Intensive Care Environmental Sustainability Recipe Book

All the ingredients and steps your team needs to reduce your carbon footprint while maintaining quality, patient-centred care.

Intensive Care Society

The Faculty of Intensive Care Medicine

UK Critical Care Nursing Alliance

Health Innovation Network
Local change, national impact

University of Brighton

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"This fantastic, practical resource focuses on 'how to' be more environmentally sustainable, providing the ingredients and methods to reduce waste and lower carbon footprint in intensive care. Based on the Principles of Sustainable Clinical Practice, the Recipes will help clinicians, educators, students, managers, researchers and those doing quality improvement and audits in intensive care to know what to do and how to do it. Everyone working in an intensive care unit should use this Recipe Book!"

Rachel Stancliffe, Chief Executive Officer, Centre for Sustainable Healthcare

The Recipe Book was developed collaboratively by the Intensive Care Society, Faculty of Intensive Care Medicine, UK Critical Care Nursing Alliance, and University of Brighton. An ICU sustainability service evaluation, which included procurement and policy/guideline reviews, clinical procedure and waste observations and carbon footprinting, also informed the Recipe Book's content.

The **Intensive Care Society's sustainability website** contains information about the service evaluation, supplemental materials and how to ask questions, provide feedback and share the impact of using the Recipes.

Endorsing organisations

Intensive Care Society

The Faculty of Intensive Care Medicine

Centre for Sustainable Healthcare — inspire • empower • transform

UK Critical Care Nursing Alliance

Royal College of Nursing

BACCN — British Association of Critical Care Nurses

CCNN — Critical Care Network-National Nurse Leads

RIGHT TIME • RIGHT PEOPLE • RIGHT PLACE — NOrF — The National Outreach Forum

PCCS — Paediatric Critical Care Society

BDA The Association of UK Dietitians — Critical Care Specialist Group

Intensive Care
Environmental Sustainability Recipe Book

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Contents

How to use the Recipe Book 5
Introduction 6
Planetary health crisis 6
National healthcare requirements 7
Intensive care requirements 7
Greenhouse gas emissions 8
Green ICU Recipes 10

Teamwork and collaboration 11
ICU Green Team 11

Prevention 13
Health promotion 13
Admissions and discharges 15
Optimising ICU care 16

Patient and family empowerment 18
Shared decision-making 18
Service user sustainability engagement 19
Rehabilitation 20

Lean service delivery 22
Medicines 23
Infection prevention and control 25
Waste management 27
Investigations 29
Personal care and linen 31
Food and nutrition 33
Energy 36

Low-carbon alternatives 38
Procurement 38
Reusables and consumables 40
Travel 42

Education, quality improvement and research 44
Education 44
Quality improvement 46
Research 47
References 48

How to use the Recipe Book

This Intensive Care Environmental Sustainability Recipe Book was developed to help intensive care units (ICUs) in the United Kingdom reduce their carbon footprint while maintaining high-quality, patient-centred care. A 'greener' ICU is not more expensive but cheaper, while being good for the planet and people.

The introduction recognises the planetary health crisis and identifies National Health Service (NHS) requirements for England, Wales, Scotland, and Northern Ireland, as well as the standards and recommendations outlined in the Guidelines for Provision of Intensive Care Services.

Each recipe covers a particular topic for improving environmental sustainability and begins with a brief explanation, cross-referencing relevant guidelines and literature. Key ingredients for that topic are listed as things that will facilitate implementing the actions in the suggested methods. These methods are context-specific, can be adapted to suit the local setting and do not need to be completed simultaneously or in any particular order.

Different methods within each recipe may be easy to achieve in some hospitals and more challenging for others. A local ICU Green Team can liaise with clinicians, management, procurement, waste management, and infection prevention and control to write an ICU Green Plan relevant to the local unit. For example, some methods within one recipe may be easy to quickly achieve locally, while others are identified as longer-term goals.

Case studies are also provided to illustrate intensive care examples of environmental sustainability for the recipe topic. Further resources are linked throughout the Recipe Book.

The Recipe Book includes recipes based on the Centre for Sustainable Healthcare's **Principles of Sustainable Clinical Practice** and is organised according to the following themes:

1. **Teamwork**
2. **Prevention**
3. **Patient and family empowerment**
4. **Lean service delivery**
5. **Low-carbon alternatives**
6. **Education, quality improvement and research**

Planetary health crisis

The triple planetary crisis of climate change, pollution, and biodiversity loss severely harms the Earth's health, posing an immediate threat to human survival.

Healthcare delivery is worsening this emergency due to the resource-intensive manufacture of large amounts of devices and equipment, the large generation of polluting waste (e.g., volatile gases, medicines, packaging, and non-recycled or disposable equipment) and the use of fossil fuel-derived power, which all lead to greenhouse gas emissions exacerbating climate breakdown.[1] Immediate action is needed, and it must be delivered at pace and scale. **The United Nations Paris Agreement** demands a 12% reduction in greenhouse gas emissions every year for the next five years in all we do, and even this is probably too little. How are you—and we—to do this?

This Recipe Book offers guidance for ICUs in the United Kingdom (UK) on how to shift to be an environmentally sustainable ICU. Public health measures for disease prevention and health promotion[2] to reduce the demand for intensive care are also important[2], and every staff member is responsible for **personal actions** to live in a way that does not destroy the planet.[3]

"Immediate action is needed, and it must be delivered at pace and scale."

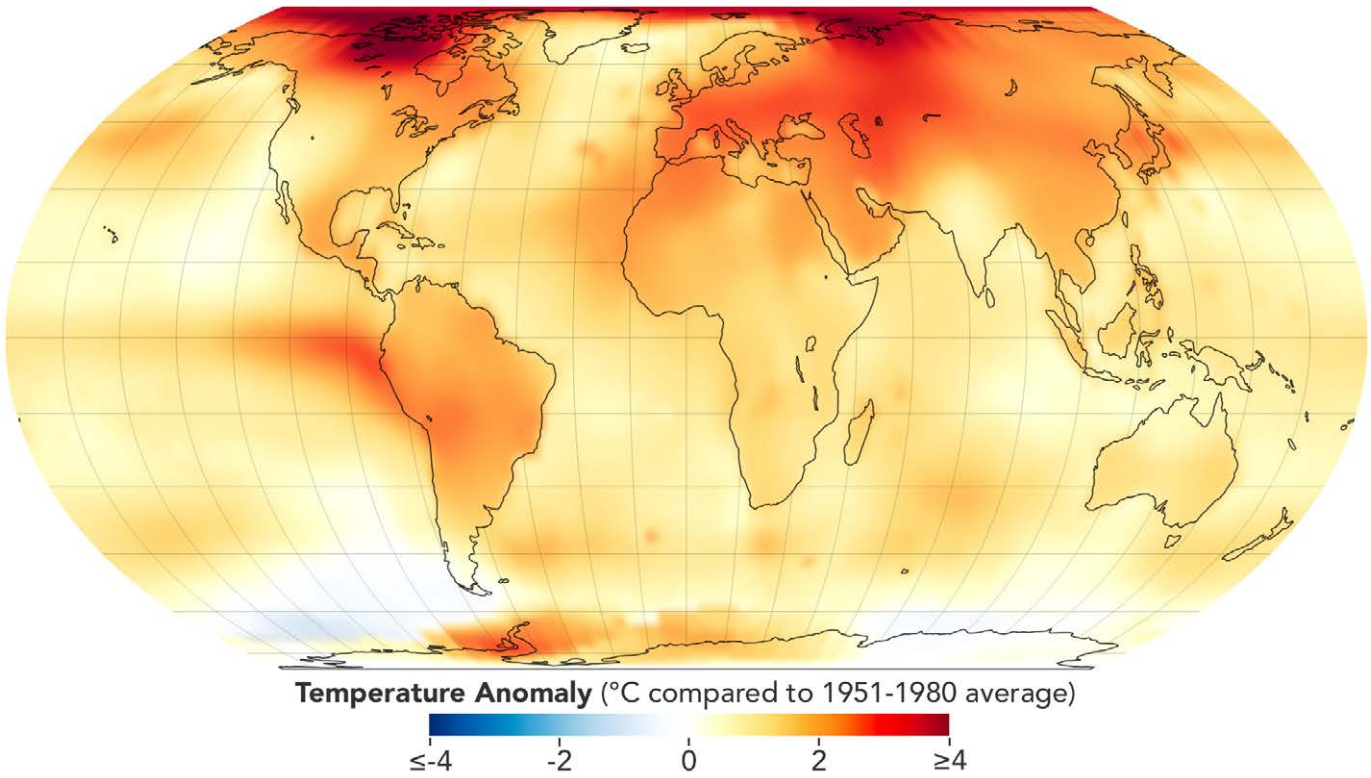


Image: NASA's Earth Observatory

2024 was the hottest year on record for planet Earth. January 2025 also beat every previous record, and heating is accelerating wildly. The **Intergovernmental Panel on Climate Change** warns that, without immediate transformative action, we will miss our chance 'to secure a liveable future for all'.

National healthcare requirements

National strategies in the UK require NHS organisations to reduce their environmental footprint and deliver healthcare in a way that is less harmful to the planet.

National environmental sustainability health service strategies in the UK

England →
- NHS England Greener NHS
- Delivering a Net Zero Health Service
- Health and Care Act 2022 – net zero legislation

Wales →
- Decarbonisation Strategic Delivery Plan
- Delivering sustainable healthcare: position statement

Scotland →
- NHS Scotland Sustainability Action
- Climate Emergency and Sustainability Strategy

Northern Ireland →
- UK Health Services mark landmark pledge to achieve net zero

Intensive care requirements

The **GPICS (Guidelines for Provision of Intensive Care Services)** 3rd edition will include environmental sustainability standards and recommendations for intensive care units in the UK.

Following the Intensive Care Environmental Sustainability Recipe Book guidance will help intensive care departments meet these GPICS requirements to provide a greener, more ecologically responsible intensive care service.

Greenhouse gas emissions

Greenhouse gases trap heat in the atmosphere, worsening global warming and climate change.

Examples of greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N2O) and fluorinated gases. CO_2 makes up the most considerable proportion of human-caused greenhouse gas emissions, which is why a 'carbon footprint' is the focus of measuring how damaging something is to global warming.

Global warming potential

Represents how much impact a greenhouse gas has on warming the Earth over a period of time compared to CO_2

CO_2e = carbon dioxide equivalence

Unit of measurement of greenhouse gas emissions, taking into account the global warming potential of each gas (CO_2, CH_4, N_2O and fluorinated gases)

Carbon footprint

Amount of greenhouse gases emitted from an item, process or system expressed as carbon dioxide equivalence (CO_2e)

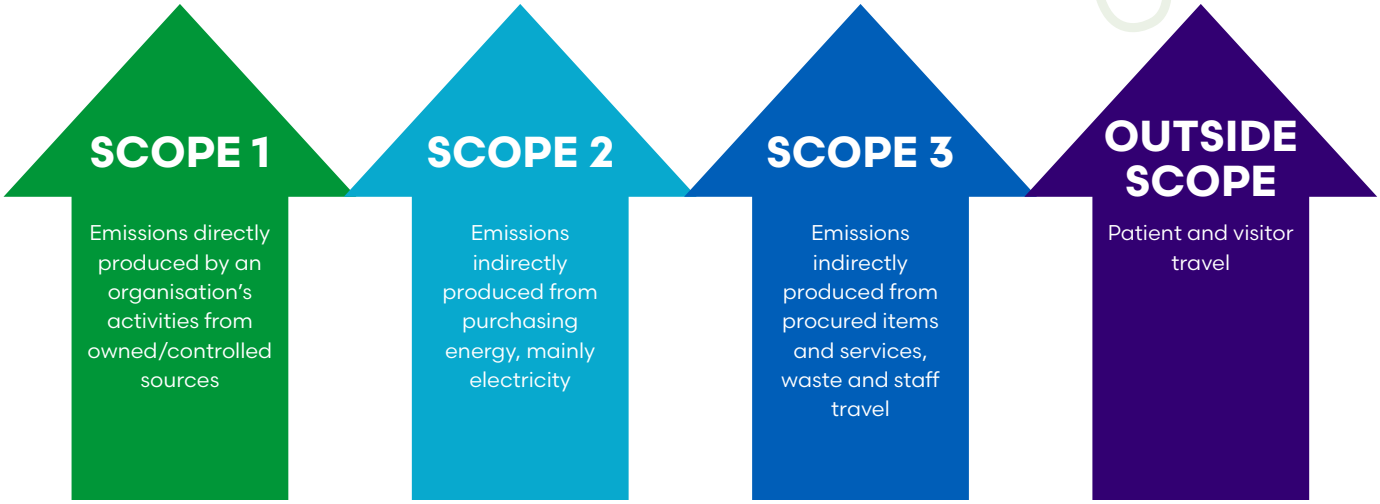
A life cycle assessment (LCA) evaluates the environmental impact across the full life span of an item, process or system, including raw materials extraction, manufacturing, transportation, use, and waste management.[4] An LCA may relate to its carbon footprint and/or (for example) impacts on land or water use, or ozone or other resource depletion.

The **HealthcareLCA database** is a free online repository of life cycle assessments of healthcare products and procedures to provide carbon footprint information.

Few LCAs relevant to intensive care have been performed, and healthcare environmental impact methodologies and reporting are not standardised. However, a systematic review of relevant studies concluded that intensive care has a significantly high carbon footprint.[1]

Introduction

Greenhouse Gas Protocol Scopes



Greenhouse Gas Emissions of the NHS

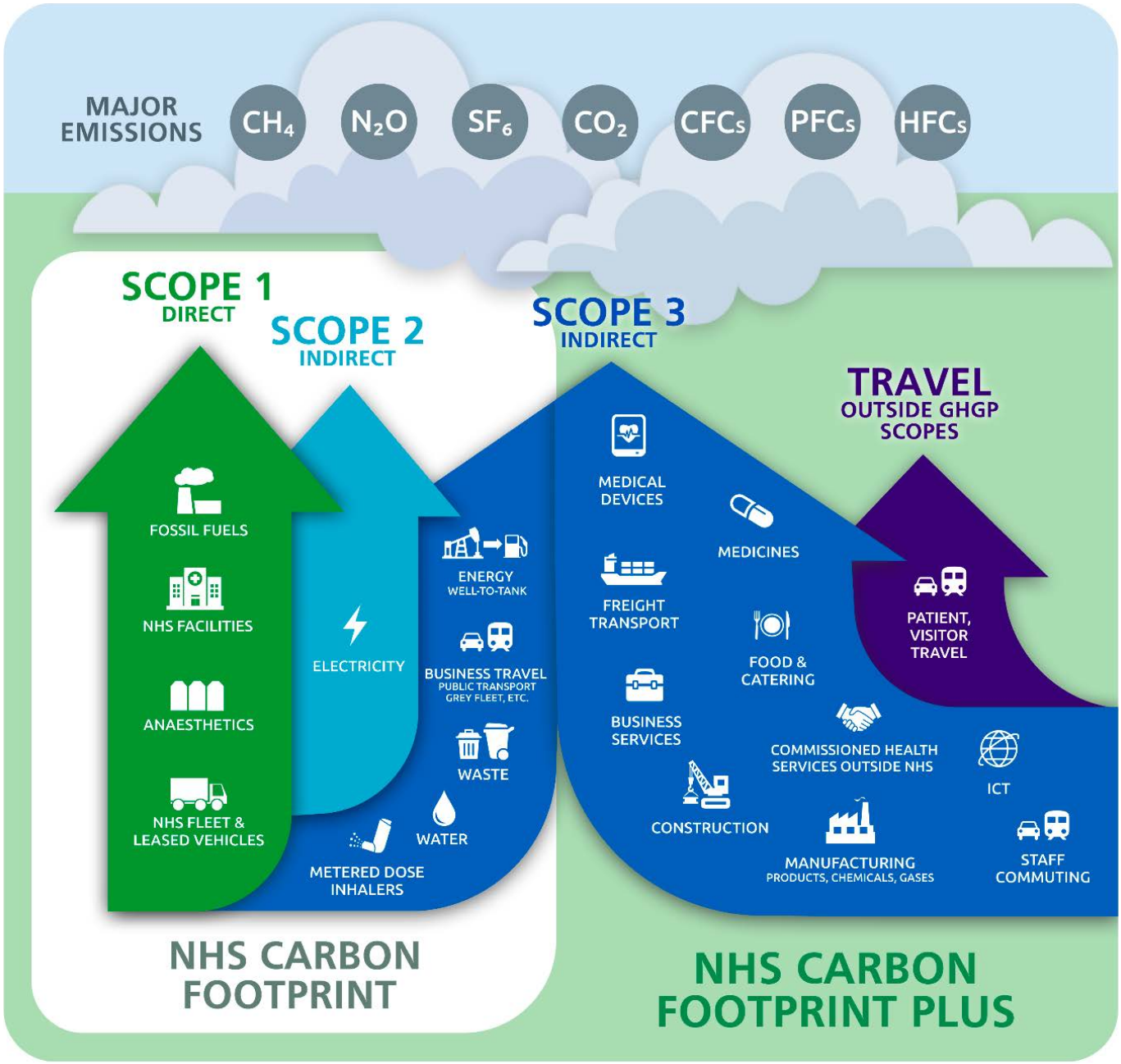


Illustration credit: **Greener NHS, NHS England**

Green ICU Recipes

1. Teamwork and collaboration

- ICU Green Team

2. Prevention

- Health promotion
- Admissions and discharges
- Optimising ICU care

3. Patient and family empowerment

- Shared decision-making
- Service user sustainability engagement
- Rehabilitation

4. Lean service delivery

- Medicines
- Infection prevention and control
- Waste management
- Investigations
- Personal care and linen
- Food and nutrition
- Energy

5. Low-carbon alternatives

- Procurement
- Reusables and consumables
- Travel

6. Education, quality improvement and research

- Education
- Quality improvement
- Research

1. Teamwork and collaboration

ICU Green Team

Changing ICU culture and behaviour requires a team effort to enable all ICU staff members to have the capability, opportunity, and motivation to work sustainably.[5]

The **ANZICS' A Beginner's Guide to Sustainability in the ICU**[6] and **A Beginner's Guide to Green Teams in the ICU**[7], along with the **'Create intensive care green teams, there is no time to waste'** article[8], provide suggestions for setting up an ICU Green Team.

Tunbridge Wells Hospital Intensive Care – multidisciplinary team.
Source: Maidstone and Tunbridge Wells NHS Trust

Ingredients:

- **ICU clinical lead for environmental sustainability**
- **ICU Green Team made up of Green Champions from different professional roles**
- **Management support for the ICU Green Team**
- **ICU Green Plan, which is linked to the hospital Green Plan**

Methods:

- Identify an ICU clinical lead for environmental sustainability
- Set up an ICU Green Team, or continue developing if an ICU Green Team exists already
- Write an annual ICU Green Plan with set targets, including a 12% reduction in emissions annually, choosing the most locally feasible methods
- Monitor ICU Green Plan progress, adjusting actions as needed to meet or exceed targets
- Seek funding and management support for protected time for ICU sustainability projects
- Collaborate with green teams in other departments
- Collaborate with hospital teams for sustainability, procurement, waste management, estates and infection prevention and control
- Include sustainability updates as a regular item in ICU newsletters
- Include sustainability as a regular agenda item in ICU quality meetings
- Communicate success, challenges and outcomes of ICU sustainability projects to the ICU, hospital Sustainability Team and **Critical Care Sustainability Network**
- Monitor completion of recipes using the Recipe Book tracking tool
- Evaluate the ICU Green Plan annually and report to ICU staff and other hospital teams
- Evaluate the staff room to identify opportunities to:
  - **Reuse:** Use reusable water bottles, cups, dishes and cutlery
  - **Recycle:** Ensure correct waste segregation into recycling bins

ICU Sustainability Team

Guy's and St Thomas' NHS Foundation Trust, England

The ICU sustainability team brings together green champions from the different ICUs in the same NHS Trust for regular online meetings to review progress on Green Plan goals, collaborate on projects and collaborate with the hospital's estates and facilities department.

Speakers from other departments and hospitals are invited to the monthly meetings to provide knowledge and explore how to address sustainability issues in the ICU. The Sustainability Team also created a Green Board for all staff to post suggestions and share ideas on how the ICU can reduce its carbon footprint.

2. Prevention

Health promotion

The Recipe Book mainly focuses on reducing the environmental footprint of ICUs. However, broader societal health promotion through public health and community disease prevention activities significantly promotes environmental sustainability by reducing the demand for hospital and ICU services.

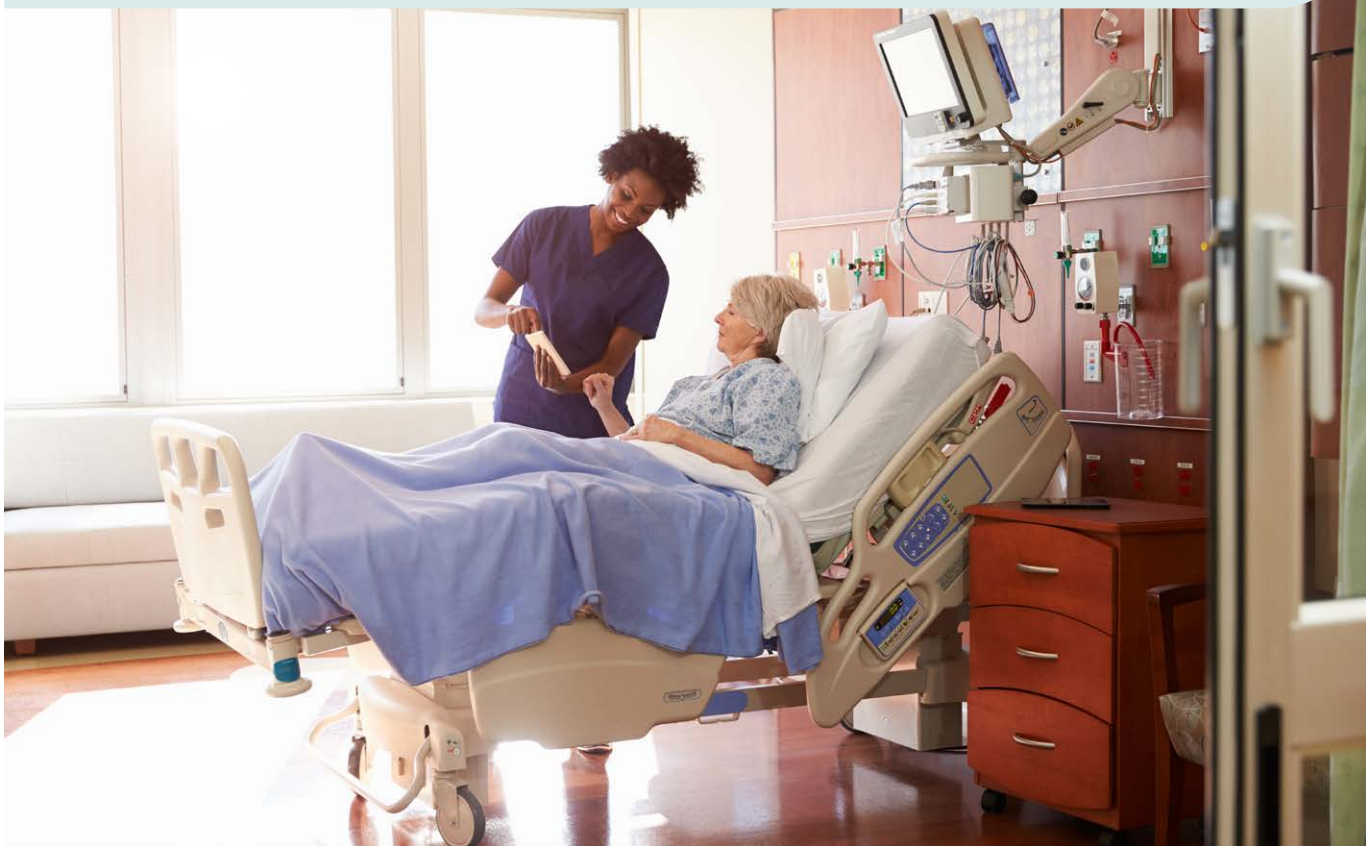
The Intensive Care Society (ICS), **Faculty of Intensive Care Medicine (FICM)** and **UK Critical Care Nursing Alliance (UKCCNA)** advocate for improved population-level public health outcomes and equitable access to healthcare services as stakeholders within relevant national initiatives and high-level policy-making. ICU staff should add their voices to public health advocacy, given how much disease which causes ICU admission is preventable.[2]

Health promotion within the ICU can also involve referrals for lifestyle and well-being support, such as specialist services addressing smoking cessation[9], substance misuse, diet, exercise, and mental health.

Prehabilitation is another example of health promotion for elective surgery patients requiring ICU post-operatively, which has the potential to decrease ICU and hospital length of stay through proactive physical, psychological, nutrition and lifestyle support before the surgery.[10]

Ingredients:

- **Public health advocacy opportunities in local groups and professional organisations**
- **Resources for ICU staff about local specialist services related to smoking cessation, substance misuse, diet, exercise and mental health**
- **Resources for prehabilitation of elective surgical patients:**
  - > **Preoperative assessment and optimisation guidance**
  - > **Fitter Better Sooner information for patients**
  - > **Prehab and Me**



Methods:

- Encourage ICU staff engagement in public health advocacy activities with local groups and professional organisations
- Raise awareness about how ICU staff can link patients to local specialist services related to post-ICU discharge healthy lifestyle and wellbeing support
- Audit referrals for local specialist services related to healthy lifestyle support to plan improvements for how ICU staff can promote the health of patients after ICU discharge
- Collaborate with local multi-disciplinary colleagues providing pre-operative assessment and preparation of elective surgical patients to link prehabilitation (physical, psychological, nutrition and lifestyle support before surgery) with ICU post-operative recovery and rehabilitation

Admissions and discharges

Achieving long-term economic and environmental sustainability for intensive care is challenging due to the planetary health crisis, an ageing population, limited resources and highly specialised technological advances.[11] National guidance in the ingredients promotes effective and efficient use of resource-intensive services for critically ill patients requiring ICU admission.

ICU staff can (through outreach) contribute to Advance Care Plans in community and nursing home settings and Treatment Escalation Plans for hospitalised patients in emergency, acute and critical care areas to help ICU admissions and discharges be patient-centred and clinically appropriate. The **Shared Decision-Making Recipe**, related to active collaboration with patients and family members, can also be applied to decisions about ICU admissions and discharges.

Critical care outreach teams prevent ICU admissions and readmissions through early recognition and management of acutely deteriorating ward patients, follow-up support for patients discharged from the ICU, and education of hospital staff.

Ingredients:

- **Getting it Right First Time: Adult Critical Care (GIRFT)**
- **Guidelines for the Provision of Intensive Care Services (GPICS)**
- **Better together: collaborative working between emergency care and critical care**
- **Treatment escalation plan form**
- **Critical Care Outreach Practitioner Framework**

Methods:

- Provide admission, discharge and treatment escalation plan resources during new staff induction
- Promote admission, discharge and treatment escalation plan resources among the ICU and critical care outreach teams
- Audit standards and recommendations in **GIRFT** and **GPICS** related to ICU admissions and discharges to plan improvements for patient flow in and out of the ICU
- Collaborate with site managers and multi-disciplinary emergency care, surgical and ward-based colleagues while planning local hospital initiatives related to preventing inappropriate ICU admissions and improving patient flow in and out of the ICU
- Establish a robust system of Treatment Escalation Planning for every admitted patient
- Consider collaborating with local nursing homes, general practitioners and palliative care teams to reach out and establish Treatment Escalation Plans in the community.
- Audit **GPICS** standard that ICU patients must have a clear and documented treatment escalation plan
- Provide Critical Care Outreach, or equivalent, based on the National Outreach Forum Quality and Operational Standards for Critical Care Outreach Services[12]

Optimising ICU care

Quality healthcare is efficient, timely, safe, person-centred, equitable and effective with sustainable use of resources.[13] Optimising ICU care to include these quality healthcare principles reduces the length of stay in the ICU and hospital and fosters more positive experiences for patients, families, and staff.

Therefore, high-quality care that optimises ICU patient pathways through a 'less is more' approach and avoiding low-value clinical care while still maintaining evidence-based practice improves environmental sustainability. Financial savings come from minimising the time critically ill patients spend in the ICU and preventing complications from occurring during the ICU stay and after discharge.

Person-centred intensive care accounts for underlying chronic medical and psychosocial conditions and involves **shared decision-making**.

For patients requiring post-operative ICU admission, **Enhanced Recovery After Surgery** initiatives optimise assessment and management to facilitate high-quality care, including reduced length of stay and preventing avoidable complications.

Optimising ICU care to include these quality healthcare principles reduces the length of stay in the ICU and hospital and fosters more positive experiences for patients, families, and staff.

Ingredients:

- **Local ICU documents (guidelines, protocols, care bundles, standard operating procedures, checklists and policies) which optimise ICU care and prevent complications through evidence-based practice relating to:**
  - **Airway – endotracheal tube and tracheostomy guidance**
  - **Breathing – non-invasive respiratory support, lung protective ventilation, ventilator-associated pneumonia prevention, prone positioning, ventilation weaning**
  - **Circulation – intravenous/arterial line guidance, infection/sepsis prevention, deep vein thrombosis prevention**
  - **Disability – pain, agitation, delirium, immobility and sleep disruption prevention and management (PADIS guidelines and ICU Liberation ABCDEF bundle)**
  - **Exposure – pressure ulcer prevention and surgical site infection prevention**
  - **Fluids – fluid stewardship and acute kidney injury prevention**
  - **Gastrointestinal – nasogastric tube and nutrition management**
  - **Holistic – psychosocial care for patients and families**
- **Intensive Care Society Safety (ICS) checklists and guidelines**
- **Faculty of Intensive Care Medicine (FICM) guidelines**
- **Enhanced Recovery After Surgery guidelines**

Methods:

- Review local ICU guidance documents to ensure they are up to date and reflect evidence-based practice while promoting health and preventing complications
- Audit local ICU guidance documents related to suggested topics in the ingredients to check compliance and plan local quality improvement
- Reduce light and noise at night, offer eye masks and ear plugs and use other non-pharmacological approaches for lightly sedated/non-sedated patients
- Begin **rehabilitation** as soon as possible
- Use checklists and guidelines from the ICS, FICM and other ICU organisations
- Use **Enhanced Recover After Surgery guidelines** for post-operative patients

3. Patient and family empowerment

Shared decision-making

Engaging patients and family members in decisions about clinical investigations and interventions helps ensure that intensive care provision reflects service users' goals, values, and wishes. It also encourages critically ill patients and their family members to participate actively in their care and recovery. Other essential aspects of sustainable intensive care clinical practice include avoiding 'low-value care'[14] and using shared decision-making with patients and family members routine practice.[15]

Ingredients:

- **Getting it Right First Time: Adult Critical Care (GIRFT)**
- **ReSPECT – Recommended Summary Plan for Emergency Care and Treatment**
- **ICUsteps resources**

Methods:

- Provide shared decision-making resources during new staff induction
- Promote shared decision-making resources amongst current staff
- Audit recommendations in GIRFT related to shared decision-making to plan improvements

Service user sustainability engagement

ICU patients and families may be worried about the planetary health crisis. However, the ICU's carbon footprint is unlikely to be their priority while experiencing critical illness or being a family member of someone who is critically ill. Service users might notice environmental sustainability initiatives, such as ICU clinicians not always wearing gloves or aprons, and express concern about changes to when PPE is worn. Therefore, clear, accessible communication is important, emphasising that the ICU Green Plan also focuses on maintaining safety and quality standards.

Ingredients:

- **NICE Listens: Public dialogue on environmental sustainability report**
- **Caring for Our Patients and the Environment flyer**

Methods:

- Display the **Caring for Our Patients and the Environment flyer** in the family waiting room
- Include service user perspectives in the ICU Green Plan

Images source: Kate Tantam, University Hospitals Plymouth NHS Trust

Rehabilitation

Early rehabilitation decreases ICU-acquired weakness to improve physical functioning and quality of life.[16] A shorter ICU stay enables patients and their families to return home faster, reducing environmental and financial costs from using fewer resources. Rehabilitation includes activities promoting physiological and psychological recovery from critical illness, including prevention and management of PADIS (pain, agitation, delirium, immobility and sleep disruption).[17]

Ingredients:

- Equipment and staffing for early mobilisation
- #rehablegend resources
- ICU Liberation Bundle (A-F) and PADIS guidelines
- Delirium guidance
- Rehabilitation framework and related resources
- Rehabilitation after critical illness in adults guidelines
- Manual of good practices to humanise intensive care units
- Transfer to the outdoors guidance
- Animal assisted intervention guidance
- Music in Hospitals & Care guidance
- ICUsteps resources
- ICU patient diary network and information
- Aftercare services for critically ill patients guidance

Methods:

- Include rehabilitation resources within new staff induction
- Promote the use of rehabilitation resources with current staff
- Audit **rehabilitation practices** and **PADIS prevention and management** (pain, agitation, delirium, immobility and sleep disruption) to identify and action areas for improvement
- De-escalate unnecessary interventions (e.g. removal of lines) when no longer required
- Advocate patient self-care and family involvement where possible
- Use patient diaries with multidisciplinary entries
- Provide **access to outdoor spaces**
- Participate in the **ICU Rehab Championships** and **#rehablegend activities**
- Give patients and families support information from the **ICS**, **FICM** and **ICUsteps**
- Offer critical care outreach inpatient and follow-up outpatient **aftercare services**
- Refer eligible patients discharged home to **ICUsteps Active** for an online rehabilitation programme in their own home

Early mobilisation in a cardiac intensive care unit

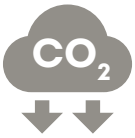
University Hospital Southampton NHS Foundation Trust

The cardiac intensive care unit evaluated the clinical, environmental, financial and social aspects before and after introducing an early mobilisation protocol (previously, patients only received physiotherapy upon referral from respiratory complications).

After routine physiotherapy following the protocolised early mobilisation activities for **238** patients over **24** months, ventilation days decreased on average by **4** days and ICU length of stay by **6** days. This reduced the carbon footprint by **48.5** tonnes CO_2e (the same amount as **18** return London-Sydney flights), saved **£1,266,327**, and enhanced patient autonomy during their intensive care stay.

Case scenario source: **SusQI Case Study Report - Early Mobilisation in a Cardiac Intensive Care unit**

Using routine physiotherapy following the protocolised early mobilisation activities



This reduced the carbon footprint by
48.5 tonnes CO_2e

The same amount as
18 return London-Sydney flights

4. Lean service delivery

Less is more

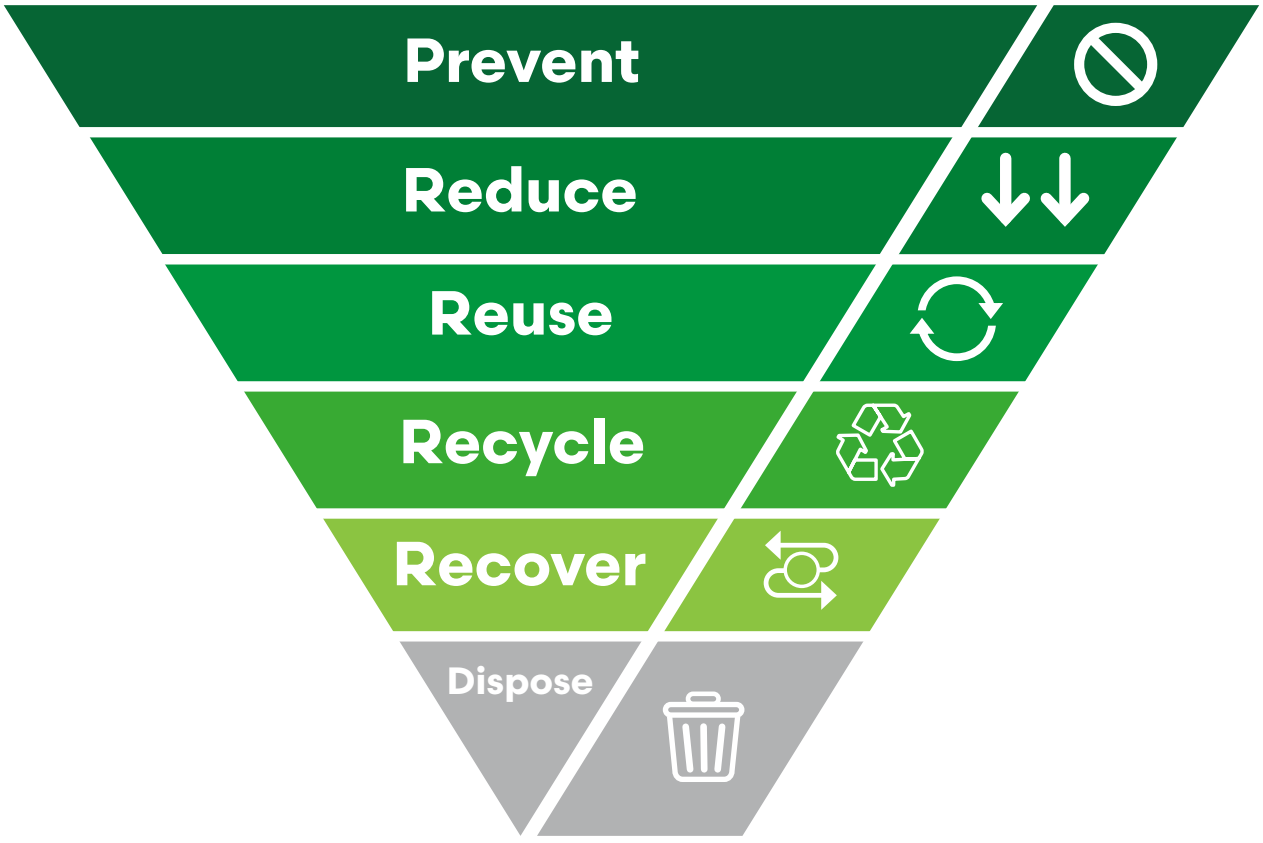
Lean service delivery involves a 'less is more' perspective to avoid low-value care in the intensive care unit[18] and use a circular economy approach to decrease waste through reducing, reusing, and recycling.[19]

A Goldilocks approach of 'not too much, not too little, but just right'[20] and a 'less is more' ethos[18] helps to ensure appropriate admissions to the ICU and stewardship in clinical practice by only doing necessary ICU investigations and interventions.[21]

Continuous treatments should be considered for the minimal amount of action for lowest duration of time, while still maintaining quality and person-centred care. For example, spontaneous awakening and breathing trials

help to minimise sedation and ventilation and renal replacement therapy prescribed doses between 20-25 ml/kg/hr when clinically appropriate reduces environmental and financial costs[22].

The seven recipes in this lean service delivery section provide guidance ICU lean service delivery for key sustainability topics.



Medicines

Manufacturing and freight in the supply chain make up 20% of medicines' emissions (25% of total Scope 3 NHS emissions).[23] Understanding pharmacokinetics promotes **optimisation** to improve patient outcomes and avoid unnecessary medicine waste. Appropriate waste management reduces the financial cost and carbon footprint of medicines used in the ICU. Correct disposal is also important to lower the impact of medicine-related pollution, which has public and planetary health risks if residual pharmaceutical waste ends up in oceans, rivers or soil.

Ingredients:

- **ICU Green Team medicines lead**
- **Start Smart Then Focus: antimicrobial stewardship toolkit**
- **National Antimicrobial Intravenous-to-Oral Switch Criteria and Decision Aid**
- **Antibiotic underdosing and disposal in NHS organisations across Great Britain**
- **Managing pharmaceutical waste guidance for:**
  - **Expired, damaged or no longer required medicines**
  - **Part-filled or empty medicine container**

Methods:

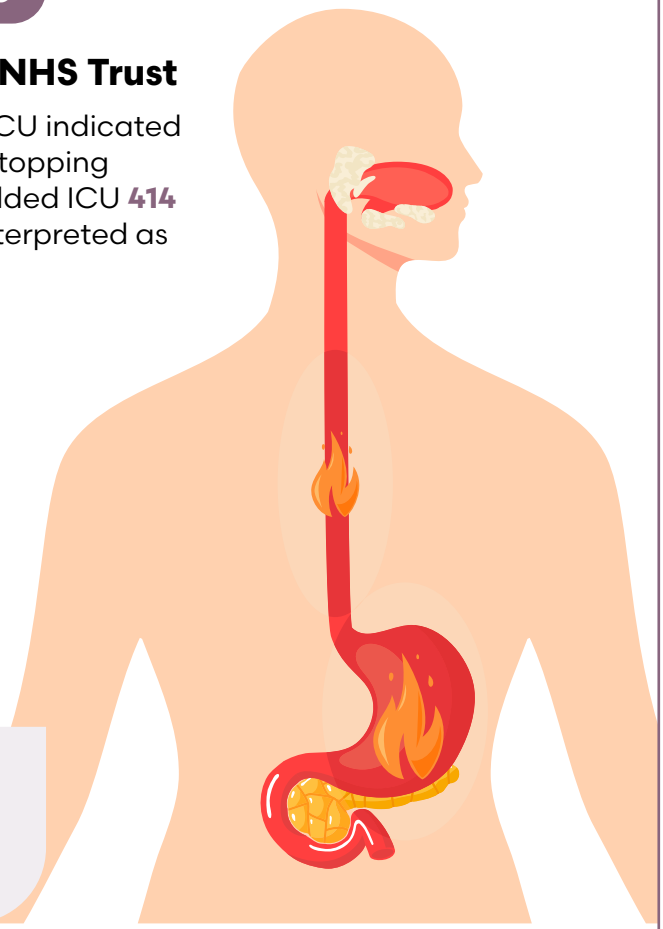
- Routinely review, organise and rotate medicines stock to prevent overstock and expiry
- Review patient medications daily and reduce/stop medications as clinically relevant
- **Medicines reconciliation** and review of inappropriate polypharmacy
- Request relatives/carers to bring in the patient's own drugs where possible
- Use oral/nasogastric route instead of intravenous when gastric absorption is established
- Extend the lifespan of intravenous giving sets, following the manufacturer's instruction
- Practice **antimicrobial stewardship**, e.g. ensuring appropriate drug/dosage/duration and IV to oral switch
- Use a dry powder inhaler instead of meter-dosed if possible to promote **green inhalers**
- **Do not wear gloves** for drug preparation and administration (IV, IM, subcutaneous, nasogastric or oral routes) except for cytotoxic drugs or monoclonal antibodies
- Follow the correct procedure for **managing pharmaceutical waste**:
  - ⓧ **Do not** put medicines down the sink or into domestic or recycling waste streams
  - ♻ **Recycle** outer packaging, leaflets and empty blister packs
- Minimise medicines kept at the bed space
- **Send labelled medications** with the patient after discharge
- Get parent teams involved early to ensure medications after discharge are appropriate
- Audit medication prescription, administration and waste management practices to identify and action areas for improvement

Proton pump inhibitor stewardship

Northamptonshire General Hospital NHS Trust

Auditing proton pump inhibitor (PPI) use in the ICU indicated that **2.8** doses were unnecessarily given daily. Stopping these unnecessary doses would save the **16**-bedded ICU **414 kgCO_2e** and **£2,237** annually, which could be interpreted as proportionately small.

However, PPI stewardship also has the potential to minimise the risk of complications, such as Clostridium difficile infection, and to ensure patients do not unnecessarily continue a PPI prescription upon ICU discharge if not needed. Project actions to reduce unnecessary PPI doses included teaching sessions to medical and nursing staff, **Fresh Eyes Tool** evaluation of local PPI practices and a ward round prompt to review if PPI is needed.



Stopping these unnecessary doses would save the 16-bedded ICU

414 kg CO_2e

Case scenario source: **SusQI Case Study Report - Critical Care getting 'Pumped Up' to reduce unnecessary doses of Proton Pump Inhibitor medication**

Infection prevention and control

The NHS uses over 1.4 billion plastic gloves yearly, causing massive carbon and fiscal costs and worsening public and planetary health damage due to soil and air pollution from waste disposal to landfills or incineration. Non-sterile gloves are often worn when not required, which increases infections from the associated poor hand hygiene and causes an increase in unnecessary financial costs and environmental footprint.[24] **Compostable aprons with hospital-based bio-digestion** are now available to decrease plastic use and waste transport. With the shift towards **reusable equipment**, more sustainable decontamination procedures that are less damaging to the planet and use renewable energy are also needed while maintaining **National Standards for Healthcare Cleanliness**.

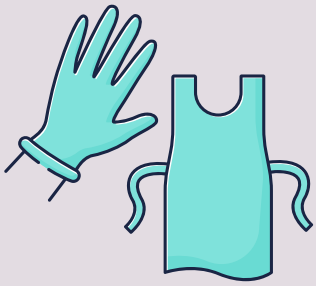
Infection prevention and control policies

England	National Infection Prevention and Control Manual
Wales	Infection Prevention and Control Policy
Scotland	National Infection Prevention and Control Manual
Northern Ireland	Infection Control Manual

Intensive Care Society (ICS) Gloves Off in ICU

The ingredients include the **ICS Gloves Off resources**, such as posters endorsed by the Infection Prevention Society and British Association of Critical Care Nurses, implementation guide, audit tool and recorded webinar with expert speakers. The ICS Gloves Off campaign aims to empower clinicians to think critically about when to wear gloves and only use when necessary.

Ingredients:



- **ICU Green Team infection prevention and control (IPC) lead**
- **Gloves posters, educational resources and audit tool**
- **Apron posters, educational resources and audit tool**
- **Green cleaning products and sterilisation procedures**
- **Sustainable personal protective equipment (PPE) products**

Methods:

- Collaborate with the intensive care IPC lead and hospital IPC teams
- Include sustainable IPC in new staff induction
- Educate all staff on the sustainable IPC and regularly update
- Review ICU policies, guidelines and protocols to identify opportunities to:
  - **Refuse:** Only include necessary items in clinical guidelines
  - **Reduce:** Clarify the length of time before routine changes of consumables
  - **Reuse:** Clean reusable items and spaces sustainably but effectively
- Display **gloves poster** and apron poster in the ICU
- Conduct a **gloves audit** and apron audit to identify and action areas for improvement
- Buy sustainable PPE products
- Use green cleaning products for cleaning equipment and spaces in the ICU
- Use sustainable cleaning and **sterilising** procedures

Gloves off in ICU through bedside micro-teaching and posters

University Hospitals Sussex NHS Foundation Trust, England

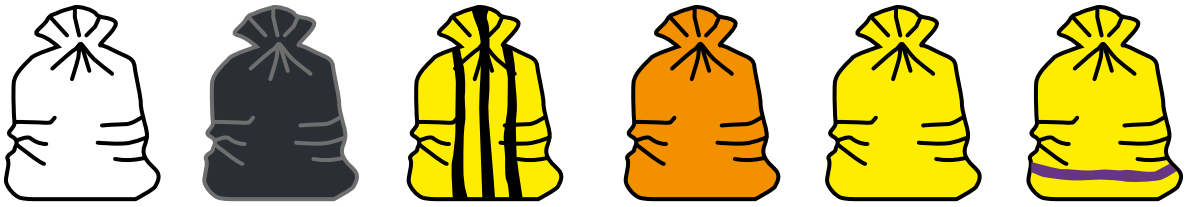
The intensive care unit undertook a local 'Gloves Off' project to promote only using non-sterile gloves when needed.

Micro-teaching sessions **(4 minutes)** were delivered at the bedside to small groups of **2-8 staff over one week**, supplemented by the **Intensive Care Society's gloves posters**. Attitudes were assessed immediately pre- and post-teaching using an anonymous survey and behaviour change was measured for one week before and after the interventions using the **Clinical Glove Use Audit Tool (Wilson et al. 2015)**. The microteaching and posters significantly improved cross-contamination risk, appropriate glove use and hand hygiene compliance.

The microteaching and posters significantly improved cross-contamination risk, appropriate glove use and hand hygiene compliance.

Waste management

The NHS has a **clinical waste strategy** to lower waste created and make waste management more sustainable. Reducing unnecessary resource use minimises waste generated in an ICU, and a **circular economy approach** next prioritises reusing and recycling.[25] Correct **waste segregation** (putting items and packaging in the appropriate bin) is essential for maintaining safety while keeping the carbon footprint and financial costs of managing ICU waste as low as possible.[26] Reusable sharps bins have a lower carbon footprint compared to single-use sharps containers.[27]



Waste management regulation for healthcare in the UK

England, Scotland, Wales and Northern Ireland →	**Health Technical Memorandum 07-01: Safe and sustainable management of healthcare waste**
Scotland →	**NHS Scotland Waste Management Guidance (SHTN 03-01)**

Ingredients:

- **ICU Green Team waste management lead**
- **Waste stream segregation posters**
- **Reusable and recycling posters**
- **Reusable sharps bins**
- **Waste audit tool**

Methods:

- Collaborate with hospital estates on sustainable waste management practices
- Review ICU waste management to identify opportunities to:
  - **Refuse:** Stock bed spaces minimally to avoid disposal of unused items
  - **Reduce:** Correct waste stream segregation to decrease unnecessary incineration
  - **Reuse:** Use reusable items when possible and ensure they are not discarded
  - **Recycle:** Put recyclable items and packaging into the correct recycling bin
- Place clearly labelled reusable and recycling bins in places easy for staff to use
- Recycle paper, cardboard and plastic items and packaging that are recyclable
- Rinse and recycle **alcohol hand gel containers** if the gel does not contain siloxanes and the safety data sheet does not prevent discharge to the sewer
- Include sustainable waste management in new staff induction
- Educate all staff on sustainable waste management and regularly update
- Audit waste practices in the ICU and report findings back to staff

Reduce disposal of unused self-inflating ventilation bags

Cardiff and Vale University Health Board, Wales

Reduce the use of Ambu bags (self-inflating ventilation bags) by not throwing them away unused for every patient through ongoing critical care bed 'set up' education. The Ambu bag project saved **500 kg** of plastic and **700 kg** of carbon emissions, with a financial savings of **£5000** in 2023.

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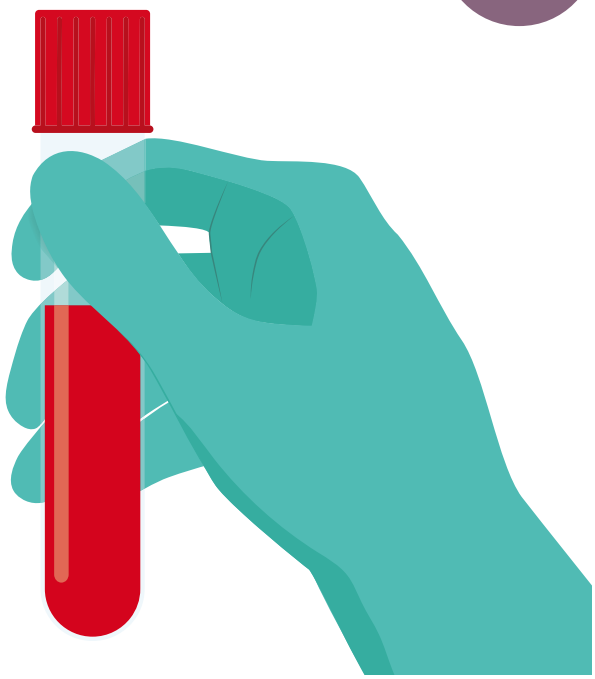
Investigations

De-implementation of low-value or routine investigations that are not clinically indicated reduces waste and financial costs. A **before-and-after study by Walsh et al. (2020)** showed that educating staff and using an ABG decision flow chart to guide clinical decisions for ABG testing significantly reduces the number of inappropriate ABGs.[28]

Testing an ABG was considered unnecessary in this study if done routinely at regular intervals, at shift change, and at the same time as other blood tests without a clinical need after ventilation/oxygen support was reduced, but the patient remained stable or after treatment was stopped. Similarly, an **education intervention** for appropriate ordering, stopping the daily order option and using an indication-based prompt reduced unnecessary CXRs in intensive care.[29]



De-implementation of low-value or routine investigations that are not clinically indicated reduces waste and financial costs

Ingredients:

- **ABG decision flow chart**
- **Small-volume blood collection tubes**
- **Point-of-care ultrasound equipment**
- **Investigations audit tool**

Methods:

- Review investigation practices (blood, urine, sputum and swab testing and imaging) to identify opportunities to:
  - ⊘ **Refuse:** Avoid tests which are not clinically relevant or needed
  - ↓ **Reduce:** Use small-volume blood collection tubes for blood testing[30]
  - ↓ **Reduce:** Order low-carbon footprint impact imaging (ultrasound and Xray) instead of high-carbon footprint impact (CT and MRI), if clinically relevant[31]
  - ↓ **Reduce:** Change from routine daily testing to indication-based prompting of investigations[28]
- Review electrolyte replacement practices to identify opportunities to:
  - ⊘ **Refuse:** Do not maintain high-normal blood potassium level after CABG surgery[32]
  - ↓ **Reduce:** Use oral/enteral administration of electrolytes if patient is able
- Include sustainable investigation practices in new staff induction
- Educate all staff on sustainable investigation practices and regularly update
- Audit investigation practices in the ICU and report findings back to staff

Reducing unnecessary tests

University Hospital Wales

The total number of arterial blood gas (ABG) samples was observed over 6 days in a Welsh critical care unit and the highest amount in one day was **139** tests in **20** level **3** patients. The average number of ABGs was **6.95** tests/patient/day.

The total financial cost of ABG sampling in 2023 (**36** level **3** equivalents) was **£154,976** (consumables and reagents), equating to **72,529 kg CO_2e**, along with the potential to cause avoidable iatrogenic anaemia if one patient is receiving more ABG tests/day than is clinically required.

By reducing the average ABG testing even by **2** tests/patient/day there would be **20,723 kg CO_2e/yr** and **£44,279/yr**.

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Personal care and linen

A circular economy approach to reducing, reusing, and recycling can be applied to mouth and eye care, washes, linen use, and other aspects of personal care.

Ingredients:

- **Sustainable mouth care products (toothbrushes, toothpaste, swabs)**
- **Sustainable body wash/hair care products**
- **Reusable absorbent pads**

Methods:

- Minimise the use of disposable items for personal care and use reusable where possible
- Encourage patients to bring their own toiletries, personal items and pyjamas
- Switch to sustainable body wash/hair care and mouth care products
- Use non-sterile water for personal care, including mouth care and washes
- Minimise personal care items kept at the bedside
- Continue to use personal items throughout the hospital journey (examples: reusable slide sheets, items used in personal care)
- Avoid unnecessary bed linen change
- Do not throw away linen that can be cleaned
- Use cloth linen bags instead of plastic
- Audit mouth and eye care and linen use in the ICU and report findings back to staff

Environmentally friendly shower gel

Sandwell and West Birmingham NHS Trust

Shower gel individual sachets were replaced by a locally produced, cruelty free, refillable shower gel, which was free of dangerous chemicals. This new gel was also a suitable replacement shampoo and the patients and staff preferred the smell. The new shower gel was half the price compared to the sachets.

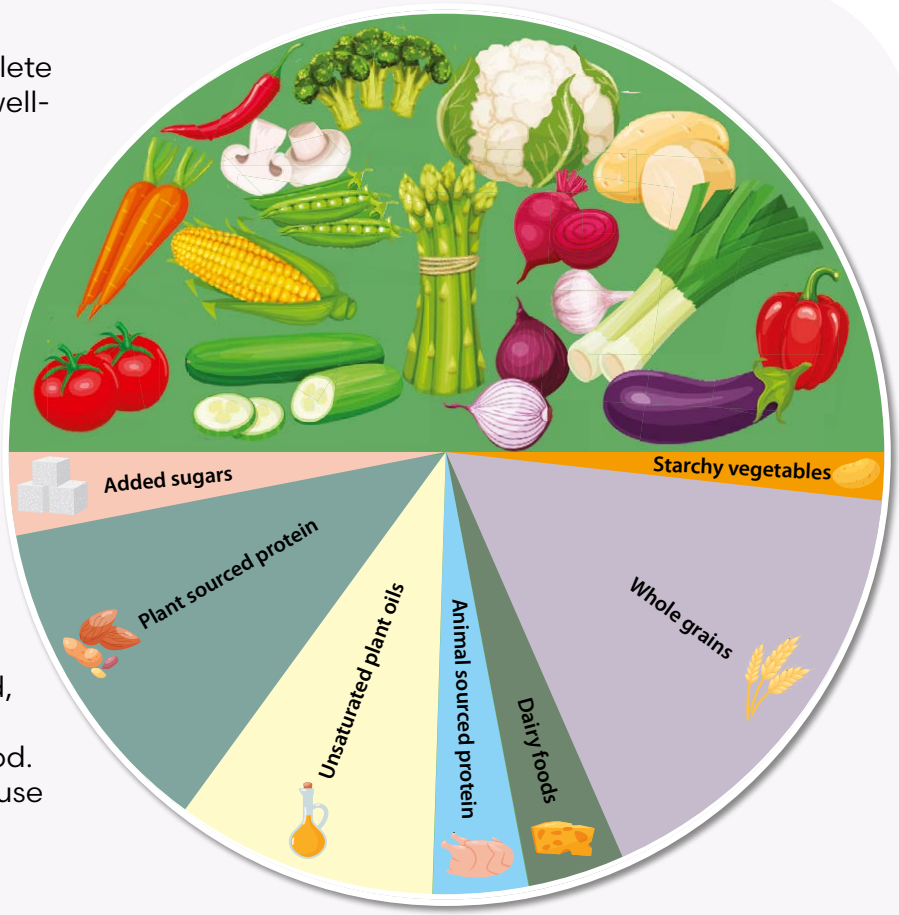
This swap has saved half of the carbon emissions per hundred sachets used on the unit – the equivalent of driving two miles in a petrol car.

Food and nutrition

Food supply chains contribute 34% of global greenhouse gas emissions.[33] Local, seasonal and plant-based food is better for the health of people and the planet, with hospital examples provided by **Nourish** and **Greener by Default**. The 'Going Green' chapter of the **Report of the Independent Review of NHS Hospital Food** highlights sustainable procurement and waste reduction actions for hospital food services. Circular economy principles can also be considered while delivering enteral and parenteral nutrition in intensive care.

A healthy diet supports complete physical, mental, and social well-being, not just the absence of disease. The planetary health diet does just that whilst also acknowledging the inextricable link between human health and environmental sustainability. A sustainable global food system must align with health and environmental boundaries to nourish nearly 10 billion people by 2050.

The planetary health diet increases plant-based food and fewer animal source food, thereby reducing the overall environmental footprint of food. This means reduced greenhouse gas emissions, land use, and biodiversity loss.



The illustration is adapted from the *EAT-Lancet Commission's* planetary health diet, which is healthy for both people and the planet.

Food and nutrition

England	National standards for healthcare food and drink
Wales	What a Waste! Bevan Commission
Scotland	Managing NHS Scotland Food Waste guide and calculator

Ingredients:

- **British Dietetic Association critical care sustainability resources**
- **One Blue Dot Environmentally Sustainable Diets Toolkit**
- **Preventing waste in the healthcare sector**
- **Report of the Independent Review of NHS Hospital Food**

Methods:

- Review gastric tube practices to identify opportunities to:
  - **Refuse:** Stop routine gastric aspiration monitoring if no longer needed e.g. once stable and tolerating enteral feeding, extubated or able to disclose feeling nauseous
  - **Reduce:** Use non-sterile water for enteral flushes and medications in line with local policies (water must be suitable for drinking)
  - **Reduce:** Use reusable or pulp container to measure gastric aspirates
- Review nutrition and food practices to identify opportunities to:
  - **Reduce:** Deescalate parenteral and enteral feeding appropriately
  - **Reduce:** Use full content of feed bags where possible to prevent waste
  - **Reduce:** Review how parenteral nutrition is compounded to be less wasteful
  - **Reduce:** Serve smaller portions to patients eating orally with poor appetite on a tea plate rather than large plate to prevent feeling overwhelmed while eating
  - **Reuse:** Use reusable cups, cutlery and dishes
  - **Recycle:** Recycle enteral feed and oral nutritional supplement bottles
- Address constipation and review laxatives daily
- Avoid routine laxative use because it is associated with subsequent diarrhoea[34], which increases length of stay, workload, linen use, microbiology tests and PPE use
- Stop acid suppression if enteral feeding is established, except in high-risk patients
- Stop B vitamin/multivitamin prescriptions once patients are established on full nutrition
- Measure disposal of unused expired enteral and parenteral nutrition and identify strategies to reduce enteral and parental nutrition waste
- **Measure oral food waste** and identify strategies to reduce food plate waste in the ICU
- **Repurpose food waste** appropriately
- Liaise with catering about increasing high protein plant-based options on the menu
- Promote ICU staff to eat sustainable food and reduce food waste and packaging

Enteral feed bottle recycling

Aberdeen Royal Infirmary, NHS Grampian, Scotland

The Aberdeen Royal Infirmary critical care unit used **117** bottles of enteral feed/week, and after the **"Recycle Plastic, It's Fantastic!"** initiative, **>80%** of bottles are now being recycled.

Across the NHS Trust, it costs **£125,000/month** to pay for clinical waste disposal, but recycling recyclable materials, including enteral feed bottles, could save the Trust **£12,000** with critical care units able to contribute to this goal.

>80% of bottles are now being recycled

Energy

The **NHS Net Zero Building Standard** endorses the energy hierarchy through these principles:

Be Lean — Use less energy through building and design decreasing demand

Be Clean — Supply energy efficiently

Be Green — Use renewable energy

Be Seen — Metering and monitoring of energy usage

Although clinicians may not be directly involved with building design and energy supply, electricity and gas are needed for heating, ventilation and air conditioning (HVAC) in the ICU and ICU staff can work in partnership with their estates department to optimise lean, clean and green energy practices in the local unit.[35]

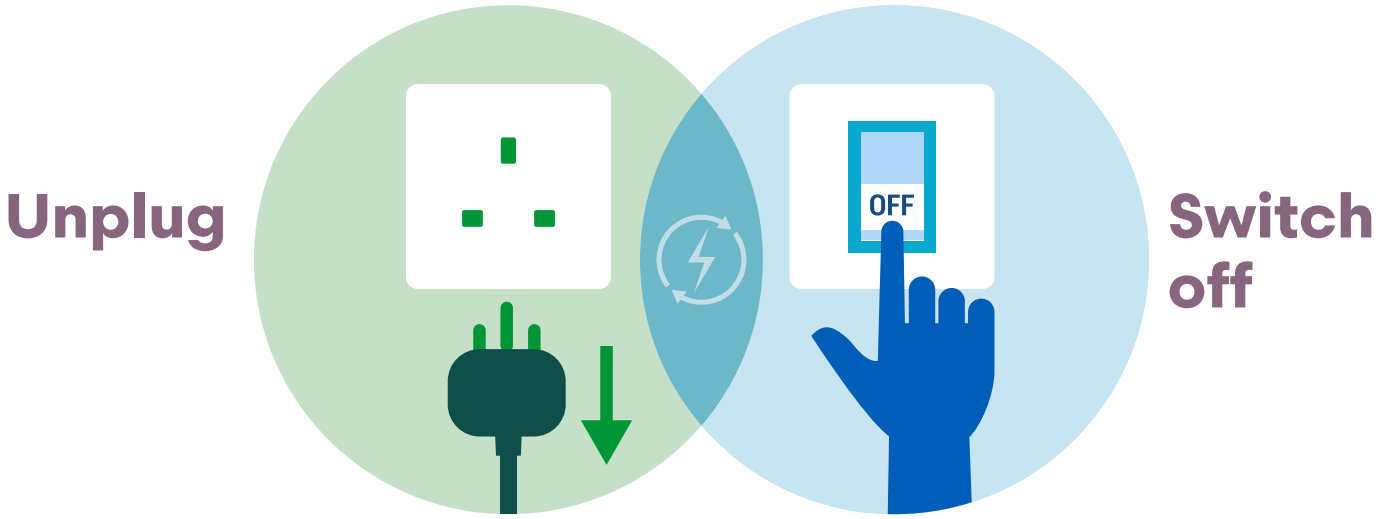
Electricity is also needed for room lighting and equipment within the ICU,[36] which ICU staff can turn off when not in use.

Ingredients:

- **LED (light-emitting diode) lighting in the ICU**
- **Motion sensor lights in non-patient rooms**
- **Room ventilation air flow, temperature and humidity set appropriately**

Methods:

- Work with the hospital Board and estates department to:
  - Use a 100% renewable power supplier, which will make the single-biggest impact and dwarf all other energy-saving measures
  - Replace gas boilers with electrically powered to remove 'scope 1' emissions
  - Install renewable power generation, e.g. solar panels on roofs and over car parks
  - Improve building energy efficiency, reducing energy waste where possible
- Turn off lights and air conditioning at night or when not needed
- Turn off ventilators, pumps, computers and other electrical equipment when not in use
- Set electrical devices to auto-switch off overnight if possible
- Seek support from estates to **monitor energy usage** in the ICU and report back to staff



Electricity consumption

Cardiff and Vale University Health Board, Wales

The amount of electricity required to look after one patient with multiple organ failure is **three times** the average daily requirement for a family house. Electricity financial savings are difficult to quantify as the department is not metered. However, critical care uses around **1%** of the Health Board's total electricity use. ICU electricity usage can be reduced by not charging equipment unnecessarily, installing LED lighting, and turning off computers when not in use.

5. Low-carbon alternatives

Procurement

Low-carbon and fairtrade ICU clinical supplies and equipment should be sought and preferentially selected where possible and available.[37] The **NHS Net Zero Supplier Roadmap** outlines a timeline for carbon reduction and social value requirements to ensure that products purchased for NHS services are environmentally sustainable and socially responsible. Reusable items using renewable energy for cleaning/sterilising help lower the ICU's carbon footprint.[38]

Procurement guidance for healthcare in the UK

England →	NHS Supply Chain Sustainability
Wales →	NHS Wales Shared Services Partnership – Sustainable procurement
Scotland →	NHS Scotland Sustainability Action – Procurement and supply chain

Ingredients:

- **ICU Green Team procurement lead**
- **Evergreen Sustainable Supplier Assessment**
- **Ethical procurement guidance**
- **'Use me first' stickers for stock nearing expiry date**

Methods:

- Collaborate with hospital procurement on sustainable purchasing decisions
- Review routine procurement and ask:
  - **Refuse:** Does the item need to be purchased? If yes, is a lower quantity sufficient?
  - **Reduce:** Does an alternative have less packaging/waste?
  - **Reuse:** Is there a reusable option to avoid a disposable product?
  - **Recycle:** Is the item and packaging recyclable?
- Choose ethically produced supplies with a low carbon footprint where possible
- Review clinical packs and liaise with the supplier to remove never/rarely used items
- Only purchase what is likely needed and review stock regularly
- Bringing the earliest expiry date to the front
- Organise and declutter cupboards to prevent stock from being unseen
- Give items to another department if unlikely to be used in ICU before expiry
- Give expired items to educators or a local University for simulation scenarios

Stopping sterile water for drinking in the ICU

Cardiff and Valey University Care Board

Stopping medical sterile water procurement for patient drinking saved **600kg** of plastic and **£11,000** per year.

Saving 600kg of plastic per year

Reusables and consumables

Reusable clinical supplies are preferred over single-use disposables because reusables reduce waste and typically have a lower financial cost and environmental footprint, particularly if renewable energy and sustainable decontamination procedures are used.[37]

The frequency of how often continuously used consumables (such as infusion lines, syringes, and closed suction catheters) should be routinely changed, is currently questioned.

For example, the RSVP randomised controlled trial indicated that infusion sets can be safely used for seven days without an increased risk of infection, suggesting that manufacturer and local guidance likely need to be updated to extend the duration of use.[38]

Reusable clinical supplies are preferred over single-use disposables because reusables reduce waste and typically have a lower financial cost and environmental footprint

Ingredients:

Reusable items

- **Gown**
- **Laryngoscope**
- **Bronchoscope**
- **Blood pressure cuff**
- **Oxygen saturation probe**
- **Tourniquet**
- **Scissors**
- **Metal clamp**
- **Batteries (rechargeable)**
- **Incontinence pad**

Optimise the life span of consumable items:

- **IV infusion line**
- **Syringes**
- **Arterial line**
- **Closed suction catheter**
- **Suction container and tubing**
- **Yankauer suction**
- **Enteral feeding line**
- **Enteral syringe**
- **Ventilator tubing**
- **Heat and moisture exchanger**
- **Heated humidifier**

Methods:

- Collaborate with hospital procurement on switching to reusable products where possible
- Include sustainable use of reusables and consumables in new staff induction
- Educate all staff on the sustainable use of reusables and consumables, following the manufacturer's information and local guidance
- Include information about sustainable **infection prevention and control** and **waste management** in education about reusables and consumables
- Use closed in-line endotracheal suction if ventilated > 3 days[40]
- Avoid routine changing of ventilator tubing and only change if clinically indicated e.g. visibly soiled or faulty[40]
- Use **sustainable sterilisation procedures** where possible

Reusables gowns

Ysbyty Gwynedd Hospital, Wales

Reusable gowns were trialled in the intensive care unit and endoscopy, demonstrating safety and effectiveness, before using in theatres. Using reusable gowns could save **£22,768** and **11,500 kg CO_2e**, which is **56,881 kWh** of electricity (equivalent to powering **11** detached houses over **15** months).

The case scenario source can be read **here**

x11

Could save 56,881 kWh of electricity

equivalent to

powering 11 detached houses over 15 months

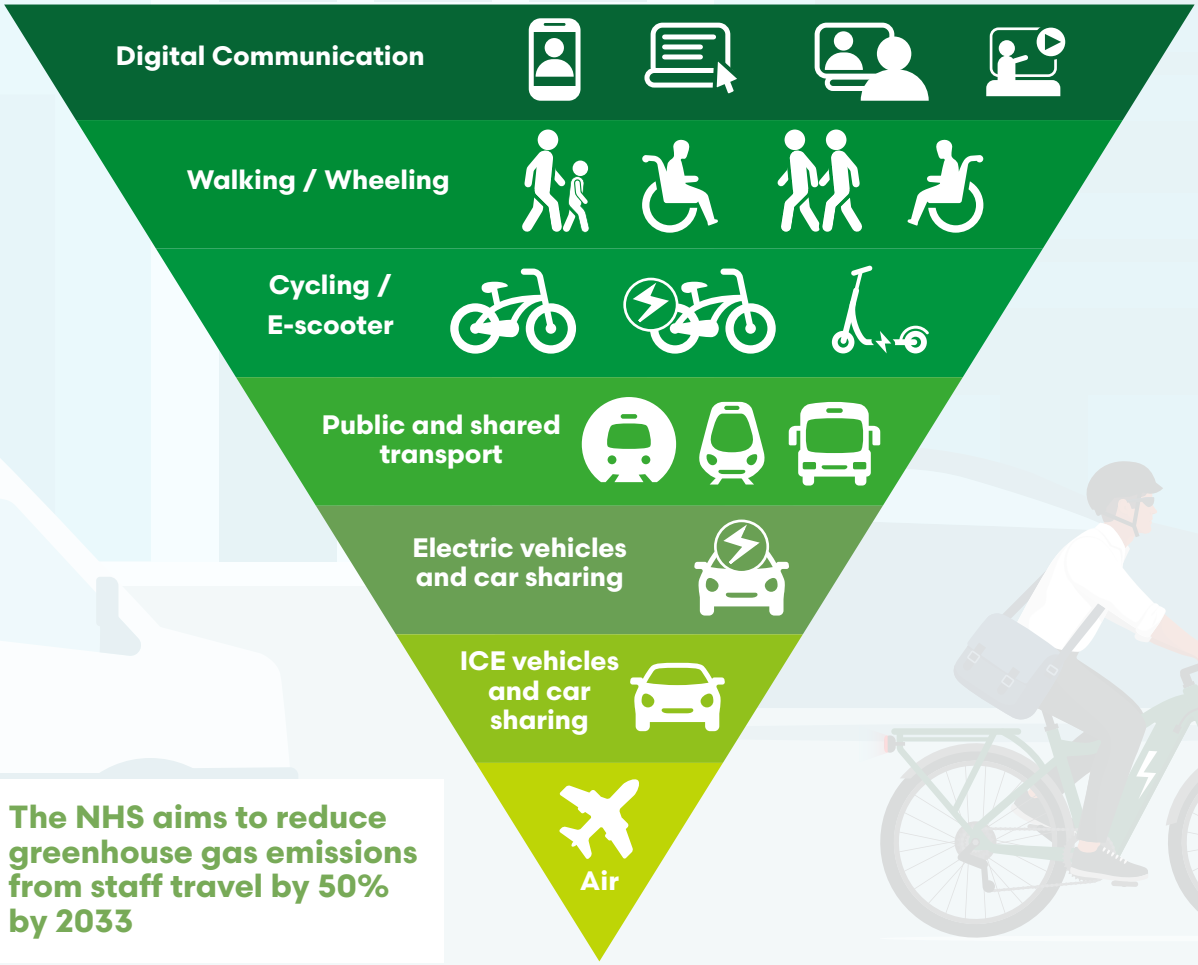
Travel

The NHS aims to reduce greenhouse gas emissions from staff travel by 50% by 2033 through increased use of active travel (walking and cycling) and more sustainable transport of patients (zero-emission ambulances), visitors, and staff.[42]

Green travel and transport guidance for healthcare in the UK

- **England** → Net Zero travel and transport strategy
- **Scotland** → Active travel

Figure 3 - Sustainable travel hierarchy



The NHS aims to reduce greenhouse gas emissions from staff travel by 50% by 2033

Ingredients:

- Local sustainable travel information available for staff and visitors
- Showers and lockers for staff using active transport
- Secure bicycle storage areas
- **Cycle to work scheme** for NHS staff to purchase bicycle/e-bicycle
- Public transport discounts for NHS staff
- Renewable energy charging points for electric vehicles
- **NHS Liftshare** or local Trust carpooling scheme
- Online, hybrid and sustainable travel options for ICU staff attending meetings/events
- Telemedicine, if relevant, for referral, communication and ICU follow-up
- Virtual visiting option for family and friends

Methods:

- Include sustainable staff travel options in induction materials for new staff
- Evaluate how ICU staff travel to work and identify how to increase sustainable travel
- Promote active transport and sustainable travel for ICU staff

NHS Trust Green Travel Plan

Guy's and St Thomas' NHS Foundation Trust, England

The Trust has a Green Travel Plan to promote cycling, public transport, walking, remote working, and a reduction in car use. Rail should be the default type of travel for domestic mainland reasons for events that do not have a virtual option

6. Education, quality improvement and research

Education

There is an urgent need to educate the intensive care workforce on the national requirements for reducing the impact of ICU care on our planet. Routine education on clinical topics is already provided to ICU staff, including during induction, mandatory annual updates, self-directed e-learning, bite-sized sessions, study days, and simulation sessions.[43] All of these offer an opportunity to use a sustainability lens on education already happening to integrate teaching on resource stewardship (reduce, reuse, recycle) as relevant to the clinical topics covered during the educational session.

There is an urgent need to educate the intensive care workforce on the national requirements for reducing the impact of ICU care on our planet

Ingredients:

- **Building a Net Zero NHS e-learning** from elfh (elearning for healthcare)
- Slides, scenarios and videos for ICU sustainability teaching
- **Critical Care Sustainability Network** resources, meetings and events
- **My Green ICU Collection** in *Intensive Care Medicine*
- **Environmental sustainability special issue** in *Nursing in Critical Care*
- **HealthcareLCA** database
- ICU environmental research studies summary
- ICU Green Plan aim to increase ICU sustainability education

Methods:

- Include ICU environmental sustainability in the induction for all new staff members
- Recommend all ICU staff complete the **Building a Net Zero NHS e-learning** from elfh (elearning for healthcare) and the **Intensive Care Society's sustainability e-learning**
- Provide short, bite-size teaching on ICU environmental sustainability, such as during a daily huddle or tea-trolley training session
- Deliver local education programmes and study days sustainably:
  - ↓ Reduce paper and provide e-resources
- Promote sustainable travel or use virtual teaching delivery
  - ↓ ↻ ♻ Reduce, reuse and recycle in **simulation rooms**
- Encourage and facilitate undergraduate student projects related to ICU environmental sustainability for students on placement in the ICU
- Liaise with local Universities and NHS Deaneries to support ICU environmental sustainability teaching and student projects for post-graduate courses
- Staff to attend sustainable healthcare conferences, external events and courses
- Sustainable travel where possible for staff attending conferences and external events, such as minimising driving and flying if possible or attending virtually
- Encourage staff to join and engage with the **Critical Care Sustainability Network**

Achieving engagement with education and training

County Durham and Darlington NHS Foundation Trust

All employees are encouraged to complete the Building a Net Zero NHS e-learning module. All new starters receive information on the Trust Green Plan' Sustainability Matters' as part of their online induction training. In **12** months, **86%** (**5856 staff** as of 31st August 2022) of the Trust workforce finished the Building a Net Zero NHS e-learning module.

Quality improvement

Quality improvement (QI) projects can include sustainability to address environmental, financial, and social impacts while considering patient or population outcomes.[13,44] Clinical audits and service evaluations can also be part of quality improvement initiatives.

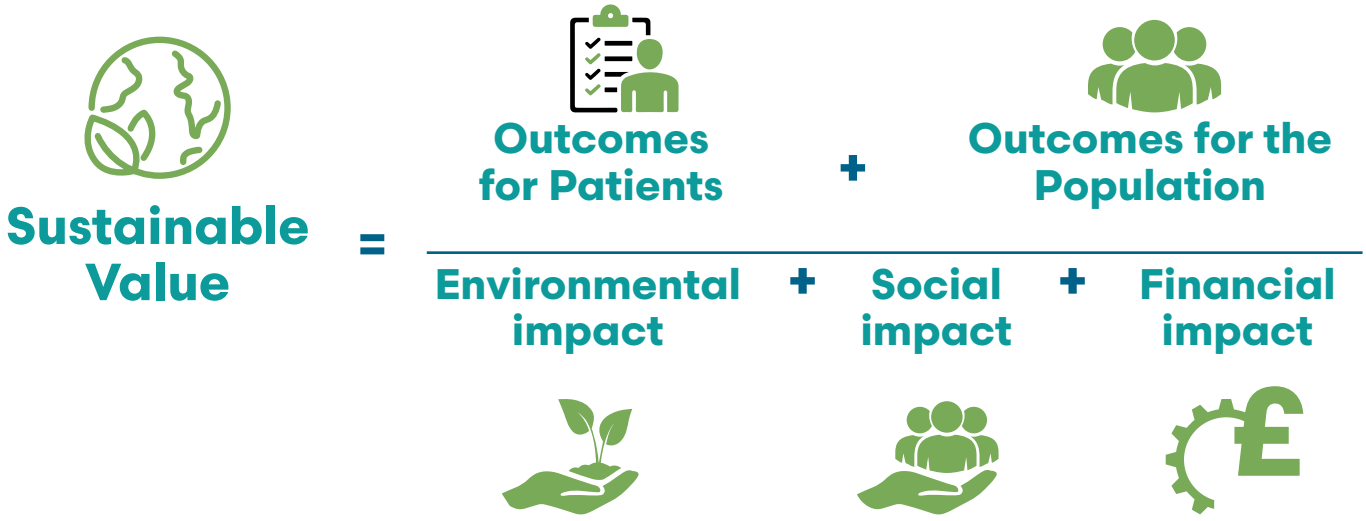


Illustration credit: **Centre for Sustainable Healthcare**

Ingredients:

- **SusQI resources**
- **Environmental Sustainability in QI e-learning** from elfh
- **ICU Green Plan aim to increase ICU SusQI projects**
- **Sustainability in agenda for ICU quality meetings**

Methods:

- Staff and students to complete the **Environmental Sustainability in QI e-learning** from elfh
- Use **SusQI Framework** for ICU staff and student QI, audit and service evaluation projects
- Inform Trust QI and Sustainability teams about ICU SusQI projects
- Disseminate ICU sustainability-related QI, audit and service evaluation projects in journal articles, conferences and on the **Critical Care Sustainability Network**
- Embed environmental sustainability into local clinical guidance documents
- Include environmental sustainability as a regular item in ICU quality meetings

Research

The **National Institute for Health Research (NIHR)** and **National Institute for Health and Care Excellence (NICE)** have committed to supporting the **NHS net zero goal** by endorsing environmental sustainability in healthcare research and clinical guideline development.

Ingredients:

- **NIHR Carbon Reduction Guidelines**
- **RAND Europe Advancing Environmentally Sustainable Health Research**
- **Checklist for environmentally responsible research within the ICU**[44]
- **Measuring environmental sustainability guidance**[45]
- **HealthcareLCA database**
- **ICU Green Plan aim to increase ICU sustainability research**

Methods:

- Conduct all ICU research studies in an environmentally sustainable manner
- Include environmental sustainability metrics as a secondary outcome in studies
- Conduct local research where the primary focus is ICU environmental sustainability
- Include ICU environmental sustainability research in journal club meetings
- Publish ICU sustainability-related research projects and post on the **Critical Care Sustainability Network** to share with the ICU community
- Promote sustainability research by undergraduate, postgraduate and doctoral students

References

1 Keil M, Frehse L, Hagemeister M, *et al.* Carbon footprint of healthcare systems: a systematic review of evidence and methods. *BMJ Open*. 2024;14:e078464. doi: 10.1136/bmjopen-2023-078464

2 Riley C, Maxwell A, Parsons A, *et al.* Disease prevention & health promotion: what's critical care got to do with it? *Transl Pediatr*. 2018;7:262–6. doi: 10.21037/tp.2018.09.13

3 Montgomery H. Final call: Climate change and us. *J R Coll Physicians Edinb*. 2024;54:101–4. doi: 10.1177/14782715241239085

4 McGinnis S, Johnson-Privitera C, Nunziato JD, *et al.* Environmental life cycle assessment in medical practice: A user's guide. *Obstet Gynecol Surv*. 2021;76:417–28. doi: 10.1097/OGX.0000000000000906

5 Michie S, Van Stralen MM, West R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Sci*. 2011;6:42. doi: 10.1186/1748-5908-6-42

6 ANZICS. A beginners guide to sustainability in the ICU. 2022. https://www.anzics.org/safety-quality-resources/

7 ANZICS and Intensive Care Society. A beginner's guide to green teams in the ICU. 2024. https://www.anzics.org/safety-quality-resources/

8 Trent L, Law J, Grimaldi D. Create intensive care green teams, there is no time to waste. *Intensive Care Med*. 2023;49:440–3. doi: 10.1007/s00134-023-07015-w

9 Polmear CM, Nathan H, Bates S, *et al.* The Effect of Intensive Care Unit Admission on Smokers' Attitudes and Their Likelihood of Quitting Smoking. *Anaesth Intensive Care*. 2017;45:720–6. doi: 10.1177/0310057X1704500612

10 Gao W, Jin J. Expanding the scope of prehabilitation: reducing critical illness weakness across elective surgical patients scheduled for postoperative ICU care. *Crit Care*. 2024;28:3. doi: 10.1186/s13054-023-04784-0

11 Cecconi M, Spies CD, Moreno R. Economic sustainability of intensive care in Europe. *Intensive Care Med*. 2024;50:136–40. doi: 10.1007/s00134-023-07268-5

12 National Outreach Forum. National Outreach Forum Quality and Operational Standards for Critical Care Outreach Services. 2020. https://www.norf.org.uk/

13 Mortimer F, Isherwood J, Wilkinson A, *et al.* Sustainability in quality improvement: redefining value. *Future Healthcare J*. 2018;5:88–93. doi: 10.7861/futurehosp.5-2-88

14 Tume LN, Aitken LM. De- implementation of low value clinical practices is essential for critical care nurses. *Nurs Crit Care*. 2024;29:244–5. doi: 10.1111/nicc.13028

15 Cussen J, Van Scoy LJ, Scott AM, *et al.* Shared decision-making in the intensive care unit requires more frequent and high-quality communication: A research critique. *Aust Crit Care*. 2020;33:480–3. doi: 10.1016/j.aucc.2019.12.001

16 Hodgson CL, Schaller SJ, Nydahl P, *et al.* Ten strategies to optimize early mobilization and rehabilitation in intensive care. *Crit Care*. 2021;25:324, s13054-021-03741-z. doi: 10.1186/s13054-021-03741-z

17 Devlin JW, Skrobik Y, Gélinas C, *et al.* Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU. *Crit Care Med*. 2018;46:e825–73. doi: 10.1097/CCM.0000000000003299

18 Bell KJL, Stancliffe R. Less is more for greener intensive care. *Intensive Care Med*. 2024;50:746–8. doi: 10.1007/s00134-024-07378-8

References

19 Baid H, Damm E, Trent L, *et al.* Towards net zero: critical care. *BMJ*. 2023;e069044. doi: 10.1136/bmj-2021-069044

20 Myers LC, Escobar G, Liu VX. Goldilocks, the Three Bears and Intensive Care Unit Utilization: Delivering Enough Intensive Care But Not Too Much. A Narrative Review. *Pulm Ther*. 2020;6:23–33. doi: 10.1007/s41030-019-00107-3

21 Baid H, Richardson J, Scholes J, *et al.* Sustainability in critical care practice: A grounded theory study. *Nurs Crit Care*. 2021;26:20–7. doi: 10.1111/nicc.12493

22 Cameron L, Harper J, Hjerpe M, *et al.* Calculating the costs, both financial and environmental, of delivering renal replacement therapy to critically ill patients - Abstract 4955. *J Intensive Care Soc*. 2023;24:49–50. doi: 10.1177/17511437231195526

23 NHS England. Delivering a 'Net Zero' National Health Service. 2022. https://www.england.nhs.uk/greenernhs/a-net-zero-nhs/

24 Wilson J, Prieto J, Singleton J, *et al.* The misuse and overuse of non-sterile gloves: application of an audit tool to define the problem. *J Infect Prev*. 2015;16:24–31. doi: 10.1177/1757177414558673

25 Barbariol F, Baid H. Introduction to an intensive care recycling program. *Intensive Care Med*. 2023;49:327–9. doi: 10.1007/s00134-023-06983-3

26 Rizan C, Bhutta MF, Reed M, *et al.* The carbon footprint of waste streams in a UK hospital. *J Clean Prod*. 2021;286:125446. doi: 10.1016/j.jclepro.2020.125446

27 Grimmond TR, Bright A, Cadman J, *et al.* Before/after intervention study to determine impact on life-cycle carbon footprint of converting from single-use to reusable sharps containers in 40 UK NHS trusts. *BMJ Open*. 2021;11:e046200. doi: 10.1136/bmjopen-2020-046200

28 Walsh OM, Davis K, Gatward J. Reducing inappropriate arterial blood gas testing in a level III intensive care unit: a before-and-after observational study. *Crit Care Resusc*. 2020;22:370–7. doi: 10.51893/2020.4.OA10

29 Keveson B, Clouser RD, Hamlin MP, *et al.* Adding value to daily chest X-rays in the ICU through education, restricted daily orders and indication-based prompting. *BMJ Open Qual*. 2017;6:e000072. doi: 10.1136/bmjoq-2017-000072

30 Siegal DM, Belley-Côté EP, Lee SF, *et al.* Small-volume blood collection tubes to reduce transfusions in intensive care: The STRATUS randomized clinical trial. *JAMA*. 2023;330:1872. doi: 10.1001/jama.2023.20820

31 McAlister S, McGain F, Breth-Petersen M, *et al.* The carbon footprint of hospital diagnostic imaging in Australia. *Lancet Reg Health West Pac*. 2022;24:100459. doi: 10.1016/j.lanwpc.2022.100459

32 O'Brien B, Campbell NG, Allen E, *et al.* Potassium Supplementation and Prevention of Atrial Fibrillation After Cardiac Surgery: The TIGHT K Randomized Clinical Trial. *JAMA*. 2024;332:979. doi: 10.1001/jama.2024.17888

33 Crippa M, Solazzo E, Guizzardi D, *et al.* Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat Food*. 2021;2:198–209. doi: 10.1038/s43016-021-00225-9

34 Hay T, Bellomo R, Rechnitzer T, *et al.* Constipation, diarrhea, and prophylactic laxative bowel regimens in the critically ill: A systematic review and meta-analysis. *J Crit Care*. 2019;52:242–50. doi: 10.1016/j.jcrc.2019.01.004

35 Saran S, Gurjar M, Baronia A, *et al.* Heating, ventilation and air conditioning (HVAC) in intensive care unit. *Crit Care*. 2020;24:194. doi: 10.1186/s13054-020-02907-5

References

36 Pollard AS, Paddle JJ, Taylor TJ, *et al.* The carbon footprint of acute care: how energy intensive is critical care? *Public Health*. 2014;128:771–6. doi: 10.1016/j.puhe.2014.06.015

37 Nash C. It's not easy being green–a tool for choosing sustainable clinical products. *Nurs Times [online]*. 2023;119. https://www.nursingtimes.net/hospital-nursing/its-not-easy-being-green-a-tool-for-choosing-sustainable-clinical-products-25-07-2023/

38 McGain F, McAlister S. Reusable versus single-use ICU equipment: what's the environmental footprint? *Intensive Care Med*. 2023;49:1523–5. doi: 10.1007/s00134-023-07256-9

39 Rickard CM, Marsh NM, Larsen EN, *et al.* Effect of infusion set replacement intervals on catheter-related bloodstream infections (RSVP): a randomised, controlled, equivalence (central venous access device)–non-inferiority (peripheral arterial catheter) trial. *Lancet*. 2021;397:1447–58. doi: 10.1016/S0140-6736(21)00351-2

40 Stilma W, Esmeijer A, Paulus F, *et al.* Open versus closed suctioning in invasively ventilated critically ill patients for sustainability of ICU care: A life-cycle assessment comparison. *Resp Care*. 2024;69:218–21. doi: 10.4187/respcare.11189

41 Hellyer TP, Ewan V, Wilson P, *et al.* The Intensive Care Society recommended bundle of interventions for the prevention of ventilator-associated pneumonia. *J Intensive Care Soc*. 2016;17:238–43. doi: 10.1177/1751143716644461

42 McNally S. Scarlett McNally: Enabling active travel can improve the UK's health. *BMJ*. 2024;q522. doi: 10.1136/bmj.q522

43 Chanchlani S, Martin K, Dunne B. Environmental sustainability in simulation education in healthcare. *Int J Healthc Simulation*. 2024;mqqv2910. doi: 10.54531/mqqv2910

44 Smale EM, Wisse JJ, Hunfeld N. A checklist for environmentally responsible research within the ICU. *Intensive Care Med*. Published Online First: 2025. doi: 10.1007/s00134-025-07815-2

45 Smale E, Baid H, Balan M, *et al.* The green ICU: how to interpret green? A multiple perspective approach. *Crit Care*. 2025;29:80. doi: 10.1186/s13054-025-05316-8

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