Multiple organ support

Introduction to multiple organ support, D. Abrams et al.
From multiple organ support therapy (MOST) to extracorporeal organ support (ECOS) in critically ill patients, C. Ronco et al.
Chronic respiratory dialysis, D. Abrams et al.
Understanding LVAD & artificial hearts, N. Aissaoui et al.

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CO₂ in the critically ill, L. Morales-Quinteros et al.
Immune dysfunction in sepsis, V. Herwanto et al.
Hypothermia in neurocritical care patients other than cardiac arrest, R. Helbok & R. Beer
Intracranial pressure monitoring devices, S. Patil & F. Fadhlillah
Complications of decompressive craniectomy in neurological emergencies, I. Gonzalez
A novel communication device for tracheostomy ICU patients, F. Howroyd
The Critical Care Resuscitation Unit, L.I. Losonczy et al.
Variation in end-of-life care, A. Michalsen
Simulate or not to simulate? M. Poggioli et al.
Being an expert witness, J. Dale-Skinner
Role of the chaplain in the ICU, K. Jones
Developing new approaches to patient safety, J. Welch et al.
How to provide better intensive care? J. Takala
Caring for critically ill immunocompromised patients, E. Azoulay
Introduction to multiple organ support

There is a renewed interest in novel extracorporeal technologies as a means of supporting individual organ failures. An emphasis should be placed on characterising the spectrum of extracorporeal devices for various organs and understanding how devices intended for support of one organ can have an indirect or direct impact on other organs, which is particularly relevant as different extracorporeal platforms may become integrated.

Likewise, the treatment of one organ failure often directly impacts and may adversely affect another, as has been demonstrated with the direct effects of invasive mechanical ventilation on haemodynamics and the downstream effects of ventilator-induced lung injury on kidney function (Goligher et al. 2016; Husain-Syed et al. 2016; Luecke and Pelosi 2005).

The concept of extracorporeal support of organ failure is not new, with mechanical ventilation and renal replacement therapy (RRT) having been available for decades as a means of artificially supporting lung and kidney function, respectively (Bellomo et al. 2016; Luecke and Pelosi 2005). However, in light of recent technological advances, there has been a renewed interest in novel extracorporeal technologies as a means of supporting individual organ failures, such as venovenous extracorporeal membrane oxygenation (ECMO) and extracorporeal carbon dioxide removal (ECCO2R) for respiratory failure, venoarterial ECMO, ventricular assist devices (VAD) and total artificial heart for cardiac failure, and artificial liver detoxification systems for hepatic failure (Abrams et al. 2014; Aissaoui et al. 2018; Brodie and Bacchetta 2011; Chiumentello et al. 2017; Thompson et al. 2017; Trudzinski et al. 2016).

As a result, an emphasis has been placed on characterising the spectrum of extracorporeal devices for various organs, collectively termed extracorporeal organ support (ECOS) (Figure) (Ranieri et al. 2017). It will be important with time to better understand how devices intended for support of one organ can have an indirect or direct impact on another organ. This becomes particularly relevant as different extracorporeal platforms may become integrated, as has already been shown to be feasible with ECMO and RRT (Fleming et al. 2012). As these devices evolve to offer simultaneous support for multiorgan failure (Ronco et al. 2015), it will be important to emphasise a multidisciplinary approach at centres with capabilities of performing both extracorporeal and advanced non-extracorporeal management strategies, which in turn may warrant particular organisational and regionalisation considerations (Abrams et al. 2018; Combes et al. 2014).

The potential for development of integrated extracorporeal platforms has significant implications for clinical outcomes. Traditionally, patients who might benefit from one form of ECOS, such as venovenous ECMO for acute respiratory distress syndrome, are often deemed to be ineligible due to severe extrapulmonary organ dysfunction (e.g. hepatic failure). However, with multiorgan ECOS availability, such patients might be considered preferred candidates for an integrated extracorporeal approach.

Importantly, the discussion of ECOS often
COVER STORY: MULTIPLE ORGAN SUPPORT

focuses on the management of acute organ failure within an intensive care setting. However, as these devices become more efficient, portable, and durable (Cheung et al. 2015; Kischkel et al. 2017; Ronco et al. 2014; Seiler et al. 2017), the conversation must also address the potential future role of ECOS in the management of chronic organ failure, both as novel single-organ devices and applications (e.g. artificial lung, chronic respiratory dialysis) and as integrated destination device systems (e.g. VAD plus artificial lung, RRT plus extracorporeal liver assist device, etc). In both the acute and chronic setting, advances in extracorporeal technology hold the promise of these integrated systems being able to engage in artificial organ crosstalk and auto-regulation, much in the way native organs currently behave (Vincent et al. 2017).

In this issue of ICU Management & Practice, the authors will address the role of various ECOS systems as they currently exist, the potential for these single organ-focused systems to be integrated into multiorgan platforms, and future directions of ECOS toward long-term, multiorgan support systems, all of which will help to reframe the concept of ECOS in a new paradigm for the management of severe organ failure.

Conflict of interest
Daniel Brodie is currently the co-chair of the Trial Steering Committee for the VENT-AVOID trial sponsored by ALung Technologies. He was previously on the medical advisory board of ALung Technologies and Kadence (Johnson & Johnson). All compensation for these activities is paid to Columbia University. Darryl Abrams and Marco Ranieri declare that they have no conflict of interest.

Abbreviations
- ECCO2R extracorporeal carbon dioxide removal
- ECMO extracorporeal membrane oxygenation
- ECOS extracorporeal organ support
- RRT renal replacement therapy
- VAD ventricular assist devices

Figure.
Phases of extracorporeal organ support for the lung, heart, kidney, and liver (Ranieri et al. 2017)
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