DOI: 10.21088/ijaa.2349.8471.13226.4

Indian Journal of Anesthesia and Analgesia
Volume 13 Number 2 April - June 2026

REVIEW ARTICLE

Artificial Intelligence in Anaesthesia and Critical Care: Augmenting, not Replacing, the Clinician

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HOW TO CITE THIS ARTICLE:

Shivani Fotedar. Artificial Intelligence in Anaesthesia and Critical Care: Augmenting, not Replacing, the Clinician. Ind J Anesth Analg. 2026; 13(2): 76-78.

ABSTRACT

Anesthesia and critical care have historically evolved alongside technology, and artificial intelligence (AI) now represents the next major step in this trajectory. By enabling prediction of perioperative and ICU complications, supporting closed-loop anesthetic delivery, and synthesizing complex physiological data, AI offers powerful tools for enhancing safety, precision, and efficiency. At the same time, challenges related to local data quality, infrastructural constraints, algorithmic bias, and medico-legal accountability are particularly salient in the Indian context. This editorial outlines key current and emerging applications of AI in anesthesia and critical care, highlights ethical and implementation concerns, and emphasises the need for "clinician-in-the-loop" models, data literacy, and interdisciplinary collaboration to ensure that AI augments rather than replaces the anesthesiologist and intensivist.

KEYWORDS

• Artificial intelligence • Machine learning • Anesthesia • Critical care • Decision support systems • Closed-loop systems

Anesthesia and critical care have always stood at the interface of physiology, pharmacology, and technology, and artificial intelligence is emerging as the next major inflection point in this evolution. Rather than being a tool of simple automation, AI increasingly functions as a form of cognitive augmentation, synthesizing vast data streams into clinically relevant predictions that can support anesthesiologists and intensivists across the perioperative and ICU continuum.[4,5,6]

Emerging applications across the continuum

In the perioperative domain, machine−learning models are now capable of predicting hypotension, acute kidney injury, postoperative

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➢ **Received :** 13-12-2025 ➢ **Accepted :** 15-01-2026

mortality, and other adverse events minutes to hours before they become clinically apparent, enabling proactive intervention. Closed loop systems integrating depth of anesthesia monitoring, hemodynamic variables, and drug delivery have demonstrated that automated control can, in defined settings, outperform manual titration in maintaining anesthetic depth and hemodynamic stability.[5,7,4]

In the ICU, AI driven decision support has been applied to sepsis detection, ventilator weaning prediction, delirium risk stratification, and dynamic adjustment of sedation and fluid therapy.

These systems can continuously analyses high frequency physiological and laboratory data to highlight subtle trends, support early escalation, and potentially optimize resource utilization in high burden, resource constrained environments.[8,6,5]

Opportunities and challenges in the Indian context

For India, where anesthesia and critical care services often function under constraints of manpower, monitoring, and bed capacity, AI enabled tools hold particular promise to standardize care and extend expertise. However, meaningful deployment demands robust digital infrastructure, high quality local datasets, and explicit attention to algorithmic bias, data security, and patient privacy in line with evolving national regulations.[6,9,8]

Most machine learning models are trained on data from high income settings and may not generalize to Indian disease patterns, demographic profiles, and care processes; deliberate efforts at indigenous data curation and model validation are therefore essential. Professional bodies such as the Indian Society of Anesthesiologists and subspecialty groups in critical care are well placed to catalase metacentric AI research, develop practice advisories, and define ethical and medico legal frameworks for clinical use.[10,11,5,8]

Ethics, accountability, and the "clinician in the loop"

The attraction of AI lies in its ability to detect patterns that escape unaided human perception, but this often comes with the opacity of "black box" models whose internal logic is not readily interpretable. In a specialty where rapid decisions carry high stakes, unquestioning reliance on opaque outputs risks eroding clinical accountability and trust, particularly in the setting of adverse outcomes and litigation.[12,5,6]

Anesthesiologists and intensivists must therefore insist on explainable and auditable systems, and on deployment models that preserve the "clinician in the loop", with AI outputs framed as decision support rather than directives. Maintaining situational awareness, contextual judgement, and the primacy of patient centred values will remain the exclusive domain of human clinicians even as cognitive labour is increasingly shared with algorithms.[7,13,12]

Education, collaboration, and future directions

As AI systems become embedded in anaesthesia information management systems and ICU platforms, future specialists will need fluency in data literacy, basic concepts of model development, and recognition of bias and failure modes. Incorporating these competencies into residency curricula, workshops, and continuing medical education will be necessary to ensure that clinicians are discerning users and collaborators, not passive recipients, of AI tools.[13,4,5,8]

Closer collaboration between clinicians, data scientists, engineers, and ethicists will help ensure that AI solutions address clinically relevant problems, are evaluated in rigorous trials, and are implemented with appropriate safeguards. If guided thoughtfully, the convergence of human expertise and artificial intelligence can deepen safety, precision, and equity in anaesthesia and critical care, especially in a diverse and resource variable healthcare system such as India's.[9,4,8,6]

Key messages

- AI is moving from experimental to clinically relevant applications in perioperative care and critical care, with demonstrated potential to improve prediction, monitoring, and automation for selected tasks.[4,5]
- Indian deployment must priorities local data, infrastructure, and explicit attention to ethics, bias, accountability, and medico legal implications.[8,6]
- The future lies in clinician in the loop models, data literate training, and interdisciplinary collaboration so that

AI augments, rather than replaces, the anesthesiologist and intensivist.[12,13]

CONCLUSION

Artificial intelligence is poised to transform perioperative and intensive care practice by augmenting clinical cognition, enabling early risk prediction, and supporting automation of selected tasks. However, meaningful and safe deployment in India will depend on robust digital infrastructure, representative local datasets, transparent and explainable systems, and clear professional guidance on ethics and accountability. Anesthesiologists and intensivists must actively shape this evolution through education, research, and collaboration so that AI remains a context-aware support to human judgement rather than an opaque authority at the bedside.

Declarations

Financial support and sponsorship Nil

Conflicts of interest: None declared

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