

Environmental Impact of Palliative and End-of-life Care Interventions in the Intensive Care Unit

Running title: Environmental Impact of ICU-Palliative Care Interventions

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Tweetable summary: We examine evidence around palliative and end-of-life care interventions in the ICU, critique the potential environmental impact, and provide considerations around sustainability.

Impact of Palliative and End-of-life Care Interventions in the Intensive Care Unit

The relationship between healthcare and environmental decline

Climate change will have a major impact on healthcare provision in the United Kingdom (UK). Higher temperatures and extreme weather events are expected to increase heat-related deaths by 5,000 per year and lead to new and increased vector-borne infectious diseases [1]. Air pollution is already a major harm to public health estimated to cause more than 20,000 respiratory and cardiovascular admissions to hospital each year [2]. The National Health Service (NHS) currently accounts for around 4% of the UK's total carbon footprint and aims to reduce this to net zero across the full scope of its emissions by 2045 [3]. Of this total, around 20% is attributable to medicines and chemicals, 10% to medical equipment, and 10% to building energy usage. As an institution that both carries and contributes to much of the burden of environmental degradation, improving the sustainability of NHS services across all settings is an urgent task.

Palliative and end-of-life care in ICUs

Provision of palliative and end-of-life care in intensive care remains an enduring challenge. Clinical uncertainty and severity of critical illness means at least one in six people admitted to the intensive care unit (ICU) in the UK will die there [4]. Dying in an ICU is associated with high use of technology and resources, and raises questions about whether the care provided is concordant and proportionate to patients' wishes; what care would they have wished to receive when dying? The implications of providing end-of-life care in high technology environments like ICU are considerable, with many patients not fully aware of what the intensity of ICU treatments entails and what death can mean in intensive care [5]. Moreover, few people are aware of the environmental impact of ICU treatments or consider this when making decisions. In this critical commentary we examine the evidence around palliative and end-of-life interventions in the ICU,

critique the potential environmental impact and considerations around sustainability, and link this to an ethical framework.

Palliative care intervention studies in the ICU

Palliative care interventions in the ICU are defined as those aimed at improving quality of life of patients (and their families) at high risk of dying, including interventions on communication, ethics consultations, education, palliative care consultation and advance care planning [6]. Studies reporting the impact of palliative care interventions in the ICU have focused on outcomes examining reductions in length of stay (LOS) [6-11], healthcare resource use – primarily using intensive care treatment utilisation as a measure (e.g., ventilator-free days, tracheostomy, and feeding tube use), readmission, and limitation of medical treatment (life-sustaining interventions) [6]. Some studies have additionally reported reductions in wider (in hospital, beyond ICUs) healthcare resource utilisation [9], and significantly improved patient/family satisfaction [10], and anxiety/depression [12].

Length of stay

Hospital and ICU length of stay are the most frequently used outcomes measures in studies examining the impact of palliative care interventions in ICUs. In a recent systematic review, which did not include a meta-analysis, 11/30 (36.7%) and 8/22 (36.4%) studies measuring ICU and hospital length of stay respectively, showed use of palliative care interventions to be associated with a statistically significant reduction in length of stay [3]. Communication interventions involving communication facilitators and structured meetings were found to be commonly associated with reduced length of stay [6]. Settings and targets for interventions were diverse, as were methods and types of trials, limiting meaningful comparisons. Since 2020, a few

more studies assessed the impact of ICU-based palliative care interventions on ICU/ hospital length of stay without a clear change in conclusions. While some studies showed a statistically significant reduction in days spent in hospital/ICU [5,7], others had contradicting results [6]. Studies have used ICU LOS as a trigger for early palliative care interventions [7, 8]. Although meaningful when the transfer of end-of-life patients to hospices and palliative care units is possible, these outcomes are difficult to generalise to most countries outside North America due to differences in the structure of ICU care.

Healthcare resources (intensive care treatments)

Limitation of life-sustaining treatment is also a frequent outcome in studies reporting palliative care interventions in ICUs [6]. 9/22 (42.9%) of studies assessing the frequency of decisions around these reported a statistically significant increase, especially following complex educational interventions and specialist palliative care team involvement [6]. Support with goals of care and advance care planning also increased in the majority of cases [6]. Some studies used intensive care treatment utilisation as measures of impact for palliative care interventions. Those that demonstrated a statistically significant difference found a reduction in therapeutic interventions [13], decrease in artificial nutrition and hydration [14], and decrease in mechanical ventilation [14-16] in patients who did not survive to discharge. Interventions leading to these results had no impact on overall mortality [13, 14, 16]. A recent study, that included ICU patients, compared early versus late palliative care input for trauma patients and found reductions in ventilator days, tracheostomies, and surgical feeding tubes [7].

Environmental cost of intensive care

Intensive care is considered one of the highest carbon footprint relevant sectors in health care [17]. Although exact contributions of intensive care to carbon dioxide emissions (CO₂-e), energy, water and single-use device consumption, and waste are not well established, studies do give insight into the potential impact. Life Cycle Assessments (LCAs) quantify the environmental emissions of a process, from raw material extraction to disposal [18]. Most LCAs in healthcare settings have focused on individual products or procedures. However, McGain et al performed an LCA of the treatment of ten septic shock patients in a United States (US) and an Australian ICU [19]. Energy consumption of 272 kWh/day and 3.4 kg/day of single-use material gave an average CO₂-e of 178 kg/day per US patient. Equivalent to daily total CO₂-e for 3.5 Americans [19]. 143kWh/day and 3.4kg/day gave an average 88 kg CO₂-e for Australian patients, equivalent to 1.5 Australians [19]. A recent LCA found the environmental footprint of intensive inpatient care in a US hospital to be 7.1 kg of solid waste and 138 kg CO₂-e/bed day [18]. An English ICU was found to use on average 15kWh/day per patient, comparable to a 4-person household [20]. It is important to consider that these calculations will be dependent on local systems and resource costs [21].

Potential environmental impact of palliative and end-of-life care interventions in ICUs

Utilitarianism, the greatest benefit for the greatest number at its most fundamental premise, separates means (actions) and ends (consequences). It places emphasis on the end result of actions and has been posited as a framework to underpin critical care and resource use [22, 23]. Bein et al presented a concept of environmentally sustainability in intensive care [17]. They posed that avoidance of treatments not in accordance with patients' goals or that produces no medical benefit for the intended patient, could be the best current contribution to environmental sustainability [17]. Baid et al presented a similar model and prioritised preventing unnecessary

resource use and optimising patient length of stay [24], both of which align with a utilitarian view point of healthcare provision [25].

Although the aforementioned studies do not address the environmental impact of reducing resource utilisation, we may do so by considering them in unison. With studies presenting the potential CO₂-e and waste production/bed day, one can see how a reduction in LOS and non-goal concordant treatments could positively impact these figures.

Conclusions and future considerations

It is important to acknowledge that there is not a straightforward relationship between resource utilisation and goal-concordant care, and we cannot use resource utilisation as a quality measure for good end-of-life care [26]. However, with the primary aim to ensure goal-concordant care for patients and their families, the literature does suggest that palliative care interventions in ICUs can also reduce resource utilisation, and potentially therefore carbon footprint. This provides a humanistic approach to the consideration of broader impacts around sustainability, beyond the individual.

Given the impact of the healthcare system on carbon footprint, it is the responsibility of all healthcare professionals to recognise opportunity to reduce this whilst not negatively impacting patient care. Ensuring review of medications and interventions for intensive care patients if they are not concordant with their goals of care is therefore imperative. Patients at high risk of dying, for whom ICU treatments are concordant with their wishes, can be offered time-limited trials of critical care whilst mindfully managing expectations [27]. A time-limited trial may aid in the understanding of the patient's likelihood of meaningful recovery and, in cases where they are not known, allow clarification of the patient's wishes and values [27].

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167 Placing the value on resources, rather than impact on quality of life does suggest a lack of
168 emphasis on the wider positive environmental impacts of goal-concordant care. With increased
169 public awareness of, and concern for, environmental issues, it is conceivable that environmental
170 sustainability may become a value in itself that some patients wish to consider in their end-of-
171 life care. Understanding the impact of the various treatment options may facilitate this.

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173 Finally, whether patients who receive palliative care in the ICU experience the potential impact
174 on outcomes may be dependent on the type of interventions used, the timing and healthcare
175 setting; future studies should reflect the complexity of this issue.

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REFERENCES

1. **Public health in a changing climate** [<https://www.jrf.org.uk/report/public-health-changing-climate>]
2. **Reducing air pollution in the UK: Progress report**
[<https://www.rcplondon.ac.uk/news/reducing-air-pollution-uk-progress-report-2018>]
3. **Delivering a net zero NHS** [<https://www.england.nhs.uk/greenernhs/a-net-zero-nhs/>]
4. Intensive Care National Audit and Research Centre I: **Key Statistics from the Case Mix Programme -adult, general critical care units**. In.; 2020.
5. Pattison N, Carr SM, Turnock C, Dolan S: **‘Viewing in slow motion’: patients’, families’, nurses’ and doctors’ perspectives on end-of-life care in critical care**. 2013, **22**:1442-1454.
6. Metaxa V, Anagnostou D, Vlachos S, Arulkumaran N, Besemane S, van Dusseldorp I, Aslakson RA, Davidson JE, Gerritsen RT, Hartog C *et al*: **Palliative care interventions in intensive care unit patients**. *Intensive Care Medicine*, **47**(12):1415-1425.
7. Spencer AL, Miller PR, 3rd, Russell GB, Cornea I, Marterre B: **Timing is everything: Early versus late palliative care consults in trauma**. *J Trauma Acute Care Surg* 2023, **94**(5):652-658.
8. Love G, Mangan S, McKay M, Caplan H, Fitzpatrick E, Marks JA, Liantonio J: **Assessing the Feasibility and Implementation of Palliative Care Triggers in a Surgical Intensive Care Unit to Improve Interdisciplinary Collaboration for Patient and Family Care**. *Am J Hosp Palliat Care* 2022:959-964.
9. Chung TH, Nguyen LK, Lal LS, Swint JM, Le Y-CL, Hanley KR, Siller E, Chanaud CM: **Palliative Care Consultation in the Intensive Care Unit Reduces Hospital Costs: A Cost-Analysis**. *Journal of palliative care* 2022:82585972210959.
10. Helgeson SA, Burnside RC, Robinson MT, Mack RC, Ball CT, Guru PK, Moss JE: **Early Versus Usual Palliative Care Consultation in the Intensive Care Unit**. *American journal of hospice & palliative medicine* 2023, **40**(5):544-551.
11. Shemme AJ, Phillips JN, Bloise R, Koehler TJ, Gorelick PB, Francis BA: **The Impact of a Neurocritical Care and Neuropalliative Collaboration on Intensive Care Unit Outcomes**. *American Journal of Hospice and Palliative Medicine®* 2022, **39**(6):687-694.
12. Kamdar HA, Gianchandani S, Strohm T, Yadav K, Chou CZ, Reed L, Norton K, Hinduja A: **Collaborative Integration of Palliative Care in Critically Ill Stroke Patients in the Neurocritical Care Unit: A Single Center Pilot Study**. *J Stroke Cerebrovasc Dis* 2022, **31**(8):106586.
13. Field BE, Devich LE, Carlson RW: **Impact of a comprehensive supportive care team on management of hopelessly ill patients with multiple organ failure**. *Chest* 1989, **96**(2):353-356.
14. Schneiderman LJ, Gilmer T, Teetzel HD: **Impact of ethics consultations in the intensive care setting: a randomized, controlled trial**. *Crit Care Med* 2000, **28**(12):3920-3924.
15. Hatler CW, Grove C, Strickland S, Barron S, White BD: **The effect of completing a surrogacy information and decision-making tool upon admission to an intensive care unit on length of stay and charges**. *J Clin Ethics* 2012, **23**(2):129-138.
16. Schneiderman LJ, Gilmer T, Teetzel HD, Dugan DO, Blustein J, Cranford R, Briggs KB, Komatsu GI, Goodman-Crews P, Cohn F *et al*: **Effect of ethics consultations on**

- nonbeneficial life-sustaining treatments in the intensive care setting: a randomized controlled trial. *Jama* 2003, **290**(9):1166-1172.
17. Bein T, Koch S, Schulz C: **What's new in intensive care: environmental sustainability.** *Intensive Care Med* 2021, **47**(8):903-905.
 18. Prasad PA, Joshi D, Lighter J, Agins J, Allen R, Collins M, Pena F, Velletri J, Thiel C: **Environmental footprint of regular and intensive inpatient care in a large US hospital.** *The International Journal of Life Cycle Assessment* 2022, **27**(1):38-49.
 19. McGain F, Burnham JP, Lau R, Aye L, Kollef MH, McAlister S: **The carbon footprint of treating patients with septic shock in the intensive care unit.** *Crit Care Resusc* 2018, **20**(4):304-312.
 20. Pollard AS, Paddle JJ, Taylor TJ, Tillyard A: **The carbon footprint of acute care: how energy intensive is critical care?** *Public Health* 2014, **128**(9):771-776.
 21. D Grimaldi ME, B Verneuil, E Hosten: **The carbon footprint of ICUs depends on the electricity mix of the national or local grid.** *BMJ* 2023, **382**:1773.
 22. Mooren N, Quante M: **Utilitarianism and Care at the End of Life.** In: *Contemporary European Perspectives on the Ethics of End of Life Care.* edn. Edited by Emmerich N, Mallia P, Gordijn B, Pistoia F. Cham: Springer International Publishing; 2020: 37-54.
 23. Yip Y-Y, Cheung JC-H, Lam KN: **Rule of Double-Effect and Utilitarianism: Intensivist Perspectives.** *Chest* 2021, **160**(2):e250-e252.
 24. Baid H, Damm E, Trent L, McGain F: **Towards net zero: critical care.** *BMJ* 2023, **381**:e069044.
 25. Marseille E, Kahn JG: **Utilitarianism and the ethical foundations of cost-effectiveness analysis in resource allocation for global health.** *Philosophy, Ethics, and Humanities in Medicine* 2019, **14**(1):5.
 26. Nayfeh A, Kamra M, Fowler RA: **Redefining Health Care Utilization as a Quality Measure for Goal Concordance at the End of Life.** *JAMA Network Open* 2021, **4**(4):e213835-e213835.
 27. Vink EE, Azoulay E, Caplan A, Kompanje EJO, Bakker J: **Time-limited trial of intensive care treatment: an overview of current literature.** *Intensive Care Medicine* 2018, **44**(9):1369-1377.