

Anesthesia Safety in Low- and Middle-Income Countries: Challenges and Solutions

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Abstract

Anesthesia safety in low- and middle-income countries (LMICs) faces unique and profound obstacles. This article examines the critical challenges: workforce shortages, infrastructure and equipment deficits, supply chain obstacles, deficient monitoring, limited training and digital data infrastructure, and systemic governance issues. It reviews proven and emerging solutions—from workforce development and low-cost technologies to innovative data capture and global partnerships. A multi-pronged, context-aware strategy is essential to bridge the persistent safety gap and improve surgical outcomes in LMICs.

Keywords: Anesthesia safety, low- and middle-income countries, LMICs, surgical safety, anesthesia workforce, pulse oximetry, WHO Surgical Safety Checklist, global health, perioperative care, resource-limited settings, anesthesia training, Lifebox, SAFE course, task-sharing.

1. Introduction

Anesthesia safety is fundamental to surgical success and patient survival, particularly in LMICs where systems are fragile and resources limited. Despite global advances, anesthesia-related mortality remains higher in these settings, underscoring the urgent need to understand and address the specific challenges involved.

2. Key Challenges

2.1 Workforce Shortages and Skill Gaps

LMICs face a critical deficit of trained anesthesia providers. For instance, East African referral centers showed only 0.08 to 0.39 anesthesiologists per 100,000 people, far below the recommended density of 20 surgical, anesthesia, and obstetric physicians per 100,000 by 2030 .

Task-sharing models—where nonphysician providers play crucial roles—help fill gaps, but require robust training and supervision to ensure safe outcomes .

2.2 Infrastructure, Equipment & Monitoring Deficiencies

Basic infrastructure such as continuous electricity and running water is often unreliable in LMIC hospitals . Many lack essential anesthesia equipment, including functional anesthesia machines, laryngoscopes, monitoring devices, oxygen sources, and medications .

In Kenya, only 6.25% of major referral hospitals had all recommended anesthesia monitors in operating theaters; capnography and nerve stimulators were particularly scarce .

2.3 Medication Access and Supply Chain Constraints

The global scarcity of analgesics is stark: over 5.5 billion people lack access to necessary narcotic medications . In India, only around 40 mg of morphine-equivalent is available per palliative care patient—versus over 40,000 mg in countries like Australia and Canada—reflecting systemic regulatory and logistical barriers.

2.4 Inadequate Training, Professional Support, & Burnout

Many anesthesia providers lack access to continuing medical education and face overwhelming workloads. This leads to burnout, high attrition, and unsafe practices .

2.5 Lack of Digital Data and Research Capacity

Reliable digital anesthesia records are rare in LMICs. Without accurate data, quality improvement and research are stifled. Mortality related to anesthesia has even increased in LMICs, from 326 per million to 467 per million, while high-income countries have seen declines .

2.6 Weak Governance, Administrative Support & Systemic Barriers

Poor management structures, weak organizational systems, and even corruption impede resource allocation and policy implementation, undermining anesthesia safety .

3. Effective Solutions and Strategies

3.1 Workforce Development & Task-Sharing

Training non-physician providers under supervision can improve access; but safe practice demands robust training, ongoing education, and specialist oversight .
Global initiatives and fellowships offered by WFSA and others strengthen capacity and knowledge exchange .

3.2 Education Programs: SAFE Course & Beyond

The SAFE (Safer Anaesthesia From Education) course empowers anesthesia technicians with hands-on skills and "train-the-trainer" frameworks. Rwanda's pilot led to behavioral changes, adoption of pre-op assessments, and better emergency management. The distribution of pulse oximeters and the introduction of WHO surgical safety checklists reinforced safety practices .

3.3 Low-Cost Tech & Lifebox Initiative

The Lifebox Foundation drastically reduced pulse oximeter costs (from ~\$2,000 to ~\$250) and distributed thousands of devices for LMIC use. This improved monitoring and likely reduced intraoperative desaturations .
Capnography—crucial for airway safety—has started to penetrate resource-constrained settings, with promising outcomes despite current pricing and access issues .

3.4 Standardization via Checklists & Protocols

The WHO Surgical Safety Checklist has halved death and complication rates in surgical settings and is particularly beneficial in LMIC emergency operations .

3.5 Digital Innovation in Recordkeeping & Quality Improvement

Introducing standardized, computer-vision-readable paper anesthesia charts allows data capture via mobile devices. This low-cost solution enables audit, feedback, and locally-driven improvements, while laying groundwork for research and multicenter quality metrics .

3.6 Global Partnerships & Government Engagement

Combining efforts of governments, WFSA, WHO, NGOs, and institutional training programs is essential. Resources like the WHO GIEESC toolkit provide clinical protocols, training materials, and guidance toward infrastructure strengthening

4. Integrated Approach for Sustainable Improvement

To move LMIC anesthesia care toward safety parity:

Strategy Area and Key Actions

- Workforce: Scale training and retention via fellowships, task-sharing, and continuing education
- Equipment & Monitoring: Deploy low-cost monitors (e.g., Lifebox), advocate for essential supplies
- Education: Expand context-adapted training (e.g., SAFE), reinforce checklist usage
- Data & Research: Implement digital records, audit systems, enable LMIC-led studies
- Governance & Policy: Strengthen administrative support, enforce standards, foster accountability

Success hinges on local ownership: tailoring solutions to specific contexts, regularly auditing progress, and ensuring support from local governments and international partners.

5. Conclusion

Anesthesia safety in LMICs faces intersecting challenges—workforce, infrastructure, medication, training, data, and governance. But a combination of targeted solutions—task-sharing, accessible technology, education programs, checklists, digital innovations, and policy partnerships—can produce lasting improvements. A coordinated, context-sensitive approach is essential for building safe, equitable anesthesia systems and driving sustainable global surgical safety.

6. References

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