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Environmental sustainability in intensive care: the path forward. An ESICM Green Paper

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Abstract

Purpose: The European Society of Intensive Care Medicine (ESICM) Green Paper aims to address the challenge of environmental sustainability in intensive care and proposes actionable strategies for integrating sustainability into intensive care unit (ICU) stakeholder actions.

Methods: The ESICM Executive Committee appointed a task force of topic experts and ESICM committee representatives to develop the ESICM Green Paper. The task force convened biweekly from January to June 2024, identifying key domains for environmental sustainability and prioritizing actions. Drafts were iteratively refined and approved by the ESICM Executive Committee.

Results: Climate change will impact activities in intensive care in many ways, but also the impact of ICU activities on the environment is considerable; drivers for this include extensive resource use and waste generation in ICUs from energy consumption, use of disposable items, and advanced therapies for critically ill patients. The ESICM Green Paper outlines a structured approach for ICUs to reduce their environmental impact, emphasizing energy efficiency, waste reduction, and sustainable procurement. Furthermore, it endorses the need for awareness and education among healthcare professionals, integration of sustainability into research, and sustainable policies within scientific societies.

Conclusions: The ESICM Green Paper reviewed the relevance of climate change to intensive care and provided suggestions for clinical practice, research, education, and ESICM organizational domains. It underscores that reducing intensive care's ecological footprint can coexist with high-quality patient care. Promoting a resilient, responsible healthcare system is a joint responsibility of all ICU stakeholders.

Keywords: Environmental sustainability, Intensive care, Waste management, Resource consumption, Procurement, Climate change, Energy efficiency

Introduction

In times when climate change is one of the greatest challenges to public health and global safety, healthcare finds itself in a challenging position [1]. While it plays a crucial role in maintaining people's health, its environmental footprint is extensive [2]. Intensive care units (ICUs) are among the most resource-intensive departments in

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the hospital: ICUs consume large amounts of energy, generate significant quantities of waste, rely heavily on single-use devices and equipment, and their patients require large amounts of drugs for their treatment [3]. However, it is possible to implement interventions for ICU care with a lower environmental impact while keeping the standards of quality care high. The ultimate goal is to develop sustainable healthcare systems, which will require huge efforts to drastically reduce greenhouse gas emissions because the decarbonization process must lead to a decrease of 80–90% of greenhouse gas emissions, which is about −6 to −7% per year until 2050 [1].

The impact of climate change on health emphasizes the need for environmental sustainability in healthcare [1]. Beyond the immediate and direct environmental consequences, the broader implications of climate change, including increased incidence of heat-related illnesses, respiratory conditions, and vector-borne diseases, put additional strain on resources. This further reinforces the need for and urgency of sustainable transformation.

Healthcare professionals (HCP) and scientific societies, including the European Society of Intensive Care Medicine (ESICM), are becoming more aware of these issues and are increasingly advocating for integrating sustainable practices into routine daily care for critically ill patients. These efforts aim to reduce the environmental impact of intensive care and can serve as examples for other sectors. Importantly, reducing the ecological impact of ICU activities does not mean decreasing the quality of care for critically ill patients; better care for the environment and safeguarding outcomes (or even improving them) for ICU patients can go hand in hand. From a patient or family perspective, there is minimal data about ICU patients and their opinion on "Green ICU practice". However, data from a Dutch patient panel ($n=2106$) on chronic disease or physical limitation showed that 57% preferred good quality of their care (regardless of environmental impact), while 40% would be willing to choose a more environmentally friendly approach [4]. Only 5% preferred the most environmentally friendly care while accepting less quality.

As a leading and global society in intensive care medicine, ESICM acknowledges this critical moment and intends to lead by example, demonstrating that it is possible to maintain and even enhance patient care at high standards while significantly limiting the environmental impact of ICU activities. ESICM's commitment to increasing environmental sustainability is not just a response to a growing planetary health crisis, but a forward-thinking vision for a more resilient and responsible healthcare system. This Green Paper represents an essential step in conveying ESICM's position on environmental sustainability. It is a declaration of our intent to identify key areas where the intensive care community and ESICM can implement meaningful changes. By proposing actionable strategies, ESICM aims to reduce the environmental impact of ICU operations and, by extension, the wider healthcare sector. This ESICM Green Paper is a testimony to our strong understanding that environmental health and human health are intrinsically linked, with the well-being of the Earth's biosphere influencing the health outcomes of our patients and HCPs, now and in the future.

Methods

The ESICM Executive Committee established a task force composed of experts from diverse backgrounds and representatives of different ESICM entities to draft an ESICM Green Paper on environmental sustainability in ICUs. Members were identified based on relevant experience, content knowledge, research experience, and prior involvement in ESICM; as this topic is relevant for all HCPs, multidisciplinarity was essential when establishing the ESICM Environmental Sustainability Task Force. The ESICM Executive Committee approved the multidisciplinary ESICM Environmental Sustainability Task Force composition in Janary 2024. The ESICM Environmental Sustainability Task Force was responsible for drafting an ESICM Green Paper within 6 months of its creation. Task Force members were required to disclose any conflicts of interest that were managed according to the ESICM conflict of interest policy.

An ESICM White Paper is a report or guide that concisely informs its members and stakeholders about a specific topic and presents ESICM's stance and philosophy on the matter. It is meant to help readers understand an issue, solve a problem, or make a decision. For this particular purpose with a focus on environmental sustainability, it was then decided to designate this as an ESICM Green Paper.

The ESICM Environmental Sustainability Task Force convened biweekly via online sessions from January to June 2024. After identifying key domains, the Task Force members discussed and delineated areas of interest and potential actions. This was informed by personal experience and practice of the ESICM Environmental Sustainability Task Force members, relevant literature on the topic personal disucssions with ESICM members, and feedback from respondents to the ESICM Environmental Sustainability survey; panel members shared relevant resources with the group. To identify and prioritize these potential actions for implementation in clinical practice by ICU HCPs, three tiers were created. Tier 1 actions are relatively easy to implement, require minimal resources, and can quickly contribute to environmental sustainability; tier 2 actions require a moderate level of investment

and coordination but can result in significant environmental benefits; and tier 3 actions are highly impactful, but may require considerable investment, long-term planning, and cultural changes within the organization. Task Force members through an iterative process categorized and ranked actions defined throughout the different domains based on their potential impact and feasibility.

Draft revisions were iteratively refined until consensus was achieved among all members. The final version underwent comprehensive review, amendments, and ultimate approval by the ESICM Executive Committee.

Objectives of this ESICM Green Paper

The objectives of this Green Paper are multiple and aim at facilitating a shift toward more sustainable practices in intensive care:

- To evaluate the impact of climate change on ICUs, to better understand how climate change affects patient care and resource availability and to prepare for these shifts.
- To describe the environmental impact of ICUs and ICU activities, highlighting the critical areas to reduce carbon footprint, waste, and resource consumption.
- To develop a framework for sustainability initiatives in clinical ICU care, offering actionable strategies to achieve significant environmental and health benefits.
- To propose policies which facilitate environmental sustainability research and innovation in the ICU, encouraging studies that seek to understand and mitigate the environmental impact of ICU practices and promote innovation.
- To suggest strategies for increasing awareness and education among ICU HCPs about the importance of environmental sustainability.
- To recommend initiatives for educating ICU HCPs on how they can contribute to sustainability efforts.
- To propose environmental sustainability strategies for ESICM as an organization, ensuring its operations reflects sustainability principles.

Subsequent sections of the ESICM Green Paper will explore these objectives in detail, delineating a path forward for ESICM and its stakeholders to embrace environmental sustainability as a core component of intensive care medicine. The ESICM Task Force on Environmental Sustainability has also identified four primary domains to explore targeted strategies and solutions (Fig. 1): (1) clinical care, (2) research and innovation, (3) awareness and education and (4) environmental sustainability leadership within ESICM.

Climate change and the ICU

The consequences of the climate crisis create a need for more intensive care beds and affect the type of patients admitted due to:

- Increase in heat-related admissions from heat stroke, collapses, and acute deterioration of chronic illnesses, e.g. cardiac, respiratory and kidney diseases.
- Increase in injuries secondary to natural disasters, such as floods [5], hurricanes, and fires. Natural disasters can also damage hospital infrastructure, cut off water, electricity, or gas, disrupt travel and impede the transport of medicines, food, and clinical supplies.
- Change in microbiological patterns. Infections treated in the ICU are evolving as pathogens adapt to climate change. For instance, fungi become more thermotolerant, and this thermotolerance increases their fitness and virulence [6]. In addition, climate change and natural disasters provide a favourable background for outbreaks of fungal diseases and the spreading of fungal pathogens. Climate changes also likely affect bacterial proliferation, dissemination, and survival. A recent review showed that the effects of climate change depend on the type of bacteria, but detecting foodborne bacteria tends to increase during summer, suggesting an association between the warm climate and the detection of bacteria; other climate factors such as rainfall, drought, and wind seem to influence the persistence and dispersal of foodborne pathogens in the environment [7]. Climate change may also exacerbate the problem of antimicrobial resistance (AMR) [8].
- Changes in social structures. Climate change is linked to social injustices because it causes a rise in poverty and migration to survive, along with a strong association between poverty and infectious diseases [9, 10]. For example, climate change increases the risk of dengue fever transmission. Thus, limiting greenhouse gas emissions could be critical to decreasing dengue fever spread [11]. The interaction between poverty and infectious diseases, such as tuberculosis, has long been established, and patient travel is spreading multi-drug-resistant strains [7]. Regarding changes in social structures, poorer populations are the most vulnerable.
- Changes in high-risk behaviours. Climate change may change people's behaviours [12, 13], resulting in an increased number of accidents and trauma patients. Poverty may exaggerate this association. For instance, an epidemiological study showed that traumatic brain injury in children was more common in those from poorer backgrounds [14]. Further, mass

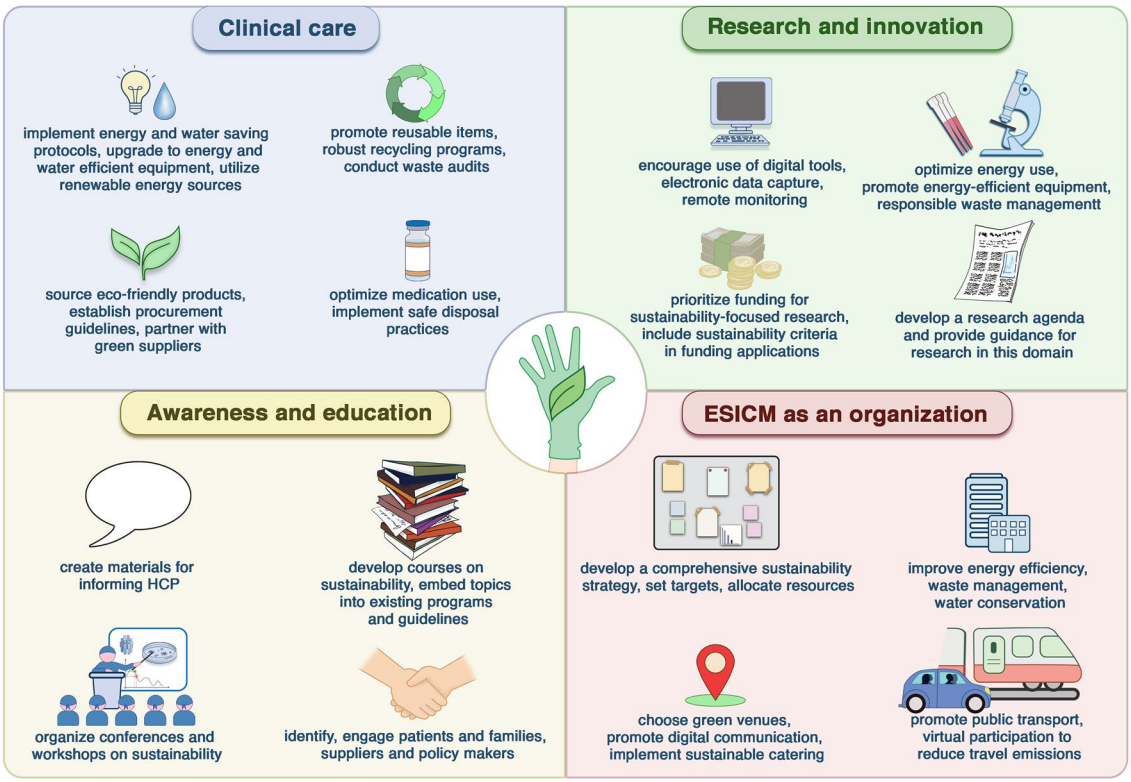

Fig. 1 The four domains relevant to environmental sustainability in intensive care with key actions identified. *ICU* intensive care unit, *HCP* healthcare professional

migration due to environmental causes [15] increases the potential risks associated with travel [16].

- Changes in mental health. Climate change and associated physical illnesses and injuries negatively impact people's mental health, especially those most marginalized [17, 18]. This may impact both healthcare professionals and patients and families in the ICU.

These consequences of climate change will have multiple implications for intensive care services, including an increased volume of patients, lack of trained staff, the need to care for patients with more complex conditions, and even new diseases that have not been encountered in ICUs before.

Environmental impact of intensive care

The environmental impact of ICUs is a pressing concern for clinicians as they confront the challenges of climate change. ICUs create a proportionately high ecological footprint by using large volumes of clinical supplies, water, and energy [2, 19]. Clinicians are re-evaluating their practices with a focus on reducing waste, particularly from disposable items. Since the 1990s, the surge in single-use items, driven by infection control guidance, has raised environmental concerns. However, recent guidance questions the necessity of single-use items in routine clinical care. Switching to reusables now hinges on economic and planetary health considerations.

Life cycle assessments (LCAs), a methodology for assessing environmental impact of a specific item, product, process, or service, play a pivotal role in comparing the impact of these different options. Studies have shown that while single-use items have a higher carbon footprint during manufacturing and disposal, reusable items still have an environmental impact, particularly during sterilization, which requires energy [20]. In regions with high renewable energy adoption, like Europe, transitioning to reusable ICU equipment presents a clear environmental benefit. As the world struggles with the escalating consequences of climate change, clinicians should adopt environmentally sound practices, including reusable equipment, to mitigate the environmental impact of healthcare delivery in ICUs.

The energy consumption in the ICU itself is another hotspot from the energy required for heating, ventilation, and cooling (HVAC) [21]. The resulting carbon dioxide equivalent (CO_2e) emissions, which amounted to 178 kg

per patient per day in the United States of America (USA) and 88 kg per patient per day in Australia [21], were primarily driven by HVAC energy consumption (constituting at least 75% of the total emissions). In a US hospital, the greenhouse gas emission per ICU bed per day was found to be more than double the greenhouse gas emission of an acute care bed [19]. The emissions linked to energy consumption exhibit significant international variations, dictated mainly by the primary energy source in each region. For instance, countries like Australia and China, which are heavily reliant on burning coal for electricity, contrast sharply with the emphasis on renewable and nuclear strategies in some countries in Europe and the mixed energy sources used in the USA for example. Energy consumption for the equipment needed for one patient receiving lung and kidney organ support with monitoring is 15 kWh/day, about 1,5 times the consumption of an average European household [22].

Water conservation in hospitals is a crucial, yet often overlooked aspect of environmental sustainability. From routine patient care to specialized procedures like dialysis, hospitals utilize vast quantities of water, encompassing activities such as handwashing, air-conditioning, and sterilization. For instance, a single surgical handwash at manually operated sinks can consume nearly 20 L of water, which could be significantly reduced with motion sensor technology. Moreover, large hospital steam sterilizers require almost 1000 L of water per cycle, highlighting the potential for substantial water savings through enhanced efficiency measures [3, 23].

Domain 1: Approaches to green clinical care

Clinical care has many opportunities for integrating environmental sustainability into daily practice. A structured, step-by-step approach is essential to turn these opportunities into impactful outcomes. The following recommendations draw from the personal experiences of the ESICM Environmental Sustainability Task Force members, relevant established practices, and suggestions from the literature.

Step 1. Align green ICU plans with existing hospital initiatives

Healthcare facilities may already have institution-wide strategies or visions for environmental sustainability. ICU teams should align their sustainability goals with those of the broader hospital. Initiating this alignment involves:

- Reviewing hospital-wide sustainability policies and plans.
- Engaging with hospital staff with sustainability responsibilities to understand existing initiatives and local systems and processes for procurement and waste management.
- Ensuring that ICU-specific actions are complementary and integrated with hospital-level efforts.

Step 2. Evaluate the current state of the ICU

A thorough quantitative evaluation of the current environmental impact is essential to propose meaningful "green interventions". This evaluation could involve:

- Material flow analysis (MFA): this assessment of the types and quantities of materials used provides insight into resource efficiency and identifies areas for reducing unnecessary resource use. An MFA can identify hotspots as a starting point for sustainable interventions.
- Waste audit: a systematic examination of waste generation and disposal helps to identify areas for improving waste management, including seperating waste by HCPs into appropriate waste flows.
- Life cycle assessment (LCA): this type of analysis identifies the environmental impact of products and services throughout their complete life cycle, from production to disposal (cradle-to-grave). Available LCAs for healthcare are listed on this website: https://healthcarelca.com/.
- Procurement data review: analysing procurement data to understand the inflow of materials into the ICU can help identify opportunities to switch to more sustainable options and help determining hot spots.
- Identify low-value clinical practices in intensive care medicine that are potential candidates for de-adoption.

Not every hospital needs to evaluate each individual item, and collaboration between units can enhance efficiency. Publishing analyses and reviews of these practices is recommended to share insights and experiences. Based on the outcome of the evaluation, the ICU can develop environmental key performance indicators (KPI) to monitor and evaluate the implemention of green interventions.

Step 3. Form an "ICU Green Team"

Establishing a multidisciplinary team rooted in clinical practice is essential for adopting a collaborative approach to sustainability [24]. Table 1 suggests potential ICU Green Team members.

In an ideal world, the "ICU Green Team" encompasses these different roles, as respectful collaboration is the cornerstone of sustainability initiatives with significant impact. This extensive list of potential members

Table 1 Potential ICU Green Team members and their role

ICU Green Team member	Role(s)
Nurses and physicians	Provide insights into bedside practices, covering various processes
Pharmacists	Understand medication sourcing, optimal use, and disposal
Environmental services staff	Fundamental to waste management can provide practical insights into daily waste streams
Procurement officers or supply chain managers	Impact the purchasing of sustainable products and engage with suppliers who prioritize sustainability
Infection prevention and control experts	Ensure that sustainable practices meet health and safety standards, and identify opportunities to reduce disposable use without compromising patient and HCP safety
Facility managers	Responsible for the maintenance and operation of physical spaces, and can make changes to reduce energy and water usage
Quality officers	Ensure that sustainable practices meet quality standards and guarantee incorporation in local protocols
Biomedical engineers	Help with the maintenance, proper disposal, and replacement of medical equipment with more energy-efficient options
Dietitians	Work on sustainable sourcing of patient meals and reducing food waste
IT specialists	Optimize the energy efficiency of electronic systems and advocate for digital over paper use where possible
Waste management experts	Develop improved recycling and composting programmes
Laboratory specialists and technicians	Aid in selecting the optimal strategy for sampling and processing
Human resources representatives	Integrate sustainable practices into staff onboarding and training programmes
Financial officers	Analyse the financial impact of sustainability initiatives and help in obtaining funds or reallocating resources for "Green ICU" projects
Sustainability officer	Provide expertise on sustainability and coordinate efforts across different departments
Patient advocates, former ICU patients or family members	Ensure that patient perspectives are included in sustainability efforts, as they are significant stakeholders in healthcare delivery
Communication specialists or departments	Assist in promoting the initiatives internally and externally and in engaging with the community and stakeholders
Legal advisor	Ensure that all sustainability initiatives comply with relevant regulations and laws

highlights the interdisciplinary nature of ICU Green Teams, underscoring that sustainability is a shared responsibility and relevant to every aspect of clinical care. However, it is essential to recognize that the feasibility of this involvement can vary widely across different institutions. The absence of some of these roles is not a barrier to beginning steps for improving environmental sustainability. Instead, each ICU Green Team should be tailored to the unique resources and capabilities of the healthcare institution, building on the motivation and expertise of available staff.

Step 4. Goal setting and planning

With an ICU Green Team in place, set specific, measurable, achievable, relevant, and time-bound (SMART) goals for environmental sustainability. Goals may include reducing energy consumption by a certain percentage or transitioning to zero-waste packaging in specific product categories within a set timeframe. Prioritize within the different goals set, based on the expected impact of the actions (replace actions by "green interventions") considered and based on the local MFA.

Step 5. Secure leadership support

Endorsement from hospital and department leadership is critical to the success of sustainability initiatives. Strategies to gain this support include:

- Demonstrating the potential cost saving and public relation benefits of sustainability initiatives.
- Presenting a clear plan with expected outcomes that align with the hospital's mission and values.
- Highlighting the health benefits for patients and HCPs associated with improved environmental practices.
- Demonstrating reduced workload for all staff.

To sustain the success of the Green Team activities, the Task Force recommends to focus on the following:

- Education and training: develop training programmes for staff to increase awareness and understanding of sustainable practices and their benefits.

- Patient and family engagement: include patients in sustainability efforts by informing them about initiatives and encouraging participation, such as proper waste segregation and sustainable travel to the hospital when visiting relatives.
- Monitoring and reporting: implement systems to monitor the progress of sustainability initiatives and report on their outcomes regularly.
- Communication: engage a communication expert to support the dissemination of the Green ICU Team actions and improvements.
- Leadership: identify champions and get support from ICU and hospital leadership.

In Table 2, the Task Force proposes a three-tier approach, going from easy to implement actions in tier 1 to more advanced actions in tier 3. The actions in each tier are in random order.

Domain 2: Integrating environmental sustainability in research and innovation

The Task Force acknowledges the environmental impact of clinical and experimental research in intensive care and advocates that research in different domains can be done in a more sustainable way. ESICM advocates for a progressive shift towards digitalization in clinical trials, aligning with strategies proposed by the Sustainable Markets Initiative Health Systems Task Force (https://www.sustainable-markets.org/taskforces/health-systems-taskforce/.

Digital health solutions present an opportunity to reduce the carbon footprint associated with clinical research. ESICM supports the integration of streamlined electronic data capture, digital biomarkers, and remote patient monitoring into research policies. Digital transformation not only diminishes the need for physical travel, thus cutting emissions, but also enhances the efficacy, speed, and reach of clinical trials. It should be noted, however, that the energy required for artificial intelligence (AI) applications is considerable as well, so this should be used selectively. Furthermore, ESICM supports using and further developing synthetic control arms and innovative concepts such as digital twins.

Also in experimental research, environmental sustainability should be considered. The Task Force advocates for implementing practices that reduce environmental impact. Also in this domain, digital methodologies can significantly diminish the ecological footprint of research. Virtual simulations and computational modelling can reduce the need for physical resources and associated waste. Adopting *in silico* trials, where possible, not only accelerates the research process, but also reduces the use of energy and consumables. Moreover, ESICM encourages the development of environmentally sustainable laboratories; the Laboratory Efficiency Assessment Framework (LEAF) has been introduced as a standard to improve the sustainability and efficiency of laboratories (https://www.ucl.ac.uk/sustainable/take-action/staff-action/leaf-laboratory-efficiency-assessment-framework). Optimizing energy use, investing in

Table 2 A three-tier approach to increasing environmental sustainability in ICUs

Tier 1: basic actions
Establish an ICU Green Team to initiate and lead sustainability initiatives
Implement energy-saving measures, such as turning off unused equipment and lights
Promote the use of reusable items over single-use items where possible
Conduct regular training sessions for all staff on the importance of environmental sustainability
Tier 2: intermediate actions
Develop and implement a comprehensive sustainability strategy for the ICU with clear goals and metrics
Reduce paper use by implementing digital records and communications
Optimize the use of heating, ventilation, and air conditioning systems to reduce energy consumption
Upgrade to energy-efficient lighting and equipment
Tier 3: advanced actions
Use LCAs to guide the selection of equipment to be used in the ICU
Install motion sensor faucets and efficient fixtures to reduce water consumption
Retrofit buildings to meet green certification standards and pursue green building certifications for ICU facilities
Prioritize renewable energy sources to supply the ICU

Tier 1: these actions are relatively easy to implement, require minimal resources, and can quickly contribute to environmental sustainability; tier 2: intermediate actions: these actions require a moderate level of investment and coordination but can result in significant environmental benefits; tier 3: advanced actions: these actions are highly impactful but may require considerable investment, long-term planning, and cultural changes within the organization

ICU intensive care unit, *LCA* life cycle analysis

energy-efficient equipment, and ensuring responsible waste management, including the recycling of consumables and the safe disposal of hazardous materials, helps to establish sustainable laboratories.

Throughout experimental and clinical research projects, researchers are encouraged to focus also on sustainability of care and the impact of climate change. Research may also focus on de-adaption of environmentally unfriendly practices.

The Task Force also calls for establishing clear guidelines for emission measurement and the measurement of the overall environmental impact, and advocating for integrating sustainability in all facets of healthcare research. Also, the tools used for analysing the impact of tools and practices such as LCA and MFA should be standardized. This also implies harmonization of international regulatory aspects in this domain.

The Task Force has identified several opportunities to facilitate research on the topic of environmentally sustainable intensive care, as well as introducing environmental sustainability in research:

- Incorporation of environmental sustainability in the ESICM Research Pathway.
- Creation of an ESICM Environmental Sustainability Award in the ESICM Award Program. This award should fund a research project focusing on ICU environmental sustainability.
- Integration of an environmental sustainability analysis in applications for the ESICM Award Program. Applicants should be invited to describe how the research project submitted will impact the environment.
- Development of a core outcome set for environmental sustainability (COS-ES). A core outcome set (COS) allows for standardizing the outcomes measured and reported in studies. Developing a COS-ES will enhance the comparability and reproducibility of research. Creating a COS-ES allows the ESICM Research Committee to collaborate internationally on sustainability promotion.
- Developing guidance and tools for assessing and quantifying the environmental impact of ICU practices and interventions, including LCAs and MFA.
- Create the ESICM Environmental Sustainability Research Group to monitor awareness, facilitate international research collaboration, and compile comprehensive data on resource utilization, waste generation, and greenhouse gas emissions associated with ICU care.
- Development of a research agenda on environmental sustainability in the ICU.

Domain 3: Fostering sustainability awareness and education

For an organization with a clear focus on education such as ESICM, there are many opportunities to enhance environmental sustainability when organizing educational events and courses. However, it should be clear that creating awareness is a joint responsibility of all stakeholders, including the individual HCP.

The Task Force recommends that ESICM considers the following:

- Developing an educational pathway on environmental sustainability.
- Organizing a yearly conference on environmental sustainability in the ICU.
- Embedding environmental sustainability in all courses organized by ESICM.
- Embedding environmental sustainability in all international guidelines.
- Creating a course on environmental sustainability in the ESICM Academy.
- Adding environmental sustainability topics to the competencies in CoBaTrICE.

Additionally, environmental sustainability should be integrated into the the scientific and educational programme at the LIVES annual meeting of ESICM, e.g. by creating workshops, thematic sessions, debates, and other formats to inform and educate members and participants about the topic. Increasing awareness about environmental sustainability and the importance of sustainable healthcare is equally important among all stakeholders, e.g. patients and families, suppliers, administrators, politicians, and policymakers. Given the relative importance of ICU activities on greenhouse gas emissions and waste generation, every aspect of intensive care should be considered of potential interest for environmental sustainability actions. Different formats may be used according to the target group for which this is developed.

Domain 4: Implementing sustainable policies in ESICM

Scientific societies can also contribute to environmental sustainability. As we advocate for green practices in clinical care, research, and education, we also need to prioritize environmental sustainability in the operational activities of ESICM. For ESICM, the Task Force suggests the following strategies:

- Develop an environmental sustainability vision and strategy that aligns with the ESICM values and objectives, sets clear sustainability targets for its activities,

and allocates sufficient resources to reach these targets.
- Commit to a Green ESICM Office by 2026 by improving energy efficiency, waste management and water conservation and ensuring sustainable procurement.
- Create a committee on environmental sustainability connected to the different ESICM committees and sections to ensure sustained attention to this theme.
- Reduce greenhouse gas emissions from transportation and commuting by staff and officers when travelling for ESICM, including flexible work arrangements.
- Enhance environmental sustainability in organizing ESICM events and activities, including committee meetings and congresses, as outlined in Table 3.
- Adopt a travel policy for ESICM staff and officers when travelling on behalf of ESICM, as well as invited speakers to ESICM activities
- Develop policies to promote train travel, public transportation, and carpooling, and inform staff, officers, and anyone travelling on behalf of ESICM about the policy and integrate this into the reimbursement policies.
- Commit to environmental sustainability advocacy in scientific associations, such as developing a certificate for green societies and other forums, e.g. the European Parliament Intensive Care Interest Group (EPIC-IG).
- Include environmental sustainability in ESICM communication by creating a specific area on the website providing information to HCPs, patients, and families about sustainable practices.
- Participate in alliances and organizations enhancing environmental sustainability.
- Reach out to other scientific ICU societies for collaborative projects on this theme.
- Integrate environmental sustainability in the Annual Report of the Society.
- Encourage industry partners to push for environmental sustainability in their activities at ESICM and beyond.

Applicability of the ESICM Green Paper

Environmental sustainability requires a global approach that exceeds economic and geographic boundaries. However, the strategies for achieving sustainability must be adaptable to the varied resources and constraints of different healthcare systems. This applicability is especially true when considering the specific challenges of resource-limited settings and the learning opportunities they present for resource-rich environments. Resource-deprived settings often face a unique set of challenges that can complicate the implementation of environmental sustainability practices in healthcare [25]. This includes limited access to sustainable technologies because of the high cost and limited availability (e.g. renewable energy sources and energy-efficient medical devices and equipment). Also, deficient local waste management infrastructure can lead to inappropriate medical waste disposal. Immediate healthcare priorities can be a significant barrier to long-term environmental sustainability investments since budget contstraints may limit the implementation of green initiatives. Finally, and foremost, there may be a lack of awareness about the importance of environmental sustainability and its impact on health, leading to low prioritization of sustainable practices among healthcare workers and hospital administrators.

Table 3 Environmental sustainability in ESICM events and activities

Location and venue selection
Choose green venues: choose venues and accommodation that prioritize energy efficiency, waste reduction, and sustainable practices.
Accessibility of the location: evaluate the accessibility for ESICM members to travel by train or other alternatives for flights
Proximity to public transport: select locations accessible by public transportation and provide free transportation with the congress registration
Online accessibility: enable people—from all over the world—to attend online for a reduced price
Promote digital communication
Paperless materials: provide digital programmes and promotional materials instead of printed materials
Waste reduction
Recycling stations: set up clearly labelled recycling bins for organic waste, paper, plastic, and other recyclables
Composting: provide composting bins where food is served
Catering
Sustainably sourced catering: opt for caterers prioritizing local, organic, and sustainably sourced food
Reusable utensils: reduce single-use plastic waste
Water taps: encourage bringing one's own bottle and refilling water

Despite these challenges, or even because of them, HCPs in resource-limited settings often employ creative and efficient practices out of necessity, which can offer valuable lessons for resource-rich settings. For example, the need to operate within strict resource limitations creates a culture of efficiency and waste minimization, leading to more efficient resource use. When facing equipment and supply shortages, HCPs in low-resource settings often develop innovative, low-cost solutions to meet their patient's needs. Their inventiveness can inspire more efficient and sustainable practices elsewhere.

To make ICU environmental sustainability a reality globally, bridging the gap between resource-rich and resource-deprived settings is essential, which requires exchanging knowledge and sharing best practices, innovations, and lessons learned between different healthcare contexts. Critical is also developing flexible sustainability strategies that can be adapted to local needs, resources, and specific conditions. The Task Force encourages collaboration between international organizations such as ESICM, non-governmental organizations and other stakeholders to support sustainability initiatives in resource-deprived settings. ESICM can contribute to this through its educational platform and existing network to build local capacity for implementing sustainable practices. By addressing the specific challenges of resource-deprived settings and incorporating the learning opportunities they offer, we can advance towards more sustainable and equitable care for critically ill patients around the globe. The proposed strategies in this Green Paper are broadly applicable, offering a blueprint for enhancing environmental sustainability worldwide—irrespective of the resources present.

This ESICM Green Paper is based on information and insights available at the time of publication. It offers suggestions in different domains that should be adapted to the individual needs of intensive care professionals and their patients, as well as the available resources in each setting. As robust data are absent in many areas, the paper mainly relied on expert consensus. The Task Force emphasizes that this is a policy paper and that it is the responsibility of individual HCPs, along with ESICM leadership and its officers, to ensure implementation.

Conclusion

This Green Paper reviewed the relevance of climate change to ICUs and suggested solutions for clinical practice, research, education, and ESICM organizational domains. The urgency of the climate crisis requires professional bodies like ESICM to commit to improving environmental sustainability and lead by example in promoting planetary health while providing intensive care service delivery. It is imperative that as ICUs strive to prioritize environmental sustainability, they remain accessible and uphold patient safety. Achieving environmental sustainability in ICUs requires collective action from all stakeholders, including every HCP.

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Author contributions

All authors contributed to the discussions on which this ESICM Green Paper is based. The initial framework and draft were prepared by JDW, NH, HB, RF, KI, AMI, ML, MO, GS, and HT. All authors provided critical revisions and feedback on various drafts of the manuscript. All authors read and approved the final version of the manuscript.

Data availability

This is not applicable to this paper.

Declarations

Conflicts of interest

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