Journal of
Surgery and
Advanced Medical Research
An International, Peer-reviewed, Open access, Quarterly Publishing, Medical Research Journal

EDITORIAL OPEN ACCESS

Perioperative Medicine at the Crossroads of Precision Surgery: Redefining Risk, Recovery, and Outcomes in Modern Surgical Practice

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Citation: Mubashir Z. Perioperative Medicine at the Crossroads of Precision Surgery: Redefining Risk, Recovery, and Outcomes in Modern Surgical Practice. J Surg Adv Med Res. 2026;1(1):1–3.

Received: 13 February, 2026 **Revised:** 01 March, 2026 **Accepted:** 05 March, 2026 **Published:** 10 March, 2026

Traditionally, peri-operative medicine was considered simply a logistics and physiological support system to complement the surgeon's skills [1]. But we are at a providential time. A new, similarly advanced perioperative counterpart is needed, along with the introduction of precision surgery based on the application of minimally invasive surgical techniques and tailored anatomical planning [2]. Perioperative medicine is emerging as a new and evidence-based specialty. It's no longer simply about the management of comorbidities; it's about the prediction of resilience, optimization of the host at the molecular level and redefining recovery as a measurable and modifiable endpoint [3]. Modern perioperative care is a transition from a reactive "one size fits all" model to a proactive individualized peri-operative care pathway, by the integration of artificial intelligence (AI), the introduction of multiple-modal perioperative biomarkers and Enhanced Recovery After Surgery (ERAS) frameworks [4]. This editorial delves into this change, examining the redefinition of risk, recovery and outcomes at the intersection of big data and biological individuality, as illustrated in the dynamic framework (Figure 1).

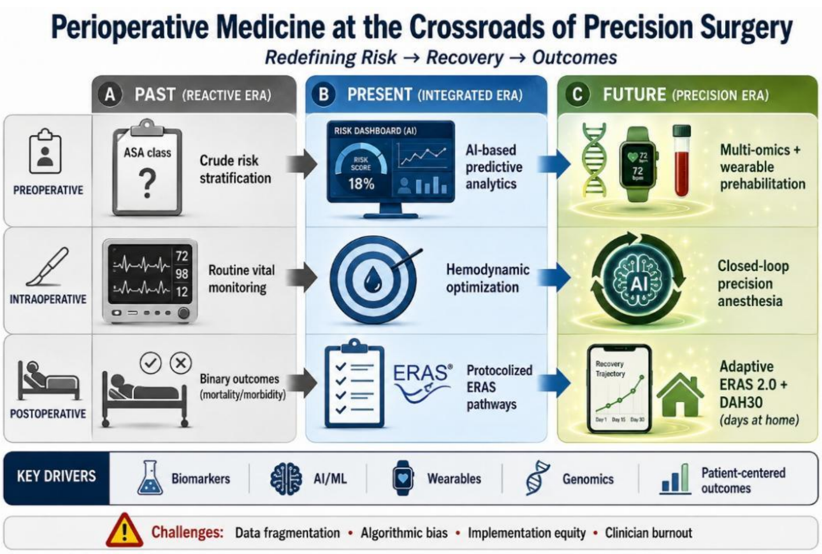

Figure 1: From Reactive Support to Precision Perioperative Medicine: A Dynamic Framework for Redefining Risk, Recovery, and Outcomes[22]

The Historical Paradigm: The traditional perioperative process was a reactive one. A patient presented with a surgical problem; standard pre-operative laboratory and imaging tests were performed; intra-operative vital signs were tracked; and post-operative complications were addressed as they emerged. However, the tools used for risk assessment were simple, such as the American Society of Anesthesiologists (ASA) Physical Status Classification which, though sufficient, doesn't describe the granular complexity of physiological reserve [5]. In this way, all patients received the same procedure as a homogenous group. This paradigm shift towards precision surgery also underscores the shortcomings of the model, that it can't answer the critical question: What is this specific patient's unique path to optimal recovery? In contrast, proactive optimization starts a few weeks before to surgery. It involves determining risk factors that can be changed and developing physiological resilience based on the patient's genetic and phenotypic traits [6].

Artificial intelligence: AI and machine learning-driven advanced risk prediction is the keystone of the new paradigm of perioperative care. AI algorithms can analyze thousands of data points, such as genetic information, wearable device readings, or electronic health records (EHR), and make accurate predictions and preventive interventions for postoperative complications such as acute kidney injury, delirium, or sepsis, unlike traditional logistic regression models [7]. An example of this is an electrocardiogram, or simply a normal blood test before a patient's operation, that can be analysed by deep learning to detect subclinical vulnerabilities that the human eye would not perceive [8]. As a result, risk assessment is redefined as a dynamic dashboard that drives action rather than a static "high risk" rating.

Biomarkers and multi-omics: Beyond digital prediction lies the frontier of biological precision. Multi-omics, genomics, proteomics, metabolomics are starting to be used perioperatively to gain insight in the surgical stress response of each patient [9]. Increased reactions to tissue damage are predicted by some genetic variations in inflammatory pathways, such as TNF-alpha and IL-6 [10]. Before surgical procedure, mitochondrial dysfunction or cellular senescence related plasma biomarkers are better predictors of the patients real physiological age or reserve, in comparison to the chronological age [11]. Targeted interventions are possible in this molecular window: anti-inflammatory prior to incision in a genetically predisposed patient or a metabolic preconditioning diet on the basis of a pre-operative metabolomic profile. This illustrates personalized optimization, instead of providing every patient the same beta-blockers, there should be utilization of advance biomarkers to determine the correct plan for each person.

Enhanced recovery after surgery: ERAS protocols have changed the treatment landscape, especially when it comes to reducing length of stay, complications and implementing evidence-based interventions [12]. But the first generation of ERAS has not fundamentally changed, there are the same indications for every colorectal procedure. The next evolution, ERAS 2.0, will be adaptive and personalized [13]. These pathways are flexible through the use of real-time information that comes from wearables (such as step count, heart rate variability) and patient-reported outcomes [14]. This model sees recovery being a real-time monitored path rather than one that will be defined over a fixed period of time, making "precision recovery" a tangible reality.

Redefining postoperative outcomes: Traditionally, surgical outcomes were defined by binary, provider-oriented metrics: mortality, major morbidity (Clavien-Dindo grade), and length of stay [15]. Although important, these do not encompass what is most important to the patient, functional recovery, return to work, cognitive clarity, and no chronic postoperative pain [16]. The new perioperative medicine will adopt a composite, patient-centered outcome. In addition, digital data from wearable accelerometers and sleep monitors provide objective, continuous data on recovery quality [17]. Days at home" within 30 days is a simple description, which combines the components of hospital readmissions, skilled nursing facility use and mortality into one comprehensive, meaningful measure.

Personalized prehabilitation: The most important application of precision perioperative medicine is personalized prehabilitation. Prehabilitation is not a one-size-fits-all approach it's a multimodal, data-guided intervention [18]. A simple phone application measures each patient's frailty and then a customized exercise program is designed for each patient [19]. The optimization of nutrients is directed by serum albumin, prealbumin and micronutrient panels which may be supplemented with immune-nutrition formulas. Preoperative screening tools are used for patients who have high anxiety levels and are prepared for using cognitive-behavioral strategies of psychological preparation [20]. Even smoking cessation and anemia management are now protocolized with pharmacogenetic guidance (e.g., nicotine replacement metabolism, iron absorption profiles) [21]. Preoperative care has transitioned from being an elective enhancement to being required for precision care, and this positively impacts the reduction in postoperative complications.

Future perspectives and challenges: This change requires a fundamentally modified surgical team and a different culture in the surgical environment. A collaborative and multidisciplinary perioperative care team is gradually replacing the traditional hierarchical structure, in which the surgeon is the primary authority overseeing all aspects. Optimization will be led by the perioperative physician, typically an anesthesiologist qualified in advanced training or an internist with a special interest in surgical care. Scientists such as data scientists, genetic counselors, and physical therapists are becoming the core members. This cultural shift had to involve removing the silos, introducing transparent data sharing and adopting a new paradigm of surgical care as a sustained continuum of care pathways.

There are still a number of obstacles that need to be handled. Data fragmentation remains one of the major issues yet to be overcome, the AI models require quality data, and there are plenty of different EHR systems that don't communicate with each other. Moreover, algorithmic bias is an important concern, as models trained on homogenous populations can reinforce or further widen the perioperative disparities of minority groups. Additionally, there is a possibility that the gap between academic and community hospitals may grow due to the high expense of installing genomic testing, advanced wearables, and AI infrastructure. Lastly, ethical and medicolegally relevant conflicts need to be resolved, such as how to handle incidental genetic findings found during preoperative evaluation, and who is responsible when an AI-predicted low-risk patient experiences a serious consequence.

Conclusion

Perioperative medicine stands at a true crossroads. It can move forward either by continuing to evolve existing or can make the transition to an era of precise, predictive and personalized therapy. As this editorial has compellingly argued, it is not only desirable, but is indeed inevitable as the parallel revolutions of AI, multi-omics and patient-centered outcomes. Recovery from surgery can be redesigned via adaptive ERAS pathways, optimizing a patient before surgery through prehabilitation and biomarkers. Surgery can be redirected through dynamic algorithms. Data integration, equity and ethics are significant, but solvable problems. The key priority is to shift from considering surgery as a single occurrence to the surgical path as a peorsonalised data-driven process. Patients awaiting surgery should be properly supported by a system during the perioperative period which includes individual risk prediction and targeted optimization of the patient for optimal recovery.

Acknowledgement: None
Competing Interests: The authors declare no competing interests.
Grant Support and Funding Source: None
Study Ethical Approval: Not Applicable
Consent for Participation and Publication: Not Applicable
Availability of Data and Materials: Not Applicable
Use of Artificial Intelligence: Figure 1 has been created by using OpenAI ChatGPT (GPT-4o) solely for the purpose of better illustration and scientific understandings. The corresponding author declared that no other artificial intelligence or AI-assisted tools were used anywhere in this manuscript.
Authors' Contribution: ZM is sole contributor of this manuscript as per ICMJE

References

1. Wall J, Dhesi J, Snowden C, Swart M. Perioperative medicine. Future Healthc J. 2022;9(2):138-43. https://doi.org/10.7861/fhj.2022-0051
2. Vetter TR. Managing a perioperative medicine program. Best Pract Res Clin Anaesthesiol. 2022;36(2):283-98. https://doi.org/10.1016/j.bpa.2022.04.008

3. Dean HF, Carter F, Francis NK. Modern perioperative medicine – past, present, and future. Innov Surg Sci. 2019;4(4):123-31. https://doi.org/10.1515/iss-2019-0014
4. Yoon HK, Yang HL, Jung CW, Lee HC. Artificial intelligence in perioperative medicine: a narrative review. Korean J Anesthesiol. 2022;75(3):202-15. https://doi.org/10.4097/kja.22157
5. Horvath B, Kloesel B, Todd MM, Cole DJ, Prielipp RC. The evolution, current value, and future of the American Society of Anesthesiologists Physical Status Classification System. Anesthesiology. 2021;135(5):904-19. https://doi.org/10.1097/ALN.0000000000003947
6. Lim L, Lee H, Jung CW, Sim D, Borrat X, Pollard TJ, et al. INSPIRE, a publicly available research dataset for perioperative medicine. Sci Data. 2024;11(1):655. https://doi.org/10.1038/s41597-024-03517-4
7. Maheshwari K, Cywinski JB, Papay F, Khanna AK, Mathur P. Artificial intelligence for perioperative medicine: perioperative intelligence. Anesth Analg. 2023;136(4):637-45. https://doi.org/10.1213/ANE.0000000000005952
8. Bellini V, Valente M, Bertorelli G, Pifferi B, Craca M, Mordonini M, et al. Machine learning in perioperative medicine: a systematic review. J Anesth Analg Crit Care. 2022;2(1):2. https://doi.org/10.1186/s44158-022-00033-y
9. Zhang J, Yang Y, Chen B, Zhao Y, Sun H. From multi-omics to precision medicine in intracranial aneurysm: biomarker discovery and multimodal integration. Interdiscip Med. 2025;3(5):e20250042. https://doi.org/10.1002/INMD.20250042
10. Azeez SH. Influence of IL-10, IL-6 and TNF-α gene polymorphism on obesity. Cell Mol Biol. 2023;69(15):277-82. https://doi.org/10.14715/cmb/2023.69.15.46
11. van Kraaij SJ, Pereira DR, Smal B, Summo L, Konkel A, Lossie J, et al. Identification of peripheral vascular function measures and circulating biomarkers of mitochondrial function in patients with mitochondrial disease. Clin Transl Sci. 2023;16(7):1258-71. https://doi.org/10.1111/cts.13530
12. Özçelik M. Implementation of ERAS protocols: in theory and practice. Turk J Anaesthesiol Reanim. 2024;52(5):163. https://doi.org/10.4274/TJAR.2024.241723
13. Gibb AC, Crosby MA, McDiarmid C, Urban D, Lam JY, Wales PW, et al. Creation of an Enhanced Recovery After Surgery (ERAS) Guideline for neonatal intestinal surgery patients: a knowledge synthesis and consensus generation approach and protocol study. BMJ Open. 2018;8(12):e023651. https://doi.org/10.1136/bmjopen-2018-023651
14. Kehlet H. ERAS implementation—time to move forward. Ann Surg. 2018;267(6):998-9. https://doi.org/10.1097/SLA.0000000000002720
15. Golder H, Casanova D, Papalois V. Evaluation of the usefulness of the Clavien-Dindo classification of surgical complications. Cir Esp. 2023;101(9):637-42. https://doi.org/10.1016/j.cireng.2023.02.002
16. Hofer DM, Lehmann T, Zaslansky R, Harnik M, Meissner W, Stüber F, et al. Rethinking the definition of chronic postsurgical pain: composites of patient-reported pain-related outcomes vs pain intensities alone. Pain. 2022;163(12):2457-65. https://doi.org/10.1097/j.pain.0000000000002653
17. Bate GL, Kirk C, Rehman RZ, Guan Y, Yarnall AJ, Del Din S, et al. The role of wearable sensors to monitor physical activity and sleep patterns in older adult inpatients: a structured review. Sensors. 2023;23(10):4881. https://doi.org/10.3390/s23104881
18. Dana F, Sebio-García R, Tena B, Sisó M, Vega F, Peláez A, et al. Perioperative nursing as the guiding thread of a prehabilitation program. Cancers. 2022;14(21):5376. https://doi.org/10.3390/cancers14215376
19. Prema SS, Ganapathy D, Shanmugamprema D. Prehabilitation strategies: enhancing surgical resilience with a focus on nutritional optimization and multimodal interventions. Adv Nutr. 2025;16(4):100392. https://doi.org/10.1016/j.advnut.2025.100392
20. Boukili IE, Flaris AN, Mercier F, Cotte E, Kepenekian V, Vaudoyer D, et al. Prehabilitation before major abdominal surgery: evaluation of the impact of a perioperative clinical pathway, a pilot study. Scand J Surg. 2022;111(2):14574969221083394. https://doi.org/10.1177/14574969221083394
21. van Koningsveld-Couperus BH, de Rooij T, van Meeteren NL, Preckel B, Hollmann MW, Nieuwenhuijs-Moeke GJ. Prehabilitation: a catalyst for transforming toward value-based, personalized perioperative health and care. J Clin Med. 2025;14(19):6747. https://doi.org/10.3390/jcm14196747
22. OpenAI. ChatGPT (GPT-4o) [Computer Software]. 2026 [cited 2026 February 6]. Available from: https://chatgpt.com