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Environmental sustainability in intensive care: an international survey of intensive care professionals' views, practices and proposals to the European Society of Intensive Care Medicine

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Authorship

All authors contributed to the discussions on which the present survey is based. The initial questionnaire and draft were prepared by KI, JDW, NH, ML, HB, RF, MO, MT, HT, GS and AMI. GF led the dissemination of the questionnaire and management of SurveyMonkey platform. All authors provided critical revisions and feedback on various drafts of the manuscript. All authors read and approved the final version of the manuscript.

Abstract

Background

The intensive care unit (ICU) is a high-resource area, generating more waste and greenhouse gas (GHG) emissions than standard hospital wards. Environmental sustainability is important for healthcare professionals worldwide, prompting scientific societies to call for urgent action. To respond to this global need, the European Society of Intensive Care Medicine (ESICM) conducted an international survey assessing intensive care professionals' attitudes and practices towards environmental sustainability.

Methods

Intensive care professionals completed an online survey between 21 October 2023, and 5 January 2024. The survey, featuring 21 questions assessing attitudes and practices towards environmental sustainability and proposals for actions from ESICM, was disseminated during the 36th ESICM Congress via National Intensive Care Societies and ESICM's social media.

Results

We received 635 responses from 48 countries. Four hundred seventy (80%) respondents acknowledged a responsibility to be aware of the environmental impact of intensive care practice, and 372 (63.5%) disagreed or were uncertain about their knowledge level to guide practice. Four hundred thirty-seven (84%) lacked formal training on making sustainable choices. Ninety-five per cent used non-sterile gloves in ICUs, and 63% were willing to reduce use to support sustainable practices. Two proposed actions for ESICM to improve environmental sustainability were increasing knowledge on ecology (91/187, 49%) and raising awareness in the field (36/187, 20%).

Conclusion

This survey highlighted the need for scientific societies, notably ESICM, to provide robust support and structured education on environmental sustainability. Intensive care professionals acknowledged the environmental impact of intensive care and seemed eager to invest in their education on this topic.

Key words: environment, sustainability, ICU, intensive care, survey

Introduction

Climate change adversely affects human health and health systems [1-3]. More than 200 health journals have called on governments to take urgent action to tackle climate change's "catastrophic harm to health" [4]. To avert catastrophic health impacts and prevent millions of climate change-related deaths, the world must limit temperature rise to 1.5°C. Past emissions have already caused a global temperature rise, and other changes to the climate are inevitable [5]. Global warming of even 1.5°C is not considered safe. However, every additional tenth of a degree of warming severely affects people's lives and health [5].

The response of the World Health Organization (WHO) to these challenges centres around three objectives in terms of climate change mitigation: 1) promote actions that both reduce carbon emissions and improve health; 2) build better, more climate-resilient and environmentally sustainable health systems; and 3) protect health from the wide range of impacts of climate change. From an intensive care unit (ICU) perspective, the second objective is the goal that can be most affected by changing daily practice into a more sustainable one [5,6]

Hospitals and other healthcare facilities use significant amounts of energy, materials, medicines and food, generating substantial waste and carbon emissions, thereby contributing to environmental pollution and health-related consequences. The healthcare sector is responsible for almost 5% of global greenhouse gas (GHG) emissions [67, reaching even 10% in some high-income nations, and has a carbon footprint equivalent to 514 coal-fired power plants [8]. As the burden of disease increases, more pressure is placed on health systems to provide an increasing number of hospital beds and medical appointments. Increasing demand and inefficiencies (such as overprescribing, preventable medical errors, and delivery of low-value care) will further increase emissions from health systems [5,9].

Environmental sustainability is germane to intensive care, a high resource area, generating 1.3 times more waste and 3.1 times more GHG than conventional wards, as shown for an ICU in the USA [10].

Using a life cycle assessment, McGain et al. [8] showed that the average daily carbon footprint of treating patients with septic shock in an ICU in the US was 178 kg carbon dioxide equivalent (CO₂-e) emissions (range, 165–228 kg CO₂-e), while in Australia, the carbon footprint was 88 kg CO₂-e (range, 77–107 kg CO₂-e) [7]. Hunfeld et al. [11] performed a material flow analysis within their ICU and identified five hotspots: non-sterile gloves, isolation gowns, bed liners, surgical masks and syringes (including packaging). Their calculation of the environmental impact of products used per ICU patient revealed 17 kg of mass, 12 kg CO₂, e.g. 300 L of water usage and 4 m² of agricultural land occupation per day [10]. These data call for action and additional research [12-15].

Recognising the importance of urgent action [16] the European Society of Intensive Care Medicine (ESICM) introduced the Environmental Sustainability Task Force in 2023. The first action of the Task Force was to assess ICU healthcare professionals' views and practices on environmental sustainability. For this purpose, a survey was designed. To capture intensive care professionals' views on environmental sustainability and identify sustainable practices in clinical practice, education, research and policymaking in intensive care, ESICM aims to use the findings to inform future ES initiatives, educational initiatives and research in intensive care.

Methods

Design

A survey led by the Environmental Sustainability Task Force of ESICM was conducted between 21st Oct 2023 to 5th January 2024.

Participants

Participants comprised attendees of the 36th ESICM Annual Congress (n = 6270), ESICM members, and intensive care professionals worldwide.

Survey development

An interprofessional team (ESICM Environmental Sustainability Task Force), comprising clinicians from medicine, nursing and pharmacy with expertise in intensive care, drafted the questionnaire items after consulting relevant literature [17] and the CHERRIES checklist [18]. The questions were organised using the following domains concerning environmental sustainability in intensive care: 1) attitudes, 2) current practices, and 3) education and actions. Items were reviewed and reduced based on face and content validity.

The survey featured 21 questions with various response options: one categorical option (age), eight multiple-choice, ten Likert scale, one binary yes/no option and one open-ended question. Questions assessed demographics; awareness of climate change and planetary health issues; perceived responsibility of the environmental impact on intensive care practice, research, and education; perceived knowledge on the environmental impact of intensive care-related products and practices; current practices towards recycling, reduction of waste, energy and emissions; prior education or training on environmental sustainability; awareness of the environmental ICU hotspots; departmental actions towards environmental sustainability; and engagement with environmental sustainability initiatives. One open-ended question elicited participants' opinions on what actions the ESICM should take to improve intensive care environmental sustainability. Open-ended questions were used to elicit professionals' innate concerns, capturing what mattered most to participants about a topic, while they were complemented with closed-ended questions to ensure validation [19].

The survey was piloted by five intensive care professionals (physician, nurse, and pharmacist) and intensive care researchers before its launch to ensure its relevance and clarity. Comments were provided, and a few minor changes were implemented. The questionnaire (Appendix 1, available online at [Survey on Environmental Sustainability Practices in Critical Care \(surveymonkey.com\)](https://www.surveymonkey.com/survey/Survey-on-Environmental-Sustainability-Practices-in-Critical-Care)) started with an explanation of the study's purpose and the use of the data. Participants were informed that the survey would take approximately five minutes to complete and was voluntary and anonymous.

Their consent was only required upon completion of the survey. Data were collected and managed using [surveymonkey.com](https://www.surveymonkey.com), a secure online electronic AI-powered feedback platform hosted in the United States, Ireland, and Canada, which adheres to strict data protection regulations. The ESICM Executive Committee approved the survey.

Survey administration

Our survey was launched at the ESICM Annual Congress in Milan in 2023. It was available to attendees via a link and a QR code on big screens at the congress venue. Additionally, the latter was shown on the presenters' slides, reminding the audience about the survey. Three posts, including the survey's link and QR code, were sent through the ESICM social media channels, one during and two after the congress, to promote further survey dissemination. A newsletter, including information about the survey, was also sent to all members of the ESICM through a blast email after the congress. National intensive care societies affiliated with ESICM were also approached, and reminder emails, including the survey link, were sent to their members. Finally, Environmental Sustainability task force members, holding key positions in ESICM and the organisations they work with, repeatedly posted the survey link through their personal social media channels until the end of data collection.

Data analysis

Descriptive statistics were generated as proportions of respondents. Since participants were allowed to skip questions, all percentages were calculated based on the total number of respondents for each question. Responses to the open-ended question were reviewed independently by three members of the Environmental Sustainability Taskforce (KI, NH, HB) to identify common categories and themes. First, raw responses were reviewed, and preliminary codes were assigned using similar words or phrases. Codes were grouped into categories, which, after searching for thematic connectivity, led to thematic patterns [20].

Results

Demographics of respondents

There were 635 completed questionnaires. The respondent characteristics are presented in Table 1. Physicians represented 66% (n = 421) of respondents. Five hundred seventy-seven (91%) respondents had clinical duties, including 367 (58%) who worked in a university medical centre. Participants' mean age was 44.2 years (SD 10.4).

Attitudes towards Environmental Sustainability intensive care practices

Among 586 respondents, 373 (63.6%) agreed or strongly agreed that it was important to be well-informed about the impact of climate change on healthcare practice, and 409 (69.8%) reported that their planetary health concerns had induced actions in their work environment. Of note, most respondents (n=470, 80.2%) agreed or strongly agreed that intensive care professionals have the responsibility to be aware of the environmental impact of intensive care practice, education, and research. However, 372 (63.5%) respondents disagreed or expressed uncertainty about their knowledge of the environmental impact of intensive care-related products and procedures to guide their practice. Figure 1 presents participants' attitudes towards environmental sustainability in intensive care.

Practices towards environmental sustainability intensive care practice and education

Among 635 respondents, 478 (75.3%) agreed or strongly agreed to recycle at home, but only 293 (46.1%) agreed or strongly agreed to recycle at work. In line with this finding, 198 (37.9%) of 523 respondents (missing values, n = 112) agreed or strongly agreed that recycling was not available in their ICUs, and 336 (64%) either strongly disagreed, disagreed, or were unsure about considering the environmental impact when choosing intensive care devices. Figure 2 presents participants' practices towards environmental sustainability in intensive care. Notably, among 523 respondents (missing values, n = 112), 498 (95.2%) indicated that they routinely used non-sterile gloves instead of sterile

ones in the ICU, and 332 (63.4%) were likely or very likely to reduce unnecessary use in daily practice to support sustainable practices.

Among 523 respondents (missing values, n = 112), 437 (84%) had no prior education or training on how to make environmental sustainability choices in their professional environment, while 363 (69%) reported that they had either rarely or never been involved in environmental sustainability initiatives to reduce the carbon footprint of intensive care activities.

Participants reported that environmental sustainability activities had already been implemented in their ICU. The most common activities were discussions at departmental staff meetings (n = 165, 42.8%) and initiatives for improving ES for staff and patients (n = 144, 37.4%).

Use of double-sided printing (n = 292, 55.8%), coffee mugs instead of single-use cups (n = 289, 55%), recycling of non-medical equipment (n = 234, 44.7%), and reusing items after decontamination (n = 193, 36.9%) were on the top of the list of actions implemented to reduce waste. Respondents described several actions to reduce energy consumption and emissions in their ICUs (Table 3). The two most frequently reported actions were encouraging the staff to cycle to work (n = 185, 45.1%) and using low-energy lighting (n = 176, 42.9%).

Participants proposed actions for ESICM to improve environmental sustainability in intensive care

As the open-ended question was optional, the frequency and not the relative proportion of each category within the total sample are reported. One hundred eighty-seven (30%) respondents answered the open-ended question, exploring their views on ESICM's actions to improve environmental sustainability in intensive care. Twelve categories emerged: 1) increasing knowledge, 2) raising awareness, 3) providing accessible resources, 4) promoting sustainable practices, 5) performance metrics and outcome goals, 6) supporting research, 7) advocacy for policies in procurement, 8) advocacy in congress activities, 9) advocacy for policy influence, 10) building a

sustainable community and culture, 11) reinforcement, and 12) regulation measures. The frequency of each action for the ESICM is presented in Figure 3.

Participants proposed that the ESICM enhances knowledge of environmental sustainability through education and guidelines, including training videos, online modules, and special courses for leaders, physicians and policymakers. They suggested raising awareness via information campaigns, dedicated web pages, and promotion of ES projects. They recommended that the ESICM provide resources like protocols to minimize waste and tools to measure the carbon footprint of intensive care practices. Participants also called for directives to discourage hospitals from purchasing low-cost, non-recyclable equipment and advocated lobbying the industry for sustainable practices, such as environmentally friendly packaging. To assess the impact of sustainable practices, they proposed using performance measures like Control Chart Templates and Environmental Rating Systems. They also urged the ESICM to support research on sustainable materials and conduct international, multilingual studies. For future ESICM congresses, they recommended prioritizing sustainability, offering hybrid participation options, and encouraging train travel. They also suggested venues use renewable energy, eliminate single-use plastics, and serve local, seasonal food.

Participants emphasized avoiding medications with a high carbon footprint, reducing single-use materials, and recycling where possible. They advocated for adequate recycling facilities, reducing unnecessary investigations without compromising patient safety, and exploring ways to reduce work-related travel. They called for the ESICM to pressure global suppliers to reduce carbon footprints, lobby for sustainable regulations, and encourage hospitals to switch to renewable energy. They also recommended building a network to share ideas and implementing a comprehensive sustainability plan in ICUs, engaging all ICU staff. Finally, they proposed reinforcing sustainable initiatives through grants, prizes, and free congress registrations, making sustainability changes mandatory, and collaborating with the European Commission to regulate healthcare waste and products. Table 4 presents the categories of proposed actions and examples of participants' quotes for each category.

Discussion

This is the first study to capture the attitudes and practices of a broad international audience of intensive care professionals regarding environmental sustainability and their proposals for the ESICM to advance this concept for intensive care medicine. Our findings showed a high awareness of the impact of climate change on healthcare practice among the respondents. However, significant gaps in knowledge precluded the implementation of effective environmental sustainability practices. Not all respondents considered the environmental impact when selecting intensive care devices and products. However, there was a deep desire to apply more sustainable practices in daily practice, and respondents' proposals highlighted their expectations for ESICM to take a proactive and leading role in promoting environmental sustainability in intensive care.

Consistent with Harris et al. [21], who surveyed UK surgeons across all grades, our study showed that most intensive care professionals were concerned about climate change and felt responsible for raising awareness of its environmental effect on intensive care practice, suggesting a tendency for environmental sustainability behaviour [22]. Similarly, Petre et al. [23] reported that most of 426 Canadian anaesthesiologists believed that climate change affected their practices, reflecting growing concern among healthcare professionals across various specialities (surgeons, anaesthesiologists, and intensive care professionals) regarding the impact of climate change on patient care. Importantly, our respondents, in their comments, underlined that the ESICM should enhance awareness through campaigns, dissemination of information on recycling and carbon footprint in ICUs, dedicated events on environmental sustainability and timely updates. Lack of strong leadership has previously been perceived as a barrier to implementing environmental sustainability [21], suggesting that a unified vision from ICU leaders to promote and advance ES practices within the field of intensive care is still required [16]. At the ESICM level, efforts are underway to disseminate examples of successful ICU sustainability practices and to support professionals in initiating sustainability-focused research projects. ESICM has also encouraged alternative travel methods to its congresses.

In our survey, several respondents reported a lack of knowledge regarding the environmental footprint of intensive care practices. This finding highlights a critical issue among healthcare professionals. While concerns about climate change motivate intensive care professionals to modify their behaviour, a significant proportion feels that their knowledge of the environmental impact of specific intensive care products and procedures is insufficient to guide them effectively towards sustainable intensive care practices. Additionally, most participants had no prior education or training on making environmentally sustainable choices, consistent with findings from previous UK and Canadian surveys [21,23] where inadequate education and training were perceived as a barrier to environmental sustainability [21]. These gaps in knowledge are confounded by limited availability of data in the literature.

Our respondents suggested that the ESICM address this gap by organizing educational and training activities, disseminating instructions on recycling, providing guidelines and carbon footprint calculators, and sharing examples of green practices aligning with Canadian anaesthesiologists, who were also willing to invest time in educating themselves on environmental sustainability topics [23]. This highlights the critical need for targeted educational initiatives, as the European Society of Anaesthesiology and Intensive Care underscored in its consensus document, which identified improving staff education on environmentally sustainable practices as one of three primary objectives [24]. However, although education is an essential step for changing behaviour, increasing awareness of the reasons for these changes must also be coupled with tailored training on implementing the changes [25].

The survey participants reported several sustainable actions aimed at reducing waste in their ICU settings. Notably, the intravenous (IV) to oral medication switch was not mentioned. Although important, this sustainable practice has only been explored for a limited number of medications thus far. Data from these studies has demonstrated that IV-to-oral switches for these medications are safe and of high value and directly decrease the environmental footprint in healthcare [28], specifically in

an ICU setting [29]. The implementation of such sustainable practices should be coupled with efforts to continuously search for additional emissions-saving options that are cost-effective and of high quality [30].

Similar to previous surveys, our respondents were more likely to recycle at home than at work, indicating a gap between non-professional activities and the infrastructure at the workplace [21,23]. Although recycling at home was identified as a driver for recycling at work, the issue of non-recyclable items placed in recycling bags, leading to the entire bag not being recycled, may demotivate recycling at work [26]. Moreover, while intensive care professionals reported recycling awareness, environmental considerations still need to be fully applied in decision-making when selecting intensive care products, as suggested in a previous study [23]. This gap suggests the need for improving awareness and promoting training initiatives to spread and implement sustainable practices in the ICU.

Most respondents reported not being involved in environmental sustainability initiatives to reduce the carbon footprint within their ICU settings or departments. This lack of direct engagement underscores the need for more structured and accessible opportunities for intensive care professionals to participate in sustainability efforts. However, the most reported environmental sustainability initiatives involved informal discussions within departments and suggestions from staff or patients. Similar approaches, such as using departmental discussions to engage staff, were also applied in previous research conducted in Canadian ICUs [27].

The study results rely on a large, international and interprofessional survey. However, we have to acknowledge several limitations. First, the survey was only available in English, which may have contributed to the under-representation of intensive care professionals whose primary language was not English. In addition, this may have generated a bias of understanding for some respondents. Second, some intensive care professionals, such as nurses, pharmacists, and allied healthcare

professionals, were under-represented, which may have limited the diversity of the perspectives captured in our study. Nevertheless, the sample, including intensive care clinicians, researchers, and academics, reflects their specific interest in environmental sustainability, offering valuable insights into their attitudes and practices and suggestions for potential changes in intensive care. Third, it is possible that intensive care professionals already involved in environmental sustainability were more prone to participate than those less involved in this field.

Conclusions

Our study highlights a commitment among intensive care professionals to incorporate environmental sustainability practices into their daily practices. Despite facing discrepancies between their aspirations and current work settings, our international sample of intensive care professionals implies a profound sense of responsibility in applying environmental sustainability principles across clinical practice, research, education, and policymaking. Acknowledging their gaps in knowledge, the respondents were committed to enhancing their education and training in ES practices. This dedication underscores an urgent call to action for the ESICM to increase awareness, provide comprehensive training tools and resources and lead by example towards environmentally sustainable intensive care.

CRedit authorship contribution statement

All authors contributed to the discussions on which the present survey is based. The initial questionnaire and draft were prepared by KI, JDW, NH, ML, HB, RF, MO, MT, HT, GS and AMI. GF led the dissemination of the questionnaire and management of SurveyMonkey platform. All authors provided critical revisions and feedback on various drafts of the manuscript. All authors read and approved the final version of the manuscript.

Declaration of competing interest

The authors declare that they have no conflict of interest related to this paper.

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