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LETTER

W(h)at(t) counts in electricity consumption in the intensive care unit

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Dear Editor,
Electrical devices such as ventilators, patient monitors, or syringe pumps are indispensable in intensive care medicine. In the European Union (EU), 35.6% of total electricity was generated from fossil sources (coal, oil, natural gas) in 2020, ranging from 0.5% in Sweden to 88.7% in Malta [electronic supplementary material, ESM, 1]. Electricity consumption thus contributes to climate change and related health implications [1], unless electricity generation is completely decarbonised. Additionally to the climate effect, high electricity prices impose a financial burden on health systems. Currently, power outages during hours of peak demand appear to be a realistic threat even in high-income nations that are not fully energy-independent [ESM2]. Efforts to identify and reduce unnecessary power consumption in hospitals are therefore highly warranted for ecological and economic reasons. Given the device-centred nature of critical care medicine, intensive care units (ICUs) are very electricity-dependent but, at the same time, could be at the forefront of saving energy in the hospital [2–4]. As has already been proposed and partially implemented in anaesthesiology [5], environmental sustainability in critical care medicine needs to be based on a multimodal approach, power saving being only one part of it. Apart from electricity, other forms of energy use, such as room heating and air conditioning are major contributors to the carbon footprint of intensive care medicine [3]. While in use for patient treatment, electrical devices necessarily consume electricity and only technical improvements by the manufactures will reduce power consumption. However, not all devices are needed all the time and behavioural changes by the ICU-staff, such as not leaving devices in standby mode for prolonged intervals, might hold potential for energy savings. To identify potential to save power without jeopardising patient safety at the ICU, we analysed the power consumption of medical devices of a typical ICU-bed-space and calculated the related possible reductions in carbon dioxide (CO_2) emissions.

Power consumption as expressed by active power P in Watts (W) of typical ICU-devices was measured in different modes of operation (Table 1). Measurements were performed with a power meter (Tevion GT-PM-04) and repeated six times. Arithmetic mean and standard deviation were calculated with GraphPad Prism (GraphPad, Boston, MA, USA). Calculations for CO_2-reduction potentials were made by multiplying the reductions in power consumption with the emission factor in grams CO_2-equivalent (CO_2-eq) per kWh of the energy mix currently provided to our hospital.

The results of the power measurements of medical devices in different modes of operation are listed in the Table 1. A typical ICU-bed-space equipped with a ventilator, a patient monitor with two screens, five syringe pumps, two infusion pumps, and a feeding pump consumes (supplementary figure) 114 W in standby, 161 W while operating (236 W with the humidifier, which uses a heating plate, in the ventilation circuit), but only 22 W (e. g. for charging internal batteries) with the devices switched off. In our hospital, one kWh of electric energy generates emissions of 427 g CO_2-equivalent (CO_2-eq). For each hour with all devices switched off instead of in standby, 39 g [1 h*(0.114–0.022 kW)*427 g CO_2-eq/kWh] CO_2 equivalent can be avoided. The respective savings of CO_2 equivalent per hour for each device are listed in the Table 1.

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Table 1 Electricity consumption of medical devices in different modes of operation

Mode Device type	Off	Start-up	Standby	Operating	Operating with humidifier H-900	Emission savings per hour by avoiding standby
Ventilator Hamilton C6	7.4 ± 0.1	48.4 ± 0.2	53.3 ± 5.1	74.1 ± 2.7	149 ± 10	20
Patient Monitor Philips X3 + M750	1.8 ± 0.0	34.1 ± 0.6	30.5 ± 0.3	34.8 ± 0.4	NA	12
Secondary Monitor Philips A75	1.8 ± 0.0	22.7 ± 0.7	11.8 ± 0.0	18.8 ± 0.3	NA	4
Syringe Pump Fresenius Agilia Injectomat MC	1.9 ± 1.2	NA	2.4 ± 1.1	4.4 ± 0.9	NA	< 1
Infusion Pump Fresenius Agilia Volumat MC	4.4 ± 2.7	NA	3.4 ± 1.0	4.6 ± 0.8	NA	< 1
Feeding Pump Fresenius Amika	0.8 ± 0.0	NA	NA	1.7 ± 0.0	NA	NA

Active power P in W. Mean ± standard deviation. Emission savings in grams CO_2 equivalent

NA not applicable

Our results demonstrate that some devices, particularly the ventilator and the patient monitor, consume almost as much electricity in standby as in use (72% and 87%, respectively). Given the short start-up times (ventilator 52 s, monitor 29 s), avoiding standby-mode and switching on devices only when needed is safe. ICU-beds often remain vacant for several hours before the next patient is admitted. Likewise, patients may spend longer times on the ICU without being mechanically ventilated. Switching off medical devices during these times saves electricity, leading to a reduction of costs for healthcare systems and positive effects for the climate. In our ICU, ventilators are in use approximately 40% of the time on average. In our 14-bed-ICU, switching the ventilator off at 80% of the time when not in use, instead of leaving it in standby, would result in a reduction of 2707 kWh and thus a decrease in green house gas emissions of approximately 1.2 tons CO_2-eq per year. Assuming a price of electricity of 50 cents per kWh, this might save approximately 1350 € annually. Expressed in kilometres of electric driving, this amounts to approximately 20,000 km in an electric car (Tesla Model 3). The potential for CO_2-saving depends on the emission factor (grams CO_2-equivalent per kWh) in the respective hospital. The national average in Estonia, the highest in the EU, is 946 g CO_2-eq/kWh [ESM3]. For that emission factor, the same power saving would result in a reduction of emissions of 2.6 tons CO_2-eq. At the Swedish emission factor of 9 g CO_2-eq/kWh, on the other hand, it would have virtually no impact on CO_2. Compared with the climate effect of volatile anaesthetics or the energy needed for heating or air conditioning of the ICU, this is a rather modest potential for CO_2-emission reductions [3, 5]. It must be noted, however, that the amount of energy needed for and the CO_2-emissions generated by heating and air conditioning depend on architectural and meteorological/geographical features as well as the primary energy sources used. The effect of just saving power is small. For comparison, the possible reduction of emissions of 1.2 tons CO_2-equivalent per year by switching of the ventilators on our ICU, as calculated above, is only approximately 15% of the average emissions per capita in Germany of 8 tons CO_2-equivalent per year [ESM4]. Therefore, further measures to reduce energy consumption and thus CO_2-emission at the ICU ought to be identified and exploited. Reducing room temperature by 1 °C during heating periods, for example, is estimated to reduce the energy needed for heating by approximately 7% [ESM5]. Nevertheless, power savings by avoiding useless electricity consumption in standby can be one of many possible contributions to make intensive care medicine more environmentally sustainable—just as we switch off the light when leaving a room.

Supplementary Information

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Author contributions

DH: conceptualisation, formal analysis, investigation, project administration, writing—original draft. CS: conceptualisation, writing—review and editing. DJ: resources, validation, writing—review and editing. WAW: investigation, supervision, writing—review and editing.

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Data availability

All underlying data can be made available upon request to the corresponding author.

Declarations

Conflicts of interest
All authors declare that they have no conflicts of interest with regard to this study.

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