Review Article • บทฟื้นฟูวิชาการ

Key Performance Indicators for Excellence in Anesthesia Services

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Abstract

This article delves into the crucial role of key performance indicators (KPIs) in optimizing anesthesia services within public healthcare systems. KPIs serve as indispensable tools for measuring and enhancing the quality, safety, efficiency, and sustainability of anesthesia care. The importance of KPIs is underscored by their ability to improve patient safety and the overall quality of anesthesia care, optimize resource allocation and cost-efficiency, support data-driven decision-making, and foster transparency and accountability in anesthesia practice. The article also explores emerging technologies such as internet of thing devices and predictive analytics, which are revolutionizing KPI monitoring in anesthesia. Additionally, it delves into evolving regulatory and accreditation standards that are shaping the future of anesthesia practice. Ethical considerations, potential pitfalls, and data quality issues associated with KPIs are carefully examined to ensure that the integration of KPIs in anesthesia services adheres to the highest ethical and data integrity standards.

Keywords: anesthesia service, healthcare quality improvement, key performance indicator

Introduction

Anesthesia services are vital in modern healthcare, extending beyond anesthesia administration to encompass patient assessment, monitoring, pain management, and emergency responses. The evolving complexity of surgeries and patient needs requires the optimization of these services.[1,2] The optimization of anesthesia services is not only essential for ensuring patient safety and well-being but also for the efficient utilization of healthcare resources. Anesthesia-related complications and errors can have profound consequences on patient outcomes, making it imperative to continually enhance the quality of care provided by anesthesia practitioners.[2,3] Moreover, as healthcare systems worldwide face increasing demands and financial pressures, the efficient delivery of anesthesia services becomes crucial in terms

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of cost-effectiveness and resource allocation. In this dynamic healthcare environment, optimizing anesthesia services becomes a cornerstone of achieving the highest standards of patient care while maintaining the sustainability of healthcare systems.[4,5]

Significance of anesthesia services

Anesthesia is undeniably an indispensable facet of modern healthcare. It serves as the gateway to various medical procedures, surgeries, and interventions, ensuring patients' comfort and safety throughout the perioperative process.[1-3]

Role of anesthesia practitioners

Anesthesia practitioners, including anesthesiologists and nurse anesthetists, occupy pivotal roles in the healthcare ecosystem. Their duties commence with comprehensive pre-operative evaluations, where they meticulously assess a patient's health status and suitability for anesthesia. This careful consideration forms the foundation upon which safe anesthesia practices are built. Once the patient is on the operating table, these skilled professionals select and administer the precise anesthesia techniques and medications tailored to the individual's unique needs. With a watchful eye, they continuously monitor vital signs and physiological responses throughout the surgical procedure, maintaining a delicate balance between sedation and consciousness.[6]

Anesthesia practitioners also bear the responsibility of managing pain, ensuring patients remain comfortable and free from distress throughout the duration of complex procedures. In the high-stakes environment of the operating room, they stand ready to respond swiftly and decisively to emergencies or adverse events that may unexpectedly arise, providing a lifeline in critical moments. As the surgery nears its conclusion, these professionals skillfully guide patients out of the anesthesia-induced state of unconsciousness, gently facilitating their return to consciousness during the emergence phase. They continue to provide post-operative care and vigilant pain management, fostering a smooth path to recovery for patients on their journey back to full health.[6]

Anesthesia service models

Public healthcare systems adopt various models for the delivery of anesthesia services, depending on regional, national, or institutional factors. An understanding of these models is crucial for anesthesia practitioners and healthcare administrators striving to provide equitable and effective anesthesia services within public healthcare systems.[7]

Anesthesia care team model: A team of anesthesia providers, often led by an anesthesiologist, collaboratively delivers care. Nurse anesthetists and anesthesia assistants may work under the supervision of the anesthesiologist, contributing to the anesthesia care team's efficiency.[7,8]

Sole anesthesiologist model: In some regions, anesthesiologists work independently, providing anesthesia services without the involvement of nurse anesthetists or anesthesia assistants. This model may be more common in areas with a surplus of anesthesiologists.[7]

Nurse anesthetist-led model: Certified registered nurse anesthetists, operate autonomously in this model, delivering anesthesia care without direct supervision by an anesthesiologist. This approach is especially prevalent in rural or underserved areas where physician resources are limited.[9]

Mixed or hybrid models: Some healthcare systems employ a combination of the above models to optimize resource utilization and ensure high-quality anesthesia services.[10]

Evolution of KPIs in healthcare

This evolution has been significant in response to the ever-changing landscape of the industry. Originally, healthcare KPIs were primarily centered around clinical outcomes and adherence to guidelines, focusing on objective measurement to facilitate fair comparisons and foster continuous improvement. Modern healthcare KPIs prioritize patient outcomes, quality of life, and satisfaction, reflecting a transition to outcome-based metrics. Patient experience and satisfaction have become integral KPIs, recognizing the importance of patient-centered care. Additionally, KPIs now assess resource utilization, efficiency, and cost-effectiveness to optimize healthcare operations, and the integration of health information technology has streamlined data collection and reporting. Benchmarking against peer institutions and the use of comparative data have also become crucial, driving performance improvement in healthcare while enhancing accountability and patient safety through the identification of deviations from established benchmarks and best practices.[11]

KPIs in anesthesia services

The utilization of KPIs in anesthesia services serves several crucial purposes. It enhances patient safety by identifying potential risks and encouraging the adoption of best practices during surgical procedures. Additionally, KPIs aid in the efficient allocation of resources, ensuring anesthesia providers, equipment, and medications are used effectively and cost-effectively. They also support quality assurance efforts by allowing practitioners and institutions to evaluate the quality of care.[3] KPIs enable continuous monitoring of anesthesia service performance, helping to identify trends and deviations from established standards. They promote evidence-based practice by providing data for clinical decision-making and foster accountability among anesthesia providers while increasing transparency in anesthesia services, ultimately benefiting both patients and healthcare systems.[3,12]

Types of KPIs

Patient safety indicators: These KPIs are designed to measure the extent to which anesthesia services prioritize and ensure patient safety during surgical and medical procedures. They encompass metrics related to the prevention of anesthesia-related complications, medication errors, infection control, and the avoidance of adverse events. Examples include the anesthesia-related mortality rate, incidence of medication errors, surgical site infection rates, and adverse events during anesthesia.[3]

Quality of anesthesia care: These KPIs gauge the effectiveness of anesthesia techniques, pain management, and the overall patient experience during anesthesia. They provide insights into the anesthesia practitioner's ability to deliver services that optimize patient comfort, minimize complications, and ensure a smooth transition between different states of consciousness.[3]

Patient outcomes and satisfaction: These KPIs assess the long-term impact of anesthesia services on patients' health, well-being, and overall experience. They measure the success of anesthesia interventions in promoting positive patient outcomes, reducing pain, and enhancing overall satisfaction, thus reflecting the quality of anesthesia care.

Operational KPIs

Efficiency and resource utilization: These KPIs focus on assessing the efficiency and effectiveness of resource allocation, including time, staff, and equipment, during anesthesia procedures. Examples include turnaround time between anesthesia cases, operating room utilization rates, equipment utilization rates, and anesthesia start and end times relative to scheduled surgery times.[12]

Staffing and workforce management: These KPIs evaluate the adequacy, competency, and performance of anesthesia providers and support staff. They ensure that anesthesia teams are appropriately staffed, well-trained, and capable of delivering high-quality care. Examples include staff-to-patient ratio during anesthesia procedures, anesthesia provider certification and continuing education rates, staff satisfaction and retention rates, and frequency of staff overtime and fatigue-related incidents.[13,14]

Equipment and supply management: These KPIs assess the efficiency of managing anesthesia-related equipment, medications, and supplies, ensuring their availability and proper maintenance. They help prevent equipment-related disruptions during anesthesia procedures, minimize waste, and control costs. Examples include equipment maintenance and servicing schedules, medication and supply inventory turnover rates, and equipment downtime and malfunction incidents.[15]

Compliance and documentation KPIs

Adherence to protocols and guidelines: These KPIs measure the extent to which anesthesia providers adhere to established protocols, guidelines, and best practices in anesthesia care. They ensure that anesthesia care consistently follows evidence-based standards, enhancing patient safety and clinical outcomes. Examples include compliance with pre-operative checklists, adherence to infection control protocols, use of standardized anesthesia protocols, and documentation of adherence to clinical guidelines.[3,16]

Accuracy of documentation: These KPIs assess the completeness, timeliness, and accuracy of anesthesia records, ensuring that critical information is properly documented and accessible. It is essential for clinical decision-making, patient safety, and legal and regulatory compliance. Examples include completeness and accuracy of anesthesia records, timeliness of documentation completion, and audit results for documentation accuracy.[3]

Financial KPIs

Cost per case: These KPIs evaluate the financial efficiency of anesthesia services, measuring the cost of providing anesthesia care for each patient. They help healthcare organizations manage costs, allocate resources effectively, and optimize financial sustainability. Examples include total anesthesia service costs per case, cost breakdown by anesthesia personnel, supplies, and equipment, cost per unit of service, and cost reduction initiatives and their impact.[8,17]

Revenue generation and billing accuracy: These KPIs assess the financial performance of anesthesia services, including revenue collection and billing processes. They ensure that anesthesia services are financially viable, billing practices are accurate, and revenue is collected promptly. Examples include revenue generated from anesthesia services, billing accuracy rates and error analysis, timeliness of claims submission and reimbursement, and billing compliance with healthcare regulations and coding standards.[7]

Importance of KPIs

1. **Enhancing patient safety and quality of care**: By systematically monitoring patient safety indicators, adherence to protocols, and clinical outcomes, anesthesia practitioners can identify potential risks, promptly address deviations from best practices, and continuously improve care delivery. This focus on patient safety and quality not only reduces the likelihood of adverse events but also promotes positive patient experiences and outcomes.[3]

2. **Optimizing resource allocation and cost-efficiency**: Anesthesia providers and healthcare institutions can use these metrics to make informed decisions about resource allocation, minimize wastage, and ensure that anesthesia care is provided cost-effectively. This, in turn, contributes to the financial sustainability of anesthesia services within public healthcare systems.[7,18]

3. **Supporting data-driven decision-making**: Anesthesia providers, administrators, and policymakers can leverage KPI data to identify trends, set priorities, and make evidence-based choices that improve patient care and resource management. Data-driven decision-making fosters transparency and accountability in anesthesia services.

4. **Demonstrating accountability and transparency**: By measuring and reporting on performance, anesthesia practitioners and organizations demonstrate their commitment to transparency and the delivery of high-quality care. This accountability extends to patients, regulatory bodies, and the broader healthcare community.[3]

5. **Promoting flexibility**: Defined as the ability to adapt to changing circumstances or patient needs during anesthesia procedures, is vital for ensuring patient safety and successful outcomes. This encourages anesthesia practitioners to remain agile in their approach, responding to unexpected challenges and optimizing care in dynamic clinical environments.[19]

6. **Ensuring fairness**: Defined as providing equitable access to anesthesia services and ensuring equal treatment for all patients, is a fundamental ethical principle. It helps

anesthesia providers and institutions monitor access to care, identify disparities, and take corrective actions to ensure that anesthesia services are accessible to all, regardless of demographic or socioeconomic factors.[20]

7. **Ensuring accountability**: Defined as taking responsibility for one's actions and decisions in anesthesia care, is essential for patient safety and trust. This holds anesthesia practitioners to high professional standards, reinforcing the importance of ethical conduct, informed decision-making, and adherence to best practices.[3]

8. **Promoting accessibility**: Defined as ensuring that anesthesia services are readily available and accessible to all patients, including those with special needs, promotes inclusivity and patient-centered care. This helps identify barriers to care access and drive initiatives to remove them, ensuring that anesthesia services are available to diverse patient populations.[20]

9. **Assessing competency**: Defined as evaluating the skills and knowledge of anesthesia providers to ensure high-quality care, is crucial for patient safety. It ensures that anesthesia practitioners are continually trained, evaluated, and equipped to deliver anesthesia services effectively and in line with evolving standards.[21]

10. **Ensuring continuity**: Defined as maintaining consistent anesthesia care throughout a patient's surgical journey, enhances patient safety and reduces the risk of complications. It helps anesthesia providers track and optimize care transitions, ensuring seamless anesthesia management from pre-operative assessment to post-operative recovery.[4]

11. **Evaluating effectiveness**: Defined as measuring the extent to which anesthesia services achieve their intended outcomes, is essential for assessing the impact of care interventions. This enables anesthesia practitioners to gauge the success of pain management, patient outcomes, and adherence to clinical protocols.[3]

12. **Enhancing efficiency**: Defined as optimizing the use of resources to deliver anesthesia care cost-effectively, supports healthcare institutions in achieving financial sustainability. It helps identify areas for streamlining processes, reducing costs, and maximizing resource utilization without compromising patient care.[3,22]

13. **Ensuring sustainability**: Defined as implementing practices that allow anesthesia services to be maintained over the long term, is essential for the continuity of care. This guides healthcare institutions in managing resources, adapting to changing healthcare environments, and ensuring that anesthesia services remain viable and accessible.[4]

14. **Measuring satisfaction**: Measuring satisfaction, both from the perspective of patients and anesthesia practitioners, provides valuable feedback on the quality of anesthesia services. It enables anesthesia providers and institutions to identify areas for improvement and enhance the overall experience of care delivery.

15. **Promoting responsibility**: Defined as encouraging anesthesia providers to take ownership of their roles and responsibilities in patient care, fosters a culture of professionalism and accountability. It reinforces the importance

of ethical conduct, patient-centered care, and continuous improvement in anesthesia services.[23]

Implementing KPIs

Setting meaningful KPIs: It is crucial to ensure that the selected KPIs are actionable, measurable, and aligned with established anesthesia standards and guidelines. This process involves a thorough assessment of critical aspects of care, such as patient safety, quality, efficiency, and financial sustainability.[24]

Data collection and management: It is crucial to ensure that data collection protocols are in alignment with anesthesia practice guidelines and workflows. The accuracy and timeliness of data collection serve as the cornerstone for informed decision-making and performance assessment.[25,26] Safeguarding patient data and maintaining security are of paramount importance, adhering to healthcare privacy and ethical standards, such as the Health Insurance Portability and Accountability Act.[21]

Performance measurement tools and software: In addition to providing training and support to anesthesia staff on the use of performance measurement tools and software, it is crucial to ensure that the selected tools seamlessly integrate with existing healthcare information systems, such as electronic health records and anesthesia information management systems.[25] This integration facilitates data collection, analysis, visualization, and reporting, streamlining the process of monitoring and improving performance.[21,26]

Staff training and education: It is essential to create training programs and resources that elucidate the significance of KPIs and how they align with anesthesia practice goals. Anesthesia practitioners should receive comprehensive training and education regarding the importance of KPIs, their role in anesthesia practice, and how to contribute to achieving KPI targets and optimizing anesthesia services.[27]

Common challenges

The foremost obstacle in implementing KPIs, is the variability in data collection methods, accuracy, and completeness, which can undermine the reliability of KPIs. Addressing this, standardizing data collection processes is essential.[18] The next challenge involves resistance from anesthesia practitioners and staff when adopting new KPIs and performance measurement practices; overcoming this resistance necessitates effective change management strategies.[1] Limited resources, including time and financial constraints, may then impede the implementation of necessary data collection and analysis systems for KPIs.[18] Maintaining the long-term sustainability of KPI programs can be challenging, particularly if initial enthusiasm wanes or if resource constraints arise.

Ethical considerations and potential pitfalls

Implementing KPIs in anesthesia services necessitates a careful consideration of ethical concerns and potential pitfalls. Following this, it is crucial to design and implement KPIs in a manner that prevents the perpetuation of bias or discrimination within anesthesia practice.[24]

Consent from patients for the collection of satisfaction data is essential, with the option to withhold consent without any impact on their care. Transparency in reporting KPIs is vital, although it carries the risk of public misinterpretation, making it essential to provide context and prevent misleading interpretations.[24] Ethical considerations should also encompass ensuring that KPIs accurately reflect performance and avoiding unwarranted praise or blame.

Data quality and reliability issues

Data quality and reliability are paramount for the effectiveness of KPIs. Ensuring the accuracy, consistency, and trustworthiness of KPI data is foundational for informed decision-making and performance improvement. Errors during data collection or entry can significantly compromise the accuracy of KPIs, underscoring the importance of quality assurance processes. Addressing missing data points or incomplete records is the next priority to prevent gaps in performance measurement.[21] To maintain data quality and reliability over time and accurately assess trends and improvements, the establishment of robust data governance frameworks and the definition of data stewardship roles are essential considerations.

Future trends and innovations

Emerging technologies

The technological advancements of smart devices and sensors into anesthesia equipment facilitated by the internet of things (IoT) is revolutionizing KPI measurement by providing real-time monitoring of vital signs, anesthesia delivery, and patient responses, thereby enhancing precision. Following this, telemedicine platforms and remote monitoring technologies extend the scope of anesthesia care, enabling practitioners to monitor patients throughout the perioperative process, thus improving patient safety and data collection.[25] Blockchain technology is being explored as a means to securely share KPI data, addressing privacy concerns while maintaining transparency. AI applications in anesthesia management assists practitioners in optimizing drug dosages, monitoring patient responses, and predicting adverse events, further advancing the field.[28]

Predictive analytics and machine learning applications

Predictive analytics and machine learning hold the potential to revolutionize anesthesia practice by delivering valuable insights into patient responses, optimizing care plans, and predicting outcomes. Machine learning algorithms can harness historical patient data to predict individual patient outcomes during and after anesthesia, allowing anesthesia practitioners to tailor care plans effectively. These machine learning models can continuously monitor patient data, swiftly detecting anomalies or deviations from expected patterns for early intervention during adverse events.[29]

Evolving regulatory and accreditation standards

In the evolving landscape of healthcare regulations and standards, several key considerations should be prioritized.[2] Firstly, regulatory bodies

and accrediting agencies are likely to increasingly incorporate anesthesia KPIs and quality metrics into their evaluation criteria for healthcare institutions.[30] Secondly, the regulatory framework for telemedicine in anesthesia may undergo changes that affect how remote monitoring and consultation are conducted, necessitating adaptation.[30] Thirdly, amidst growing data privacy concerns, anesthesia services must focus on ensuring compliance with evolving data protection regulations. Fourthly, efforts aimed at standardizing data definitions and promoting interoperability among healthcare information systems will significantly impact the collection and sharing of anesthesia KPI data, warranting attention.[21] Lastly, it's crucial to recognize that accreditation standards may place an elevated emphasis on patient-centered care, which will drive the utilization of patient satisfaction KPIs in anesthesia practice.[5]

Conclusion

This review underscores the pivotal role of KPIs in improving anesthesia services within public healthcare systems. KPIs serve as potent tools for enhancing patient safety, care quality, and resource allocation while fostering data-driven decision-making and ethical considerations. Their implementation offers a continuous improvement opportunity by enabling evidence-based strategies for better patient outcomes, aligning services with evolving healthcare dynamics and emerging technologies, and ensuring the long-term sustainability of anesthesia care. Embracing KPIs is essential for achieving excellence in anesthesia care, requiring active participation, data-driven decision-making, and collaborative efforts among practitioners, administrators, and policymakers to promote safer, more efficient, and patient-centered practices.

References

1. Setiawan I, Purba H. A systematic literature review of key performance indicators (KPIs) implementation. J Indust Engin Manag Res. 2020;1:200-8.
2. Jazieh AR. Quality measures: types, selection, and application in health care quality improvement projects. Glob J Qual Saf Healthc. 2020;3:144-6.
3. Wacker J. Quality indicators for anesthesia and perioperative medicine. Curr Opin Anaesthesiol. 2023;36:208-15.
4. Hailemariam M, Bustos T, Montgomery B, Barajas R, Evans LB, Drahota A. Evidence-based intervention sustainability strategies: a systematic review. Implement Sci. 2019;14:57.
5. Al-Sayedahmed H, Al-Tawfiq J, Al-Dossary B, Al-Yami S. Impact of accreditation certification on improving healthcare quality and patient safety at Johns Hopkins Aramco Healthcare. Glob J Qual Saf Healthc. 2021;4:117-22.
6. Wicker P. The role of the anaesthetic practitioner. In: Wicker P, Dalby S, eds. Rapid perioperative care preoperative preparation. John Wiley & Sons, Ltd. 2017;p1-6.
7. Hoyem RL, Quraishi JA, Jordan L, Nicely KL. Advocacy, research, and anesthesia practice models: key studies of safety and cost-effectiveness. Policy Polit Nurs Pract. 2019;20:193-204.
8. Franklin D, Johannes L, Thomas CS, David G, Bradley JH. Influence of provider type (nurse anesthetist or resident physician), staff assignments, and other covariates on daily evaluations of anesthesiologists' quality of supervision. Anesth Analg. 2014;119:670-8.
9. Needleman J, Minnick AF. Anesthesia provider model, hospital resources, and maternal outcomes. Health Serv Res. 2009;44:464-82.

10. Dexter F, Abouleish A, Marian AA, Epstein RH. The anesthetizing sites supervised to anesthesiologist ratio is an invalid surrogate for group productivity in academic anesthesia departments when used without consideration of the corresponding managerial decisions. J Clin Anaesth. 2021;71:110194.
11. Khalifa M, Khalid P. Developing strategic health care key performance indicators: a case study on a tertiary care hospital. Procedia Comput Sci. 2015;63:459-66.
12. Bashir A, Aslam I, Waseem A, Kazmi IH, Mubeen M. Key performance indicators of anesthetic practice: a clinical audit. Arch Surg Clin Res. 2021;2:23-5.
13. Abcejo AS, Methangkool E. Staffing shortages, patient safety, and me: embracing the reality of a symbiotic feedback loop. ASA Monitor. 2023;87:37-8.
14. Afonso AM, Cadwell JB, Staffa SJ, Zurakowski D, Vinson AE. Burnout rate and risk factors among anesthesiologists in the United States. Anesthesiology. 2021;134:683-96.
15. Gisvold SE, Fasting S. How do we know that we are doing a good job-can we measure the quality of our work? Best Pract Res Clin Anaesthesiol. 2011;25:109-22.
16. Rong LQ, Audisio K, O'Shaughnessy SM. Guidelines and evidence-based recommendations in anaesthesia: where do we stand? Br J Anaesth. 2022;128:903-8.
17. Malhotra R, Kumar N, Jain A. Cost identification analysis of general anesthesia. J Anaesthesiol Clin Pharmacol. 2020;36:219-26.
18. Sharma D, Cotton M. Overcoming the barriers between resource constraints and healthcare quality. Trop Doct. 2023;53:341-3.
19. Dutton RP, Isaak R, Cammarata BJ, Zvara DA. The future of anesthesia practice: pro-pro-pro. Adv Anesth. 2019;37:111-26.
20. Diallo MS, Tan JM, Heitmiller ES, Vetter TR. Achieving greater health equity: an opportunity for anesthesiology. Anesth Analg. 2022;134:1175-84.
21. Riddle D, Baker K, Sapp A. Evaluation of testing as a method to assess continued competency in nurse anesthesia practice: a systematic review. AANA J. 2016;84:239-45.
22. Ahmed F, Chithrala B, Barve K, Biladeau S, Clifford SP. Value-based care and anesthesiology in the USA. Cureus. 2023;15:e44410.
23. Ekmekci PE, Kazak Bengisun Z, Arda B. Resolving ethical issues in the field of anaesthesia: a mixed-methods study. Turk J Anaesthesiol Reanim. 2021;49:407-13.
24. Peden CJ, Campbell M, Aggarwal G. Quality, safety, and outcomes in anaesthesia: what's to be done? An international perspective. Br J Anaesth. 2017;119(Suppl1):i5-14.
25. Alhmoud B, Melley D, Khan N, Bonicci T, Patel R, Banerjee A. Evaluating a novel, integrative dashboard for health professionals' performance in managing deteriorating patients: a quality improvement project. BMJ Open Qual. 2022;11:e002033.
26. Ozonze O, Scott PJ, Hopgood AA. Automating electronic health record data quality assessment. J Med Syst. 2023;47:23.
27. Pardo M Jr. Anesthesia: how to organize and train our teachers. Anesthesiology. 2010;112:773-4.
28. Kumar R, Arjunaditya, Singh D, Srinivasan K, Hu YC. AI-powered blockchain technology for public health: a contemporary review, open challenges, and future research directions. Healthcare. 2023;11:81.
29. Char DS, Burgart A. Machine-learning implementation in clinical anesthesia: opportunities and challenges. Anesth Analg. 2020;130:1709-12.
30. Al Meslamani AZ. Technical and regulatory challenges of digital health implementation in developing countries. J Med Econ. 2023;26:1057-60.