

EDITORIAL



Economic sustainability of intensive care in Europe

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The changing demographics and increase in demand

During the last decades, the classical age pyramid distribution of age has been inverted in most European countries. As a result, fewer working-age people can work in healthcare or financially support the social case (including healthcare) of the growing number of aging people [1].

The combination of falling birth rates and increasing lifespan is accelerating these demographic shifts in Europe. These trends are resulting in most European countries in increased healthcare costs. This applies obviously to the intensive care unit (ICU) and creates opportunities and challenges.

Shifting demographics will also mean increased healthcare delivery in the community, even at home, with remote monitoring and home care becoming part of integrated healthcare systems. This will be necessary to deliver care where needed, mainly to invest in disease prevention and management of chronic conditions. And while these changes are welcome, hospitals and intensive care budgets will compete with these changes in resource allocations.

Even resource-rich countries must consider balancing the costs of interventions like providing intensive care adequately and appropriately, considering the benefits for individuals and society. In this sense, healthcare must be seen as a continuum; for instance, rather than expanding the capacity of healthcare services to treat a disease, we should put significant efforts into preventing it and/or recognizing and treating it early. The recent coronavirus

disease 2019 (COVID-19) pandemic has shown that reducing severe COVID-19 infections with vaccinations and public health measures was more effective and sustainable than surging ICU capacity during uncontrolled outbreaks [2, 3].

This should not come as a surprise. Childhood mortality rates have decreased significantly over the past century as a result of widespread vaccinations and public health measures. Sepsis is an example of where ICU leaders should work with public health and policymakers to prevent, recognize, and treat it better before hospitalization, in the first hours of hospitalization, and finally in the ICU.

To create this continuum of care, more efforts must also be in place to follow-up and help rehabilitate patients (and their families) after critical illness, allowing them to return to a good quality of life and, if possible, to a productive role in society.

In times of economic and geopolitical turbulence, managing reduced budgets in some European countries can become increasingly complex. The adoption of new drugs and technology is necessary, but with constrained budgets, it must compete for allocation with staff pay, impacting healthcare professions' attractiveness and worsening the demand-resource imbalance. Managing healthcare in countries where budgets are already reduced as a percentage of gross domestic product (GDP) can be challenging, especially when the expenditure for drugs is continuously rising due to the increase in antimicrobial resistance or new biological agents. This is why we need to view healthcare as a continuum. To tackle the challenge of antimicrobial resistance, a systemic approach is required, which takes into consideration all aspects of drug consumption, from the food industry to prescription practices.

It is crucial to use data-driven approaches to increase ICU efficiency and ensure long-term sustainability. For

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instance, after hard work structuring and annotating data using a consented terminology—a prerequisite to use artificial intelligence (AI), real-time data monitoring will be able to fine-tune the prediction of required resources in ICU demand and help plan and allocate resources accordingly and flexibly.

Supply and demand, local and global impacts, and the need for new disruptive solutions

An imbalance in healthcare resource allocation has global and local impacts. The persistent shortage of healthcare professionals presents a daunting challenge. This shortage has resulted in a concerning trend where countries offering more lucrative compensation packages attract healthcare workers from regions with less competitive pay scales. The migration of healthcare professionals from the South and East to Central and Northern European countries has become a long-standing reality, a phenomenon viewed differently depending on one's perspective [4, 5]. In response to this predicament, some European nations have turned to global recruitment efforts, particularly from low- and middle-income countries, to meet their healthcare workforce needs. It is essential to note that Europe's healthcare workforce shortage may be addressed sustainably by enhancing local working conditions, developing new professional roles, and utilizing new technology.

It may not always be the best idea to assign more tasks to healthcare technicians. Overburdening them with additional responsibilities could lower the quality of care they provide and compromise training standards. Therefore, it is crucial to balance their workload to ensure holistic and comprehensive patient care. This is applicable to any healthcare profession. While new technology can assist with economic sustainability, the most valuable assets of any ICU are its teams, including doctors, nurses, physiotherapists, pharmacists, and many more team members working in health care. It is essential to value and preserve their competence and well-being and define communicational interaction periods to enhance patient safety.

Resource-strapped ICUs are exploring solutions like telemedicine and AI. During the pandemic, telemedicine allowed specialized units to assist smaller hospitals efficiently in urgent cases and provided evidence-based translational expertise [6]. When combined with blended learning and regional hospital collaboration, telemedicine can improve care quality while cutting costs. Its also becoming essential for long-term patient monitoring, including timely diagnostic procedures and management of post-intensive care syndrome. Telemedicine for routine data collection through Patient-Reported Outcome Measures (PROMs) and Patient-Reported Experience

Measures (PREMs) has shown promise in managing chronic conditions. It could similarly improve long-term ICU care [7]. In addition, due to the European and global empowerment of healthcare professionals applying evidence-based medicine everywhere, it is one tool for decreasing inequity.

The healthcare industry is experiencing a transformation with the introduction of advanced technologies such as robotics in surgery and AI-managed pre-hospital consultations. However, it is crucial to thoroughly evaluate the impact of these technologies on patient outcomes and safety before implementing them. The mere adoption of modern technology does not automatically result in better outcomes for patients [8].

The field of AI is rapidly evolving, and its time to welcome it in the ICU. However, we cannot fully utilize AI in healthcare decision-making, which is based on extensive databases, unless we speed up the adoption of electronic health records (EHRs) in the areas where they are not available yet. In addition, it is essential to create interconnected data lakes that form a federated network at the European level. This collaborative effort will allow for the use of real-time evidence in ICUs, identify research gaps, and ultimately improve patient safety. While automated care will still need time, wearable remote devices and interconnected monitoring systems can be implemented preventively by tracking patients after ICU discharge, detecting problems, and identifying the need for augmented care.

To guarantee the economic sustainability of our ICUs, we may need to adopt these technologies sooner rather than later for well-studied processes, such as weaning protocols, bundles of care, changes in the way working hours are distributed, etc. This may be free time now spent on bureaucratic tasks, which could be spent with patients and families instead, improving the perceived satisfaction of patients and families and our healthcare workers and reducing their burnout and turnover [9]. This requires full-time working bridge workers between medicine and medical informatics, improving structure and annotation of data based on a clearly defined terminology, knowing that this step is immensely time-consuming. Only if this step has been taken can data be used in AI, clinical routine, and data science to close the relevant gaps. There will be a growing need for new professional figures to drive this revolution and physicians with engineering skills and vice versa [10].

It is essential that we find new disruptive solutions and that we involve the younger generations in these debates [11]. This is important from a patient and family perspective, healthcare practitioner, and societal perspective. The generational shifts in values and attitudes, especially with the Z generation and millennials, are changing all aspects

of our societies and healthcare system, trading the possibility of extra money per quality of life and family time. Rather than fighting it, we should embrace it and use technology, research, and new working methods to adapt to these changes in life values. Optimizing healthcare efficiency must be factored into ICU operational models to ensure future economic sustainability without compromising quality and recent established trends such as environmental sustainability.

Complexity of systems and sustainability

Addressing supply–demand imbalances is critical, but its equally important to consider the sustainability of healthcare systems. This involves not only resource management but also technological and environmental considerations. In conjunction with the surging demand for intensive care and increasing severity of illness in those admitted to the ICU, we have seen tremendous technological progress and advances in evidence-based care. Caring for more severely ill patients with advanced care drives costs [12] not only because of new technologies. Advanced technology and the implementation of evidence-based care recommendations require specialized skills and training from medical professionals. These staff costs are also significant contributors to European ICU costs [13] but also the most relevant drivers of the future reshaping medicine sustainably in Europe. These improvements will likely be cost-effective from a societal perspective but may bring extra immediate costs. Funding schemes need to consider this to ensure these changes are sustainable.

Embedded in complex hospital ecosystems, we must also reinvent ICU workflows and energy supplies for renewables, waste reduction, and recycling [14, 15]. We must work toward the vision of fully self-sufficient hospitals with reduced bed capacity but with beds capable of flexible acuity, shifting from low to high intensity of care, and vice versa when needed. Patients will stay in the hospital only when acute care is needed. Across Europe, there is a need for solidarity between high- and low-resource regions to ensure the broad implementation of green and high-quality ICU care. In addition, we can learn from other countries that telemedicine allows many medical interventions close to hospitals, in hotels, or even at home. In addition, ICU and regular ward hospital beds require other environments to allow AI-supported self-healing. Resources must be balanced within the next years to allow this change management.

Benchmarking and cost-effective care

Given the increased complexity of ICU care, ICUs must consider long-term goals, such as research, public

engagement, and sustainability, and bring these topics to the forum that asks for active participation from society.

ICU process and results outcome measurements are strongly recommended in the context of a healthcare continuum. The sustainability of ICU is completely interconnected with the sustainability of healthcare and societies in general. Prevention of critical illness is as important as providing intensive care when prevention has failed. Support and rehabilitation from critical illness and family support are as essential as life-saving intervention during hospital / ICU admissions.

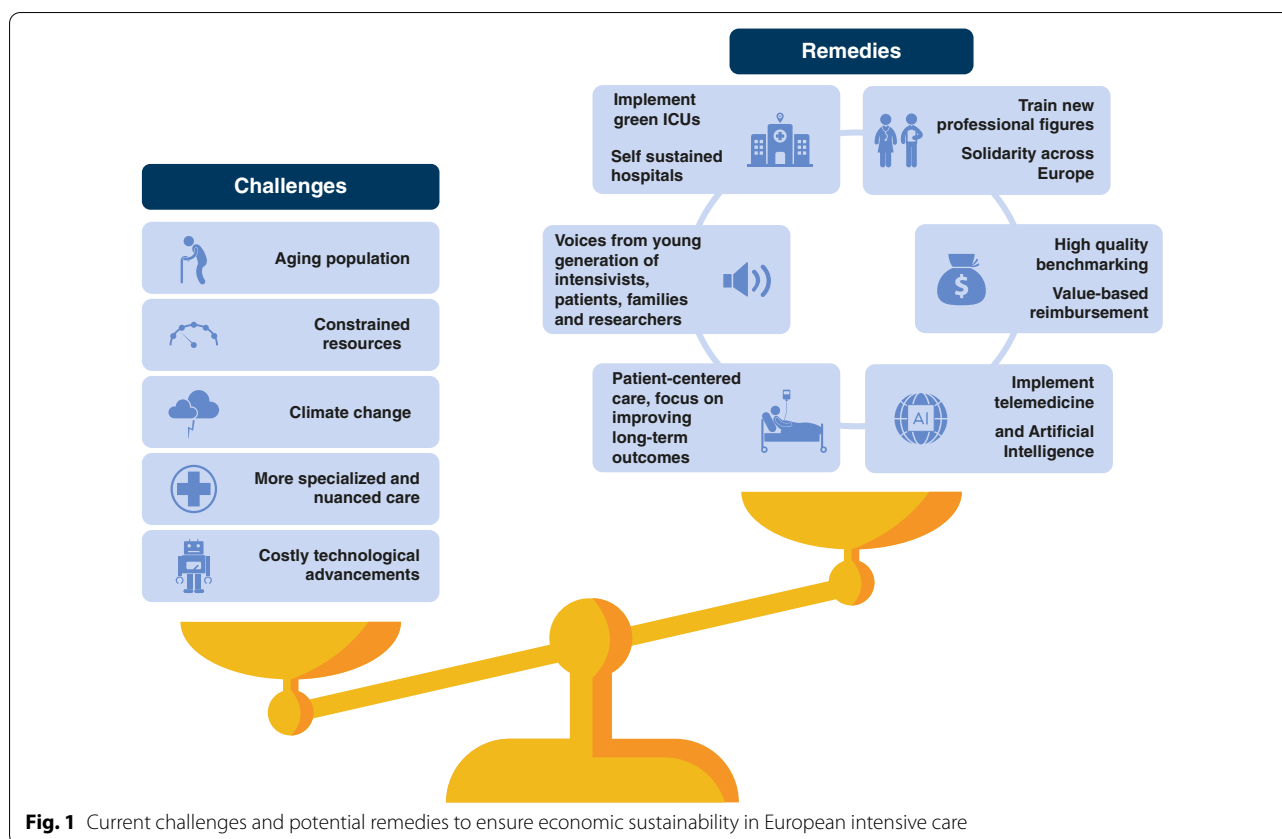
Reflections on ICU care are crucial for two main reasons. First, ICU care significantly affects the outcomes of patients with acute-on-chronic conditions. Second, it contributes to the overall hospital and long-term costs. Therefore, it is vital to strike a balance between what is possible and what is appropriate to avoid pursuing futile treatments.

Hence, there is a need to set benchmarks for the quality of patient care and its expenses. When properly analyzed, many of the changes introduced as significant resolutions in the last years result in only a few days or weeks of increase in the lifespan of the population [16] and, therefore, require adequate ethical and palliative standards to be integrated into the ICU workflow.

Reimbursement schemes in different healthcare systems across Europe must move toward reimbursing the cost-effective provision of high-quality ICU care. Considering these policy needs, there still needs to be more cost-effectiveness analyses in critical care research. New reimbursement schemes incentivizing cost-effectiveness also need to consider that patients with different severity of illness have different healthcare needs. To meet those ends without having a standard definition of an ICU bed in Europe, hospitals must provide different hierarchy levels of ICU care (e.g., PACU and ICU) in a fluid, interactive network [17]. To ensure the best use of ICU beds, a shared-decision allocation process is needed for ICU reimbursement. In the future, AI technology may guide this process, allowing for flexible criteria when admitting and discharging patients to and from the fluid network of ICU beds. In addition, reimbursement should consider the long-term outcomes of patients, such as their condition 6 months after receiving ICU care.

Take-home message

As we have discussed the many challenges and opportunities that ICUs face, it becomes evident that a multidimensional approach is essential for future sustainability and efficiency. ICUs stand at a crossroads, grappling with demographic shifts, technological advancements, and financial constraints (Fig. 1). These challenges are not just economic but ethical and societal. Innovations like



telemedicine and AI hold promise but require a collaborative, resource-intensive approach to establish structured and annotated data, and they will still pose questions about quality and ethics. A multi-pronged approach prioritizing efficiency and quality is crucial as we navigate these complexities. It is imperative for healthcare providers, policymakers, and society to collaboratively evolve ICUs into resilient, efficient, and inclusive systems acting for patients and their relatives during the difficulties of a critical illness. Immediate action is essential for the long-term health and sustainability of our communities.

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Conflict of interest

The authors declare that they have no conflict of interest.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received: 22 September 2023 Accepted: 3 November 2023

Published: 6 December 2023

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