A Beginner's Guide to

Collaborative Sustainability and Resource Stewardship in the ICU

ANZICS

Intensive Care Society

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Introduction

This toolkit is the result of an enduring collaboration between Australian and New Zealand Intensive Care Society (ANZICS) and the Intensive Care Society (ICS). It builds on the first partnership in 2024, which introduced A Beginner's Guide to Green Teams in the ICU[1] as a grassroots catalyst for action. This new toolkit – A Beginner's Guide to Collaborative Sustainability and Resource Stewardship in the ICU – focuses on resource stewardship in the Intensive Care Unit (ICU), targeting the most significant ICU environmental hotspots.

The race to net zero and ultimately real zero is urgent.[2] Climate change is already impacting the delivery of intensive care services. With rising patient demand and worsening socio-economic pressures, our ability to provide optimal intensive care will be increasingly threatened.[3] In the most severe scenarios, ICU services, which sit at the pinnacle of healthcare, may cease to exist in some regions without functioning health systems.

The ICU is inherently resource intensive: energy-intensive, staff-intensive (due to high staff-to-patient ratios), and healthcare supplies intensive. This creates both challenges and opportunities. Given the sheer scale of resources used, the ICU offers potential for significant greenhouse gas (GHG) reductions and waste minimisation. All while maintaining high quality, safe patient care.

The most significant environmental hotspots in intensive care medicine are energy, transport and the medical supply chain. This toolkit focuses on these factors intentionally, as they have tremendous potential for a swift and sharp decrease in ICU GHG emissions.

Energy use is substantial in the ICU, and it is crucial to understand its importance. Clinicians can drive change by collaborating on and advocating for: maximally energy-efficient, fully electrified hospital buildings, systems powered by 100% renewable energy, policies and investments that phase out fossil fuels.

Transport contributes disproportionally to healthcare GHG emissions. Clinicians can reduce their professional and personal travel footprints, with the added health co-benefits of more active and sustainable choices. This is a "win-win" scenario.

Single use items are a major driver of ICU emissions.[4] The current linear healthcare- take, make, waste-economy must transition to a circular economy. This may be complex, but transformation is achievable when steps are taken in collaboration with procurement teams and suppliers with clinical advocacy.

This toolkit also encourages the cultivation of a sustainability mindset. This means applying a sustainability lens to all areas of intensive care practice. Many components of doing less are already part of day-to-day Evidence-Based Medicine (EBM); other choices will be deliberate:

- Choosing consciously aligns with environmental responsibility.
- Avoiding low-value care and waste.
- Embedding sustainability into education, research, and quality improvement.
- Strengthening governance from our professional groups and societies.

Every action creates a ripple. Success within our green teams and ICUs can inspire others, build collective purpose, accelerate the shift towards a sustainable, resilient, and eventually a more regenerative healthcare system. Let's get going!

(1) ANZICS: A beginner's guide to sustainability in the ICU ABN: 19 657 679 556 ISBN: 978-1-876980-56-6
(2) Working Group III: Climate Change 2022: Mitigation of Climate Change. In: 6th assessment report IPCC. IPCC; 2022.
(3) Koch S, Klitzman R: Reliance on fossil fuels: ethical implications for intensivists. Intensive Care Med 2023, 49(3):330-333.
(4) Hemberg L, Singh J, Bentzer P: A process-based life cycle assessment of the climate impact of a Swedish intensive care unit. Sci Rep 2025, 15(1):19435.

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Summary

Energy in the ICU

Forbes McGain

In the original ANZICS Sustainability Toolkit[1] relatively few pages were devoted to energy, despite its major role in the ICU's total carbon footprint.[1, 2] This updated version acknowledges the challenge that while reducing waste and improving clinical care can often deliver quicker wins, energy efficiency is equally vital. Clinicians can make an impact through knowledge, collaboration, and policy change.

Actions for energy

1. Know where the energy goes

Energy required for heating, ventilation and air conditioning (HVAC) uses 10 x more energy than lighting and running ICU equipment (ventilators etc.).[1] Avoid becoming overly concerned about switching the lights off, rather focus on HVAC efficiency. For example: switch off unused negative pressure rooms (double the air changes per hour), and power down unoccupied single ICU rooms (found in many modern ICUs). Adjust the ICU temperature range by 2 °C (e.g. lowering from 21-23 °C to 19-21 °C in winter, and the opposite in summer) will save >10% of total energy costs without harming patients. Collaborate with the hospital engineers, ICU staff and infection prevention staff to ensure safe and supported changes.

2. Know your electricity grid

Emission intensity varies greatly. Renewables (wind, solar, hydro) are 10-fold cleaner than coal or gas. In Australia, renewable electricity now supplies 35% of the grid, which is only just behind the UK (43%)[2] Further, there are examples of more rapid transition of healthcare systems to close to 100% renewable electricity.[3] Clinicians can collaborate with the hospital executive, engineers, and advocacy groups (e.g. Doctors for the Environment Australia, the Ora Taiao (New Zealand Climate and Health Council) and the UK Health Alliance on Climate Change) to accelerate change.

3. Know how you heat

Even if you have 100% renewable electricity, hospitals still use gas for water and room heating. Clinicians can advocate for hospitals to electrify heating- a critical and feasible step towards net zero.[4]

4. Know that Renewables make Reusables Better

Know that the reach of energy and its sources goes deeper than HVAC and lighting, extending on to equipment. As we transition away from single use equipment again be mindful of your energy sources. Reusable devices must be cleaned/disinfected, whilst some also require sterilisation, which can have higher footprints if powered by coal. This reinforces the importance of aligning equipment choices with energy decarbonisation.[3]

1 https://www.anzics.org/wp-content/uploads/2022/04/A-beginners-guide-to-Sustainability-in-the-ICU.pdf

2 https://www.nationalgrid.com/stories/energy-explained/how-much-uks-energy-renewable?__cf_chl_tk=WLFkp6DJaQ278xlud3MFhEZYyrodxP8YYCmkA7vkp7c-1757459303-1.0.1.1-ike3GemzrmCpTmFzzw4bQ87PNf4VO2.y1PmyOSQfFDM

3 https://www.climatechange.vic.gov.au/victorian-government-action-on-climate-change/Whole-of-Victorian-Government-sector-pledge-accessible.pdf

5. Know the bigger picture

Once energy grids switch to renewables and away from gas, the relative importance of reducing single use items increases. For example, a 2025 life cycle assessment of an ICU in Sweden showed that single use waste contributes more ICU emissions than energy use (unlike our Australian study). Sweden's electricity grid is 40% wind power, 40% nuclear, 10% hydro. ICU staff need to be more focussed on waste occurring from their single use supplies.[4]

Actions from the original ANZICS Toolkit

- **Measure power use within your intensive care.**
- **Work with hospital engineers to reduce energy use from HVAC.**
- **Install and use energy efficient lighting.**
- **Turn off computers and equipment not in use.**
- **Design and refurbish ICUs with energy efficiency in mind.**

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4 https://www.vhba.vic.gov.au/news/new-melton-hospital-funding

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Travel

Louise Trent

We travel every day, and the choices we make have a direct impact on both our health and environment, some more harmful than others. We already know the benefits of exercising more and are often reminded to fly and drive less. Many workplaces even have institutional sustainable travel plans in place.

Sustainable travel choices offer multiple co-benefits such as less air pollution, leading to improved public health and more active travel contributing to better personal physical and mental wellbeing. Despite knowing this, travel related emissions remain one of the largest contributors to our overall footprint. So what could truly motivate us to change our travel behaviour?[5]

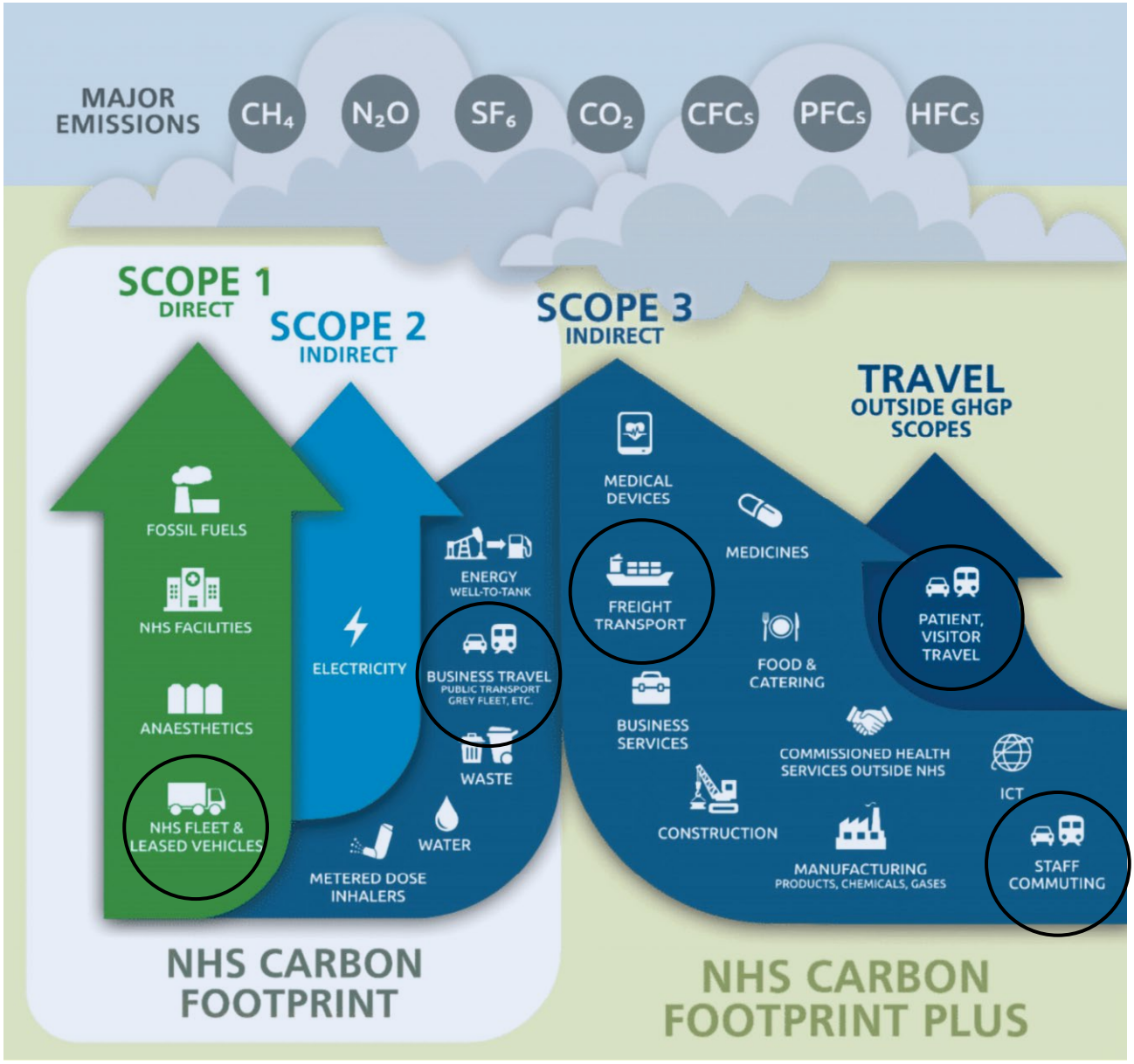
It's worth comparing transport emissions with some of our clinical sustainability efforts. For example, a 25 km single occupant commute in a petrol car generates the same emissions as 115 arterial blood gases (ABGs). A one hour domestic flight for a work meeting is equivalent to 2,500 ABGs. This doesn't mean reducing unnecessary ABG testing is unimportant, but it highlights more conscious travel choices, even modest shifts up the sustainable transport pyramid[6] could deliver a faster and greater reduction in both healthcare emissions and our personal carbon footprints.

Travel and transport emissions come from multiple areas in healthcare (Figure 1).

Source: Skyline Aviation

5 https://reneelertzman.substack.com/p/to-fly-or-not-to-fly-why-this-is?r=1oh8d&utm_campaign=post&utm_medium=email&triedRedirect=true
6 https://www.england.nhs.uk/wp-content/uploads/2023/10/figure-2-sustainable-travel-hierarchy.png

Figure 1: The pervasive impact of travel and transport on healthcare's Greenhouse gas emissions.[7]



Business travel, staff commuting, patient and visitor travel are discussed here. All of these are within our sphere of influence, and by making collective changes we can achieve significant health, environmental, and financial benefits.

Travel for professional development

Continuing professional development is essential, but it also contributes significantly to GHG emissions. This is particularly true in New Zealand and Australia, where geographical isolation means long haul flights are often undertaken. Within Health New Zealand, for example, staff air travel ranks second in its top 10 emission hotspots.(4) Despite years of discussion, there has been little systemic change in how conference-related emissions are managed. The medical education sector, like all others, must innovate.

Virtual and hybrid meetings offer a clear solution. A fully virtual meeting produces less than 1% of the emissions of an in-person event.(5) Hybrid formats have demonstrated up to 86% reductions in carbon emissions.(6) These formats are evolving to provide networking and educational opportunities comparable to traditional conferences.(7) Participants are increasingly willing (60%) to accept the drawbacks of virtual in return for the environmental and personal benefits.(5) Simple measures such as turning off cameras when not needed can reduce emissions from virtual meetings by 96% although these virtual efforts are relatively insignificant compared with choosing to avoid long haul flights.(8)

7 https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2021/02/NZR-Scopes.png

Beyond emissions, virtual meetings bring co-benefits: cost savings, wider accessibility, greater inclusivity for those facing financial, geographical or health barriers. This can translate into broader attendance and more diverse participation.

Clinicians should carefully weigh up the benefits of in-person attendance. Hands-on and practical training may justify travel, while predominantly didactic events may not. As stakeholders, clinicians can advocate for medical education providers and professional organisations to bring about radical change in the medical educational industry. Professional organisations should offer virtual/hybrid registration at their larger events and consider alternating fully virtual to in-person events year to year. Establishing regional hubs can reduce emissions by more than 50% while fostering regional communities of practice and improving equity, especially in the global south.[6]

When air travel is necessary, lower carbon travel choices matter. For instance, economy seats have less than one-third the carbon footprint of a business class seat, which can emit 3-4 times more.[8] Taking a direct flight during the daytime and seeking more sustainable airlines further reduce impact.[9]

Emissions calculators[9] can help inform travel choices.[10] Clinicians can choose sustainable accommodation providers near to venues and public transport routes (knowing that such efforts pale in comparison to flying less). Carbon offsetting is an intermediate step until lower carbon options are available. Calendar linking with other professional meetings and satellite meetings create efficiency and save separate trips. Finally, healthcare organisations can support change by aligning professional development allowances with climate-conscious behaviours, ensuring clinicians are not penalised for choosing low carbon options.

Table 1: Travel for Professional Development Actions

Actions for Clinicians

- Lead by example, talk about travel choices
- Choose virtual attendance
- Advocate for virtual options to education providers
- If virtual when appropriate turn camera off and dim screens
- Fly less
- Choose lower impact modes of land travel
- Use an emissions calculator to inform travel choice
- Choose a regional conference hub if offered
- Avoid business class
- Take direct flights and daytime flights
- Choose a greener aircraft and airline
- Buy carbon offsets if flying necessary
- Use public transport at the event
- Select accommodation with good access to conference for walking or public transport
- Look for opportunities to combine trips or travel with colleagues

Actions for Intensive care departments and hospitals

- Provide hospital based virtual mini conference hubs (increased equity of access for all ICU staff)
- Subsidise virtual team registration in-house to increase access and inclusion
- Sustainable Travel policy with majority economy flights, preference for public transport and BEVs/hybrids rentals. Long distance train, sustainable accommodation and mass transit locally. Carbon offsets included
- Report impact of clinician CPD travel on hospital GHG emissions

8 https://www.procurement.govt.nz/contracts/air-travel-services/air-travel-services-broader-outcomes/
9 https://www.futurefit.nz/questionnaire

Actions for professional colleges and societies, medical education providers, healthcare systems

- Ask if an in-person event is needed
- Always offer virtual participation at larger events
- Refine the hybrid model experience
- Maximise virtual participation through incentives like reduced conference fees, enhanced networking
- Alternate virtual and in person events year to year
- Provide information for attendees over various options to minimise environmental impact
- Central conference locations offer modest GHG reductions[6]
- Offer regional spoke and hub model for large events[6]
- Purchase carbon credits to offset event costs from an accredited carbon offset provider
- Ensure venue accessible by public transport and other low emissions options and promote these options to attendees

CASE STUDY:

Travel to an international intensive care event

Air travel is essentially one of the more manageable aspects of high-carbon lifestyles to address. The suggested personal carbon budget for staying under 1.5- and 2-degrees warming is 2 and 5 tonnes per person, respectively.[10] Surprisingly taking one trip by air to a single international conference can actually end up using a person's annual carbon budget.

Table 2: International air travel carbon emissions related to travel class

Units- Kg CO_2 eq	ESICM Auckland to Brussels Airbus 380	ICS Congress Sydney to London Airbus 380	SCCM ASM London to San Francisco
Economy	1,211	1,075	485
Premium economy	1,786	1,613	727
Business class	4,661	4,302	1,939

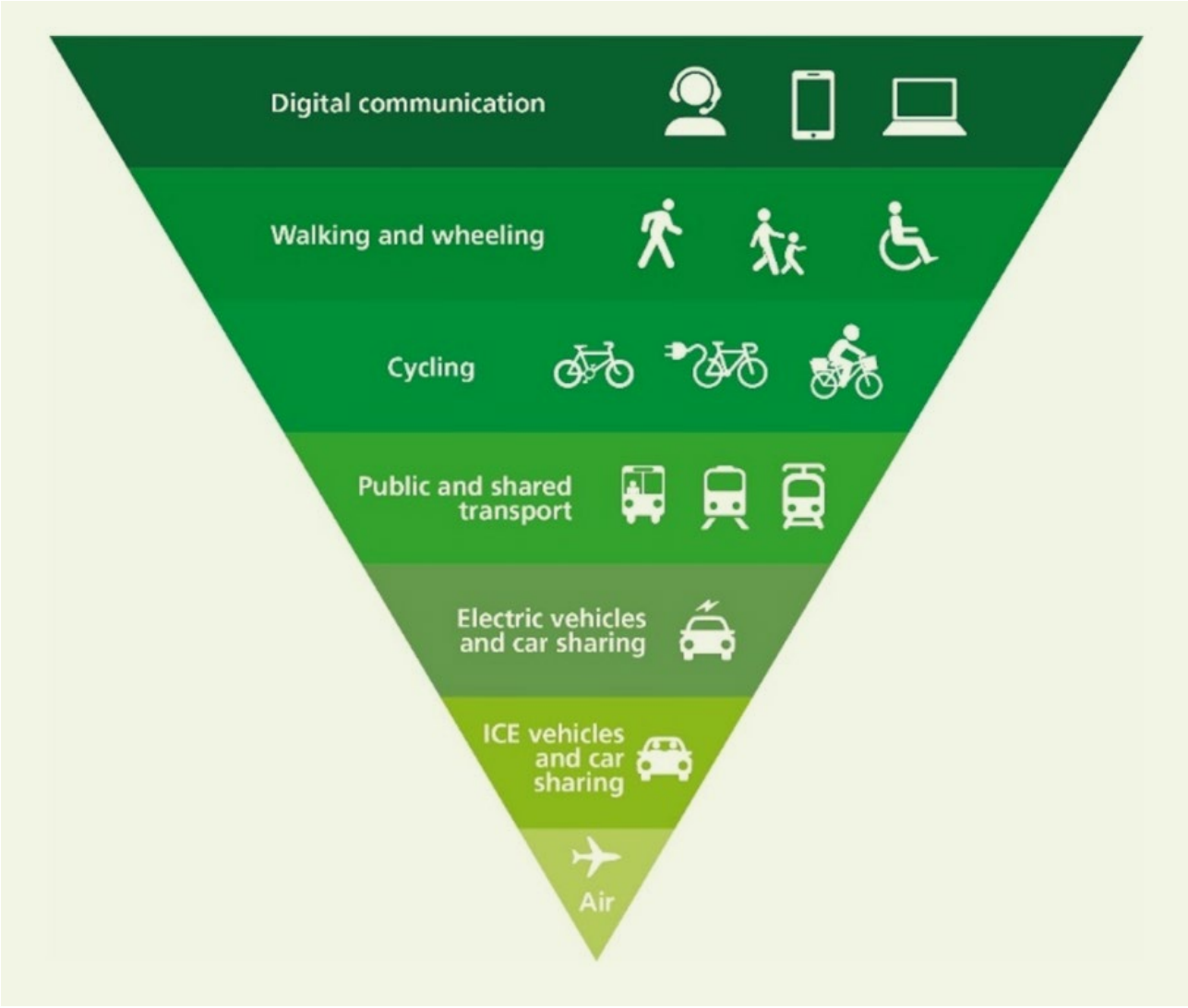
10 https://ourworldindata.org/how-much-co2-can-the-world-emit-while-keeping-warming-below-15c-and-2c

Staff Commuting

Healthcare workers have a unique opportunity to role model a healthy and sustainable lifestyle through their commuting choices. Staff commuting emissions are substantial, with approximately 560Kt CO_2e emissions[11] each year for 1.4 million NHS staff, many of whom travel in single occupancy vehicles. This is the largest transport-related emissions source in the UK, and transport has the highest potential impact for personal mitigation across all consumption choices.[11]

Moving higher up the sustainable travel pyramid (figure 2) is one of the most effective ways individuals can reduce their carbon footprint.[12] The biggest gains come from reducing car travel, especially single occupancy trips, transitioning to lower carbon fuel sources, and shifting to active transport (walking, cycling), which delivers both major carbon savings and proven physical and mental health benefits.[11, 13-15]

Figure 2: Sustainable travel pyramid NHS[12]



Australian 2021 census data showed 53% of Australians drive solo to work. Even switching just one commute per week to a more sustainable option can make a meaningful collective difference. Active transport like walking and biking has the largest benefit in terms of carbon emission reductions and studies repeatedly report significant physical and mental health benefits associated with active travel.[13-15]

There are also large potential savings from telecommuting and flexible working models. While not always feasible for frontline clinicians, home-based non-clinical work and hybrid meetings can reduce unnecessary commuting.

Clinicians are trusted and respected voices. By making sustainable commuting choices themselves, they can lead by example, create social contagion, and accelerate positive behaviour change across healthcare and society.

11 https://www.england.nhs.uk/long-read/net-zero-travel-and-transport-strategy/
12 https://www.england.nhs.uk/wp-content/uploads/2023/10/figure-2-sustainable-travel-hierarchy.png

Table 3: Commuting Actions

Staff commuting actions for clinicians

Role model sustainable commute:

- Choose active transport first with added health benefits
- Replace even one sustainable commute per week
- Get organised for biking: Register your bike, get a high-quality lock and lock the frame
- Join hospital incentive schemes for active transport
- Be encouraged competitively with bike challenges for the commute to work like Love To Ride
- Carpool
- Use route planning tools to drive efficiently

Actions for intensive care departments and hospitals

Educate and Encourage:

- Highlight benefits of an active commute, such as health and environmental benefits as well as cost savings, to all staff regularly
- Include travel options at induction for new staff
- Use active travel incentives like bike service centres, free bike use, free tune-ups, biking tips

Exemplify:

- Share success stories and make visible in ICU and organisation
- Have contests and promotions, find bike champions and promote friendly competition between hospitals with programmes like Love to Ride

Enable:

- Provide secure safe and convenient bike storage
- Provide easy access to showers and lockers
- Subsidise public transport
- Provide shuttle service to remote parking and mass transit hubs and between different hospital sites
- Organise formal carpooling programmes - apps, prime parking locations, easy payment methods
- Prioritise carpool and EV parking and charging
- Provide access to staff for e-bike and EV fleet pools

Evaluate:

- Audit staff commute and create competitive targets
- Charge appropriately for carparking (free or steeply discounted carparking incentivises driving). Per day parking rate, no free parking

Excite:

- Create an ICU community of practice with bikers/walkers- set a target for staff travelling actively
- Provide flexible start and finish time or homebased nonclinical work options and have virtual attendance option at departmental meetings and teaching/education

Advocate:

- Advocate for high-quality active and public transport infrastructure that serves the hospital- protected bike lanes and safe walking

Actions for healthcare systems and government

- Strengthen Transport Demand Management policies and strategies with hard targets
- Fund schemes to subsidise E-bikes and safety equipment for staff
- Create and support programmes like workride with subsides for bikes
- Subsidise public transport
- Use salary sacrifice for public transport passes

Patient and family travel to hospital

Similar strategies can also help reduce the travel footprint of patients and families. Virtual visits allow families to participate in care and decision-making when they cannot be physically present in the ICU. These provide co-benefits such as saving travel time and cost with lower GHG emissions.[16] Virtual intensive care visiting also increases visiting flexibility and improved equity of access for those facing distance or financial barriers.[17] Staff education is essential to ensure success, along with healthcare-appropriate user-friendly technology.

Beyond visiting, streamlined care pathways can reduce unnecessary journeys. Care pathways can be developed that eliminate the need for unnecessary journeys, using tools like the Carbon care calculator.[18] Virtual telemedicine may also have a role in ICU follow-up, provided quality and patient satisfaction are maintained, as shown in other specialities.[19] Further research is needed to understand trade-offs between in-person, virtual, and hybrid approaches.

While ICU clinicians have fewer opportunities to promote active travel or prescribe green prescriptions compared to primary care, ICU teams can still refer patients and families to local preventative health supports after discharge. This helps reinforce the broader health and environmental benefits of sustainable travel.

Table 4: Patient and Family Travel Actions

Actions for clinicians

- Complete training to optimise virtual visiting experience
- Research the benefits and the unintended consequences of virtual care
- Promote sustainable and active travel co-benefits with patients and their families or by referral to wellbeing services post ICU discharge

Actions for ICUs

- Provide sustainable travel options in information for visitors
- Offer virtual visiting for all patients
- Optimise care pathways
- Develop virtual ICU telemedicine

Beyond

- Public transport corridors to hospitals
- Subsidise public transport

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Circular Economy for Healthcare and the Waste Hierarchy

Louise Trent

A circular economy is built on three principles: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.[1]

Healthcare is currently dominated by a linear model, where devices are manufactured, used only once and then discarded. This comes at a high environmental cost. A recent carbon footprint of a Swedish ICU (running on a renewable electricity grid) found that 63% of its climate impact came from single-use items.[2] Transitioning to a circular healthcare economy requires rethinking how resources are designed, used and recovered. High income country ICUs rely heavily on disposables and can learn much from the practices of low- and middle-income countries (LMICs) where resource reuse and efficiency is already a necessity.[3]

Shifting to a circular healthcare economy demands system wide change involving manufacturers, government regulators, independent oversight bodies, professional organisations, healthcare organisations, consumers, and device users.[4]

The benefits of a circular healthcare economy are significant: greater supply chain resilience, waste minimisation, reduced healthcare costs and improved public and environmental health through reduced pollution.

Circularity in healthcare is not just an environmental necessity, it is an opportunity to deliver more resilient, affordable and equitable care.

How can clinicians advance the transition to circular use?

Clinicians everyday use of a wide range of medical devices which places them in a unique position to drive the shift to circular healthcare systems. To support this, activities are outlined across four phases: Upstream (procurement), User phase, End-of-use, and Feedback & Learning.

1. Upstream: Production & Procurement

Principles: REFUSE · RETHINK · REDUCE · REDESIGN

- Collaborate for sustainable procurement
  - Advocate for environmentally preferable supplies (with procurement teams, regulators, sustainability officers).
  - Influence local procurement policies to prioritise reusables and lower-carbon devices.
  - Update ICU guidelines using a waste-minimisation lens.
- Advocate for durability & ethics
  - Push for ethically produced, reusable, repairable products.
  - Question evidence for single-use superiority where safe reusables exist.
- Support local suppliers to reduce transport footprint.
- Provide clinical feedback on reusable/low-carbon devices (e.g. durability, safety, usability).

2. User Phase in the ICU

Principles: REFUSE · RETHINK · REDUCE · REUSE

- Commit to high-value care
  - Include environmental and social costs alongside financial ones.[4, 5]
- Use supplies efficiently, following the waste hierarchy:
  - REFUSE – Only take what is truly needed; use near-expired stock first.
  - REDUCE – Minimise unnecessary use; focus on ICU hotspots like gloves, aprons/ gowns, masks, bed liners, syringes.[6]
  - Extend the life of single use consumables on the same patient and find the most efficient and sustainable protocols; IV therapeutics, ventilator consumables, enteral feeding consumables, suctioning consumables. For example, patients predicted to be ventilated for less than 24 hours use tape rather than customised endotracheal holders, open suctioning rather than closed inline suctioning.[7]
  - REUSE – Where safe, adopt reusable items (e.g. PPE gowns).
  - Conduct susQI[8] to introduce new reusables into clinical practice.
  - Consider reprocessed items when available.
- Collaborate to overcome barriers
  - Work with infection prevention teams and engage staff in change, e.g. reusable PPE gowns can be preferred by ICU staff.[9]
- Reorganise for reuse
  - Evaluate ICU and CSSD facilities ability to support circular use now and into the future.
- Strengthen governance
  - Report against hospital sustainability plans.
  - Advocate for stronger professional standards.
- Maintain equipment to extend lifespan and prevent premature disposal.

3. End-of-Use Phase

Principles: REPROCESS · REPAIR · REFURBISH · REPURPOSE · REHOME · RECYCLE · RECOVER

Whilst recycling and waste produce less than 3% of worldwide healthcare GHG emissions it's still important to:

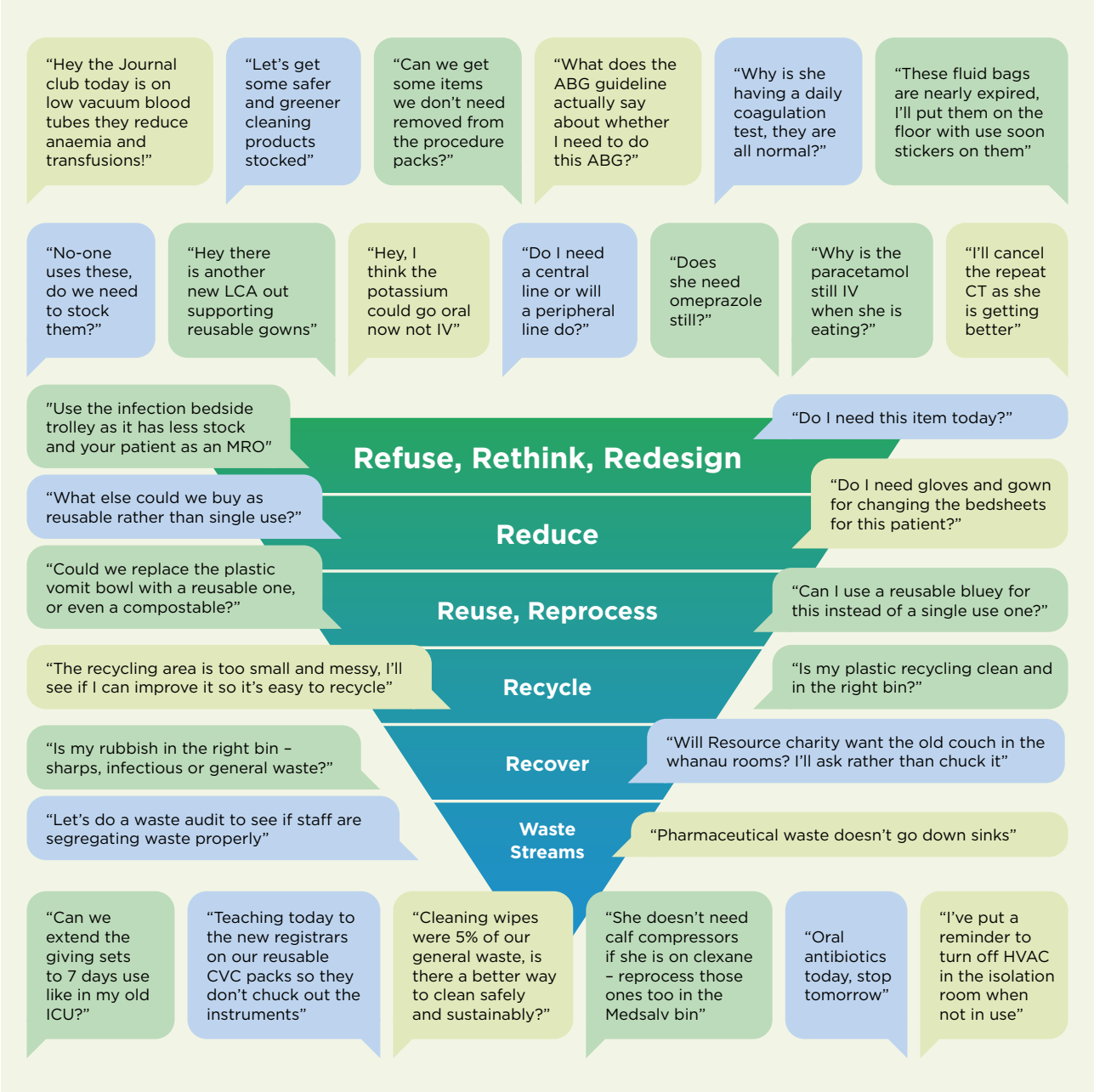
- Segregate waste accurately – education and audit to monitor and improve compliance.
- Recycle whenever possible – emissions are 50× lower than high temperature incineration.[10]
- Identify avoidable waste streams – through mini audits and feedback.
- Engage in stewardship & take-back schemes with manufacturers.
- Partner with community groups to refurbish, repurpose, rehome or donate suitable equipment.

4. Feedback & Learning

Principles: RESEARCH · EDUCATE

- Contribute to environmental impact research– LCAs, healthcare economic evaluations and sustainability implementation research.
- All ICU research should be environmentally responsible.[11]
- Scale innovation – work with engineers, designers, suppliers/manufacturers and sustainability specialists.
- Provide usage data to manufacturers and evaluation committees.
- Educate colleagues – through inductions, micro-teaching, journal clubs, meetings and structured education programs.
- Join communities of practice to share and spread successful initiatives.

Figure 3. "Don't just do something stand there and think": Practical application of the waste hierarchy in intensive care practice



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Medical Supplies

Angely Bolzon and Matt Anstey

Addressing waste in healthcare to minimise harmful environmental impacts

In the hierarchy of sustainability principles, reduction in usage is the most effective strategy – using fewer resources from the outset, by ordering appropriately, designing right sized kits and packs, and preventing expired stock through good inventory management.

Reducing consumables requires collaboration across the system through management of supplies and stock in the clinical environment. Procurement teams, equipment nurses and bedside staff, all play a role in ensuring supplies are used efficiently and responsibly.

Background

Most of healthcare's climate footprint lies in Scope 3 carbon emissions – those generated from the purchasing of goods and services, use of sold products, waste disposal, and transport/ distribution. Table 1 highlights common causes of waste related to medical supply and how they link to Scope 3 emissions.

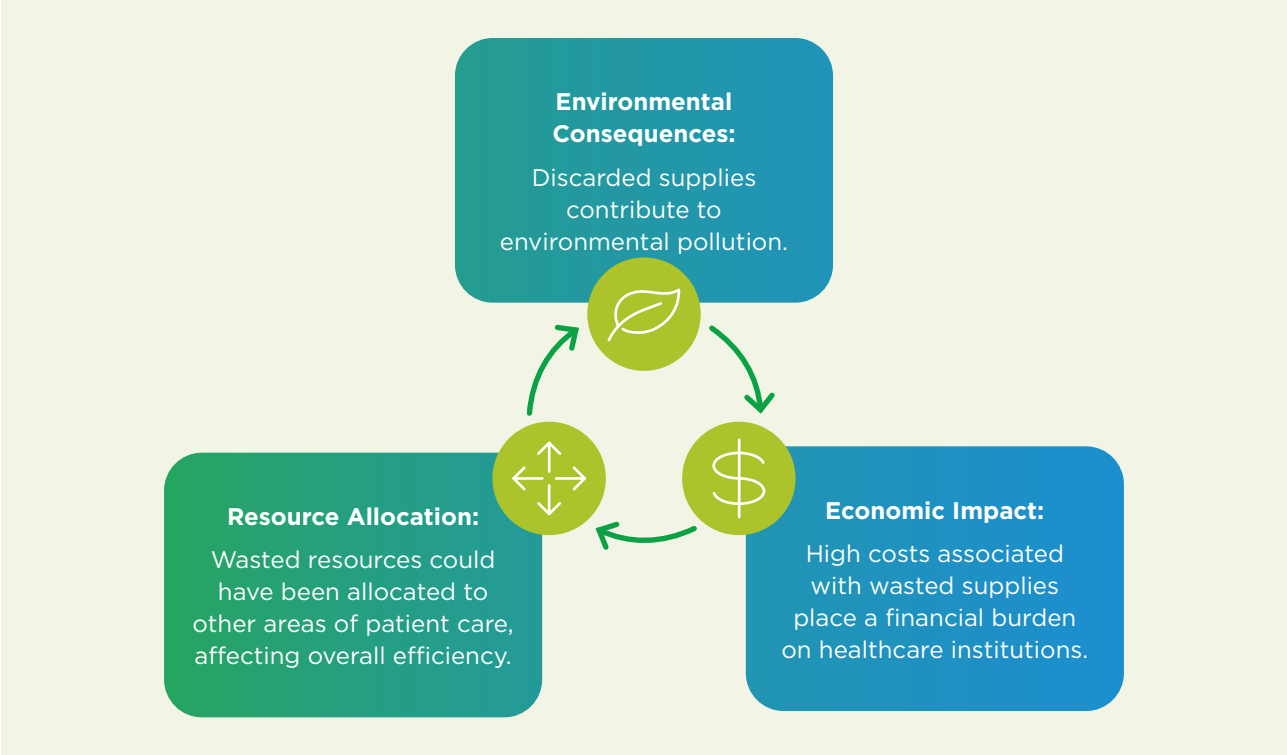
Table 5: Causes of waste in the Healthcare system

Cause of waste	Description
Overstocking	• Excessive stocking of items inside patient rooms and other ICU storage areas • Perception that a higher stock volume reduces the risk of shortages
Emergency preparation	• Maintaining supplies for unpredictable emergencies is sometimes necessary, but can also lead to overstocking and unnecessary waste
Standardised procedure kits and packs	• Prepackaged kits often contain items that are not used during procedure, leading to unused item disposal
Inefficient inventory management systems	• Manual inventory management systems can fail to track supply use efficiently, leading to difficulties assessing stock levels and identifying near expired stock

Impacts

Poor stock management leads to large volumes of medical supplies being discarded unused, either due to expiration or contamination from opened but unused items in kits. Disposal of medical waste also creates significant environmental pollutants from incineration. Expired medications and unused medical supplies can make up to 20% of ICU waste. This creates three major impacts.

Figure 4: Impacts of ICU Waste



How can critical care clinicians directly influence change?

Clinicians play a key role in reducing waste at the source:

- Prevent expiration through better stock rotation and accurate ordering practices.
- Redistribute or reuse excess items before expiry where safe and appropriate.
- Redesign supply kits—breaking down large standard packs into smaller, flexible kits reduces the number of items discarded unused.

Table 6: The Albatross Project Summary

Category	Details
Project Title	The Albatross Project – Reducing Consumable Waste in Royal Adelaide ICU
Leads	Angela Reid (CN), Jo Buttery (NUM)
Location	Royal Adelaide Hospital ICU (48-bed unit, ~4,000 patients/year)
Problem Identified	Incorrect and excessive stocking of bedside trolleys in additional precaution rooms causing waste of unopened items
Aim	Reduce unnecessary waste, lower costs of consumables, and reduce waste disposal expenses
Background	In ICU, bedside trolleys are commonly used but contribute to significant waste. Morrow, Hunt et al. (2013) noted this practice
Audit Findings	• Trolleys overstocked • Guidelines not followed • Unnecessary items included • Annual waste: >$106,500
Intervention	Reviewed and reduced items on stocking guideline; decreased per-trolley cost from $170 to $138, saving $32 per trolley
Projected Savings	$38,400/year (based on 1,200 admissions/year with transmission-based precautions)
Staff Engagement	Survey feedback showed support for changes, increased cost-awareness, and 50% reduction in discarded items
Education Strategies	Provided via email, newsletter, face-to-face sessions, staff huddles, and room signage
Barriers	Patient acuity and length of stay not measured but likely affected waste
Recommendations	• Limit restocking to once or twice per day • Expand use of restocking trolleys • Maintain leadership support • Ongoing staff involvement

Other stock management opportunities

Clinicians can help reduce waste and improve sustainability by rethinking how supplies are used, stored, and shared.

Thoughtful use of products

- Send unused, unopened supplies with the patient during transfers.
- Use decanting stations for toiletries (e.g., shaving cream, shampoo, moisturiser, mouthwash).
- Adopt closed in-line arterial sampling systems to reduce blood waste, syringes, gauze, and infection risk.
- Apply a “green team” lens to restocking, limiting items stored in each room.

Smarter procurement and inventory systems

- Implement systems such as Periodic Automatic Replacement (PAR) systems for daily count of stock on compactus shelves using barcode scanning.

  At the RAH ICU dashboards track high/ low-use products helping procurement and sustainability teams reduce waste.
- Explore tech and AI solutions to stock manage issues across departments, hospitals and regions. e.g. Mutu[13] is a resource efficiency tool that helps companies easily identify reuse.
- Trial people-based solutions like the Medical supplies’ café[14] at Queensland Children’s Hospital where monthly “swap meets” redistribute supplies.

13 https://mutu.co.nz/
14 https://www.clinicalexcellence.qld.gov.au/improvement-exchange/hospital-recycling-revolution-and-sustainable-reform

Alternative uses for expired stock

Send expired but unused stock to Simulation (SIM) centres or universities for education and simulation sessions.

- Donate to humanitarian organisations, veterinarians.

Cleaning and infection control precautions

- Review whether consumables in precaution rooms can be safely wiped down with cleaning solutions instead of discarding. See appendix A for WIPEDOWN TOOL card.
- Limit unnecessary staff entry into patient rooms when extra precautions are in place (reduces gowns/masks use).

Collaboration with manufacturers

- Customise procedure packs: e.g. CVC kits to remove routinely wasted items, such as syringes, needles, cotton wool and bungs.
- Advocate for reduced packaging of products where possible to reduce size of product for transport, and lower weight transport solutions, further reducing GHG emissions.
- Prefer reusable equipment, where not possible, consider the use of maceratable and biodegradable items especially if biocomposting facilities are available in your region (kidney dishes and urine bottles, cleaning wipes and gloves, white gowns for staff).
- Support local suppliers to cut transport related Scope 3 carbon emissions.

Choosing products with longer life span

- Replace single use items with multiuse options. (The current nebulisation consumables are recommended for disposal after each use, however the Aerogen can be utilized for intubated and extubated patients for 28 days).
- Order carefully, source from other departments if only small amounts are needed.

Sharing and redistributing stock

- Rotate near expiry items to higher use areas.
- Use expiry stickers so staff prioritise older stock.
- Collaborate with the nearby departments/hospitals, for stock sharing.
- Share responsibility between the Emergency Department (ED) and the ICU for rare use emergency equipment, such as obstetric devices and consumables for obstetric resuscitation.

Clear waste removal and reprocessing pathways

- Support reprocessing programs for devices like blood pressure cuffs, oxygen saturation probes, DVT prophylaxis devices.
- Set up battery and ECG cable recycling.

The takeaway message is that wasting unused supplies significantly harms both the environment and healthcare budgets. To enable change requires: greater mindfulness of supply costs and quantities, utilising reusable devices where possible, reducing the quantity of the supplies inside patient rooms, identifying areas of focus for waste reduction and engaging staff at all levels.

Useful resources

Appendix A: Medical Supplies Case study two: ICU not wasting Environmental Sustainability Project Example of a cleaning matrix from NSW ICU net zero hub

Appendix B: Examples of stock management quality improvement projects from NSW ICU Net Zero Hub
BEDSTOCK 1: Optimizing Consumables in ICU Patient Bedspaces
BEDSTOCK 2: Reviewing and Managing Consumables Stocked in MRO Patient Bedspaces

Pharmaceutical Stewardship and Environmental Sustainability in ICU

Marie Scott and Abhinav Gupta

Pharmaceuticals are essential for patient care, they also contribute significantly to the environmental impact of healthcare. They account for 20% of Australia's healthcare CO_2e emissions[1] and 25% in the NHS.[15] A process based LCA estimated pharmaceuticals and fluids were 7% of climate impact, and medical gases 5%.[2] Much of the carbon footprint arises from the manufacturing, procurement and transport[1] as many of our pharmaceuticals are produced overseas[3]. Given the ICUs are high pharmaceutical consumers, both staff and patients have a role to play in ensuring their sustainable use.

General principles for sustainable use

- Cease unnecessary medications.[1]
- Reduce the use of pharmaceuticals and associated consumables.
- Utilise nonpharmacological measures first.
- Recycle packaging, glass and plastics. Investigate if PVC plastics can be recycled.
- Rethink using plastics such as plastic pill cups.
- Replace single use drug trays/kidney dishes with reusables.
- Ensure safe disposal of pharmaceutical waste to prevent environmental impact.
- Choose lower impact medications when options exist and evidence supports their use.

Role of Pharmacists

Pharmacists play a vital role in advancing sustainable pharmaceutical practice in the ICU[16]. Their expertise supports both staff and patients through prevention and education.[4] Pharmacists should be integral members of every ICU green team driving quality improvements and embedding sustainable medication practices.[5]

Medicine reconciliation

- On ICU admission review polypharmacy. Discontinue inappropriate medicines during ICU e.g. over the counter and bisphosphonates.
- On ICU discharge stop ICU specific drugs.

Advise on appropriate prescribing and administration of medication

- Provide audit and feedback to doctors on prescribing.
- Provide recommendations to doctors when a switch from IV to oral medications may be appropriate.[6]
- Assist doctors in choosing an alternative medication with sufficient oral bioavailability when switching from an IV drug with little or no oral bioavailability such as gentamicin.[6]
- Encourage and educate doctors to prescribe according to hospital prescribing guidelines.[6]
- Advise nurses on infusion methods for pharmaceuticals with the most sustainable administration. This may include medications that can be given neat through central venous access or appropriate dilution to reduce IV fluid usage.

15 https://www.england.nhs.uk/greenernhs/a-net-zero-nhs/
16 https://pharmaceutical-journal.com/article/ld/principles-of-sustainable-healthcare-in-pharmacy-practice#principles

Minimising pharmaceutical waste through efficient stock management and systems

- Advocate for a high-quality pharmaceutical inventory management system in ICU if you don't have one, to avoid overstocking and expiry.
- Manage stock volumes to avoid expiry of medications.
- Consider stocking selected medications in a few departments to reduce drug waste or expiry. These include stocking labetalol in birth suites or Idarucizumab for dabigatran reversal in ICU.
- Manage near expiry drugs by utilising them in other departments across the hospital.
- Pharmaceuticals may be stored outside the ICU pharmacy like in emergency drug boxes; rationalise to what is needed and ensure stock rotation to avoid expiry.

Role of Doctors

ICU doctors play a pivotal role in ensuring medications and interventions are used safely, effectively, and sustainably. This involves daily review, evidence-based prescribing, and targeted reduction of unnecessary interventions.

Medication prescription

- Utilise guidelines and available evidence when prescribing. Resources such as national quality standards[7] Therapeutic Guidelines or local hospital protocols can assist with advice on appropriate antibiotic choices and duration.
- Practice antimicrobial stewardship.
- Provide appropriate oxygen saturation and blood pressure or mean arterial pressure targets for patients to reduce oxygen and vasopressor requirements.[1]

Blood products

- Transfuse red blood cells only if Hb < 70g/L, the patient is haemodynamically unstable or has significant cardiovascular or respiratory disease.[8]
- Cease the activation of "massive transfusion protocols" when no longer required to avoid blood product wastage.

Greener inhalers for asthma and COPD

- Hydrofluorocarbons used as propellants in metered dose inhalers (MDIs) such as salbutamol are powerful greenhouse gases[9] which account for approximately 13% of the NHS's carbon footprint related to the delivery of care.[9]
- Real world evidence demonstrates once daily combination dry powder inhalers (DPIs), which are propellant free[10], can improve compliance and asthma control and have a lower carbon footprint[9]. MDIs have a carbon footprint of 500g CO_2eq per dose compared to 20g in DPIs.[1]
- Provide information on the environmental impact of different inhalers and the environmental benefits of a greener inhaler.[9]
- Promote discussion between the patient and their GP regarding switching from an MDI to a greener inhaler such as a DPI or soft mist inhaler (SMI) if appropriate.[9,10]
- Avoid MDI use in ICU by using ventilator and oxygen driven nebulisers.[1]

Proton Pump Inhibitors (PPIs)

- Reduce overprescribing of PPIs for stress ulcer prophylaxis. Although there is controversy regarding the population of patients that may benefit from stress ulcer prophylaxis, PPIs are initiated in up to 90% of ICU patients.[11]
- Stop acid suppression medication in patients established on enteral nutrition except high -risk groups.[1]
- Cease PPIs commenced in ICU for stress ulcer prophylaxis at time of ICU discharge[1]. Continued PPI therapy without indication after hospital discharge is associated with increased morbidity, higher 1 year rehospitalisation rates and lower 2-year survival.[11]

Medical gases

- Avoid anaesthetic gas use in the ICU due to significant environmental harm.[12]
- Decommission leaky piped nitrous oxide in the ICU and advocate for no piped supplies in new builds.[13].
- Don't over utilise high flow oxygen therapy. Hemberg's ICU LCA showed almost all the environmental impact from medical gases came from producing liquid oxygen, with more than 70% that being used for high flow oxygen therapy.[2]

Intravenous (IV) to oral switch when enteral route is equally safe and effective

- The carbon footprint of manufacturing, transporting, using and disposing of IV medications and their packaging is likely higher than oral medications.[6]
- Intravenous antibiotics have been found to have 10-70 times greater carbon footprint than the equivalent oral form.[14]
- A life cycle analysis and calculated CO2e of different forms of paracetamol demonstrated a 16-fold increase of emissions with IV administration when compared with oral.[15,16]
- Consider prescribing oral medications whenever IV therapy would be unlikely to be more benefit than enteral preparations[6], especially when the oral bioavailability is high.
- Consider prescribing oral medications if the patient is able to tolerate and absorb the medication at the required dose.[6]

Medication cessation and changes

- Consider antibiotic de-escalation daily.[8]
- Consider a stop date on prescribed medications such as antibiotics or analgesics.
- Stop admission medications that may not be needed after a critical illness episode.
- Deprescribe low value care medication that provide limited to no benefit for patients.[17] These include homeopathic and over the counter preparations which are not evidence based. In ICU, some examples include stress ulcer prophylaxis[17] and melatonin being prescribed prophylactically to prevent delirium.[18]
- Liaise with parent teams about changes to usual medications during intensive care to ensure medicines are appropriate on hospital discharge.

Sedatives, sleep and delirium management

- Try nonpharmacological measures for sleep disturbance as first line.[1]
- Undertake daily attempts to lighten sedation in mechanically ventilated patients unless contraindicated.[8]
- Only keep mechanically ventilated patients deeply sedated if there is a specific indication.[8]
- Aim to discontinue sedation as soon as possible. Prolonged and/or excessive sedation can be associated with increased delirium, prolonged ventilation and ICU length of stay.[8, 14]
- Limit routine use of antipsychotic drugs to manage symptoms of delirium.[19,20] Utilise nonpharmacological interventions in the prevention and management of delirium as the evidence does not support starting medications to prevent or treat hypoactive delirium.[20] Only treat delirium pharmacologically when the symptoms are distressing to the patient or are affecting care.[20]

Role of Nurses

ICU nurses play a crucial role in reducing pharmaceutical and consumable waste through safe, efficient, and sustainable medication practices.

Reduce and limit the volume of pharmaceuticals discarded

- Leave emergency drugs unopened but immediately available. Half of the drugs drawn up for emergencies in ICU are unused and subsequently discarded.[21]
- Prefilled syringes have a longer shelf life and can reduce waste and cost.[21]
- Use appropriate dose vials for medication dose delivery. Match the patient's fluid requirements to the smallest suitable bag size.[22]
- Don't take boxes of prescribed medicine to the bedside for convenience where they may be discarded if not used.

- Communicate with medical team when infusions are due to be replaced in case the medicine is no longer required or there is prescription modification, to avoid discarded IV medication waste.[23]
- Don't prepare drug syringes too far in advance unless necessary and don't systematically change IV infusions at a predefined time of day.[23]

Reduce the use of consumables when administering medications

- Use the minimum number of syringes when drawing up medications.[1]
- Deliver suitable medications as an IV push or bolus rather than as an infusion.
- Assess if a medication can be administered neat.[24]
- Consider burettes; these are volumetric I.V. solution administration sets which can be used in patients with a central line requiring regular IV medications, such as antibiotics and electrolytes. Burettes are intended to reduce wastage and ensure the whole dose of each IV medication is administered by flushing the giving set after each medication. A burette can stay connected to a CVC for up to 7 days if not disconnected and can therefore reduce the need for multiple giving sets.[25]
- Consider using a syringe driver for drug administration if appropriate rather than IV fluid bags.[24] Some drugs like propofol can be administered straight from their vials without the additional need to draw into syringes saving consumables and staff time.
- Change infusion sets connected to invasive vascular devices every 7 days rather than every 3-4 days[25,26] Extending routine replacement of intravenous administration or invasive pressure monitoring line sets to 7 days has been shown to reduce costs and workloads[26], reduce plastic waste by 62% and was safe in terms of catheter related bloodstream infections.[25]
- Gloves are not needed to prepare and administer most pharmaceuticals, use only when necessary.

Table 6: Gloves use and Pharmaceuticals

No gloves needed	Use nonsterile gloves for protection
When preparing medications	Preparation of cytotoxic medications
Administration of medications via needle free connectors not visibly contaminated with blood	Therapeutically active creams such as steroid or antibiotic creams
Administration via SC or IM injection	You have a severe allergy to the medication
If no risk of exposure to blood, body fluids or hazardous pharmaceuticals or substances	Monoclonal antibody preparations
	If pregnant (lack of data for many drugs)

Role of Educators

Educators are central to embedding sustainability into ICU culture. By teaching stewardship, reinforcing safe practices, and involving patients and families, they help ensure long-term impact.

- Make pharmaceutical stewardship part of regular teaching programmes for all staff.
- Educate and provide feedback to staff on reducing drug wastage with a waste hierarchy approach.[1, 27] A cost benefit of waste reduction can be helpful.
- Educate on proper handling and disposal of pharmaceutical waste to ensure safety and compliance. This includes identifying items that can be recycled, such as pharmaceutical glass, and distinguishing between different types of waste. For example, certain fluids or nutrient solutions may be safely disposed of down the sink or sluice, while other pharmaceuticals must be placed in designated biohazard waste containers.

Involve the patient and their family

- The patient's family may provide their own medication.
- Be aware of decision making around nonpharmaceutical management and lower carbon options for drugs like MDIs.

Recycling and repurposing pharmaceutical waste

- Recycle paper packaging from pharmaceuticals.
- Recycle glass vials if residual drug can be disposed of by correct procedures.
- Repurpose medication vial tops.
  - Collect and donate flip caps to schools.[28]
  - Use for creative and staff art projects and competitions.[29]

Safe waste disposal of pharmaceuticals and reducing environmental contamination

Evidence shows pharmaceutical waste in hospitals is often discarded into clinical sharps bins, general waste or down sinks.[3] These practices breach legislation and EPA regulations and can harm the environment. Improper disposal can be harmful to wildlife[3] and can contribute to water contamination and toxicity. Improper discarding of unused propofol may have harmful effects on aquatic and land ecosystems as the drug has high persistence and toxicity in the environment.[27] Medicines and metabolites can accumulate in vegetables and meat[3] [30] while antibiotics in the environment may fuel antimicrobial resistance.

In Australia disposal is managed under individual state and territory specific legislation.[3] Pharmacists are key in providing guidance on safe handling, storage and disposal to ensure legislative compliance and minimise the environmental impact of incorrect waste disposal. Education and training for all staff are essential to ensure compliance and reduce environmental harm.[3]

Future directions for pharmaceuticals to reduce waste

Consider the environmental impact in purchasing and prescribing:

- Ask suppliers about the environmental impact of drugs.
- Request life cycle assessment (LCA) data for pharmaceuticals under consideration. For example, for morphine sterilisation and packaging, account for almost 90% of the footprint.[31]
- Know LCAs to date of medications relevant to use in ICU and use this assessment and environmental sustainability considerations[32] when prescribing and purchasing pharmaceuticals. LCAs for pharmaceuticals are growing, see healthcareLCAs[17] as a guide to choosing lower carbon alternatives within drug classes.
- Prefer drugs with lower environmental impact. The Stockholm Drug Therapeutic Committee Janusinfo website provides information on the environmental impact of various pharmaceutical.[33] They classify pharmaceuticals by “hazard” or harmful and “risk” of toxic effects.

Supply chain stability

Most Australian medicines are manufactured overseas[3] often with narrow margins and few global producers.[24] This causes vulnerability to shortages[24] with the current worldwide IV fluid shortage a good example of this.

Future directions may include making core drugs in your own country for resilience and to reduce dependence on international manufacturing and transportation. This would potentially reduce the reliance on long supply chains, transport emissions and global instability.

Environmental impact in health economics

- Health economic evaluations have the potential to identify strategies to improve economic and environmental efficiency without negatively affecting patient outcomes, yet they rarely include environmental costs.[34]
- Future frameworks should incorporate environmental impacts into health economic evaluations in critical care. In the interim LCAs can provide valuable environmental data to guide policy and purchasing decisions.[34]

Preventing pharmaceutical waste pollution

- Emerging strategies aim to remove residues from hospital wastewater, including biological wastewater treatment plants and technologies to degrade pharmaceutical residues.[35]

17 https://healthcarelca.com/database

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Antibiotic Stewardship and Environmental Sustainability in ICU

Deepak Bhonagiri

Antimicrobials account for approximately 20% of all pharmaceuticals used in intensive care and carry a significant carbon footprint. The problem is not only their production and transport but also their overuse and misuse. One study found that 30-50% of antibiotic use in healthcare is unnecessary. While the percentage may be lower in ICU, antimicrobial stewardship (AMS) programs consistency reveal that avoidable antimicrobial use remains significant.[1]

Antibiotic footprints are a clever way to visualise antibiotic usage in a community.[2] Creating antibiotic footprints for ICUs may be helpful to promote antibiotic stewardship.

Figure 5: Antibiotic Footprint

Source: AntibioticFootprint.net.
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"There is considerable similarity between the concept of 'carbon footprint' and that of Antibiotic Footprint. While we need to use some level of energy to survive, using too much energy has been driving climate change globally. Similarly, while we need antibiotics if we are infected with bacteria, the overuse and misuse of antibiotics have driven more and more bacteria to become 'superbugs' – bacteria that are resistant to multiple antibiotics. Without global action to reduce antibiotic usage, more and more people will die of these superbugs".[2]

Antimicrobial Stewardship and Environmental Sustainability in Intensive Care

Antimicrobial stewardship (AMS) not only improves patient outcomes and reduces antimicrobial resistance (AMR) but also supports environmental sustainability by reducing unnecessary pharmaceutical use, consumables, and waste.

1. Reduce unnecessary antimicrobial use

- **Follow guidelines** Avoid peri-procedural antibiotics unless specifically required.[18] Multidisciplinary team based Antimicrobial Stewardship Teams have been shown to reduce unnecessary antimicrobial use. The use of antimicrobial guidelines e.g. (Choosing Wisely Australia[19] NICE in the UK[20]) can help in making rational antimicrobial choices. Local antibiogram derived prescriptions allow for the most rational antimicrobial choices while awaiting specific therapies based on cultures and sensitivity.
- **Using supportive tests** C Reactive Protein or procalcitonin assays to avoid starting or to cease antimicrobials where appropriate.(3, 4) Using point-of-care rapid tests for diagnosis of bacterial, fungal, viral, and mycobacterial pathogens may facilitate earlier selection of tailored antimicrobial therapy and reduce the total duration of antimicrobial therapy.(5)
- **Narrowing spectrum** Perform "antimicrobial time-out"(6) within 48-72 hours. Review clinical and microbiology results and patient's clinical status to narrow, broaden, switch or cease the therapy. Record indication and duration in the medical notes. In a single centre tertiary ICU study, antibiotic timeouts were associated with improved patient outcomes.(7) Duration of antibiotic use was reduced in another paediatric ICU study.(8)
- **Shorten the duration.**(9) Infectious disease syndromes, such as pneumonia, Staphylococcus aureus infection, candidemia, and complicated intra-abdominal infections have well studied durations of therapy. In other conditions, clinical progress or use of supportive tests like procalcitonin assays may be helpful e.g. 3 days instead of 5 days of antibiotics.

2. Change from intravenous (IV) to oral antibiotics early

This change from parenteral to oral antibiotics may not always be feasible in intensive care patients but has been shown to decrease costs, facilitate discharges, and reduce complications associated with intravenous access without compromising clinical outcomes.(10-14) Decision aids to convert form parenteral to oral antibiotics are also available.(15)

3. Reduce consumable and diluent use

Administer antimicrobials by IV push in minimal volume, when clinically appropriate, reducing fluid bags, drawing up needles and burettes. Information regarding specific drugs is available in drugs guidelines like Micromedex, Australian Medicines Handbook, and the Australian Injectable Drugs handbook. Studies in outpatient or emergency medicine settings support the use of intravenous push antimicrobials. It is possible to infuse rather than push antimicrobials with the commonly available syringe drivers or infusion pumps used in most ICUs.(16-20)

Specific antibiotics like cotrimoxazole + trimethoprim and antifungals like liposomal amphotericin are often infused in larger volumes to avoid precipitation and thrombophlebitis. Consider infusing through a central line in ICU to avoid volume overload with the added benefit of reducing consumable use. Specific guidelines for each drug are available in the above resources and can be used in writing local policies for infusing these drugs. The environmental impact of different preparations of drugs should be considered when changing modes of administration like beta-lactams by continuous infusion.(21)

4. Ensure safe disposal of antimicrobials

Local pharmacy departments and antimicrobial manufacturers have guidelines for their safe disposal.(22) Discarding antimicrobials by flushing down sinks or in general waste can lead to contamination of waterways and soils by antimicrobials with potential for developing antimicrobial resistance. Antimicrobial disposal should be managed like contaminated waste, and regular education and audits to ensure safe disposal should be considered. Refer to the document from Geneva for more information related to the impact of antibiotic use and disposal on Antimicrobial resistance.(23)

18 https://www.safetyandquality.gov.au/our-work/antimicrobial-stewardship/antimicrobial-stewardship-clinical-care-standard
19 https://www.choosingwisely.org.au/recommendations
20 https://www.nice.org.uk/guidance/ng15

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Fluid Stewardship and Environmental Sustainability in the ICU

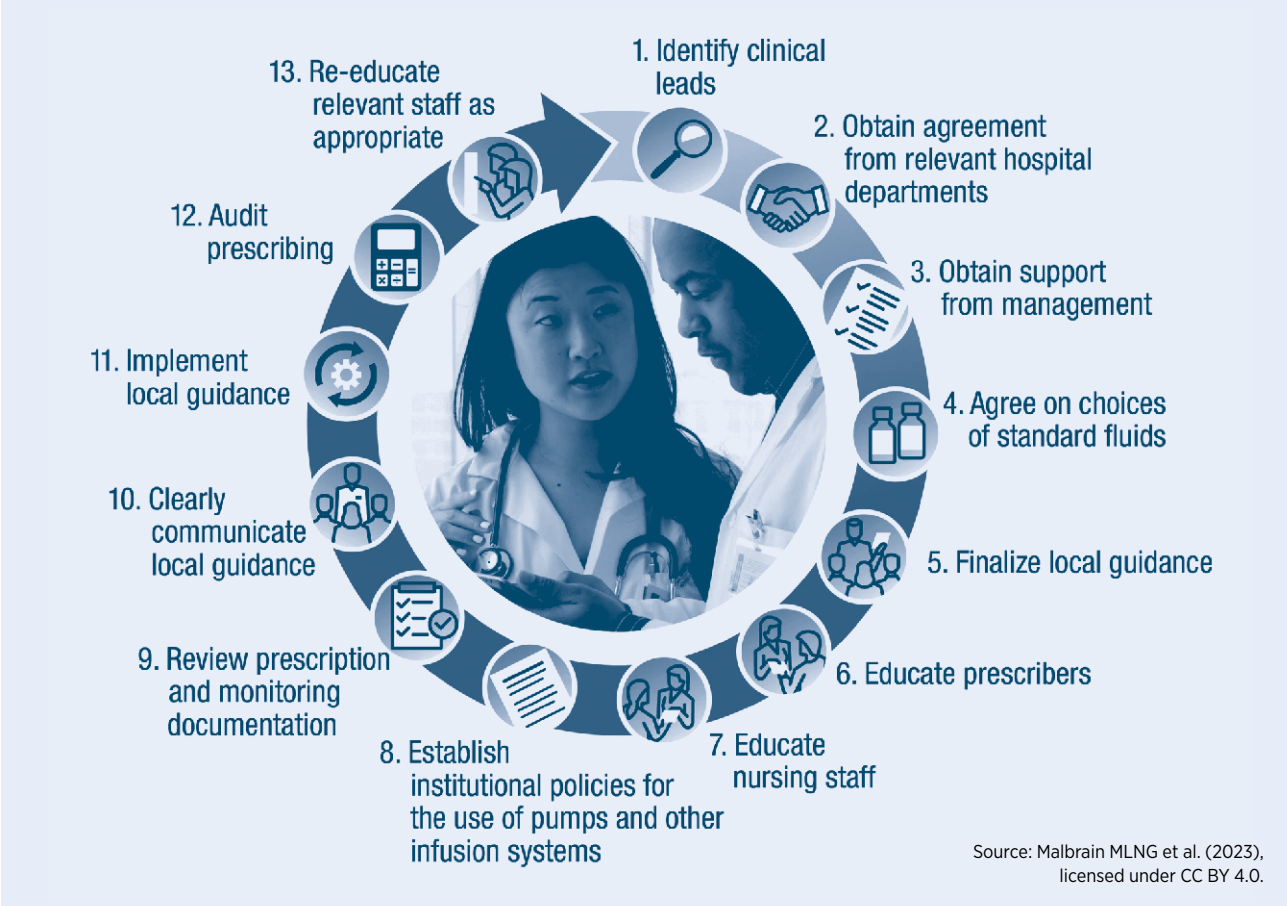
Marlies Ostermann and Deepak Bhonagiri

Fluid management

Intravenous (IV) fluids are among the most frequently used therapies in hospital and a significant source of environmental waste. A one litre bag of saline produced in Europe has a carbon footprint of approximately 0.5 kg CO_2e.[1] Fluid Stewardship and better waste management are important opportunities to reduce both the environmental impact and unnecessary costs.

Several bodies provide useful starting points for IV stewardship: NICE (United Kingdom's National Institute for Health and Care Excellence), European Society of Intensive Care Medicine (ESICM) and ANZCA (Australia New Zealand College of Anaesthetists). There is also a need for institutional leadership. Dedicated fluid stewardship teams with clinical leads are essential to comprehensively address fluid management in the whole hospital.[2] A suggested plan for institutional fluid management is below.

Figure 6: Strategies to achieve institutional best practices in fluid stewardship[2]



In the ICU setting, most IV fluid use is not for resuscitation (6%) but for maintenance (25%), nutrition (33%) and fluid creep (33%) – the inadvertent (and sometimes unavoidable) administration of fluids given with drugs or other therapies[3].

The following advice forms a practical guide to fluid stewardship in ICUs should include a review of all aspects of fluid management:

Fluid prescription

- Promote oral/enteric hydration whenever possible.
- Consider fluid-restrictive strategies (under close monitoring and daily assessment). Recent fluid trials in critically ill patients with sepsis have shown that restrictive fluid management is safe and non-inferior to liberal approaches.[4]
- Avoid 'maintenance fluids' when possible and replace with oral/enteric feeding.
- Optimise fluid management protocols: select the right volume, prevent spillage and waste, and extend the use of parenteral bags (beyond 24 hours if safe and within guidelines).
- Use standard giving sets as default. Blood giving sets and fluid warmers should be reserved for patients with high likelihood of blood transfusion or large volume fluid resuscitation.
- Avoid continuous infusion to keep catheters patent. Consider catheter locks where appropriate.
- Balanced salt solutions may be associated with better outcomes than normal saline in critically ill patients. Albumin for fluid resuscitation offers no clear advantage over crystalloids. Life cycle data of IV fluids is limited; environmental impact should be considered when available.

Fluids for medication administration

- Use oral/enteric medications were appropriate.
- Dilute drugs in lowest possible volume.
- Adopt Enhanced Recovery after Surgery protocols for post-surgical patient where appropriate.[5] [6]

Stock management

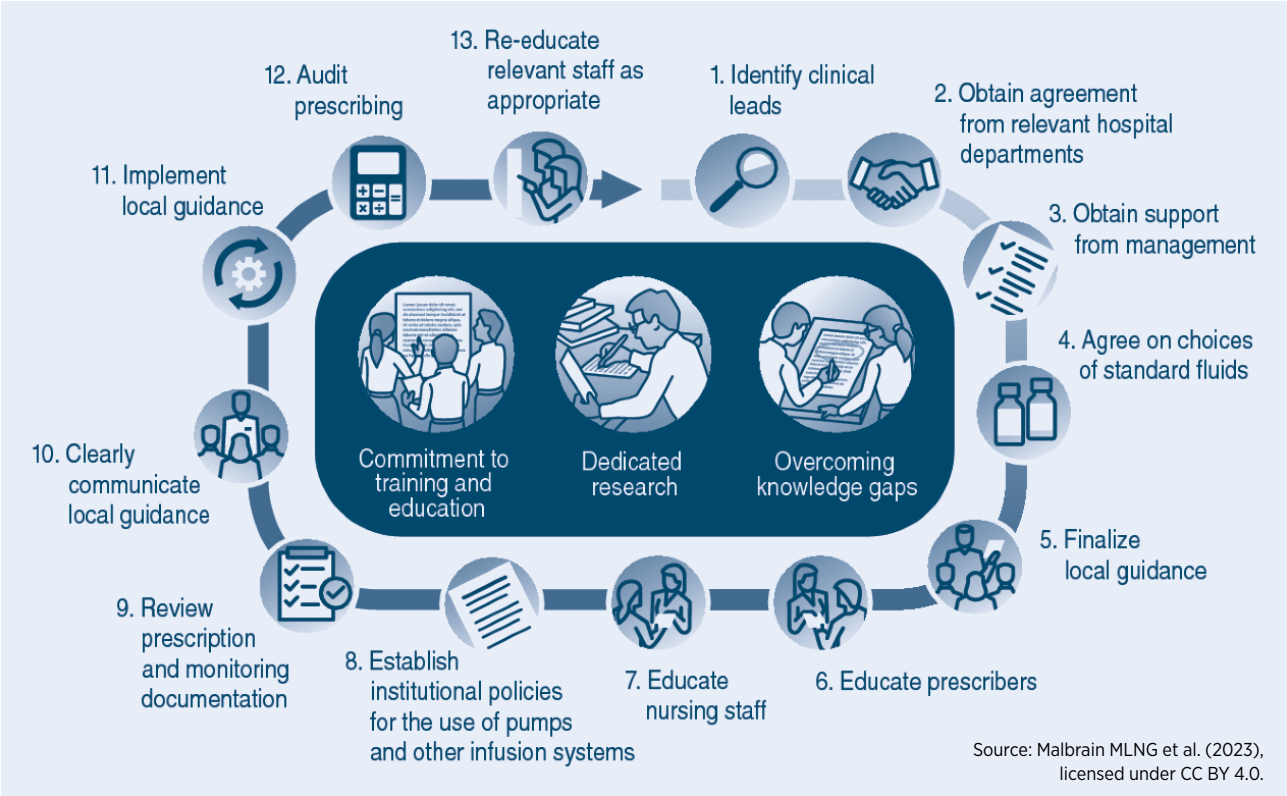
- Monitor expiry dates, check if official shelf-life extensions apply.
- Incorporate carbon footprint and LCA of infusion pumps, consumables and disposables into procurement policies[7].

General management

- Establish a 'fluid team', responsible for implementation of iv fluid conversation measures, communication, review (audit) and regular feedback to the clinical team[2]. Clinical leads including nursing, pharmacy, medical and environmental sustainability representatives should form part of the team with executive sponsors.
- Fluid stewardship teams can have educational, research, audit and governance roles.
- Benchmarking of patient outcomes, cost and carbon impact of fluid stewardship should be conducted.
- Report findings to executives and boards to promote rational use of intravenous fluids within hospitals.

A guide to setting up a fluid stewardship team and activities for the team is shown in the figure below.

Figure 7: Activities for fluid stewardship team adapted[2]



Source: Malbrain MLNG et al. (2023), licensed under CC BY 4.0.

Waste management

Non-pharmaceutically active intravenous fluids in small quantities, with no other hazards (such as infectious due to contamination with body fluids or the addition of pharmaceutically active substances), may be disposed of as follows:

- Placing in the appropriate medicinal waste stream.
- Fluid bags containing a pharmaceutically active ingredient must be placed in the appropriate pharmaceutical waste container.

Essential Reading

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Radiology Stewardship and Environmental Sustainability in ICU

Abhinav Gupta and Marie Scott

Sustainable practices in radiology in ICUs involve limiting Low Value Care, including unnecessary radiological imaging that offers minimal or no benefit to patient care and helps reduce carbon emissions within healthcare.[1] Low value imaging wastes resources with negative consequences including risks from ionising radiation and contrast media, false positive test results, unnecessary follow-ups, and overtreatment.[2]

A trial of 165 ICU patients found that adopting a restrictive chest X-ray (CXR) strategy resulted in new therapeutic findings in 56.4% of patients compared to 5.5% in the routine imaging group-with no differences between the two groups in terms of ICU mortality, hospital mortality, number of ventilation-free days, duration of ICU stay, and duration of hospital stay.[3]

Medical imaging has a considerable impact on global greenhouse gas emissions in high income countries.[4] Approximately two-thirds of energy use in CT occurs in a nonproductive idle state and one-third of energy use for MRI occurs during the system-off state due to cooling requirements. ICUs can plan non-prioritised scans with the radiology department to increase efficiency and reduce idle time for MRI and CT, resulting in a smaller environmental impact per scan. The energy used by a single abdominal MRI study can cool a three-bedroom home for an entire day and generates greenhouse gas emissions equivalent to driving a motor vehicle for 290 km.[5] The energy to power four MRI and three CT scanners over the course of 1 year, with their associated cooling systems, has been shown to be equivalent to that required to power a town of 852 people.[6]

Strategies for Sustainability Radiology

Reduce low value imaging:

- Replace routine daily imaging with indication-based CXR requests.
- Low-value imaging (CXR, CT scan, MRI) and energy intense imaging sequences that do not add clinical value, have the potential to incur unnecessary costs and contribute to environmental footprint.[7]
- Add decision prompts to ensure CXRs are only performed when clinically indicated.[8]

Point of Care Ultrasound (POCUS)

- Over last 30 years, there has been a progress in lung ultrasound and a decline of chest X-ray use in ICU.[10]
- Lung ultrasound has been shown to be effective in reducing the number of chest X-rays by 26% and diagnostic CT scans by 47%, with a 39% cost saving in radiological examinations and reductions in relative medical costs and radiation exposure in the ICU, without adversely affecting patient outcomes.[11]
- POCUS has wide applications in ICU, including sonography of the heart, lungs, abdomen, kidneys, and vascular system for management and procedural guidance.
- Brain ultrasound has the advantage of low costs, short investigation times, repeatability, bedside availability and environmental sustainability. Transcranial sonography is an underestimated modality requiring wider diffusion and training process[12] and can potentially reduce CT scan requirements.
- Nasogastric tube position: ultrasound shows 98.9% sensitivity, 57.9% specificity, with potential to reduce reliance on CXRs, although they remain the gold standard.[13]
- Training, competence and credentialling are the key factors in developing POCUS in ICU.

Optimising Scheduling

- Approximately two-thirds of energy use in CT occurs in a nonproductive idle state and one-third of energy use for MRI occurs during the system-off state due to cooling requirements.
- Coordinate non urgent scans with radiology department to reduce nonproductive idle state time for MRI and CT.[6]

Choose lower impact modalities

- Average carbon emissions per scan:
  i. MRI 17.5 kg CO_2e (equivalents)
  ii. CT 9.2 kg CO_2e[5]
  iii. CXR 0.76 kg CO_2e
  iv. US 0.53 kg CO_2e[9]
- Minimise use of contrast agents:
  v. Iodinated contrast waste and their breakdown products have been associated with contamination of aquatic environments posing toxicity risks to animals and humans.[14]
  vi. There are reports of traces of gadolinium in urine following contrast-based MRI examinations, which can accumulate in sewage systems and water bodies, posing risks to aquatic plants and organisms and potentially entering the human food chain.[15]
- Restraining low value scans also supports "digital temperance" - restraint in production, use, and promotion of digital technologies ensuring that the benefits outweigh the financial, environmental, and other associated costs.[16]

Power management

- Ensure workstations and communication system (PACS) are shut down out of hours. Radiology department computers left on continuously produce emissions equivalent to the annual emissions of 10 vehicles.[17]
- Most modern computers have a standby mode where they will eventually switch off after a set number of hours idling.

Leverage AI for Stewardship

- AI can reduce unnecessary imaging by integrating decision support.
- "EXAM" (EMR CXR AI Model) predicted oxygen requirements of symptomatic COVID-19 patients using inputs of vital signs, laboratory data, and chest X-rays, without the need of CT scan and additional patient travel.[18]

Promote multidisciplinary collaboration

- Multidisciplinary meetings with radiology to explore 'over-diagnosis' reduce low value imaging.
- Globally 20–50% of radiological examinations[19] are estimated to be unnecessary.

'The greenest scan is the one you don't need to do.' – Dr Sarah Sheard

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Reducing Unnecessary Laboratory Testing in the ICU

Matthew Anstey and Christine Waters

Having arterial and central lines in patients makes it easy to order blood tests on ICU patients. However, there are downsides to this: from iatrogenic anaemia, increasing staff workload (both within the ICU and pathology), creating false positive and incidental, non-clinically relevant results to financial and environmental costs.

Studies show it is possible to safely:

- Reduce arterial blood gas tests.[1, 2]
- Reduce coagulation tests.[3]
- Reduce overall testing.[4]

To reduce inappropriate testing in ICUs, several effective interventions have been identified. Multifaceted interventions (MFI) have proven most effective and long-lasting. These typically combine education and guidance with other strategies like audit and feedback, gatekeeping, and computerised physician order entry systems. Education helps staff understand the importance of appropriate testing, while feedback and computerized systems can guide better decision-making. While future improvements may come from artificial intelligence and machine learning tools, it is leadership from clinicians that drives the change, highlighting to junior staff that ordering practices are important. Importantly, these interventions reduce unnecessary tests. By implementing these strategies, hospitals can significantly reduce the 20-40% of inappropriate tests currently requested, leading to better resource use and patient care.[5]

Other simple strategies that reduce the carbon footprint of phlebotomy is the utilisation of small volume blood tubes (SVTs) as well as the use of closed arterial sampling devices.[6, 7] Firstly, SVTs can be used for most routine tests[6]. Although further research is required, SVTs reduce sampling volume without increasing laboratory error or cost. Secondly, it has been determined that closed arterial line sets can reduce phlebotomy related blood loss by up to 25%.[8] Often these sets are overlooked, and frequently underutilised, but it is important to consider the potential offset of this increased cost with the cost savings attributed to transfusions.[8] [9] Flow-on patient benefits are a reduced risk of low haemoglobin concentration and anaemia, therefore reducing the need for transfusion and improving patient outcomes.[9] It is important to note that the use of both SVTs and closed sampling systems is supported by patient blood management groups worldwide, whose aim is to improve patient outcomes through the application of evidence-based strategies that optimise and conserve the patient's own blood.[10]

Four-Step Approach to Reducing Testing

1 Audit – assess local practice and algorithms, partnering with your local laboratory team to including the financial and environmental impacts.

2 Define – clarify what makes a test necessary and establish repeat testing intervals.

3 Educate – share findings and engage stakeholders (i.e., nurses, medical team) and then recruit an interested and passionate multidisciplinary team of champions to co-develop guidelines.

4 Measure and feedback – repeat audits, highlight changes and capture reasons for persistent ordering testing.[11]

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Reusables Every ICU Should Consider

Kylie Feely and Florian Pracher

Convenience and infection-control considerations have led to the introduction of a multitude of single-use items into modern ICU practice. This practice often is associated with an increased carbon-footprint and will lead to increased waste with associated disposal costs (both financially and environmentally).

Life-cycle analysis is increasingly available to inform on expected environmental impact of reusable compared to single-use items. An important consideration is the national/regional energy mix (i.e. proportion of renewable energy sources), and reusable items generally fare better in European countries and New Zealand than in (Northern) Australia.

Below we outline priority reusable items for ICUs and the supporting evidence.

Reusable linen and gowns

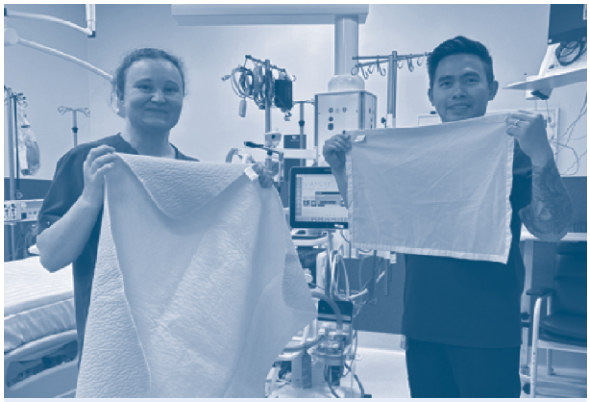
- Reusable linen is a simple cost-effective way to reduce carbon emissions (typically 100+ washes, can be recycled at the end of its life cycle).
- Linen is cleaned in accordance with regulator standard (e.g. AS4146:2000) and disinfected using a combination of thermal and chemical methodology, so even infectious patients can have reusable linen options.
- The hospital linen provider will be able to advise what linen products can be provided (e.g. slide sheets, pinkies, blueys, surgical/isolation gowns, surgical drapes, reusable cleaning cloths).

Evidence

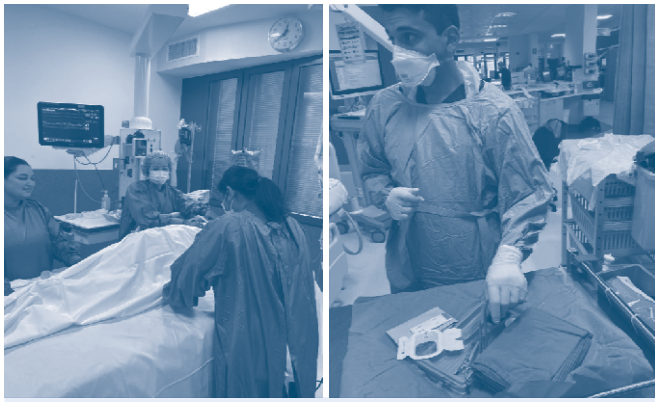
- Replacing single use with reusable linens in a Melbourne ICU LCA reduced total carbon emissions by 50%, landfill waste significantly, with a small 3% increase in overall cost.[1]
- Reusable incontinence pads reduce energy consumption, CO_2, water and solid waste.[2]
- Reusable gowns when compared to single use reduced: energy consumption by 28%, GHGs by 30%, water by 41% and solid waste by 93%.[3]
- Reduced pressure injuries with reusable linen in addition to the benefits mentioned above.[4]
- Staff preferred reusable isolation gowns as they were more comfortable.[5]
- LCA comparing reusable and single-use cleaning wipes and different disinfectants found that the optimal option for clinical surface decontamination was the microfibre cloth used with a quaternary ammonium compound.[6]

Implementation considerations

- Review disposable usage and cost reports of disposable linen. Often cost for reusable linen is equivalent (or cheaper) compared to disposables.
- Factor in disposal cost.
- Educate all staff about the appropriate use of certain linen choices. Multiple layers of linen are unnecessary and risks skin integrity.[7]
- Reduced usage will then also lead to reduced financial and environmental costs.
- Reusable isolation gowns are still single use per wear. They cannot be hung at a patient's bedside for use again.
- If reusable options are not available, reduction strategies should be implemented.



Reusable bluey and fusion pad designed by Linen Australia and tested by Sunshine Intensive Care Unit in Victoria.



Reusable isolation and sterile gowns.

Reusable air transfer mats

- Reusable air transfer mats last up to 10 years. Given most carbon emissions are generated during production, reusable is the better environmental option.
- Air transfer mats (e.g. Hovermat©) can be purchased as both disposable and reusable. The disposable option appears cheaper but can be more expensive in the long run.
- Request a quote for a reusable option. Compare the price to a yearly usage report for disposable air transfer mats. This will help gain financial support for the venture.

Implementation considerations

- Work closely with environmental services to develop a cleaning protocol. Does the health service have a washing machine onsite because a barrier to using reusable options is often the time it takes to clean heavily soiled mats when processed offsite.
- Work with Infection Prevention to ensure the cleaning protocol is in line with local policy.
- Label and track air transfer mats.
- Collaborate with a reprocessing company (see below). If this is not available, consider donating them to an animal hospital or zoo.
- In some situations, such as carbapenem producing organisms (CPO), infection prevention teams are switching patients with these diseases to single use items. In this case a disposable mat may be the only option to fulfill IP requirements.

A 50-inch reusable air transfer mat.

Videolaryngoscopy-blades

- As complex items, single-use VL blades are associated with significant carbon emissions during production and disposal.
- Single use and reusable blades typically use same monitor.
- Guaranteed minimum use cycles for reusable blades.
- When comparing cost for single use with cost for reusable blades, the reusable option will likely be significantly cheaper.
- Transition to reusable will also reduce carbon footprint significantly and reduce waste.

Evidence

- LCA comparing reusable and single use laryngoscope handles, found a significant benefit of the reusable option both in terms of cost and eCO_2.[8]
- Explore the environmental impact of transitioning to reusable anaesthetic equipment, including laryngoscopy blades. Significant cost savings were found yet no environmental benefit in Australia because at the time the energy grid was fossil fuel heavy, not the case with Europe or the US.[9]

Implementation considerations

- Explore costing and if additional equipment is required (e.g. separate cables).
- Clinical trial to confirm that image quality and handling of reusable blades is equivalent or superior to single use item.
- They typically require high-level decontamination/disinfection and packaging for storage: discuss with company whether a bactericidal/sporicidal wipe system (e.g. Tristel®) is appropriate or whether blades have to be sent to CSSD.
- If CSSD is required discuss process/cost with them and setup tracking system.
- Review evidence and consider a local LCA.

Bronchoscopes/nasoendoscopes

- Reusable bronchoscopes have better image quality and typically have larger working channels.
- Single use bronchoscopes have become the preferred alternative in many ICUs due to concerns for damage of expensive reusable bronchoscope during clinical use or cleaning and disinfection.
- While transition to reusable bronchoscopes might lower carbon (see evidence section), it will likely not be cost-effective due to repair/replacement costs if reusable bronchoscope is damaged.

Evidence

- Potential cost and environmental benefit of single use over reusable bronchoscopes, dependent on a hypothetical cleaning process (industry sponsored).[10]
- Lower environmental impact and global warming potential (26% reduction), but a 50% increase in water consumption.[11]
- Small cost benefit of single use bronchoscopes. This cost benefit increased substantially when a 2.8% infection rate associated with reusable bronchoscopes was assumed.[12]
- It is difficult to interpret the literature because these LCAs make assumptions in relation to variability of local cleaning processes, and waste was not considered.
- It is important to assess the local situation and decide whether transition to reusable bronchoscopes is prudent from an infection-control, cost and environmental perspective.

Implementation considerations

- Explore historical costing of single use versus reusable bronchoscopes to estimate how often a reusable bronchoscope gets damaged and what repair/replacement costs are.
- Are service contracts available and does the supplier provide replacements while bronchoscope is being repaired.
- Can CSSD staff clean/reprocess bronchoscopes after use.
- Is a new reusable bronchoscope compatible with available monitors? Is a stack required (cost and clinical space consideration).
- Does better image quality/larger working channel justify transition to reusable bronchoscopes even if a cost analysis demonstrates that single use bronchoscopes are cost effective?
- Is a partial transition feasible where experienced operators use reusable bronchoscopes and less experienced staff continues to use single-use bronchoscopes?
- Disinfection with ultraviolet based technology may be more environmentally preferable than other CSSD sterilisation techniques if available.

Re-processing of single use items

- Many single use items are of good quality and could be used more than once (sequential calf compression sleeves, air transfer mats, tourniquets).
- Companies exist that collect these single use items and reprocess them. The items will be checked for damage, cleaned, repackaged and returned to hospital.
- This process is typically supported by the manufacturer and approved by regulator (e.g. ARTG/TGA in Australia).

Evidence

- Small environmental benefit and cost saving of using reprocessed devices. They also demonstrated a potential small increase of adverse health effects related to use of ethylene oxide, water and electricity, dependent on the specific reprocessing practice.[13]
- LCA compared single-use and reprocessed IPC sleeves. Treatment of 5 patients was associated with a 40% reduction of carbon emissions (4.2kg CO_2e with reprocessed IPCs vs 7kg CO_2e with single-use IPCs, respectively). Waste disposal costs were reduced by 90%.[14]

Implementation considerations

- Explore whether there is a local/regional reprocessing company.
- Include transport emissions.
- Explore costing (expect cost saving).
- Discuss transition to reprocessed products with IPC and other key stakeholders.
- Review feasibility of process with focus on collection, storage, transfer to reprocessing facility, return of reprocessed products.

Procedure/suture kits

- Many ICU's receive pre-packed procedure packs from a central supplier.
- These packs often include single use items for which reusable alternatives are available, such as scissors, forceps, needle holders, etc.

Evidence

- Compared single-use with reusable CVC packs and showed a cost saving (A$6.35 for re-usable vs A$8.65 for single-use packs) but emissions were higher for reusable packs (ranging from 436g per pack, if electricity originated from hospital gas-cogeneration, to 1211g if electricity came from coal powered plants) compared single use packs (407g). Water use for a single use pack was 2.5 litres which increased to as much as 27.7 litres for reusable packs.[15]
- Swedish study demonstrated a 65% lower resource impact for reusable kits and 90% reduced impact on climate change with their low carbon electricity mix. Their packs included sterile textiles, and they used different assumptions for energy related autoclaving and washer-disinfection.[16]

Implementation considerations

- Suppliers of CVC-packs (or procedure packs in general) can modify pack contents and remove unused items to reduce cost and environmental impact.
- Customise your ICU CVC- pack to maximise available reusable devices and linens with your hospital CSSD.
- Replace single use items including sterile instruments with reusables that can be cleaned and autoclaved by the hospitals CSSD.
- This was cost effective in both studies.
- Local grid supply affects the level of environmental impact of this change and needs to be assessed.

Blood pressure cuffs and pulse oximeters

- Reusable blood pressure cuffs and pulse oximeters are common in adult ICUs, and it is pointing out the environmental and financial advantages.

Evidence

- Up to 40-fold lower carbon emissions and cost savings with reusable blood pressure cuffs, especially with single patient use (such as in an ICU).[17]
- LCA on reusable pulse oximetry sensors found a significant reduction in carbon emissions with prolonged use.[18]
- Over $500 million could be saved annually if all US operating theatres transitioned to reusable pulse oximetry sensors.[19]
- Infection control risks are not higher with reusable pulse oximetry sensors.

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A Sustainability Mindset

Louise Trent

A sustainability mindset applies an environmental sustainability lens to everything we do in ICU. Clinicians are resource stewards, and there are numerous ways we can reduce what we do without compromising high quality care. Often the best approach is to pause and reflect: "Don't just do something, stand there and think".[1]

Focus on de-implementation

Overuse and unnecessary use of care, also called Low value care (LVC) are healthcare practices that provide little to no benefit and can sometimes cause harm. In Australia, at least 30% of healthcare is wasteful and further 10% harmful.[2] LVC is common in ICU and consumes financial, environmental and staff resources.[3, 4]

Clinician factors that drive LVC in ICU include diagnostic uncertainty, time critical assessments, fears of missing diagnoses, criticism or litigation. It is also driven by cultural norms such as 'more is better' along with easy access to supplies in a throw away linear system.

Strategies for de-implementation—the reduction or removal of healthcare practices that provide little or no benefit—include audit, education and training, feedback, shared decision-making with patients and families, and system-level change.[5] Initiatives like the Choosing Wisely[21] movement have had much success, but LVC remains persistent and pervasive.[6, 7]

Implementing change involves an intentional approach with structured quality improvement frameworks like susQI[22],and effective project management. Enhanced capability, opportunity and motivation are linked and frameworks like COM B model[23] can be useful to lead effective change.[8] Storytelling by sharing cases where overuse caused harm or unnecessary costs/inconvenience can shift habits and culture. Learning about cognitive biases and strategies to overcome these, and challenging entrenched unit culture, "how we do things here" is critical as we strive for high value intensive care.[9]

De-implementation is not about doing less, but about doing what is evidence-based, high-value, and meaningful. The reasons for LVC are complex and multifactorial as outlined in detail in the appendix C along with strategies.

21 https://www.choosingwisely.org.au/
22 https://www.susqi.org
23 https://thedecisionlab.com/reference-guide/organizational-behavior/the-com-b-model-for-behavior-change

Focus on Value Based Care

Figure 8. What is value?[24]

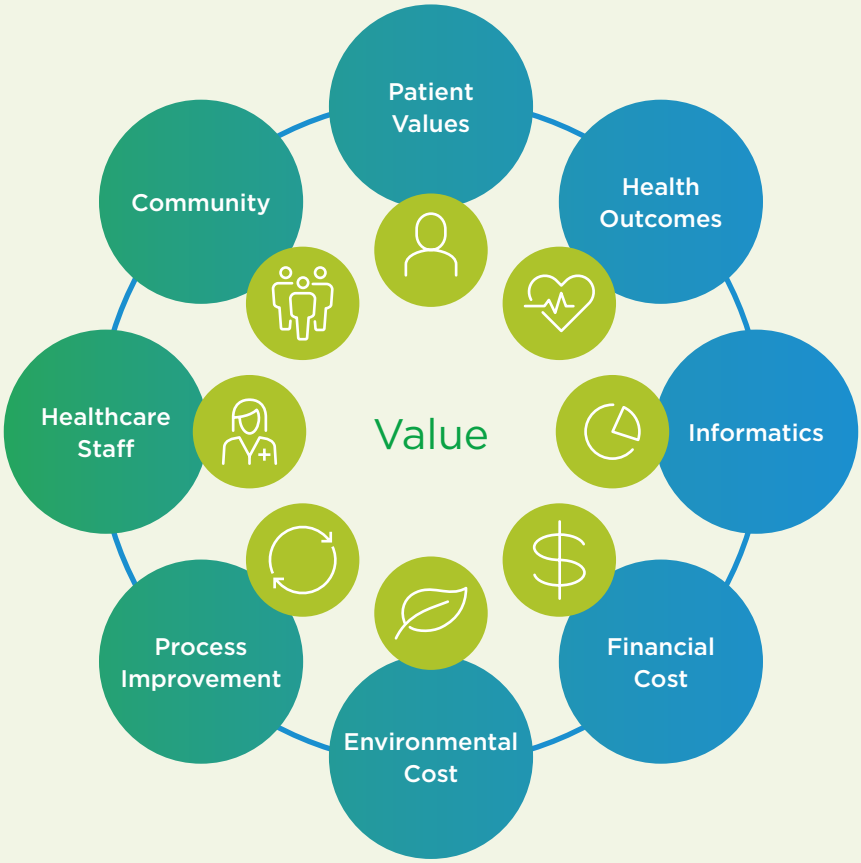


Figure 9: Centre for Sustainable Healthcare Principles of Sustainable Value[25]

24 Image from Professor Matt Maidens with permission
25 https://sustainablehealthcare.org.uk/what-we-do/principles-of-sustainable-value/

Intensive care could be associated with the idea that "more is better" but the true focus should be on the word "care". High value ICU care is about providing treatments that are grounded in evidence, effective and efficient, likely to improve outcomes and that align with patient preferences, whilst also being conscious of financial and environmental costs

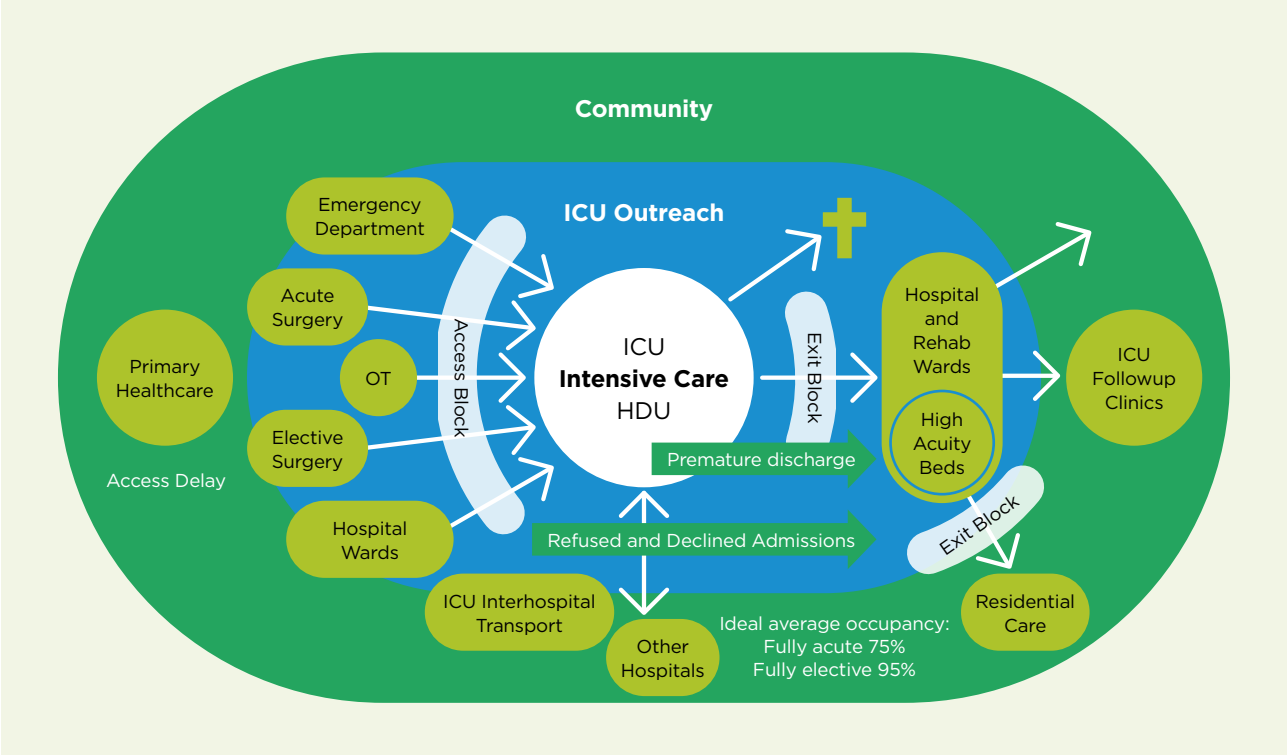
High value care has been part of formal medical curricular worldwide for many years. For it to truly be embraced it must continue to be integrated into daily clinical practice.[10] As intensivists with a sustainability mindset, we must role model and normalise discussions about healthcare stewardship, emphasising that resources are finite, and physicians face difficult decisions about how to allocate them effectively.

Decarbonising high value ICU care involves maximising low carbon alternatives as well as lean efficient and effective care.[1, 11-13] Transitioning from our current predominantly linear to a circular economy via the waste hierarchy- Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Recycle and Recover is core business.

Developing specific evidenced based knowledge in environmental sustainability related topics by conducting and promoting sustainability research in our ICUs is urgent and essential. When evidence is not yet clear or there is clinical equipoise, we can choose the lower carbon treatment option.[26]

Optimise ICU Flow and efficiency

Figure 10: Intensive care flow – stress and strain



The image above illustrates the concept of stress and strain in intensive care flow. Patients move into ICU from the community via the emergency department, theatres and hospital wards, and exit via ward transfer, and rehabilitation. Key systemic pressures include access block (delays in admission due to resource constraints), exit block (delayed discharges), and premature discharges driven by capacity pressures. Some emergency admissions are also refused or elective admissions declined (due to inadequate ICU resources- beds or staff[27]).

Queuing theory [4] predicts optimal efficiency when ICU occupancy is maintained at around 75% for acute admissions and 95% for elective surgery.[14, 15] Additional safety nets include ICU outreach, ward-based high acuity areas, interhospital transfers, and coordination with community services. Together, these factors highlight the interdependence of ICU and the wider health system, with resource limitations directly influencing patient flow and outcomes. Matching supply with demand for intensive care involves avoiding excess capacity while ensuring equitable access to care. Secondary prevention through appropriate intensive care admission and efficient patient flow is essential.

26 https://healthcarelca.com/database
27 https://www.qminder.com/blog/queue-management/queuing-theory-guide/

ICU Outreach Teams are vital. A value based intensive care approach shifts the focus from an "ICU episode of care" to the patient's entire health journey, involving the ICU outreach team from early critical illness through to recovery and beyond.[16] By recognising the deteriorating patient, facilitating goals of care conversations to guide treatment escalation, and keeping people safe on the wards, outreach teams aim to prevent unnecessary ICU admissions and readmissions. Intensive care input in high-risk patient preoperative assessment clinics is also valuable.

Advocate for prevention and the environment

Reducing demand for intensive care is part of a sustainability mindset via prevention and promoting wellbeing. Whilst Public Health is primarily tasked with improving the social and environmental determinants of health, we too have a role in disease prevention.

Advocacy is a key competency for all intensive care staff groups. We promote health through providing or accessing lifestyle and wellbeing support for our patients on discharge -addressing diet, exercise, smoking cessation and mental health. We must also normalise talking about how the rapidly deteriorating environment is affecting our health driven by climate change, pollution and biodiversity loss.

Patients and their families should be part of the dialogue, and with clear understanding of risks, benefits and uncertainties, they can understand and opt for lower carbon treatment pathways. High quality care that is also low carbon is our objective, but increasingly some patients may also choose the lower carbon treatment even if it potentially impinges on individual treatment quality.

Intensive care clinicians can contribute to professional working groups in areas such as trauma, sepsis, and nutrition, aiming to prevent illness and injury, ensure early recognition to reduce condition severity and intensity of care required, and support community public health advocacy. Increasingly advocacy and contribution to healthcare environmental sustainability workstreams is needed if we are to achieve net zero.[17]

First nations climate justice and equity

Addressing climate change within healthcare requires a commitment to both climate justice and equity. Decarbonisation strategies must be implemented carefully to avoid unintended harms, recognising that *decarbonisation must proceed in tandem with decolonisation.*[28]

For First Nations peoples, including Māori in Aotearoa and Aboriginal peoples in Australia, environmental stewardship is deeply embedded in indigenous knowledge systems. These traditions emphasise the interdependence of people and the environment: when the land suffers so do the people, impacting spiritual, physical and emotional wellbeing.

A sustainable ICU therefore extends beyond carbon reduction. For example, the Mauri Model framework[29] in Aōtearoa NZ considers restoration of *mauri* (life force) across *te taiao* (a healthy environment), *hapū* (cultural integrity and identity), *hapori* (wellbeing of staff and whānau), and *whānau and ōhanga* (equitable and sustainable economics) which can be applied to ICU sustainability initiatives and facilities work.

Practical applications include enabling *whānau* presence throughout the ICU journey which can improve patient outcomes and reduce length of stay.[18]

Achieving this requires unrestrictive visiting policies[30] and facilities designed to accommodate larger whānau groups.[19] Culturally grounded design features can connect local people and place. Fiscally directed decisions often mean these important spaces are removed from designs for new ICU builds.

Access to *Hauora Māori* (traditional healing practices), *karakia* (traditional prayer) and *kaiawhina* (Maori support workers) are integral in helping to address health inequities.

Embodying principles such as *kaitiakitanga* (guardianship) and *mātauranga Māori* (Māori worldview) into ICU procurement, waste management and food systems grounds sustainability in cultural values and environmental responsibility. For instance, a circular hospital food system with onsite composting[31] to supply marae or community gardens illustrates equity-driven, locally embedded practice.[20]

28 https://catalystmcgill.com/cop-27-why-decarbonization-and-decolonization-need-to-go-hand-in-hand/
29 https://www.maurimodel.nz/about-1
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The Role of Governance and Standards for Improving ICU Environmental Sustainability

Forbes McGain

In addition to efforts and opportunities at the micro level by individual clinicians to improve the environmental sustainability of the ICU, or ICU green teams at the meso level, there is an important role at the macro level for intensive care societies and colleges. At this macro level opportunities to make the intensive care 'system' more sustainable are found not by making concrete, day-to-day changes, but by integrating sustainability thinking into governance structures such as ICU accreditation, as well as education and training, and research.

There is a vital role to play at the macro level. ANZICS (a society that includes medical, nursing, and allied health colleagues) has been engaged with environmental sustainability since 2022 with the launch of the Sustainability Toolkit.[32] Sustainability is embedded in the ANZICS Quality and Safety Committee workstreams and a core part of the annual quality and safety scientific meeting. ANZICS core database collects a quality metric on sustainability teams in their annual Critical Care Resources survey. Nevertheless, there is no ongoing working party that meets regularly to specifically discuss environmental sustainability.

In Australia and New Zealand (ANZ) the College of Intensive Care Medicine (CICM) accredits individual ICUs, like the Faculty of Intensive Care Medicine (UK). There are currently no mandatory requirements that CICM Accreditors ask about environmental sustainability as part of the accreditation process (Pers Comm. CICM representatives). CICM, however, has had an Environmental Sustainability Special Interest Group[33] since 2022 that has been focussed upon advocacy, education and research in the field of ICU sustainability. There are, however, no mandatory nor aspirational requirements for CICM teaching of junior doctors nor examinations themselves to include environmental sustainability themes.

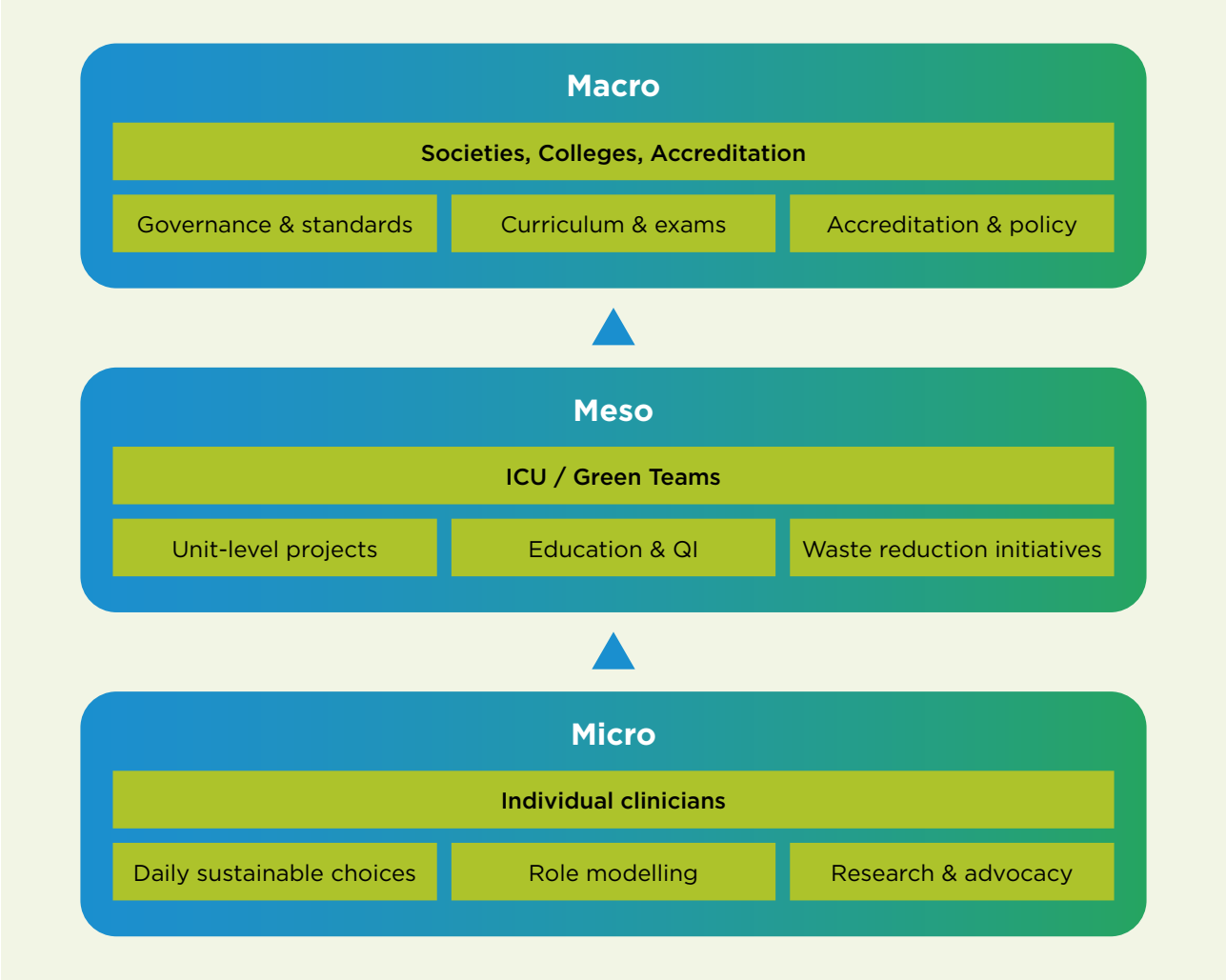
The Australian College of Intensive Care Nursing ACCCN and the New Zealand College of Critical care nursing NZCCCN do not make mention of environmental sustainability. The New Zealand Nurses Organisation has an unofficial environmental sustainability group which has no weight in accreditation or training matters.

The Australian Commission on Safety and Quality in Health Care (ACSQH) is the body that develops standards and accredits healthcare institutions (hospitals, private clinics, etc.) in Australia. Beginning in 2024, the ACSQH began piloting the Environmental Sustainability and Climate Resilience Healthcare Module.[34] Processes are now in place to examine what hospitals and other healthcare institutions are committing towards sustainability. Importantly, however, this module is generalised to all aspects of healthcare activity (i.e., not focused on the ICU), still at a pilot stage, purely elective (non-mandatory), and has no targets for achieving low-carbon healthcare.

In the UK the Care Quality Commission[35] oversee a similar role in accrediting healthcare institutions to the ACSQH and is engaging with hospitals including ICUs in the field of environmental sustainability. CQC have developed a Quality Statement on Sustainability and suggested scoring Environmental sustainability during NHS Trusts assessment at the trust level at present. They will continue to develop and co-produce the approach to assessing quality statements for other sectors prior to rollout.

32 https://www.anzics.org/safety-quality-resources/
33 https://cicm.org.au/Web/Web/Fellows/Special-Interest-Groups/Environmental-Sustainability.aspx
34 https://www.safetyandquality.gov.au/standards/healthcare-sustainability-and-resilience-module
35 https://www.cqc.org.uk/

Figure 11: Governance Levels in ICU Sustainability



The Intensive Care Society has taken a leading role in embedding sustainability within the ICU, driven by champions such as Prof Hugh Montgomery and Dr Eleanor Damm. Since developing a Climate Strategy in 2021, the Society has divested from fossil fuels, joined the UK Health Alliance on Climate Change[36] (UKHACC), and embedded sustainability within its 2023-27 Strategy. Collaboration with ANZICS has enabled shared learning and led to the publication of the Beginners Guide to Green Teams in the ICU[37] in 2024. More recently in February 2025, the Intensive Care Society launched the Intensive Care Environmental Sustainability Recipe Book[38] with partners including the University of Brighton, Faculty of Intensive Care Medicine, UK Critical Care Nursing Alliance providing guidance for UK ICUs to cut their carbon.

The Faculty of Intensive Care medicine UK- FICM- has a commitment to Sustainable Critical Care through education, training and promoting standards, with a proposal to include it in the FICM curriculum.[39]

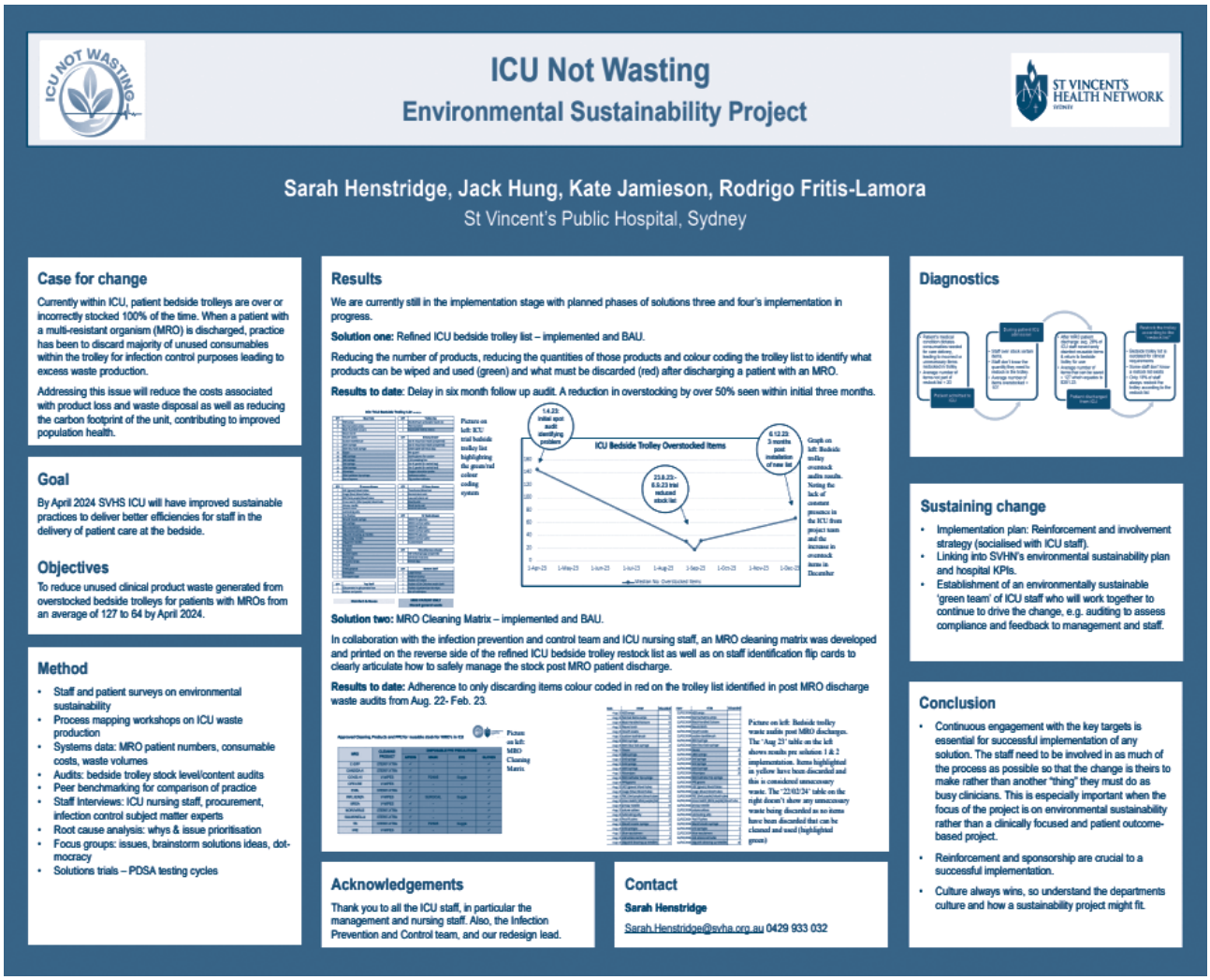
There is a steady increase in macro level engagement with environmental sustainability from intensive care societies and colleges in the UK and ANZ. However, further progress is required, particularly in integrating sustainability into education and examinations, in establishing mandatory accreditation standards, and providing an environment of agency encouraging important practice changes such as ICU reusable equipment, renewable energy, and the closely aligning patient-centred concept of Choosing Wisely.

36 https://ukhealthalliance.org/about/
37 https://ics.ac.uk/resource/green-teams-in-the-icu-anzics-and-ics.html
38 https://ics.ac.uk/guidance/sustainability/ic-environmental-sustainability-recipe-book.html
39 https://www.ficm.ac.uk/aboutusaboutthefaculty/sustainable-critical-care

Appendix

Appendix A

Medical Supplies Case study 2: ICU not wasting Environmental Sustainability Project



ICU Not Wasting

Environmental Sustainability Project

ST VINCENT'S HEALTH NETWORK

Sarah Henstridge, Jack Hung, Kate Jamieson, Rodrigo Fritis-Lamora

St Vincent's Public Hospital, Sydney

Case for change

Currently within ICU, patient bedside trolleys are over or incorrectly stocked 100% of the time. When a patient with a multi-resistant organism (MRO) is discharged, practice has been to discard majority of unused consumables within the trolley for infection control purposes leading to excess waste production.

Addressing this issue will reduce the costs associated with product loss and waste disposal as well as reducing the carbon footprint of the unit, contributing to improved population health.

Goal

By April 2024 SVHS ICU will have improved sustainable practices to deliver better efficiencies for staff in the delivery of patient care at the bedside.

Objectives

To reduce unused clinical product waste generated from overstocked bedside trolleys for patients with MROs from an average of 127 to 64 by April 2024.

Method

- Staff and patient surveys on environmental sustainability
- Process mapping workshops on ICU waste production
- Systems data: MRO patient numbers, consumable costs, waste volumes
- Audits: bedside trolley stock level/content audits
- Peer benchmarking for comparison of practice
- Staff Interviews: ICU nursing staff, procurement, infection control subject matter experts
- Root cause analysis: whys & issue prioritisation
- Focus groups: issues, brainstorm solutions ideas, dot-mocracy
- Solutions trials – PDSA testing cycles

Results

We are currently still in the implementation stage with planned phases of solutions three and four's implementation in progress.

Solution one: Refined ICU bedside trolley list – implemented and BAU.

Reducing the number of products, reducing the quantities of those products and colour coding the trolley list to identify what products can be wiped and used (green) and what must be discarded (red) after discharging a patient with an MRO.

Results to date: Delay in six month follow up audit. A reduction in overstocking by over 50% seen within initial three months.

Picture on left: ICU trial bedside trolley list highlighting the green/red colour coding system

Graph on left: Bedside trolley overstock audits results. Noting the lack of constant presence in the ICU from project team and the increase in overstock items in December

Solution two: MRO Cleaning Matrix – implemented and BAU.

In collaboration with the infection prevention and control team and ICU nursing staff, an MRO cleaning matrix was developed and printed on the reverse side of the refined ICU bedside trolley restock list as well as on staff identification flip cards to clearly articulate how to safely manage the stock post MRO patient discharge.

Results to date: Adherence to only discarding items colour coded in red on the trolley list identified in post MRO discharge waste audits from Aug. 22- Feb. 23.

Picture on left: MRO Cleaning Matrix

Picture on left: Bedside trolley waste audits post MRO discharges. The 'Aug 23' table on the left shows results pre solution 1 & 2 implementation. Items highlighted in yellow have been discarded and this is considered unnecessary waste. The '22/02/24' table on the right doesn't show any unnecessary waste being discarded as no items have been discarded that can be cleaned and used (highlighted green)

Diagnostics

Sustaining change

- Implementation plan: Reinforcement and involvement strategy (socialised with ICU staff).
- Linking into SVHN's environmental sustainability plan and hospital KPIs.
- Establishment of an environmentally sustainable 'green team' of ICU staff who will work together to continue to drive the change, e.g. auditing to assess compliance and feedback to management and staff.

Conclusion

- Continuous engagement with the key targets is essential for successful implementation of any solution. The staff need to be involved in as much of the process as possible so that the change is theirs to make rather than another "thing" they must do as busy clinicians. This is especially important when the focus of the project is on environmental sustainability rather than a clinically focused and patient outcome-based project.
- Reinforcement and sponsorship are crucial to a successful implementation.
- Culture always wins, so understand the departments culture and how a sustainability project might fit.

Acknowledgements

Thank you to all the ICU staff, in particular the management and nursing staff. Also, the Infection Prevention and Control team, and our redesign lead.

Contact

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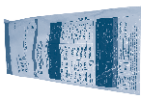
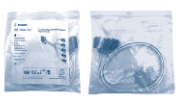
Example of a cleaning matrix card from NSW net zero hub

Item	Cost item		Can be cleaned & reused?	Can it be wiped with Clinell or Bleach
Metaraminol Syringe (unopened sealed plastic)	$17.78		Yes/No	Clinell/Bleach
Aqium Hand Sanitiser	$3.97		Yes/No	Clinell/Bleach
Clinell Universal Wipes	$10.70		Yes/No	Clinell/Bleach
Stethoscope	$4.95		Yes/No	Clinell/Bleach
Guedels (unopened sealed plastic)	$0.50		Yes/No	Clinell/Bleach
Face Mask (unopened sealed plastic)	$1.80		Yes/No	Clinell/Bleach
ETCO2 (unopened sealed plastic) with paper sticker	$14.60		Yes/No	Clinell/Bleach
Neuro Torch	$0.80		Yes/No	Clinell/Bleach
Rivacol Mouth Wash	$4.00		Yes/No	Clinell/Bleach
Shampoo	$2.71		Yes/No	Clinell/Bleach
Cleansing Foam	$6.25		Yes/No	Clinell/Bleach
Shaving Foam	$2.80		Yes/No	Clinell/Bleach
Calf Compressors (unopened sealed plastic)	$17.00		Yes/No	Clinell/Bleach
IV Fluids (unopened sealed plastic)	$1-8		Yes/No	Clinell/Bleach
BVM (unopened sealed plastic)	$11.50		Yes/No	Clinell/Bleach
ECG Leads (unopened sealed plastic) with paper sticker	$13.00		Yes/No	Clinell/Bleach

Appendix B

Examples of stock management quality improvement projects from NSW ICU Net Zero Hub

A project outline from NSW Sydney ICU net zero hub

Ms Azmeen Azeem, Ms Jennifer Mcclure, Ms Kathleen Cavill, Dr Shilpa Dsa, Prof Deepak Bhonagiri

BEDSTOCK 1: Optimising Consumables in ICU Patient Bedspaces

Project Background

Due to patient acuity, workflow demands, and bed availability constraints, the ICU encounters difficulties in managing stock, allocating resources efficiently, and minimising waste. Current practices lead to excessive stock disposal when patients are discharged, creating unnecessary waste. This project introduces a structured system to reduce waste, enhance efficiency, and support sustainability for all ICU patients.

Key Issues Identified:

- The ICU lacks clear guidelines on essential equipment in patient zones.
- Unnecessary stock enters patient areas without a control strategy.
- No concise protocols exist for disinfecting and reusing unopened medical supplies.

Project Scope and Objectives

Primary Objective:

Reduce discarded unused stock from ICU patient rooms by 50% over eight months (May–December 2025), aligning with NSW Health's sustainability targets.

SMART Criteria:

- Specific: Cut waste of unused/discarded stock by 50%.
- Measurable: Conduct regular audits.
- Achievable: Feasible within ICU practices.
- Relevant: Supports NSW Health's 50% carbon reduction target by 2030.
- Time-bound: Achieve goals within eight months.

Secondary Objectives:

- Optimise Admission Setup: Reduce unnecessary stock prepared for ICU admissions.
- Standardise Bedside Stock Trolleys: Develop a checklist to ensure only essential supplies are placed in the patient clinical zone.
- Improve Cleaning Processes: Create a structured cleaning matrix to disinfect and reuse unopened items safely.
- Enhance Communication: Ensure full compliance in documenting infectious status throughout a patient's ICU stay.
- Educate Staff: Train ICU staff on the revised stock lists and best practices for change in unit culture.
- Evaluate Sustainability: Assess economic and environmental impacts.
- Gather Staff Feedback: Conduct six-monthly surveys to evaluate effectiveness.

Methodology

This project follows the PDSA (Plan-Do-Study-Act) cycle in five phases:

Phase 1 – Planning:

- Identify key stakeholders, including ICU medical and nursing staff, the Infection Prevention Unit (IPU), sustainability teams, and cleaning managers.
- Form a project team and conduct brainstorming sessions.
- Develop a standardised bedside stock trolley to minimize overstocking.
- Obtain approval from ICU leadership, sustainability teams, and infection prevention units.

Phase 2 – Baseline Audits:

- Audit 10–15 discharged ICU rooms to measure discarded stock.
- Create an inventory of stock in patient rooms and calculate associated costs and environmental impact.
- Identify areas where stock levels can be optimised.

Phase 3 – Staff Education and Preparation:

- Work with the Infection Prevention Unit to determine which sealed, unused supplies can be disinfected and reused.
- Develop and distribute a cleaning matrix for safe disinfection and reuse.
- Implement standardised bedside stock requirements and conduct cost analysis.
- Train staff through in-service sessions, flyers, huddles, and handover updates.

Phase 4 – Pilot Testing:

- Implement new stock management practices in a single ICU room for four weeks.
- Conduct discharge audits to measure waste reduction.
- Gather staff feedback on the practicality of new stock management processes.
- Assess cost savings and evaluate the impact on patient care.

Phase 5 – Full Implementation:

- Expand successful interventions to all ICU rooms, including those with MRO patients.
- Conduct additional PDSA cycles as needed.
- Maintain six-monthly staff surveys to track long-term effectiveness.
- Monitor and address any adverse events associated with implementation.

Project Costs & Budget:

- Covered within existing facility and LHD budgets.
- Explore grant opportunities for sustainability projects.

Project Timeline:

- Collect baseline data and conduct quarterly reviews to measure progress and maintain improvements.

This initiative aims to enhance ICU sustainability, improve resource efficiency, and reduce waste, aligning with broader environmental and healthcare sustainability goals.

BEDSTOCK 2: Reviewing and Managing Consumables Stocked in MRO Patient Bedspaces

A project outline from NSW Sydney ICU net zero hub

Ms Azmeen Azeem, Ms Jennifer Mcclure, Ms Kathleen Cavill, Dr Shilpa Dsa, Prof Deepak Bhonagiri

Project Background

The increase in admissions of patients with multi-resistant organisms has challenged stock storage and disposal in the Intensive Care Unit with considerable amounts of hospital, financial and physical resources in addition to energy utilisation and significant waste production. There is the opportunity to improve management of resources to minimise the waste associated with MRO patients.

Key gaps in the management of infectious/MRO patient rooms include:

- A lack of guidelines specifying essential equipment required within the patient zone.
- No strategy to limit unnecessary stock being brought into patient areas.
- No clear protocols for safely disinfecting and reusing unused, unopened medical supplies.

Objectives

Primary objective

A 50% reduction in discarded unused stock from MRO patient rooms over eight months (May–December 2025), aligning with NSW Health's sustainability targets.

- Specific – 50% reduction.
- Measurable – With regular audits.
- Achievable – Yes.
- Relevant – NSW Health have committed to reduce their carbon footprint by 50% by 2030.
- Timebound – 8 months by December 2025.

Secondary Objectives

1. Optimised Admission Setup: Review and reduce the number of items routinely prepared for ICU patient admissions to minimize unnecessary stock usage.
2. Standardised Bedside Stock Trolley Checklist: Develop a sustainable and essential stock list for setting up bedside trolleys, ensuring only necessary items are included.
3. Efficient Cleaning Process: Establish a structured cleaning matrix to identify which unopened or unused items can be safely disinfected and reused, and which must be discarded. For reusable items, define appropriate cleaning agents based on the specific MRO.
4. Enhanced Communication: Achieve 100% compliance in documenting and verbally communicating patients' infectious status during admission, ICU stay, and discharge.
5. Staff Education: Train ICU staff on the revised stock list and reinforce best practices to prevent excessive stock accumulation in patient areas.
6. Sustainability Evaluation: Assess the long-term impact of the implementation, including its carbon footprint and economic implications for healthcare costs.
7. Staff Survey: Assess staff response to the implementation with 6-monthy staff satisfaction survey.

Method

Employing the PDSA (Plan, Do, Study, Act) methodology, multiple PDSA cycles will be employed to achieve the primary and secondary objectives.

Phase 1 – Planning

- Identify key stakeholders, including Nursing and Medical ICU staff, the ICU sustainability team, ICU cleaners, the cleaning managers, and the Infection Prevention Unit (IPU).

- Conduct brainstorming sessions to identify and define the project's objectives, expectations, and desired outcomes.
- Develop a plan how to restructure the bedside stock trolley in the ICU, to reduce overstocking and waste whilst maintaining adequate equipment to deliver patient care.

Obtain consensus from the ICU leadership team, the ICU sustainability group/green team, and the district and local IPU.

Phase 2 – Baseline Audits

- Location: Conduct baseline audit of focusing only on discharged MRO bedspaces of stock that is discarded.
- Duration: A total of 10 to 20 bedspaces will be audited for the stock discarded upon discharge (this will depend on your local unit size).
- Stock: An inventory list of current stock in infectious bed spaces will be compiled. The cost of each item will be listed, and the cost of waste and the carbon footprint will be calculated. This will then be reviewed to identify over-stocking and identify areas for waste minimisation.

Phase 3 – Staff Education and Preparation of Resources

- In consultation with your local Infection Prevention Unit, identify what unused sealed stock can safely be disinfected and reused.
- Cleaning matrix: Create and display a cleaning matrix with guidance from the Infection Prevention Unit (IPU) so cleaning standards are maintained by nurses and cleaners.
- Stocklist: A list of standard stock requirements for all bed areas should be developed and implemented for all bed spaces. The carbon footprint and the cost analysis of the same will be calculated.
- Staff Education: Conducted by the Clinical Nurse Educator (CNE) and the ICU project champions. Can be done as flyers, in-service sessions, updates at regular huddles, and handover to inform the entire ICU staff about the practice modifications.
- Duration: This education and preparation phase can be planned over a two-to-three-week period.

Phase 4 – Pilot Testing

- Location: Implement the cleaning matrix, the new practices and use of the smaller bedside trolley in a single room to assess its effectiveness.
- Duration: 4 weeks.
- Audits: Conducted on any discharged MRO room, all items discarded will be recorded.
- Staff Survey: Collect feedback from staff to refine and improve the cleaning matrix.
- Cost Reduction: Assess whether the new practices resulted in a reduced cost of wastage upon discharge.

Phase 5 – Project Roll Out

If the planned targets are not met, additional PDSA cycles will be conducted. Once the optimum solution is realised, this will be implemented for all patients with infection in ICU. We will include 6-monthly staff satisfaction survey in this phase. We will also review any adverse events /IMS reported because of this implementation.

Project costs & budget

Absorbed within facility and LHD budgets. Check to see if grant applications for sustainability projects are available.

Project timeline

Baseline and then quarterly for data to sustain implemented changes.

Appendix C

Low Value Care, Drivers and Strategies for De-Implementation

This appendix provides a comprehensive overview of low value care practices, their drivers, and strategies for de-implementation across various healthcare contexts. Each section addresses different stakeholder perspectives and intervention approaches. An important consideration is to pick a strategy to change behaviour based on understanding of the key drivers of the behaviour in the particular setting- some strategies can also be ineffective if they do not match the drivers/barriers for the behaviour. [1] The strategies below aren't necessarily pigeonholed against each driver and may be appropriate elsewhere as well.

Physician Factors

Factors that impact the use of low value care (LVC) and the processes of de-implementation [5]

Low Value Care	Drivers of Low Value Care	Strategies for De-implementation / High Value Care	Specific Cognition and behaviour Strategies
Diagnostic Uncertainty	Uncertainty in diagnosis [2, 3]	• Build clinical reasoning skills [4] • Understand your cognitive biases [5] • Understand your gut reaction to uncertainty [3] • Diagnose the type of uncertainty [3] • Develop uncertainty tolerance [3] • Set the culture: Role model embracing the inherent uncertainty of clinical medicine [3]	• Tolerate uncertainty • Do not chase zebras • Probabilistic notation* • Time out • Safety netting and follow up • Tincture of time [6] • Slow diagnosis [4] • Lean on your colleagues [3] • Promote curiosity over certainty with students, juniors [3]
Clinical Habits/ beliefs/ reinforcement	Force of habit and doing it for a long time, years of training. Difficult to change existing routine	• Education and training • Updated research and guidelines • Clinical resources like Choosing Wisely	• Habit breaking techniques [7]
Time-Critical Decisions	Time critical decisions in ICU	• Think fast, and then think slow - recognise clinical momentum [8] • Explore deliberate clinical inertia [5]	• Stepped care • Deliberate clinical inertia [5] • Cognitive huddles • Narrative of patient harm • Value consideration in clinical assessments [9] • Defining acceptable level of risk for adverse outcomes • Substitutions • Reflective practice and role modelling [9] • Normalization of deviance • Nudge techniques [7]

Physician Factors (continued)

Low Value Care	Drivers of Low Value Care	Strategies for De-implementation / High Value Care	Specific Cognition and behaviour Strategies
Cognitive Dissonance	Perception/ reality mismatch	• Audit and feedback [1] • Reminders	• Use imagery to motivate responsible use of health resources [1]
Fear	Fear of missing a diagnosis	• Peer review and feedback • Understand your cognitive biases [4] • Reflective practice • Defining acceptable levels of risk of adverse outcomes	• De-intensification • Instantiation of suboptimal care [5] • Patient stories that illustrate how overuse also causes harm [10]
Lack of Knowledge and skill Gaps	Prior training, knowledge gap, outdated guidelines	• Education sessions • Living EBM guidelines • Audit and feedback	• Increase knowledge and understanding • Decision aids
Treatment Approach	• Belief more is better - desire for optimal care can motivate more care than is needed	• Shared decision making • Serious illness conversations	• Shared decision making • Stepped care • De-intensification [5]
Professional Concerns/ beliefs/ attitudes about consequences	• Fear of malpractice • Fear of criticism • Reputation and desire to meet expectations	• Peer review and feedback • Value considerations in clinical assessments "Value based care" [11]	• Use peer influence • Use opinion leaders [1]
Resource context	Heavy workload/ Perceive engaging with resource conservation programmes will take too much time	• Enablement - Attend to physical and resource factors that support the practice - lack of time, access of patients to care • Increase means/ Reduce barriers by increasing capability and opportunity [7]	• Data that shows CW initiatives can save time too • Decision support tools
Apathy Lack of motivation	Apathy / Helplessness / what's the point? Excessive waste is so widespread that any individual attempt to waste less will be insignificant and pointless	• Set targets • Quality improvement that collects metrics showing positive change • Informatics and decision support - Hard coded intervention strategies via EHR	• Build a coalition to make change, discuss both data and patient stories of harm • Incentives and sanctions

* Probabilistic notation refers to statistical language to represent uncertainty, likelihoods, and outcomes in a structured way. It is often used to help individuals or systems make more rational decisions by explicitly quantifying uncertainty, thereby reducing reliance on intuitive (and potentially biased) judgments. When documenting diagnosis clarify confidence, e.g. unlikely -0-10% but needs ruling out because of critical impact, uncertain but no other diagnoses-10-50%, working diagnosis- 50-75%, likely or definite diagnosis - > 75.[5]

Patient and Family Factors

Patient factors were not identified as significant factors for majority of LVC in some studies. [4, 5]
Some LVC is not influenced by patients like duplicative lab testing, antibiotics in ICU [3, 13]

Low Value Care	Drivers of Low Value Care	Strategies for De-implementation / High Value Care	Specific Cognition Mitigation Strategies
Patient and caregiver expectations and concerns	• Seeking immediate relief • Patient/ caregiver expectations	• Shared decision making • Training for HCWs to Communicate risks and benefits effectively [12] • Educate patients and caregivers about LVC and harms	• Communicate diagnostic uncertainty and risk with patients [3] • Communicate harms of low value treatments too • Use decision aids - apps/posters/videos etc.
Risk adverse	• Fear of missing a diagnosis	• Discuss uncertainty openly with patients [3]	
Cultural Factors	• Cultural norms	• Cultural training	
Access Issues	• Poor access to care - get test done now so not lost to follow-up - get treatment now so don't need to come back	• Some populations need more care not less	

Setting/Team Level Factors

Organisational and team-based considerations affecting de-implementation

Low Value Care	Drivers of Low Value Care	Strategies for De-implementation / High Value Care	Specific Cognition Mitigation Strategies
Care Coordination	Fragmentation of care	• Patient centred multidisciplinary team-based care [13] • Process redesign	• Cultivate clinical teams with trust, collaboration, compassion who share decision making [9] • Have courage to discuss and explore difficult decisions, practice variation, challenge defensive medicine, and question indication creep [9]
Data Issues	Lack of data and quality of data or difficult accessing and obtaining data (Prevalence of interventions and how much is inappropriate not known therefore targets for reduction may not be established)	• Collect metrics and report • Work out targets if able	
Workload Environmental Context	Teams too busy	• Clinical reminders and prompts [1] • Soft nudge strategies [7] • Restricted ordering via default settings in computerised ordering or prescribing systems • Modified order sets • Environmental restructuring [1]	• Make the change easier than the alternative [7] • Make the smart choice the easy choice through environmental cues [1] • Enablement; addressing time constraints
Change Management	Change is hard and often doesn't stick	• Follow implementation science frameworks of quality improvement • Use preexisting implementation resources like Choosing Wisely [14] • Provide dedicated time for project management • Expand internal and external stakeholder relationships	• Use a COMs B model • Incentives-to achieve LVC reduction targets • Model behaviour by senior clinicians [1] • Communication and marketing campaigns • Guidelines
Cultural Resistance	Perceived as status quo/unit culture - part of existing order set or directive	• Facilitation, building a coalition • Clinical guidelines and education • Revisit checklists with unnecessary items	• Role model uncertainty tolerance [15] • Plan for difficulty when changing habits and entrenched culture - COM-B model [7] • Incentives to change culture around overtreatment and "just in case" culture [1]
Technology Factors	• Lots of new technology • Overuse of tech without evidence for efficacy	• Guidelines to avoid indication creep with new tech • Clinical decision tools	• Balance the early adopters versus the laggards to question indication creep

Health System Factors

Structural and policy elements that influence de-implementation at the system level

Low Value Care	Drivers of Low Value Care	Strategies for De-implementation / High Value Care	Specific Cognition and behavioural Strategies
Financial Incentives	Income generation - Fee for service models	• System design - e.g. Fee for outcomes/value, capitation funding [1] • Values based healthcare [10]	• Process redesign
System Design	Fragmentation of care/siloed	• Integrated care, EHRs, care coordinators/case managers	• Process redesign
Resource Utilisation	Easy access/ availability of resources/throw away single use culture	• Use education programmes Choosing wisely programme • Develop clinical decision supports and guidelines • Build in Stewardship via informatics- Restriction of ordering via IT and AI rules [16] • Regulation- establish rules and principles of practice [1] • Legislation- restriction provision of certain treatments [1] • Consider life cycle assessments and whole of life cost [16]	• Make costs transparent [2] • Coercion; e.g. departments changed higher rates for some tests • Incentives • Communication and marketing
Access Inequity	Poor healthcare access for some populations	• Preventative healthcare	
Uncertainty	Intolerance of uncertainty	• Formally integrate uncertainty into the curriculum of medical education [3] • Systems infrastructure to support the embracing of uncertainty [3]	• More flexible diagnostic codes and treatment algorithms that build in uncertainty and room for modification over time in EHRs [3] • Provisional diagnoses

Useful Reading

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(8) Kruser JM, Cox CE, Schwarze ML: Clinical Momentum in the Intensive Care Unit. A Latent Contributor to Unwanted Care. Ann Am Thorac Soc 2017, 14(3):426-431.

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