement:

Patient outcomes:

1) REDUCE: Improving central line packs

It is known that using pre-prepared packs for central line insertion reduces rates of technical mistakes and the duration of the procedure from start to finish, compared to gathering individual equipment items separately (Fenik *et al.,* 2013)[2]. It thus follows that if a pre-prepared pack does not contain all the items required or includes unnecessary items that need sorting through and removing before the procedure, the potential benefit of the pack is reduced. At this current stage of the project**,** it is not possible to measure a tangible patient outcome, but in the future retrospective study of incident rates (using the Datix reporting system) when using the old pack compared to the new pack will be possible.

2) REUSE: Investigating the feasibility of reusable PPE gowns and aprons

Although PPE was created for its user, it does have a direct impact on patient safety. On a day-to-day basis PPE is used to prevent contamination of clothing, in turn reducing patient-to-patient transmission of infection via soiled uniform. It has been shown that re-usable gowns are superior to single use ones in standardised tests of protection and durability, (McQuerry, Easter & Cau, 2021)[3] thus offering potential to reduce incidence of healthcare associated infections.

Unfortunately, the PPE project did not progress past the analysis stage due to financial and environmental considerations, discussed below. Had it progressed further, we would have liaised with IPC to test the durability and permeability of the new PPE items. This could be compared directly to the current single use items to measure whether they were likely to reduce rates of uniform contamination. A further study could look at droplet-born nosocomial infection rates before, and after, implementation of reusable PPE.

1) **RECYCLE: Recycling of nasogastric feed and supplement bottles**

Disposal of feed bottles is performed after a patient no longer needs them, thus will have no direct impact on patient care and, therefore, no measurement is required.

Environmental sustainability:

1) **REDUCE: Improving central line packs**

To gather current usage data, our survey asked staff members their role, grade, working environment and usage of items in the insertion pack. All healthcare practitioners (including doctors and critical care practitioners) who routinely do CVC insertion were invited to complete the questionnaire, whereas those who do not routinely do CVC insertion were excluded. The responses from the questionnaire were then analysed using Microsoft Excel.

Based on the survey results, we suggested which items could be removed from the packs and gained approval from the general consultant body in the department. Some of the items could be improved upon; manufactured from more sustainable materials, or being reduced in size. With the help of the sustainable healthcare team, we were able to analyse the carbon footprint of these items to understand and measure the carbon dioxide equivalent savings.

A process-based lifecycle assessment was used to estimate the GHG emissions associated with all the consumables being removed from the CVC insertion packs. The analysis included GHG emissions associated with raw material extraction, transport, and disposal. Transport emissions associated with the plastic tray were excluded due to data unavailability. Material weights and transport distance were converted into GHG emissions using emission factors taken from the 2024 UK Government Greenhouse Gas Conversion Factors database.

2) **REUSE: Investigating the feasibility of reusable PPE gowns and aprons**

Our plan was to source suitable reusable aprons and gowns to replace the single use items, confirm their viability with IPC, and then order a small number of these to undertake a trial of their use, over a specific period of time, in a specific area of the critical care unit. To keep the trial small and more easily monitored we would have used a few of the side rooms where gowns and level 3 PPE were required, and a four-bed bay to trial the aprons. We would have required customised laundering bins to explicitly state their purpose (I.e. used PPE requiring laundering). This would have required working with the estates team to firstly provide these bins and signage, and in moving these bags to an appropriate location for collection by a laundering service or for an on-site laundering service.

Our estates team have been developing a waste bag tracking system that would have been used to monitor how many bags were generated per patient area per day. Data could also be obtained from the launderer on how many items they have washed over the trial period.

To establish our current PPE usage, we had a team of volunteers who were going to stand in the trial areas described above, before we made the switch to reusable PPE, and count the number of gowns or aprons used within a period of time, e.g. over 4 hours. From this data we could extrapolate how much single-use PPE is used in a year, how much reusable PPE was needed to replace it, and thus the carbon dioxide equivalent saving. Unfortunately, the project could not continue beyond delivery of sample products due to high cost and lack of available laundering services.

3) RECYCLE: Recycling of nasogastric feed and supplement bottles

Our initial staff survey allowed us to quantify the scale of feed and supplement bottle waste by working out what percentage of the bottles were currently recycled.

The trial of recycling bin and signage implementation, and staff education, lasted two weeks (starting 24/11/24). Each new recycling bin's contents was checked daily, waste was removed and kept separate from other waste streams, and each item weighed. Emission factors for waste disposal were taken from Rizan *et al*. (2021)[4] which details 21 $kgCO_2e$ /Tonne for recycling and 1074 $kgCO_2e$ /tonne for high temperature incineration.

Economic sustainability:

1. REDUCE: Improving central line packs

The original packs cost £30 as per our department's equipment lead, procurement team and current supplier. Given that our ordering data for the previous year showed 1,872 packs were used, this equated to £56,160 over a year. The original contract also detailed the pricing of the constituent items. Although these costs are likely to change over years, it still aided review of which items were most expensive and whether the cost seemed appropriate, or if a suitable cheaper and more environmentally friendly alternative could be sought.

Two companies were approached to produce the revised packs. One was the company that made our current packs, and the second one was new for this purpose but had a good reputation from other departments in the hospital.

2. REUSE: Investigating the feasibility of reusable PPE gowns and aprons

To switch to reusable PPE, the most significant financial burdens are the initial implementation costs for purchase of products, and the ongoing maintenance costs of their transportation and laundering. We contacted Revolution Zero, a British company who aim to provide more sustainable medical textiles, and their charge for production was £13.50 per apron. They did offer laundering solutions but the challenge would have been transportation to their distant laundering facility, thus negating any carbon footprint improvement.

We also contacted Northumbria Healthcare, who were able to provide samples of reusable PPE aprons. There were options to purchase non-sterile aprons from them for £11.40 per unit, and sterile aprons for £14.16 per unit. These would require local laundering arrangements at further cost, which would differ from one hospital to another and need bespoke costing. Some hospitals have on-site laundering facilities, but currently our major laundering contract is outsourced to a firm that deals with sheets, blankets and similar items. We tried to contact them several times during the project to discuss the feasibility of laundering new reusable aprons but they did not engage in the process.

There would be further implementation costs for bespoke laundry bags and bins for the reusable PPE items. The items have a maximum safe number of times they can be reused before they are felt to be at risk of perishing, meaning repeated implementation costs, but also potential cost for a monitoring system to identify when PPE needs to be switched out or replaced. Some companies such as NTH Solutions (Stockton-on-Tees) have bar-code technology that does this as part of their service, and they also offer transportation and laundering, but are based too far away to be used. If this service was not offered we would have had to cost for a bespoke monitoring system to ensure PPE was not used past its maximum number of washes. Furthermore, if ownership and in-house laundering of PPE was planned, rather than a fully comprehensive service, one would have to organise and budget for transportation to a local suitable laundering facility or purchase the equipment needed and fund setting up the facility, if space was available on the hospital site.

A further cost would have been staff time. Our IPC team wanted to do their own quality tests of any PPE purchased. They also would have needed to validate the quality of the cleaning by a private firm, if the laundering was outsourced, to ensure it was up to standard. Clinical staff members would need re-training on donning and doffing new PPE, and how to dispose of the items in a suitable laundry receptacle.

3. **<u>RECYCLE: Recycling of nasogastric feed and supplement bottles</u>**

Due to the Private Finance Initiative (PFI) contract which the hospital operates, and the engagement by the estates teams in the process, there was no additional cost for the provision of the two recycling bins. If this project were to be expanded on a hospital-wide scale, further calculation would be needed to look at the cost of recycling bins and which budgets **these impacts**. Staff members' time was used to inform of the new method of disposal of the feed bottles, but this was within staff working hours rather than their own time. A small amount of time was used to produce a poster for the bins, and posters that could be put up in staff areas, but this was not of measurable cost.

We worked very closely with the hospital's waste and sustainability manager who was invaluable in this process. He organised the two-week trial and gathered the data about waste produced by sorting through it himself. He also had up-to-date information on how much the hospital pays for disposal of waste via different waste streams (price per ton), allowing calculation of the cost avoidance by increasing recycling during the trial.

Social sustainability:

For all three projects there was no objective measurable way to quantify the social impact on staff. We surveyed staff on how supportive they would be of increased recycling and sustainability in critical care, and whether recycling feed and supplement bottles would be a significant inconvenience to them, to ensure we would not have a negative impact on social sustainability.

Results:

Patient outcomes:

1. **REDUCE: Reducing unnecessary equipment in central line packs**

This project involved refining our CVC packs. Although we reduced the items in the pack for a cost and carbon-dioxide equivalent saving, we also added two skin-disinfecting applicators; use of skin disinfection is a mandatory part of the procedure. At present, these need to be collected by a staff member, separately to the packs, which means it is possible to forget to collect them (human factors). By adding them to the packs, this reduces the cognitive load required when preparing for the procedure and improves its overall safety.

2. **REUSE: Investigating the feasibility of reusable gowns and aprons**

If the project had progressed past evaluation of samples, we would have gathered data from the IPC team to ensure the PPE was suitable and safe. We would have performed the trial with the new PPE and surveyed staff afterwards to enquire about their thoughts on the PPE, including ease of use, to ensure that there were no negative patient outcomes from the trial.

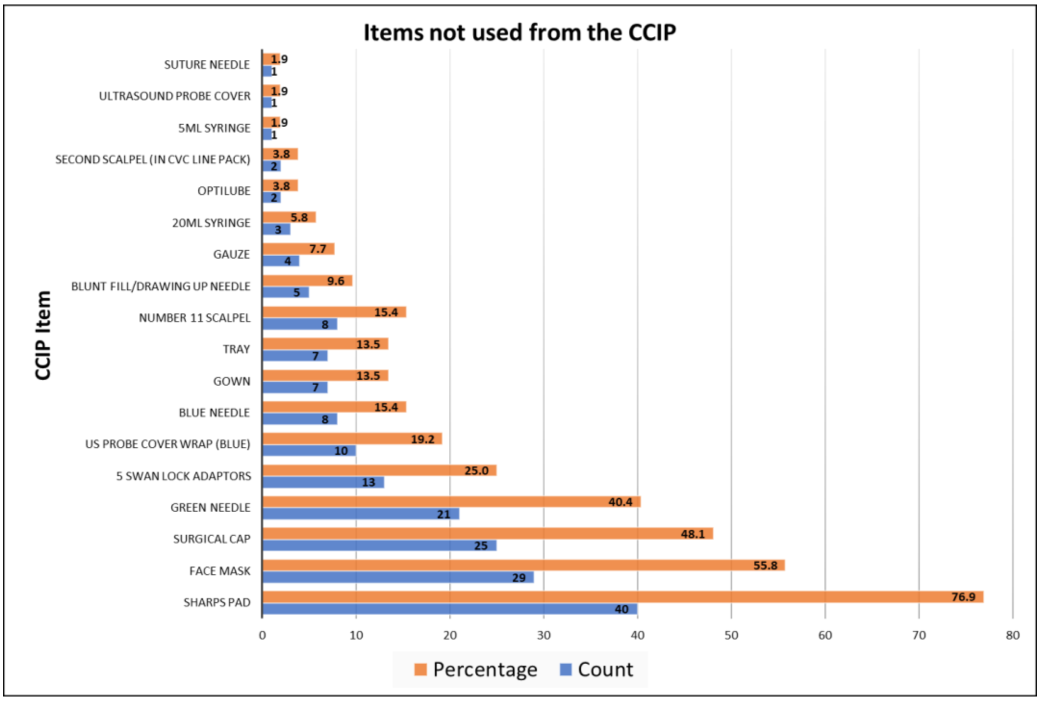
3. **RECYCLE: Recycling of nasogastric feed and supplement bottles**

This project involved recycling of items after they had been used for patient care, so there was no impact on patient outcome.

Environmental sustainability:

1. **REDUCE: Improving central line packs**

Our survey received 52 responses. The figure below shows which items from the Coventry Central Line Insertion Pack (CCIP) were not used.



Based on this data (and the fact that the scalpel was duplicated, as there is always one included in the separate package containing the central line itself) we removed the 5ml syringe, 18G green needle, a number 11 scalpel, the plastic blue cover around the ultrasound probe, a sharps pad and five swan-lock connectors. We also reduced the size of the tray included in the pack, used for keeping the items together in the pack and used as a drawing up surface during the procedure.

Table 1 details the carbon footprint of each item.

Item	GHG emissions (kgCO2e)
5ml syringe	0.0211
Green needle	0.0167
No. 11 scalpel	0.0321
Blue covering around US probe cover	0.0053
Sharps pad	0.1152
Swann connector (x5)	0.0495
Difference in plastic tray size	0.1526
Total saving per pack	***0.3925***

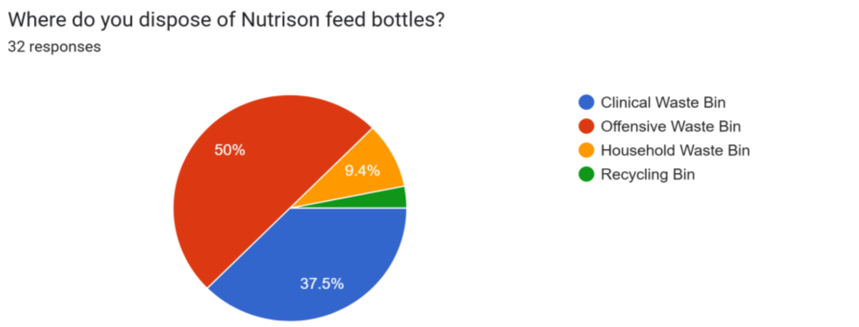
It's estimated that through the reduction of consumables we will save 0.3925 kgCO2e per pack. Based on our annual procurement of 1,872 pack per year, this reduction is estimated to save 734.76 kgCO2e per year.

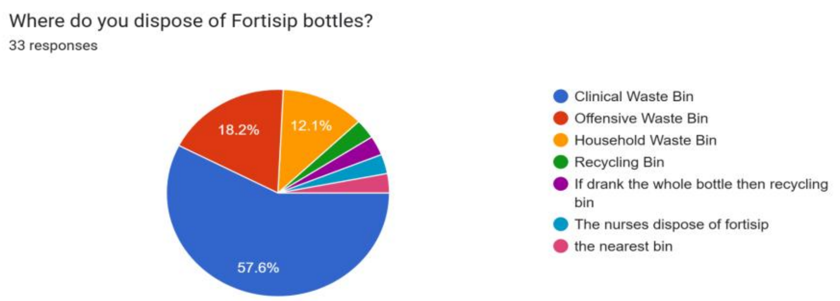
2) **<u>REUSE: Investigating the feasibility of reusable gowns and aprons</u>**

We would have to use an external launderer unless a new site was developed to handle this process (which would be a much larger project if initiated) as there is no physical on-site space where laundering facilities could be installed. The simplest option would be to purchase the PPE from one of the companies that offered transportation and continuing laundering and monitoring. We were such a distance from these companies, however, that the transportation mileage would have a significant negative impact on the environmental sustainability of this project. With this in mind, and lack of funds for the significant implementation costs, this project could not progress to a stage where usage and environmental impact data could be gathered.

3) <u>RECYCLE: Recycling of nasogastric feed and supplement bottles</u>

Our survey was completed by 33 members of staff. The respondents were 91% registered nurses and 9% healthcare support workers, which is in line with proportions of each type of staff on critical care at the time of the survey. Data on the trends in disposal of NG feed bottles (Nutrison) and oral supplement drinks bottles (Fortisips) are below.





Only 12.5% of staff were putting the feed bottles in bins where waste may be recycled (as the household waste bin contents go to a processing plant which can separate general refuse from recycling). Oral supplement drinks bottles were also put in these bins by only 18% of respondents. 67% of respondents indicated that it would not be a significant inconvenience to recycle the bottles, if time allowed (as any remaining liquid of significant volume would need to be poured down a suitable waste disposal receptacle, and then the bottle put in a non-clinical waste bin).

Over the 2-week trial 28.06 Kg of waste was collected from the new bins. The breakdown of waste types can be seen in the table below.

Waste Type	Weight (Kg)	% of Total
Plastic Packaging	4.87	17.36
Card or Paper	4.46	15.89
Food Supplement	4.42	15.75
General/Residue	4.3	15.32
Plastic Bottles	4.23	15.07
Clinical	3.8	13.54
Food/Water	1.98	7.06

Of all waste collected in these bins 19.96 Kg (71%) could be recycled. Clinical waste (where these items would have been disposed of before recycling bins were added) is disposed of by high temperature incineration with an emission factor of 1,074 kgCO_2e/Tonne (as detailed in the earlier measurement section,) compared to 21 kgCO_2e/Tonne for recycling. Over the trial period this meant that without intervention this waste would have generated 30.14KgCO2e of emissions but instead generated 9.12KgCO2e (a reduction of 21.02KgCO2e). This 70% reduction in carbon dioxide equivalent emissions forecasted over a year would be a reduction of 546.52KgCO2e just by adding a suitably labelled bin to each of two sluice rooms on general critical care.

The above figure shows [A] The informative posters placed above the trial recycling bins; [B] The feed bottles that we were aiming to be recycled in this project; [C] The plastic bottles that were recycled; [D] All bags collected during the trial period prior to sorting. Photos kindly provided by Dean Harrison, Waste and Sustainability Manager, University Hospitals Coventry & Warwickshire.

Economic sustainability:

1. **REDUCE: Reducing unnecessary equipment in central line packs**

Two companies tendered contracts to provide the new revised packs after we informed them of our project and a desired reduced procurement of medical equipment in the packs. The company that produced the old packs quoted £22.45 to produce the revised version. At time of writing this does not include two skin cleaning devices (which currently must be collected separately from the pack for each central line insertion). According to the British National Formulary (BNF) these devices (applicators of chlorhexidine gluconate with isopropyl alcohol) have an NHS cost of £23 for a box of 25 applicators. At a unit price of £0.92, and with two required for each central line insertion, this means that the cost of using new packs from the pre-existing supplier (and for two applicators) is £24.29. To avoid procedural mistakes, we would prefer to add these applicators to the packs; although our goal was to remove unnecessary items, the survey showed that these were missing and are necessary for patient safety, which must be paramount. To include the two applicators within the pack, our current supplier has quoted a price of £25.05.

The second company quoted £27.70 per pack, including the two applicators. Their packs also had less unnecessary packaging of smaller items that are already in a larger sterile pack, and they could also provide a smaller and lighter plastic tray (which we desired to reduce the carbon footprint).

Both companies were asked about making some items out of cardboard instead of plastic, but we were informed that sterile medical-grade cardboard is too expensive for manufacturers to produce. The cost reduction of using the pre-existing company to produce the proposed revised packs would be £5.71 per pack, or £10,689.12 per year, based on forecasted ordering. The cost of using the new company with our requested packs would mean a reduction in cost of £2.30 per pack, or £4,305.60 per year, based on forecasted ordering.

2. **REUSE: Investigating the feasibility of reusable gowns and aprons**

The project could not progress sufficiently to allow measurement of economic impact, as detailed in previous sections.

3. **RECYCLE: Recycling of nasogastric feed and supplement bottles**

Our clinical waste is disposed of at a cost of £950/Ton, our general waste at £150/Ton (plus transport cost of £30 per Ton), and our mixed recycling at a cost of £130/Ton (information kindly provided by our hospital's waste and sustainability manager). Addition of the two bins generated 19.96 Kg of recyclable waste, 4.3 Kg of general waste, and 3.8 Kg of clinical waste. This means that disposal of this waste over the trial period would have cost £26.66 but as a result of the trial cost £6.97 (a saving of £19.69). Over a whole year this would save £511.94.

Social sustainability:

All three projects had similar social sustainability impacts. We had general questions at the end of our targeted surveys about ease of access of recycling bins (68% of staff said they were not easily accessible) and whether staff supported us all doing more to recycle on critical care (94% said yes). Just doing our surveys seemed to boost engagement in the projects and improve morale amongst staff, as it meant concerns over lack of recycling facilities, and ideas about increasing sustainability were being acknowledged. Many staff made comments that they take steps to reduce unnecessary packaging and recycle at home, and they wanted to be able to do more of this in their workplace too, so were pleased to see the projects being implemented.

Discussion:

This tripartite approach to sustainability improvements on critical care allowed us to learn as a team, gain new contacts and networks, and foster support for sustainability on the unit.

Of the three projects, the 'reduce' project appeared easiest to complete, initially. The slowest part of the process was engagement from the companies tendering contracts to manufacture the packs. We did find in the process that items (e.g. applicators) had to be added to the packs, although more were removed than added overall (hence the reduction of 0.3925 $KgCO_2e$ per pack). Given that patient safety is paramount, it should be considered a positive of the project (and any similar sustainability project) that items had to be added to the packs, as it shows thorough review of the packs took place that otherwise would not have done. It may be that from a sustainability perspective, different things are noticed than one's normal clinical view of the environment which can occasionally (such as in this project) prompt an opportunity for clinical improvements. Having the two missing skin cleaning applicators in the pack reduces the likelihood that a critical step of central line insertion gets missed, so the project has aided patient safety. This project did permit an environmental sustainability improvement. Although our preference would have been to use the new manufacturer for the packs due to quality of materials used and engagement in the sustainability improvement process, the original manufacturer was cheaper, as detailed in the economic sustainability data, hence we decided to use their packs for financial responsibility. It was disappointing that both companies had little information on the carbon footprint of their products or knowledge of sustainable alternatives.

The risk of a project such as our 'reduce' project must be managed diligently. Some staff indicated that some items were not used in the pack which should have been, such as a hat and face mask, which should be used when scrubbed and sterile. This prompted informative updates to the team rather than removing these items from the packs. The results and contents were reviewed in the department monthly multidisciplinary learning meeting, and by the consultant body afterwards, to ensure the proposed changes were suitable. We would encourage a similar process for other sustainability projects reviewing packs of clinical contents.

The ‘reuse’ project had great potential and was inspired by the literature previously cited, detailing how to start using reusable PPE and the environmental and economic benefits. We were hindered by lack of funds for the initial outlay to buy the products. Had this not been a barrier we would still not have been able to progress with the project as off-site laundering would have been required. As detailed above, there are good options for companies that provide this service, after the purchase of their PPE, but they were too far away from our hospital site to logistically be an option, and to have a positive environmental impact. In a longer time period, a hospital could set up their own laundering, if space and funds were available, or create a bespoke agreement with a suitable laundering company in the area; but this would require thorough review by the IPC team to ensure laundering is performed to correct standards. Furthermore, a system would need to be devised to monitor the number of washes an item has had to allow disposal once it reaches the maximum number of reuses (this service is provided by some companies if you use their products and services). There is certainly a gap in the market for these products and services; if a more local company was available there would be many benefits to trialling reusable PPE. Unfortunately, the timeline required, particularly for customisation of the PPE items, approval by hospital management and IPC, and verification of appropriate quality of laundering would take longer than the scope of this SusQI project.

The ‘recycle’ project was our greatest success. It generated a reduction of 21.02KgCO2e across the two-week trial period. This was a 70% reduction in carbon-dioxide equivalent emissions. The project came about as a result of identifying a problem and working with staff to find a solution. When walking around the unit watching staff practices, (from a sustainability perspective) we quickly noticed all the plastic packaging from the feed and supplement bottles going into the clinical waste bins. The survey helped us identify the cause; lack of appropriately located recycling bins, and that staff were actually very keen to recycle. A key step for success in recycling was placing the bins somewhere logical when considering staff workflow. They could not be burdensome to walk to as clinical staff are busy all day, and remembering to change their normal route to do a task to include a recycling bin is burdensome and a barrier to encouraging recycling. Interestingly, the breakdown of disposed waste by type showed that whilst approximately 4.5 Kg of feed bottle waste was recycled (as desired), another 4 Kg of plastic bottles (used for other clinical tasks), 5 Kg of packaging (mostly of separated clinical items) and 4.5 Kg of card or paper (also mostly packaging of clinical items that had been separated) were disposed of in these bins. This shows that staff have the drive to recycle and know that packaging can be recycled, even if the product inside cannot (often because it gets used in patient care and is soiled). Our suggestion is that if you place a recycling bin in a location that staff members go past or through regularly, to perform a task that involves recycling not only do they recycle that desired item, but it builds familiarity of where an easily accessible recycling bin is, hence encouraging recycling of other items.

From the data obtained in the recycling trial, forecasted over a year there would be a reduction of 546.52KgCO2e just by adding a suitably labelled bin to each of the two sluice rooms on general critical care. Furthermore, this would yield a cost reduction of £511.94 per year in waste disposal. These benefits can be immediately augmented, as we have a cardiothoracic critical care department with a further two sluice rooms where these recycling bins and posters could be implemented. This project could be replicated well and simply in other critical care units. It might work well in gastroenterology inpatient wards where NG feeding, and use of oral supplemental drinks is more common. The focus was on feed bottles so in wards where these are used less frequently this system would not be optimal, but could be easily adjusted for, other, more commonly used, recyclable items in that department.

Unfortunately, during the recycling project an inappropriate clinical item was disposed of in the recycling bin which was caught during the trial (when waste was assessed) and then appropriately disposed of in the clinical waste. This highlights that implementation of a targeted recycling strategy is not without risks in a hospital and good staff education about categories of waste and how to dispose of it is important. This does fall under mandatory training for staff but informative posters (and feedback in safety meetings if anything is disposed of incorrectly) can mitigate this issue.

The projects were received well by staff on the unit who, in the vast majority, were keen for more recycling and sustainability considerations in the workplace. Surveying staff trends and opinion fostered support of these projects as they felt listened to. Moral distress at not being able to do more for the environment in the workplace would also hopefully be reduced.

Conclusions:

These projects allowed our new and small critical care Green Team to learn key concepts in SusQI and identify targets for immediate sustainability improvement.

Surveying staff trends, implementing a change guided by this, and then measuring the response is a method that worked well for us and we will repeat again in the future.

Although the reusable PPE was a good project with a potential for large environmental and economic benefit, the structure of NHS financing and organisation can provide long-term challenges that make a project like this a longer-term higher input project. During this process we found that there are many 'lower hanging fruit' projects that can be done more easily and quickly to improve sustainability promptly, whilst having slower projects running in the background. There is a gap in the market for companies that provide reusable PPE and a transport, laundering, and monitoring service, as there were few to choose from across the UK.

After the recycling project we are keen to roll out a similar targeted recycling improvement project across other areas of the hospital due to the environmental and economic sustainability success of this project. The impact of these projects, however, is larger than our targeted recyclable items, as building staff familiarity with recycling bin location through frequent use can encourage easy recycling of other items, too.

References and Resources

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3) Meredith McQuerry, Elizabeth Easter, Alex Cao. Disposable versus reusable medical gowns: A performance comparison. *American Journal of Infection Control*. 49 (5), 563-570 (2021). https://www.sciencedirect.com/science/article/pii/S0196655320309299
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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 X Staff engagement X 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) X Support from senior organisational or system leaders	X clear guidance / evidence / policy to support the intervention. X Incentivisation of the strategy – e.g., QOF in general practice X systematic and coordinated approach ☐ clear, measurable targets ☐ long-term strategy for sustaining and embedding change developed in planning phase X integrating the intervention into the natural workflow, team functions, technology systems, and incentive structures of the team/service/organisation	X Dedicated time ☐ QI training / information resources and organisation process / support X 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. X Links to patient benefits / clinical outcomes ☐ Links to staff benefits X 'Permission' given through the organisational context, capacity and positive change culture.