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EDITORIAL

Machines that save lives in intensive care: why a special issue in ICM?

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This special issue entitled "Machines that save lives" provides a state-of-the-art update by the most renowned world experts on extracorporeal organ support (ECOS) machines and monitoring devices used to treat patients in the intensive care unit (ICU).

This year marks the 70th anniversary of the foundation of intensive care medicine. In 1952, a devastating polio epidemic arose in Copenhagen (Denmark), which resulted in thousands of patients requiring artificial ventilation for severe respiratory failure. At that time, the iron lung that used negative pressure was the only treatment to provide respiratory support to paralyzed people with poliovirus. However, only one machine was available in Copenhagen, while the hospital admitted dozens of infected people daily. Furthermore, aspiration of saliva or stomach content was frequent under negative pressure ventilation in patients with bulbospinal polio. To overcome these difficulties, Bjorn Ibsen, an anesthesiologist at Blegdam Hospital in Copenhagen, suggested to apply positive pressure ventilation through a tracheostomy to ventilate the lungs and protect the airways. Medical and dental students (> 1500) were employed to provide manual ventilation for weeks to these patients and hundreds of lives were saved. To improve the logistics related to the care of so many patients, it was decided to gather them at a single hospital location. The first ICU was born in Europe. In the following months, machines previously used for short-term anesthesia that delivered positive pressure to the lungs replaced manual ventilation. This was the birth of the concept of "machines that save lives of critically ill patients".

Over the following seven decades, many other machines and monitoring devices that help to save lives in the ICU have been developed. Indeed, since critically ill patients need constant, close monitoring and support, organ suppliance machines and medications to preserve organ function, the ICU is one of hospital departments in which are deployed most of the "machines to better treat patients" and probably "to save lives". In the last decade, major advances in computer science and device technologies occurred, making the latest generation of machines even more efficacious and user-friendly. A versatile ECOS platform may now be used for single or multiple organ support, while monitoring devices have been miniaturized and equipped with artificial intelligence algorithms to provide better and safer care to our patients with multiple organ dysfunction syndrome (MODS). In the future, multiple organ support therapy (MOST) may provide combined and simultaneous support to different failing organs. MOST could include oxygenation and ventilatory support, extracorporeal membrane oxygenation (ECMO)/extracorporeal carbon dioxide removal ($ECCO_2R$), mechanical circulatory support ECMO, percutaneous and surgical ventricular assist devices, renal replacement therapy (RRT), extracorporeal liver support, plasmapheresis and sorbent therapies. All these techniques are currently used in the ICU although very little is known about their interaction with native organs and other artificial organ support systems. The principle of *primum non nocere* (first, do no harm) should be always applied to all critical ill patients, and specifically for these machines. A multidisciplinary approach may be needed to minimize additive negative interactions and unwanted adverse effects of each ECOS devices. Also, it should

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always be reminded that medical competence, humanity, and the collaborative care provided by the ICU team are the cornerstone of the quality of care delivered to our patients.

As in previous special issues of Intensive Care Medicine (ICM), you will read both short and long pieces. The goal of the short pieces is to briefly summarize key messages in relation to important topics. Long pieces are more extensive and summarize recent advances related to different ICU syndromes in a much more thorough manner. In addition, there are selected hot topics, original articles, conference reports and expert panel papers, position papers, and all manner of manuscripts guided by the best way to use the machines and the monitoring devices. We strongly encouraged authors to include informative figures and summary tables in their manuscripts. Specifically, regarding the respiratory system, especially for patients with acute respiratory failure and/or acute respiratory distress syndrome (ARDS) (both associated and non-associated with coronavirus disease 2019 (COVID-19), you will read manuscripts including the most up to date approach on the use of invasive and non-invasive ventilatory support devices or machines [1–3], the most recent evolution of the ECOS therapies such as extracorporeal lung support (ECLS) including ECMO [4, 5] and $ECCO_2R$ [6, 7]. New paradigms are developed such as lung and diaphragm protective ventilation guided by the esophageal pressure [8] and the use of phrenic nerve stimulation to protect the diaphragm, lung, and brain during mechanical ventilation [9]. You will find the most recent update on optimal renal replacement therapy (RRT) strategies in critically ill patients with acute kidney injury [10] and the optimal monitoring of renal perfusion [11]. Regarding cardiovascular failure, you will find manuscripts including the most up to date approach on monitoring tools that assess volume status [12], monitor invasive arterial pressure [13], central venous pressure [14], the prevention of intra-vascular accesses complications [15] and the optimal use of ultrasonography machines [16]. Since blood purification techniques are being extensively used in ICU, narrative state-of-the-art reviews of plasma exchange [17] and hemoperfusion are provided [18]. For central nervous system injury, several updates are included on devices and monitoring of intracranial pressure [19], targeted temperature management (TTM) especially after cardiac arrest [20] and the use of electroencephalogram in acute brain injury [21]. Assisted nutritional and metabolic support machines [22] and liver suppliance machines are also discussed [23]. However, given that SARS-CoV-2 had such a major impact on the function of the lungs and other vital organs, we expanded the range of topics to address some COVID-19 specific issues.

In this special issue, we were not able to address every relevant topic. Instead, we focused on the most recent and important advances, which have influenced our daily practice [24–30]. We are grateful to all experts who have contributed to this particular issue of the Journal. We hope that it will benefit to clinicians and caregivers, and that it will ultimately improve the outcomes of critically ill patients. We hope that you, our readers, will enjoy this special issue and its many articles.

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Declarations

Conflict of interests
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