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EDITORIAL

Less is more for greener intensive care

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Climate change threatens human health and increases demand for healthcare. Global temperature is rising in near linear relationship with increasing carbon dioxide (CO_2) in Earth's atmosphere, bringing hotter and more extreme weather. Health consequences include direct injuries, deaths and illness, and indirect effects such as infectious diseases and malnutrition. These impacts drive more people to seek healthcare, adding to global increases in health service demand and provision.

However, healthcare itself is polluting, including that delivered in the intensive care unit (ICU) [1]. The majority of healthcare's climate footprint comes from healthcare products such as pharmaceuticals and medical devices and from the delivery of health care services. This means that to achieve net zero health systems, we must lower the footprint of clinical care itself [2, 3]. The ICU is a carbon hotspot within hospitals, which themselves account for a large proportion of healthcare's total footprint [1]. There is an urgent need to transition to more sustainable models of delivering healthcare, and a key strategy in this is to limit healthcare overuse.

Sustainable healthcare in intensive care setting, as with other settings, may be guided by the United Kingdom (UK) Centre for Sustainable Healthcare's Principles of Sustainable Clinical Practice [4]. The principle of lean service delivery is equivalent to the "Less is More" concept advocating for a less aggressive approach to care of the critically ill patient [5, 6]. The aim is to limit low-value or harmful care, including unnecessary screening, diagnostic and monitoring tests, diagnoses (overdiagnosis) and treatment (overtreatment). Low-value care is a compelling target for reducing carbon emissions within healthcare, as this care offers minimal to no benefit in terms of patient care and health outcomes, and may even cause net harm, so there is no deficit to health from its omission [2].

There is increasing awareness of potential harms from low-value care in ICU settings. Thresholds to intervene tend to be lower in the ICU—both for decisions to test and to treat—and frequent routine monitoring and pre-emptive treatments are the norm. At the same time, critically ill patients are more vulnerable to adverse effects that each of these interventions may cause [5]. Combined, these two factors may mean that low-value care is particularly prevalent in the ICU [5]. Recognition of this has led to a shift in several important paradigms for care delivered in the ICU in the last decade [5, 6]. These include a move away from protocolized care (such as routine use of central venous catheters in the management of sepsis), less aggressive approaches to use of ventilatory support, resuscitation fluids, red blood cell transfusions, renal replacement therapy, blood pressure support, and nutrition [1]. The need for ICU care in the first place may also be reduced by preventing the progression of illnesses and inpatient admissions, and by avoiding unnecessary or futile ICU admissions. Using the principles of palliative care, the delivery of goal-concordant care means that patients are less likely to get care that will not benefit them especially at the end of life.

To further elucidate potential "less is more" strategies that may be used in the ICU, we undertook a scoping review of interventional studies targeting low-value care in the ICU. Full details of the review are provided elsewhere [7] and briefly summarised here. Of 1146 records screened, we included 27 studies published from 1993 to 2023 and conducted in nine countries. The studies reported on interventions to reduce routine blood tests ($n=11$), daily routine chest X-rays ($n=8$), transition to small volume blood collection tubes ($n=1$), reduce unnecessary red blood cell transfusion ($n=1$), unnecessary stress ulcer prophylaxis ($n=1$), and multiple low-value care targets ($n=5$). Table 1 highlights 5 of

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Table 1 Health benefits and financial savings from interventions to limit low-value care in the ICU

Author, Year, Country	Study design	Intervention	Health impacts and financial savings
Siegel, 2023, Canada[8]	Stepped-wedge cluster randomised trial including 27,411 patients	Smaller volume blood test tubes	9.84 (95% CI, 0.24 to 20.76) fewer RBC units transfused per 100 patients during their ICU stay Financial savings not reported
Bodley, 2023, Canada[9]	Quality Improvement Study including 702 patients pre-intervention, 440 patients during implementation, 954 patients post-implementation	Education and awareness campaign including audit and feedback of ICU blood test volumes, a bedside rounds checklist, and electronic order set modifications	2.2 fewer RBC units transfused per 100 patients during their ICU stay; Incident Rate Ratio 0.56 (95% CI 0.35 to 0.88) Financial savings not reported
Dhanani, 2018, Australia[10]	Quality Improvement Study including 1141 patients pre-intervention, 1067 patients during implementation, 1042 patients post-implementation	Review and targeting tests, redesigning the laboratory order form, medical staff education, consultant intensivist-led ordering practices, intensive non-invasive monitoring	Compared to pre-intervention, there was a significant reduction in the duration of mechanical ventilation and number of patients ventilated, and a (non-significant) 17.9% reduction in the packed red blood cell usage in the intervention period. Similar reductions in fresh frozen plasma and platelet transfusions in the intervention and post-intervention periods Financial savings of $388,593 over two years (Australian dollars).
Murphy, 2016, USA[11]	Quality Improvement Study of seven ICUs over three years (number of participants not reported)	Group-based financial incentives (all or nothing), provider education, and an audit and feedback to lower frequency of arterial blood gas testing, CXRs, and RBC transfusions	Proportionately 33% lower probability of receiving RBCs ($p < 0.01$) Lower ICU mortality: odds ratio = 0.41 (CI 0.35–0.48; $p < 0.01$) Lower hospital mortality; odds ratio (CI 0.37–0.51; $p < 0.01$) Estimated total gross direct cost savings of $1,942,735 over the study period of three years directly attributable to reduced utilisation of ABGs, CXRs, and RBCs. Accounting for $398,640 paid out for provider incentives, estimated net savings of $1,544,095 over the study period, averaging approximately $772,048 net savings per year (US Dollars).
Gutsche, 2013, USA[12]	Quality Improvement Study including 495 patients	Implementation of an anaemia clinical practice guideline reinforced with education and retrospective audit/feedback	Unnecessary transfusion decreased from 14.7% before to 8.1% after guideline implementation ($p = 0.016$). The post-intervention group had non-significantly lower rates of: postoperative renal failure (6% v 4.5%) ICU length of stay (mean hours, 79 vs 80.5), hospital length of stay (mean days, 10 vs 9.1), and 30 days mortality (3.6% vs 2.1%). Financial savings not reported

ABGs arterial blood gas analyses, *CI* condifence interval, *CXRs* chest X radiographies, *ICU* intensive care unit, *RBC* red blood cells

the included studies that reported benefits to health (for findings on all 27 studies included in the review, see [7]). One large stepped wedge cluster randomised trial [8] and four quality improvement studies (with before/after comparisons) [9–12] demonstrated the following benefits to health from doing less in the ICU: decreased red blood cell transfusions [8–12], decreased days of ventilatory support [10], and decreased mortality [11]. Among the full 27 included studies, financial savings were reported in all studies where this was measured and were as high as $1,544,095 United States Dollars (savings reported by one study over three years and across seven ICUs). A striking finding of the review is that not one of the 27 studies considered potential environmental benefits of limiting low-value care.

There are already multiple reasons to limit unnecessary or harmful care in the ICU-to improve patient health, free up ICU nurses and other clinicians' time, and lower financial costs. Decreasing the environmental footprint of the ICU is another compelling reason, and one that may be especially motivating to clinicians [13]. The high proportion of clinician-run quality improvement studies included in our review suggests that there is already strong clinician interest in limiting low-value care. Coupled with clinician concern about the climate crisis, this is creating clinician champions who will lead the way to achieving net zero care in the ICU [14].

The co-benefits of limiting low-value care has been recognised for health, resource use, financial savings for some time. But only recently are those working to promote value-based health care recognising that there are substantial environmental co-benefits to limiting unnecessary or harmful care [15]. Similarly, the importance of "lean care" in lowering healthcare's carbon footprint is increasingly recognised among those working to promote sustainable health care [16]. The close alignment of agendas for both fields should encourage researchers, practitioners, and policy makers to collaborate on shared endeavours with the common goal of health care stewardship [16]. For a greener ICU, we call for healthcare researchers to measure the environmental benefits of interventions to limit low-value care, and for healthcare practitioners to increase implementation of "less is more" interventions.

For details of 27 studies of interventions to limit low-value care in the ICU, see [7].

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Declarations

Conflicts of interest
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