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Intensive Care Medicine in 2050: toward an intensive care unit without waste

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In the year 2050 we will unambiguously reimburse healthcare based on value [1], and so there is good reason to suspect that we will have targeted and reduced many services that provide little or no benefit to patients. Because it is impossible to prove that an intervention provides zero benefit for all conceivable patients, it is useful to consider ways to reduce both no-value care and low-value care (e.g., services that provide small benefits, but come at a high cost).

There are two main categories of low-value critical care: (1) the allocation of intensive care unit (ICU) beds to patients who will not benefit over admission to a ward, and (2) the provision of excessive critical care resources to patients who appropriately gain entry into the ICU. While both are important, avoiding low-value ICU admissions portends generally greater cost reductions than avoiding waste from low-value services delivered to patients already admitted to the ICU [2–4].

A high-value ICU, therefore, will strive to admit only patients who will benefit from critical care services, and will maximize the value of care delivery to those who are admitted. Optimizing triage decisions for potential ICU admissions is an emerging and challenging area of research. This will require innovative study designs that allow for quasi-experimental, if not fully randomized, comparisons of outcomes of ward and ICU patients admitted from emergency departments. Such work will require highly granular adjustment for hospital- and patient-level risk factors. Ultimately, it may yield personalized triage approaches that are based not only on such formative work but also incorporate genetic

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predispositions [5] and real-time biomarkers [6] to help predict individual risk of clinical decompensation and ultimately “net ICU benefits”.

To date, the literature has not been up to this formidable challenge. Several studies suggest that patients who may not benefit from ICU admission are nonetheless commonly admitted to ICUs. These groups include patients with diabetic ketoacidosis, non-massive pulmonary emboli, and heart failure not requiring mechanical ventilation [7]. On the other hand, one recent study—the first to use a quasi-experimental design by incorporating an instrumental variable—identified a potential benefit to ICU admission for low-risk older adults with pneumonia [8]. However, it is difficult to draw practice-relevant conclusions from even this rigorous study because of potential confounding by unmeasured differences among hospitals (its design addressed whether admission to one hospital’s ICU yields better outcomes than admission to another hospital’s ward).

Other data suggest there are also patients who are admitted to ICUs when aggressive care will be insufficient to meaningfully forestall death [9]. While mortality is an important outcome, many factors other than survival should also be considered when studying optimal ICU bed allocation such as hospital length of stay, effective symptom palliation, and caregiver bereavement outcomes. If preference-concordant palliation can be better achieved in some ICUs than on corresponding hospitals’ wards, ICU admission for this purpose may be valuable indeed.

Another important question to ask in an effort to reduce waste is when has a critically ill patient recovered sufficiently for a safe ICU discharge. ICU resources delivered to a patient after critical care is no longer considered necessary are wasteful [10]. Additionally, interventions that may shorten ICU length of stay without improving mortality may nonetheless serve the goals both of patients and families (by shortening uncomfortable ICU stays) and of society (by reducing costs). Thus, future ICUs that more routinely perform daily sedation interruption and spontaneous breathing trials [11] and more commonly administer corticosteroids in septic shock [12] will reduce wasteful time in the ICU.

Aside from efforts to improve ICU triage decisions, there is also strong motivation to promote non-maleficence by eliminating ICU care that is burdensome without improving morbidity or mortality. Comparative effectiveness research, such as that which informed the Critical Care Collaborative’s Choosing Wisely list [2], seeks to identify high-value diagnostic and therapeutic interventions to reduce wasteful practices. In addition to the Choosing Wisely list, there are many additional interventions for which the harms or costs may outweigh the benefits. Future efforts to evaluate, and potentially reduce, utilization of diagnostics such as serial arterial blood gas measurements, peripheral arterial catheters for hemodynamic monitoring [13], brain imaging in the absence of focal neurological deficits, and routine echocardiography may therefore further improve the value of critical care (Table 1).

As with any paradigmatic shift, implementation is as vital as discovery. Data predicting which patients would benefit from an ICU admission, for example, would need to be immediately and inexpensively available to clinicians making real-time triage decisions.

Similar data to inform advance care planning before the onset of critical illness could further improve the efficiency of critical care.

Finally, we must fully embrace the importance of educating our next generation of ward and critical care providers to lead in practicing high-value care [14]. More generally, we must engage society in open dialogue about how such changes in our approach will be evidence based, ethically sound, and equitably applied. While still nascent in their approach to integrating value with medical education, the Accreditation Council for Graduate Medical Education in the USA now includes safety, quality, and cost-effectiveness as mandatory training milestones that encompass medical professionalism by serving both individual patients and society [15]. To succeed in 2050, medical professionals must recognize their own cognitive biases, train future clinicians as responsible stewards of resources, and devise evidence-based strategies to efficiently de-adopt wasteful practice modalities that impair our ability to deliver high-quality critical care [16–18].

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Compliance with ethical standards

Conflicts of interest

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Table 1

Known and potential sources of ICU waste

Category of waste	Examples	Research approaches	Relevance
Inappropriate ICU admission for patients who will not benefit relative to ward admission	Patients potentially too well to benefit from ICU: DKA, non-massive PE, CHF exacerbation without MV	Nuanced comparison of ICU and ward cohorts	Greatest potential waste reduction
	Patients potentially too sick to benefit from ICU: some non-modifiable end-stage diseases	Personalized predictive modeling for risk of decompensation, response to therapies, and outcomes	
Deploying low-value care for patients appropriately admitted to the ICU	Known: standing diagnostic tests, unnecessary RBC transfusions, early TPN, excessive sedation, continued life support without discussions of comfort-based approaches for appropriately ill patients	Comparative effectiveness research focused on interventions that are expensive, obvious barriers to other good outcomes, or are of high risk to patients	Non-maleficence: patients avoid ineffective interventions
	Potential: serial ABGs for MV patients, arterial catheters for hemodynamic monitoring, brain imaging for non-focal AMS, routine TTEs for shock		
Unnecessarily prolonging ICU length of stay	Failure to discharge when ICU care no longer better than ward care	Reduction in ward strain to facilitate timely ICU discharge	Reduce long-term sequelae of critical illness
	Failure to deploy interventions that shorten critical illness/ICU LOS	Personalized predictive modeling for post-ICU outcomes	

ABG arterial blood gas, *AM* altered mental status, *CHF* congestive heart failure, *DKA* diabetic ketoacidosis, *ICU* intensive care unit, *LOS* length-of-stay, *MV* mechanical ventilation, *PE* pulmonary embolism, *RBC* red blood cell, *TPN* total parenteral nutrition, *TTE* transthoracic echocardiogram