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EDITORIAL

Critical Care Services in Low- and Middle-Income Countries (LMICs): Advancing Access, Quality and Safety

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INTRODUCTION

Critical care medicine is essential for managing acute organ failure and reducing global mortality. However, an immense disparity exists between high-income countries (HICs) and low- and middle-income countries (LMICs). This divide results not just in terms of availability of services, but also from the quality and safety of the services being delivered. While HICs are diverting their focus to quality and safety, LMICs are often found struggling to address the issues of access. This editorial synthesizes the current landscape of LMIC critical care across four key domains: mapping barriers, contextualizing clinical quality indicators, establishing patient safety systems and outlining strategic pathways to attenuate global health inequities.

CRITICAL CARE ACCESS IN LMICs

Global critical care capacity reveals a profound geographic divide. In HICs, intensive care unit (ICU) bed availability generally ranges between 5 and 30 beds per 100,000 population. Among high-income Asian economies, the median bed density reaches 12.3 per 100,000. In stark contrast, low- and middle- income countries (LMICs) report between 0.1 and 2.5 ICU beds per 100,000 population, with low- and lower-middle-income Asian economies averaging a median of just 2.3 beds per 100,000.[1,2] In several low-income settings, national figures drop even lower, such as 2.8 beds per 100,000 in Nepal and 1.0 bed per million population in Uganda.[2,3] This structural deficit is further compounded by severe regional centralisation; in Nepal's Bagmati Province, for instance, 95% of all ICU beds are concentrated in four urban districts, leaving six out of 13 districts with no ICU facilities at all.[4] Crisis situations when medical care processes are pushed to the limit as the severe acute respiratory syndrome (SARS) epidemic, Middle East respiratory syndrome (MERS) epidemic, often tend to increase the capacity of critical care services exponentially. The recent SARS-COV-2 epidemic has been a boost to increase the availability of ICU services in many LMICs like Nepal. The previously mentioned numbers are from the pre- SARS-COV-2 and current the numbers have increased significantly.

Beyond physical bed counts, LMICs face critical shortages in essential infrastructure, equipment, and trained personnel. Conventional HIC models depend on resource-intensive ICUs equipped with sophisticated physiological monitoring devices, diagnostic laboratories, and specialized multidisciplinary teams. In LMICs, sustaining such technology is severely restricted by high costs needed for purchase and maintenance.[5,6]

Compounding these material gaps is an acute shortage of certified intensivists and specialized ICU nurses, frequently leaving general medical staff, anesthesiologists, or non-physician providers to manage critically ill patients.[3,6]

This crisis of physical availability is reinforced by insurmountable economic barriers. In HICs, daily ICU care averages between US$1,700 and US$4,500. The absolute daily cost in LMICs is lower due to reduced labor expenses. For example a study from India has reported US$109 per day. However, it has to be noted that the average annual per capita healthcare spending across LMICs is only about 5% of HIC levels.[7] Also because public ICU capacity is sparse, private providers dominate the sector (e.g., accounting for nearly 70% of ICUs in Bagmati Province), charging fees three to five times higher than government hospitals. Lacking universal health coverage, patients and families incur large out-of-pocket expenses, resulting in premature hospital discharge due to an inability to pay or total exclusion from life-saving care.[4,7] These factors related to the critical care economics prohibit access to the already less available critical care resources (Figure 1).

Quality Indicators in LMICs

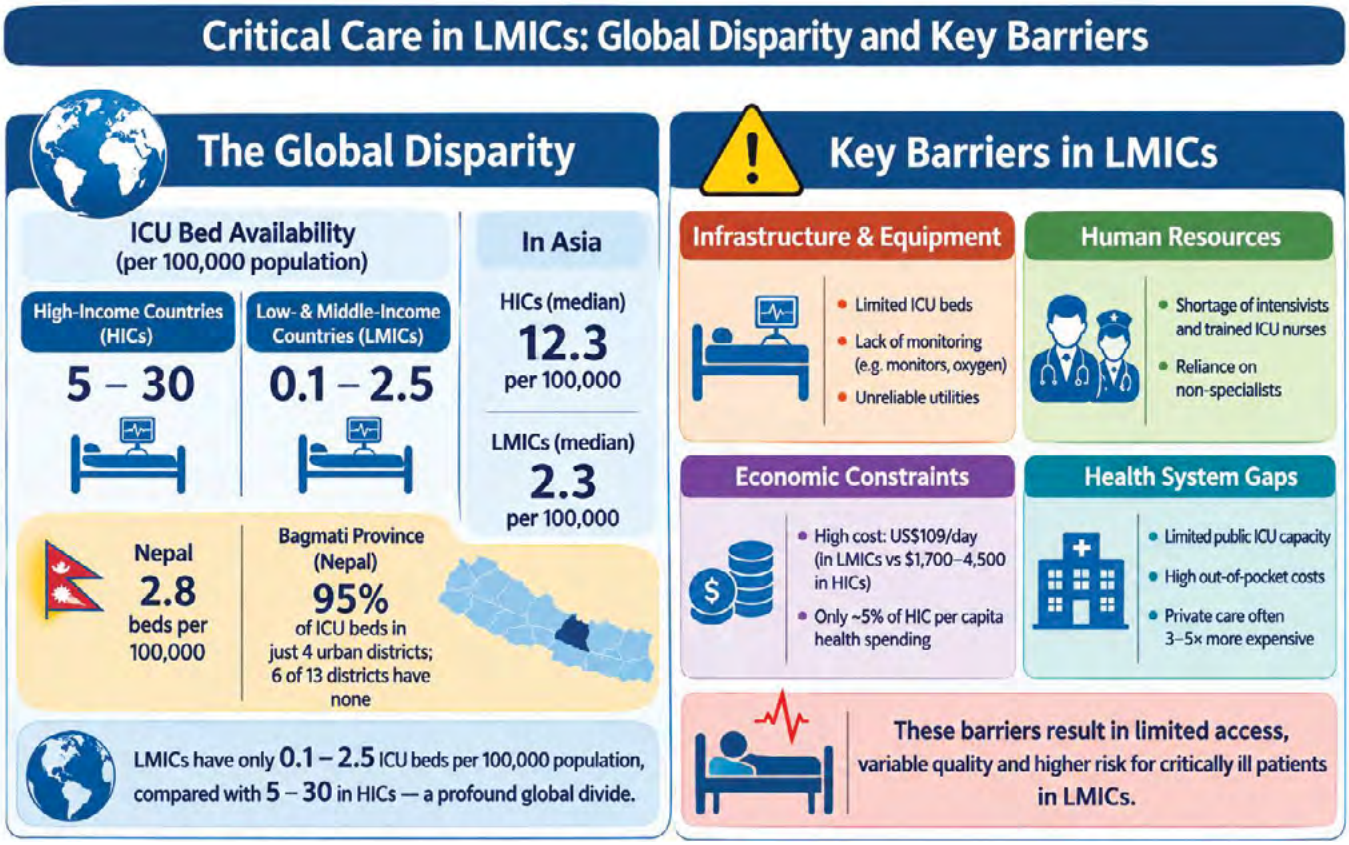


Figure 1. Global disparity in critical care services and key barriers in LMICs.

Quality in critical care is systematically evaluated across three core domains: foundation (structure), clinical processes, and quality impacts (outcomes) (Figure 2).[8] In HICs, quality indicators heavily reflect well-resourced health systems, prioritizing multidisciplinary staffing models which include in house availability of dieticians, respiratory therapists and nutritionists among others; advanced diagnostic technology (such as routine capnography, indirect calorimetry, invasive arterial monitoring, cardiac output monitors), and automated physiological data collection.[6,9] In contrast, directly translating HIC quality metrics to LMICs creates severe operational misalignment. When essential infrastructure such as continuous piped oxygen and suctioning, reliable and uninterrupted electrical supply, or onsite laboratory services are absent or inconsistent, high-resource metrics fail to evaluate true clinical performance. This imposes an overwhelming burden when manual data-collection is added on for frontline clinicians.[9,10]

To drive meaningful healthcare advancement, quality indicators in LMICs must be recalibrated around local realities and achievable priorities. At the foundational level, structural indicators must pivot from high-cost diagnostic tools toward baseline service readiness and human resource capacity. Multinational consensus initiatives, such as the Delphi study by the Collaboration for Research, Implementation and Training in Critical Care in Asia-Africa (CCAA), highlight essential foundation metrics: nurse-to-patient staffing ratios, the level of ICU-trained nursing experience on shift, dedicated physician night coverage, and the uninterrupted availability

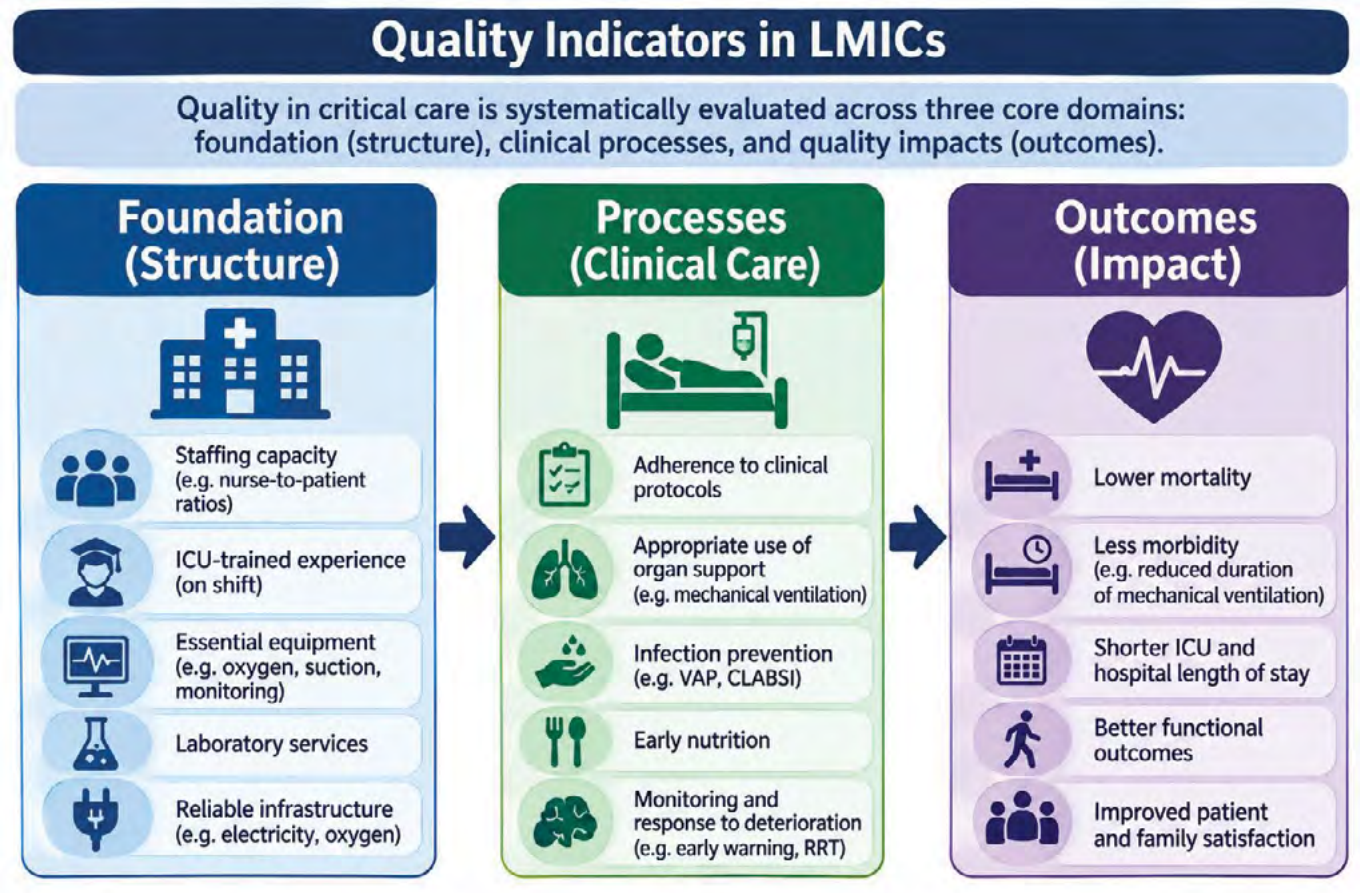


Figure 2. Components of quality indicators in ICU.

of basic vital-sign monitoring (pulse oximetry, heart rate, and non-invasive blood pressure) for all mechanically ventilated patients, alongside guaranteed oxygen supply.[9]

Similarly, care process indicators in resource-constrained settings must target high-impact, low-cost daily interventions that eliminate avoidable inpatient harm. Rather than tracking compliance with complex, capital-intensive therapeutic guidelines, LMIC process metrics emphasize fundamental safety bundles. Key process indicators include monitoring the incidence of nosocomial bloodstream infections, ventilator-associated pneumonia, pressure injuries, catheter-associated urinary tract infections, and hospital-acquired drug-resistant organisms. Enforcing structured clinical protocols specifically for infection prevention and control, pain management, patient management protocols for spontaneous breathing and awakening trials, and antimicrobial stewardship enables resource-limited ICUs to systematically reduce preventable complications.[5,9,10]

Finally, outcome indicators in LMICs must incorporate socio-economic dimensions alongside traditional clinical endpoints. While ICU length of stay and risk-adjusted mortality remain fundamental, risk-prediction models must utilize scoring systems calibrated for resource-limited environments (such as e-TropICS or SAPS III) rather than lab-heavy HIC algorithms. Crucially, quality frameworks in LMICs must integrate novel equity metrics, most notably the proportion of patients discharged alive from the ICU due to an inability to afford continued life-sustaining care which can be a major driver of premature mortality and financial hardship.[7,9]

Operationalizing these context-specific metrics relies on streamlined digital infrastructure. Utilizing electronic clinical quality registries (such as the CCAA network and Nepalese intensive care research foundation- NICRF registry in Nepal) mitigates data-collection burdens, ensures standardized definitions, and provides real-time audit feedback. By anchoring quality metrics in local feasibility and patient safety, LMICs can transition from passive benchmarking toward actionable, continuous quality improvement.[9,11]

Advancing Patient Safety

In LMICs, critically ill patients face heightened vulnerability to avoidable medical harm, hospital-acquired infections, and medication errors. This safety crisis is driven by severe staffing deficits, overcrowded facilities, and intermittent shortages of basic sanitation or protective supplies. High-income safety frameworks such as the full Surviving Sepsis Campaign guidelines are frequently unimplementable in low-resource ICUs, where fewer than 2% of surveyed facilities in developing regions maintain the full prerequisite equipment and pharmaceuticals. Consequently, establishing patient safety in LMICs requires shifting from capital-intensive models toward pragmatic, resource-adapted clinical bundles and location-independent frameworks like Essential

Emergency and Critical Care (EECC) and Essential Critical Care Training (ECCT).[6,12]

At the point of care, safety depends on enforcing high-impact, low-cost clinical standards. Key interventions include standardized care bundles for infection prevention and control (IPC), pain management protocols, and antimicrobial stewardship programs though adherence to these remains inconsistent across developing health systems. To overcome acute specialist shortages, national health policies must adopt formal task-shifting and team-based care models, empowering generalist physicians, mid-level providers, and bedside nurses through protocolized training (such as WHO Basic Emergency Care and ETAT) to recognize early clinical deterioration and deliver time-sensitive resuscitation. Local level trainings by different societies like those conducted by Critical Care Nurses Association of Nepal (CCNAN), Essential Critical Care Training (ECCT) and the National Health Training Center (NHTC), Nepal will be definitely helpful to improve patient safety.[12,13]

Systemic progress is also being led by strategic global leadership from the World Health Organization (WHO). WHO launched the Global Patient Safety Action Plan 2021–2030 as part of its flagship initiative, *"A Decade of Patient Safety 2021–2030"*. The action plan establishes an overarching vision of *"a world in which no one is harmed in health care, and every patient receives safe and respectful care, every time, everywhere"*. Structured around seven core strategic objectives, the framework drives global and national commitments toward building a zero-avoidable-harm mindset, assuring clinical procedure safety, safeguarding health workers' well-being, and establishing open, blame-free adverse event reporting systems.[14]

Furthermore, WHO's flagship Global Patient Safety Challenges directly target major sources of inpatient morbidity. Programs such as *Clean Care is Safer Care*, *Safe Surgery Saves Lives*, and *Medication Without Harm* offer actionable toolkits for resource-constrained environments.[11,14] Supported by international networks like the Global Patient Safety Collaborative and public advocacy campaigns like World Patient Safety Day (17 September), these initiatives empower LMICs to embed safety guidelines directly into Universal Health Coverage (UHC) agendas. By combining WHO's strategic policies with local level commitments, LMICs can systematically eliminate preventable harm across the critical care continuum.[6,14]

Attenuating Discrepancies- Solutions for LMIC Critical Care

Bridging the global divide in critical care requires moving away from the replication of expensive, high-income ICU models toward contextualized, sustainable strategies. Attenuating disparities in access, quality, and safety across



Figure 3. Components for building effective critical care system in LMICs.

LMICs demands coordinated action across care delivery models, workforce development and expansion, digital innovation and incorporation into practice, and health policy financing.

First, health systems must adopt flexible, location-independent care frameworks. Rather than restricting life-saving interventions to tertiary-level urban ICUs, countries will have to adopt fundamental, low-cost physiological support and monitoring that can be delivered at any point of patient contact across the entire care continuum, including pre-hospital settings, emergency units, and general hospital wards. Simultaneously, decentralizing critical care resources to secondary and district hospitals reduces geographical inequities and avoids delays in acute resuscitation.[15]

Second, acute workforce shortages can be rapidly mitigated through protocolized education, training and task-shifting which has been found to be successful in times of crisis as in SARS-COV-2 pandemic.[16] Developing full subspecialty physician cadres requires long term institutional investment, but immediate clinical gaps can be bridged by task shifting responsibilities to generalists, mid-level providers, and bedside nurses. Short- and medium-term training initiatives such as the WHO Basic Emergency Care (BEC) course, Emergency Triage Assessment and Treatment (ETAT), Critical Care Nurse Training Program (CCNTP), Essential Critical Care Training (ECCT) and the BASIC ICU course equip frontline health workers with standardized resuscitation skills.[12,13,17,18] These need to be scaled up to empower ground level staff with specialized critical care competencies to ensure sustainable care delivery.

Third, newer digital technologies and AI offer scalable pathways to reduce costs and enhance care quality. Low-cost wearable sensors and mobile-connected point-of-care ultrasound can replace prohibitively expensive commercial monitors and diagnostic hardware. Paired with artificial intelligence decision-support algorithms, these tools can guide non-specialist clinicians through complex diagnostics and treatment protocols.[19,20] Furthermore, embedding data collection into electronic clinical quality registries like NICRF mitigates manual data burdens, standardizes definitions, and drives continuous quality improvement.[21]

Finally, policy reforms must embed critical care to ensure universal health coverage. Governments must establish clear public health infrastructure guidelines, regulate private-sector pricing to prevent financial exploitation, and ensure patients receive time-sensitive emergency resuscitation regardless of ability to pay. By combining task-shifting, frugal technology, data registries, and robust financial protection, LMICs can establish equitable, safe, and sustainable critical care systems tailored to their operational realities.[15]

CONCLUSIONS

The global critical care crisis in LMICs cannot be solved by simply duplicating the resource-heavy ICU infrastructure of wealthy nations. Advancing access, quality, and safety demands a paradigm shift toward location-independent care models, protocolized task-shifting, adoption of novel technology, and context-specific quality metrics. By aligning local clinical practices with WHO policy frameworks and embedding critical care into national Universal Health Coverage schemes, health systems worldwide can ensure that timely, high-quality, and safe critical care becomes an accessible reality for all (Figure 3).

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CONFLICT OF INTEREST

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