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ECOLOGIC ANALYSIS OF CRITICAL CARE BURDEN WORLDWIDE AND POTENTIAL IMPLICATIONS IN ORGANIZATIONAL STRUCTURE OF INTENSIVE CARE UNITS

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The care of critically-ill patients is a specialized task that demands high human and financial resources. As an example, in the United States, each day of critical care costs approximately USD 3500 and in total accounts for 13% of hospital costs, all of which amounts to 1% of the gross national product (1). This burden is carried by more countries than just the United States; Adhikari et al. estimated that in 2004there were 13 to 20 million mechanically ventilated patients, 1.2 to 5.5 million patients with ARDS and 15 to 19 million patients with sepsis worldwide (3). However, despite the rapid expansion of critical care medicine and rising costs associated with treatment of the critically-ill worldwide, there is a dearth of information regarding the epidemiology of critical care particularly among low- and middle-income countries (2). Data regarding organizational structure and staffing of ICUs across different settings around the world remains scarce, which makes it difficult to estimatethe current global capacity to provide critical care (3). This is even more relevant in low- and middle-income countries where the availability of critical care services is limited and resources have to be used judiciously.

In this edition of the Journal,Vincent *et al.* (4) present a worldwide audit of 10,069 critically-ill patients admitted to 730 intensive care units (ICUs) in 84 countries and nine geographic regions. Overall ICU and hospital mortality rates were 16% and 22%, respectively. This study is important for several reasons. First, the authors found that sepsis accounted for 30% of the burden of critical care. While there was some variability by region in sepsis prevalence rate, the range was relatively narrow (20% to 39%) with the exception of South Asia that had a prevalence of 14%. These data suggest that an important proportion of critical care resources should be directed towards the management of sepsis regardless of setting. Second, the authors found an inverse relationship between gross national income

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(GNI) and severity-of-illness-adjusted mortality even though severity of illness was also inversely related with GNI. In their analysis, the authors stratified participating countries into three income groups according to GNI as defined by the World Bank 2011 Atlas method (5). The authors constructed a three-level hierarchical model of critically-ill patients within hospital within country to model the risk of inhospital death as a function of GNI tertiles, adjusted for individual patient (age, sex, SAPS II score, type of admission, source of admission, mechanical ventilation, renal replacement therapy, comorbidities and presence of infection) and ICU factors (type of hospital, ICU specialty, total number of ICU patients in 2011 and number of staffed ICU beds). This finding is not entirely surprising given what we know about the association between poverty and mortality from other conditions around the world. Well-recognized factors that may help explain this association include lack of resources, medical and ancillary staff, and specialized training in lowand middle-income countries when compared to high-income countries. One limitation in the interpretation of these data, however, is that the authors do not evaluate differences in admission criteria, staffing and care practices across countries or geographic regions, which may be a source of confounding and consequently complicate the interpretation of findings. As an example, in Peru, where our group is currently conducting studies on the relationship between best practices and clinical outcomes in the ICU, we found that there are no respiratory therapists available in the ICUs. This may have an untoward effect in clinical outcomes of mechanically ventilated patients.

Third, the authors found that there was a substantial amount of residual heterogeneity in mortality rates of critically-ill patients among ICUs across countries but not within countries even after controlling for specific patient- and ICU-level factors. This suggests that there were other patient and ICUfactors, and probably country- or region-specific-factors, not identified by this study that may help explain variability in mortality rates. The authors speculate that variations in ICU organizational structure may be implicated; however, they stopped short of developing this concept further by analyzing the data on ancillary staff including pharmacy and physical therapy.Other important factors to consider include bed availability, access to healthcare, regionalization of ICU care, availability of trained critical care providers among other variables.

There is a growing interest in the role of structure of the organization (i.e., conditions under which patient care is provided) and process of care (i.e., activities that constitute patient care) in the ICU and how these affect clinical outcomes (6-8). Some of these factors are well recognized. For example, Kahn *et al.* showed that mechanically ventilated patients have improved patient-centered outcomes in high-volume vs. low-volume hospitals (9). This may be explained by a greater experience in the management of the critically ill simply because of a high case volume or because high-volume hospitals are more likely to implement best practices including high-intensity staffing (10, 11), higher nurse-to-patient ratio (6) and use of multidisciplinary care teams (12). The role of other organizational factors, however, remains controversial. For example, we studied the role of multiple structure- and process-factors on annual ICU mortality in 69 ICUs participating in the United States Critical Illness and Injury Trials Group Critical Illness Outcomes Study (USCIITG-CIOS) and found that daily team communication strategies were associated with a lower annual ICU mortality

whereas protocolled-care wasnot (6). While 24-hour intensivist care is the standard in many countries (Vincent *et al*. reported that 95% of participating ICUs had 24-hour coverage), current evidence suggests that around the clock coverage by an attending intensivist only makes a difference in patient-centered outcomes in low-intensity ICUs and not in high-intensity ICUs(13, 14).

In summary, the study by Vincent *et al.* highlights the need to better characterize ICU structure- and process-related factors across settings around the world and explore how these factors may affect clinical outcomes. The information collected by Vincent *et al.*in this large, multi-center observational study fills an important knowledge gap on the global burden of critical illness. Further studies are needed to determine which components of ICU organization lead to improved patient-centered outcomes.

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