Received: 30 September 2024 | Revised: 18 November 2024 | Accepted: 22 November 2024 | Published online: 26 November 2024

International Journal of Advance in Clinical Science Research, Volume 3, 2024
https://h-tsp.com/

The Role of Precision Anesthesia in High-risk Surgical Patients: A Comprehensive Review and Future Direction

Sifang Lin[1], Hongyu Tan[2], Liyun Zhao[3], Bo Zhu[4], Tiehu Ye[5]

[1]Anesthesiology, Peking Union Medical College, Beijing, China
[2]Anesthesiology, Director of the Department of Anesthesiology, Beijing Cancer Hospital, Beijing, China
[3]Anesthesiology, Beijing Anzhen Hospital, Capital Medical University, Beijing, China
[4]Anesthesiology, Peking Union Medical College Hospital, Beijing, China
[5]Anesthesiology, Peking Union Medical College Hospital, Beijing, China

Abstract: ***This paper aims to comprehensively review the application of precision anesthesia in high-risk surgical patients, explore its role, technical basis, clinical effects and its challenges, and look forward to the future development direction. Through the in-depth analysis of the characteristics, anesthesia risk and precision anesthesia related technologies of high-risk surgical patients, combined with modern medical means such as genomics, biomarker monitoring, artificial intelligence and big data analysis, the application of precision anesthesia in improving anesthesia safety, reducing complications and optimizing postoperative recovery is discussed. Through individualized preoperative evaluation and planning, drug selection and dose adjustment, and intraoperative real-time monitoring and adjustment, precision anesthesia significantly reduces anesthesia-related complications, improves the safety of anesthesia and the quality of patients postoperative recovery. However, technical limitations, cost issues, ethical privacy challenges, and the universality of individualized schemes still need to be addressed. Precision anesthesia has significant clinical significance in high-risk surgical patients and and well-demonstrating great potential. Future development needs to further promote the deep integration of genomics and anesthesiology, strengthen the application of big data and artificial intelligence, and promote interdisciplinary cooperation, so as to realize the popularization and optimization of precision medicine.***

Keywords: Precision anesthesia; High-risk surgical patients; Review.

1. Introduction

1.1 Research Background

High-risk surgery patients are typically those who are at higher risk during surgery or during recovery. Such patients tend to have a variety of underlying conditions such as cardiovascular disease, respiratory disease, diabetes, etc. Their physiological functions may have been compromised and their immunity may be weak, so any fluctuations during surgery and anesthesia may have irreversible consequences for them. In addition, more elderly patients are often considered high-risk due to natural decline organ function function[1].

A key feature of high-risk surgery patients is that their less physiologic reserve, meaning surgery and anesthesia often hit them harder than healthy people. For example, in patients with severe emphysema, if lung function is near its limit, respiratory suppression during anesthesia may directly lead to severe respiratory failure. In addition, the mental state of such patients is important, and preoperative anxiety and depression can increase the risk of surgery and anesthesia[2].

1.2 The concept of precision anesthesia

The core of precision anaesthesia is individualization, that is, tailoring anesthesia plan to each patient's unique physiological and pathological characteristics. This principle requires a comprehensive assessment of the patient's genomic information, biochemical status, organ function, etc. Through genetic testing, anesthesiologists can learn about a patient's ability to metabolize a particular narcotic to avoid side effects of drug accumulation. Similarly, by dynamically monitoring biochemical indicators and organ function, doctors can adjust anesthesia depth and drug dose in real time to ensure smooth surgery[3].

Secondly, precision anesthesia emphasizes multidisciplinary cooperation. This includes not only anesthesiologists, but also geneticists, clinical pharmacologists and physicians. By working together, patient information can be thoroughly analyzed to develop the most anesthesia plan program. Geneticists, for example, can help interpret a patient's genetic information, while pharmacologists suggest the best combination of drugs based on their metabolic properties. This cooperation mode greatly improves the scientific and accuracy of anesthesia management.

Finally, precision anesthesia also focuses on the integration of technical means. The real-time monitoring of modern biomarkers, the application of smart anesthesia equipment, and the support of big data analysis platforms are all indispensable tools for achieving precision anaesthesia. With these techniques, the anesthesia process can not only be more accurate and safe, but also provide patients with a better postoperative recovery experience. This multi-dimensional, multi-layered approach has revolutionized anesthesia management for high-risk surgical patients[4].

2. Characteristics and anesthetic risk of patients undergoing high-risk surgery

2.1 Classification of high-risk patients

Age is an important factor in assessing the risk of surgery. Older patients are often at higher risk of anesthesia, and with age, the body's physiological functions gradually decline. The function of vital organs such as heart, lung and kidney is weakened in the elderly, and these changes directly affect the tolerance and safety of anesthesia. For example, the reduced ability of the heart to constrict makes more elderly people more vulnerable to the negative effects of narcotic drugs, leading to arrhythmias and low blood pressure. anesthesia programs for more elderly patients therefore require special attention to monitoring and protection of cardiac function to ensure safety during surgery[5].

In addition, declining immune function in the elderly is a problem that cannot be ignored. During anesthesia, patients can be exposed to a variety of bacteria and viruses, therefore older people with weakened immune systems are more likely to develop postoperative infections. Therefore, a comprehensive preoperative evaluation of more elderly patients, including immune function testing, selection of the most appropriate anesthetic and intraoperative medication to reduce the risk of infection, is important. In addition, these comorbid conditions add to the complexity of anesthesia because more elderly people often suffer from a variety of chronic conditions, such as high blood pressure and diabetes. Therefore, a comprehensive preoperative pathophysiological assessment and multidisciplinary consultation before operation are the key to ensure the safety of anesthesia[6].

2.2 Common anesthesia complications occur in high-risk patients

Patients with high-risk surgery are prone to a variety of complications during anesthesia, of which there are many types and risks. First is cardiovascular complications such as arrhythmia and myocardial ischemia. Because high-risk patients have pre-existing cardiovascular conditions, the use of any anesthetic may further burden the heart, leading to arrhythmias. For example, older patients may experience sudden atrial fibrillation during anesthesia and, in severe cases, cardiac arrest. Myocardial ischemia is another common cardiovascular disease caused by anesthesia. Due to insufficient coronary blood supply, myocardial ischemia is easily induced in such patients during anesthesia, and timely adjustment of the anesthesia regimen is necessary to avoid and manage myocardial ischemia[7].

Second, respiratory complications are a common anesthetic risk for high-risk patients. Including respiratory suppression, airway blockage, lung infection, etc. Because of impaired respiratory function, high-risk patients are more likely to experience respiratory suppression while under anesthesia. For example, COPD patients may experience apnea under the influence of anesthetic drugs and require timely supportive ventilation. Obstruction of the airways is common in patients with existing airway stenosis, such as asthma and inflammation of the airways caused by upper respiratory tract tract infection. Preventive medication and close monitoring should be taken to avoid these complications. Lung infections are a common problem after surgery. Bacterial infections are more likely due to anaesthesia and decreased immunity during surgery, so the postoperative anti-infection management needs to be strengthened[8].

Severe metabolic and endocrine complications can also occur in some high-risk patients. This includes hypoglycemia and hyperglycemia, especially in diabetics. Because of metabolic abnormalities, medication and treatment during anesthesia can disrupt glycemic balance, leading to hypoglycemia or hyperglycemia complications, in severe cases life-threatening. Anesthesiologists must keep patients blood glucose within safe limits through preoperative blood glucose management, continuous intraoperative monitoring and timely adjustment. In addition, endocrine dysfunction can affect stress response and recovery in patients. For example, patients with hypothyroidism may be particularly sensitive to anesthetics and may need to adjust their medication regimen to avoid unnecessary risks[9].

3. Basic techniques and methods of precision anesthesia

3.1 Genomics and individualized anesthesia

3.1.1 Application of genetic testing in anesthesia

The application of genetic testing in anesthesiology provides a new prospect for accurate anesthesia. Through the analysis of individual genetic information, it is possible to predict the response of patients to anaesthesia and provide scientific basis for the formulation of anesthetic protocol. For example, different patients may have different metabolisms and reactions to the same anesthetic, and genetic testing can identify these individual differences. Analysis of the genotypes of CYP2D6 patients found significant differences in response to conventional doses of fentanyl among patients with specific genetic variants, information that could help anesthesiologists adjust anesthesia plans to reduce the incidence of adverse reactions and complications. Therefore, the application of genetic testing in anesthesia provides important technical support for personalized anesthesia and improves the safety and success rate of surgery[10].

Genetic testing can also be used to screen for anaesthetic regimens suitable for specific procedures. Different types of surgery require different depth and duration of anesthesia, and genetic testing can predict a patient's susceptibility and metabolic rate to different anesthetics based on their genetic characteristics. This allows anesthesiologists to select the combination and dose of anesthetic that best suits each patient, optimizing the effect while reducing the risk of surgery. For high-risk heart surgery patients, for example, screening patients with slower propofol metabolism through genetic testing can reduce the risk of low blood pressure and heart suppression due to overdose during anesthesia, ensuring smooth surgery and patient safety.

In addition, the application of genetic testing in anesthesia can help identify the risk of anaesthesis-related adverse reactions. Because of genetic factors, some patients may have a severe allergic or toxic reaction to a particular anesthetic, and genetic testing can identify these risks before surgery, avoid the drugs and choose safer alternatives. For example, studies have shown that the use of these drugs in patients with digoxin specific MDR 1 varichanges can avoid the risk of potential side effects and improve the quality of postoperative recovery[11].

3.1.2 Genotype analysis of drug-metabolizing enzymes (e. g., CYP450) and dosage adjustment of anesthetic drugs

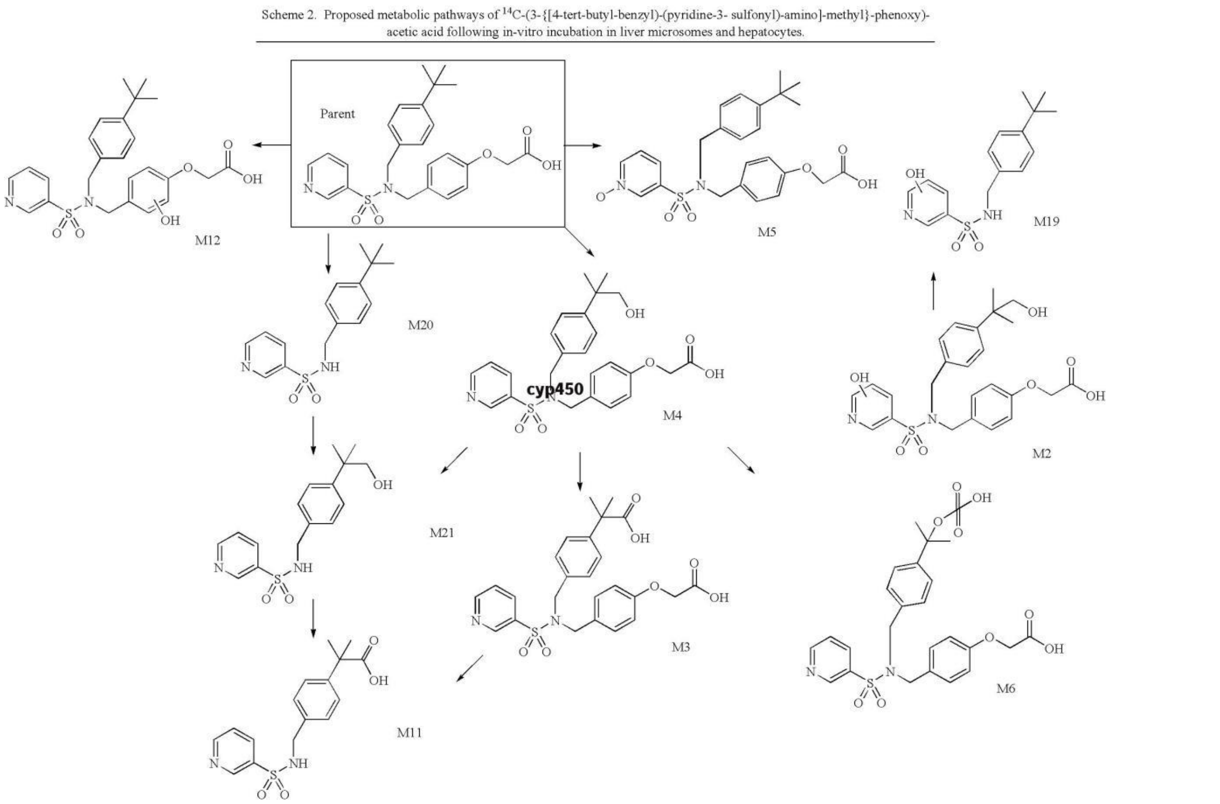

Figure 1: Drug Metabolism enzymes (e. g., CYP450)

Genotype analysis of drug metabolizing enzymes is a key step in precision anesthesia. The CYP450 enzyme line plays an important role in the metabolism of a wide range of narcotic drugs, but the speed and extent of metabolism of the same drug varies significantly from individual to individual due to genetic differences. By analyzing the CYP450 genotype, anesthesiologists can predict how quickly the drug will metabolize in the body and adjust the dose accordingly to achieve optimal anesthetic effect while reducing adverse reactions. For example, individual differences in genotypes of CYP2C9 and CYP2C19 affect the metabolic rate of commonly used anesthetics such as propofol and etomidate, which have important implications for surgery. One study evaluated surgical patients with the CYP2C9 genotype and found that patients with a specific genotype experienced significant hypotension after a routine dose of propofol, significantly improving anesthesia and intraoperative stability by adjusting the dose[12].

CYP450 Genotype analysis could also play a role in preventing anesthesia delays due to inadequate drug metabolism. Mutations in the CYP450 gene lead to slow metabolism of some anesthetic drugs in some patients, resulting in delayed postoperative recovery and increased complications. By performing preoperative genotype testing, anesthesiologists can adjust anesthesia schedule in advance and select drugs that metabolize faster and are safer, reducing recovery time and risk after surgery. For example, a patient undergoing co-operative surgery was found to have a slow Fentanyl metabolism through a CYP2D6 genotype testing. Anesthesiologists chose to reduce the dose of fentanyl and increased the use of other anesthetic drugs, which ultimately led to smooth surgery and a quick recovery.

In addition, genotype analysis of drug metabolism enzymes can effectively reduce adverse drug reactions. Due to individual differences, some patients may experience serious side effects such as respiratory suppression and arrhythmia. By analyzing the relevant CYP450 genotypes, anesthesiologists can adjust the risk of these serious side effects. For example, patients undergoing tumor resection were slowly metabolized into midazolam by CYP3A4 / 5 genotype. Adjusting the dose avoids the risk of respiratory suppression during the operation and ensured the operation is safe[13].

3.2 Monitoring and application of biomarkers

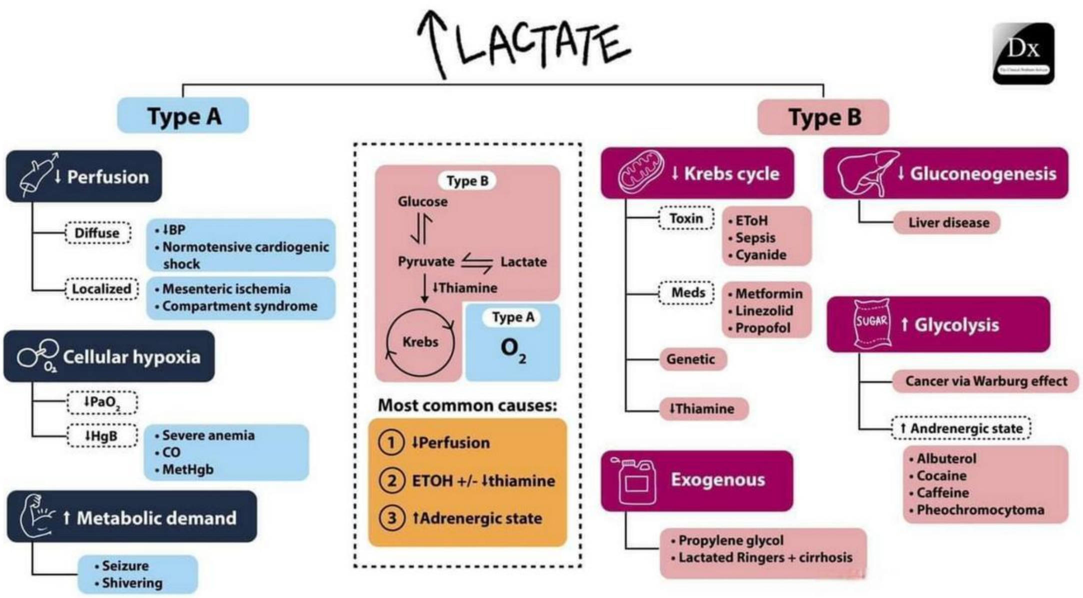

Figure 2: Real-time intraoperative monitoring of biomarkers

Real-time monitoring of biomarkers plays an important role in precision anesthesia. By monitoring changes in biomarkers during surgery, anesthesiologists can assess their physiological status and anesthetic effectiveness in a timely manner to ensure safe surgery. For example, cardiac markers such as interleukin-6 (IL-6) and troponin (cTnI) change rapidly during surgery, reflecting a patient's inflammatory response and heart function. By monitoring these markers in real time, anesthesiologists can identify and treat underlying inflammation and heart problems during surgery, adjust anesthesia strategies, and reduce postoperative complications. Real-time monitoring of IL-6 levels was increased during cardiac surgery, and anaesthetists took rapid anti-inflammatory measures to effectively prevented postoperative infection and inflammatory response, ensuring smooth operation and patient safety[14].

Real-time monitoring of biomarkers during surgery can also help optimize anesthesia depth and drug use. For example, some patients may experience intraoperative tachycardia and blood pressure fluctuations due to inappropriate depth of anesthesia. By monitoring heart markers and blood pressure indicators in real time, anesthesiologists can adjust the depth of anesthesia based on real-time data to ensure the stability of patients' intraoperative physiological indicators. Patients undergoing orthopedic surgery have brain nataturetic peptide and blood pressure levels monitored in real time during surgery. Anaesthetists find significant blood pressure and BNP levels during surgical resection and immediately adjust the anesthesia dose to restore blood pressure and heart index, avoid possible cardiovascular events, and ensure safe and smooth surgery.

In addition, intraoperative monitoring biomarkers may help prevent anaesthesis-related adverse reactions. For example, some patients may experience allergic reactions after using a specific anesthetic. By monitoring changes in inflammatory factors such as histamine and substance P, anesthesiologists can detect these allergic reactions in a timely manner and take appropriate measures to reduce the incidence of adverse reactions. During laryngeal surgery, anesthesiologists immediately stopped using propofol by monitoring histamine levels in real time and givingallergy medications to avoid potentially severe allergic reactions, ensuring smooth surgery and patient safety[15].

3.3 Artificial intelligence and Big Data analysis

The application of big data in precision anesthesia provides a new way to achieve more personalized and efficient anesthesia. With the spread of electronic medical records and medical information systems, medical institutions have accumulated a wealth of patient information and clinical data that can reveal patients' underlying characteristics and anesthesia needs through big data analysis. For example, an anesthesia team analyzed data from hundreds of surgical cases and found significant differences in how patients of a particular age group and genetic background responded to certain anesthetic drugs. Further use of these data to optimize anesthesia regimen and improve the safety and efficiency of surgery. Big data can not only identify and predict the anesthesia needs of individual patients, but also find problems and trends that are difficult to be detected by traditional methods through data mining and pattern recognition, and provide important reference basis for accurate anaesthesia.

Big data analysis can also help optimize the selection and dose of narcotic drugs. By analyzing a large number of surgical cases, anesthesiologists can determine which combination of drugs works best in a particular population and which dose combination guarantees anesthesia while reducing side effects. For example, a large medical organization analyzed thousands of heart surgery cases and found that more elderly patients treated with a certain combination of remifentanil and propofol had better anesthesia and faster recovery after surgery. Using the results of big data analysis, anesthesiologists can develop more scientific and personalized anesthesia plans that improve overall patient experience and surgical success.

In addition, big data play an important role in anesthesia risk assessment and early warning system. Traditional risk assessment often rely on physician experience and small amounts of data with limited accuracy. Through big data analysis, anesthesiologists can build complex risk models based on a variety of factors, including a patient's age, genetic information, preexisting medical history, and preoperative examination results, in order to more accurately predict anesthesia risk and prepare in advance. Using big data analytics, a team of researchers has developed a anesthesia risk prediction system that integrates a variety of medical data to provide anesthesiologists with detailed risk assessment reports to guide clinical decisions and significantly reduce the incidence of intraoperative accidents and postoperative complications[16].

4. Application of precision anesthesia in high-risk surgical patients

preoperative genetic screening and health assessment are important starting points for accurate anesthesia in patients with high-risk surgery. Genetic screening can identify patients' metabolic capacity and risk of response to specific anesthetics and provide a scientific basis for the development of personalized anesthesia regimens. Certain gene mutations may significantly affect drug metabolism, such as CYP2D6, which may lead to abnormal fentanyl metabolism, increasing the risk of insufficient intraoperative anesthetic effect or drug residue. Through preoperative genetic screening, anesthesiologists can more accurately predict and adjust the dose of anesthetic to ensure the safety of surgery. The CYP2D6 gene screen found that some patients metabolized fentanyl more slowly, and anesthesiologists reduced fentanyl doses and increased use of other anesthetic drugs, ensuring smooth surgery and patient safety, the study found. In addition, a health assessment is an essential preoperative link. Anesthesiologists can identify potential risk points, such as the preoperative cardiac function assessment, by assessing a patient's physical condition, prior medical history, and risk factors in a comprehensive manner[17].

Preoperative genetic screening not only helps optimize the use of narcotic drugs, but also identifies the risk of anaesthesis-related adverse reactions. Some patients may have severe allergic or toxic reactions to specific anesthetic drugs due to genetic factors, and genetic screening can identify these risks before surgery, avoid the drugs and choose safer alternatives. For example, preoperative MDR 1 genetic testing revealed a high toxicity risk to propofol in patients undergoing heart surgery. As a result, the anesthesiologist chose to replace other medications, avoiding serious complications due to drug toxicity during and after surgery and ultimately ensuring the safety and success of the procedure. This individualized anesthesia protocol not only improves the safety of the procedure, but also greatly reduces the risk of postoperative complications and improves the overall quality of patient's recovery.
In addition, preoperative health assessment can help anesthesiologists fully understand a patient's overall health and develop more accurate anesthesia plan. For example, a comprehensive lung function assessment in patients with chronic lung disease can help anesthesiologists select anesthesia drugs with less impact on the respiratory system and develop appropriate intraoperative monitoring and first aid. In the case of patients with chronic lung disease lung disease a gastrectomy surgery, a detailed assessment of preoperative health revealed a significant decline in lung function. As a result, anesthesiologists developed anesthesia based on remifentanil and sevoflurane, which reduced respiratory burden, shortened recovery time and improved quality of life after surgery. Anesthesiologists improve the safety and success of surgery by making a comprehensive assessment of the patient's health and developing a personalized anesthesia plan that best suits the patient.

5. Clinical effects and advantages of precision anesthesia

Accurate anesthesia significantly reduced anaesthesis-related complications such as hypotension and sedation through personalized medication selection and dose adjustment. For example, the preoperative genomic analysis can accurately adjust the dose of an anesthetic to avoid hypotension caused by differences in drug metabolism. One study found a 30% reduction in hypotension incidences among heart surgery patients, significantly improving safety.

In addition, precision anesthesia can effectively prevent excessive sedation, ensure good intraoperative cooperation, and rapid postoperative recovery. By monitoring EEG, EMG and other physiological indicators in real time, anesthesiologists can adjust the depth of anesthesia in time to avoid excessive sedation leading to respiratory depression and delayed postoperative recovery. In neurosurgery, the recovery time was reduced by an average of 20 minutes for patients on a precision anesthesia protocol, with no complications associated with excessive sedation, significantly improving the quality of the patient's in-surgery experience and postoperative recovery, the study noted[18].

Accurate anesthesia can also reduce other complications caused by an overdose or insufficiency of narcotic drugs. Through detailed preoperative genomic evaluation and real-time intraoperative monitoring, anesthesiologists are able to accurately adjust the type and dose of anesthetics to ensure that residual drugs are free of toxic side effects. Case studies showed that when orthopedic surgery was performed on older patients, patients woke up smoothly and quickly with personalized anesthesia protocol, significantly reducing the risk of postoperative complications.

6. Challenges of precision anesthesia

Although genetic testing and biomarker monitoring techniques in precision anesthesia have significant advantages in improving the safety and efficacy of anesthesia, their high cost and technical complexity have become major barriers to their wider application. Genetic testing requires advanced high-throughput sequencing equipment and specialized technicians and is extremely expensive to purchase and maintain. The introduction of whole-genome sequencing equipment in large hospitals, for example, costs millions of dollars annually in maintenance and operation, which is unaffordable for most small and medium-sized medical institutions. In addition, the popularization genetic testing requires significant upfront investment, including technical training and data analysis systems, all of which increase overall costs[19].

Biomarker monitoring techniques also face technical and cost challenges. The technology requires high sensitivity detection equipment and high precision data analysis system, with high economic pressure. A study found that a large hospital would need to invest about $5 million to buy and upgrade testing equipment for comprehensive biomarker monitoring, as well as about $1 million annually for equipment maintenance and operation. These cost factors make it difficult for biomarker monitoring to be widely used in small and medium-sized hospitals and affect the comprehensive application of precision anesthesia technology.

In addition, the process of data collection and analysis requires the support of professionals, and the training and introduction of these professionals requires higher costs and time. The case study shows that following the introduction of biomarker monitoring technology in hospitals, specialized training of existing medical personnel for three months is required to ensure the accuracy and validity of monitoring data. The training costs about $10,000 per person, has a long training cycle and affects overall medical efficiency. Taken together, the high cost and complexity of genetic testing and biomarker monitoring techniques are major constraints to the wide application of precision anesthesia in clinical practice.

7. Deep Fusion of Genomics and Precision Anesthesia

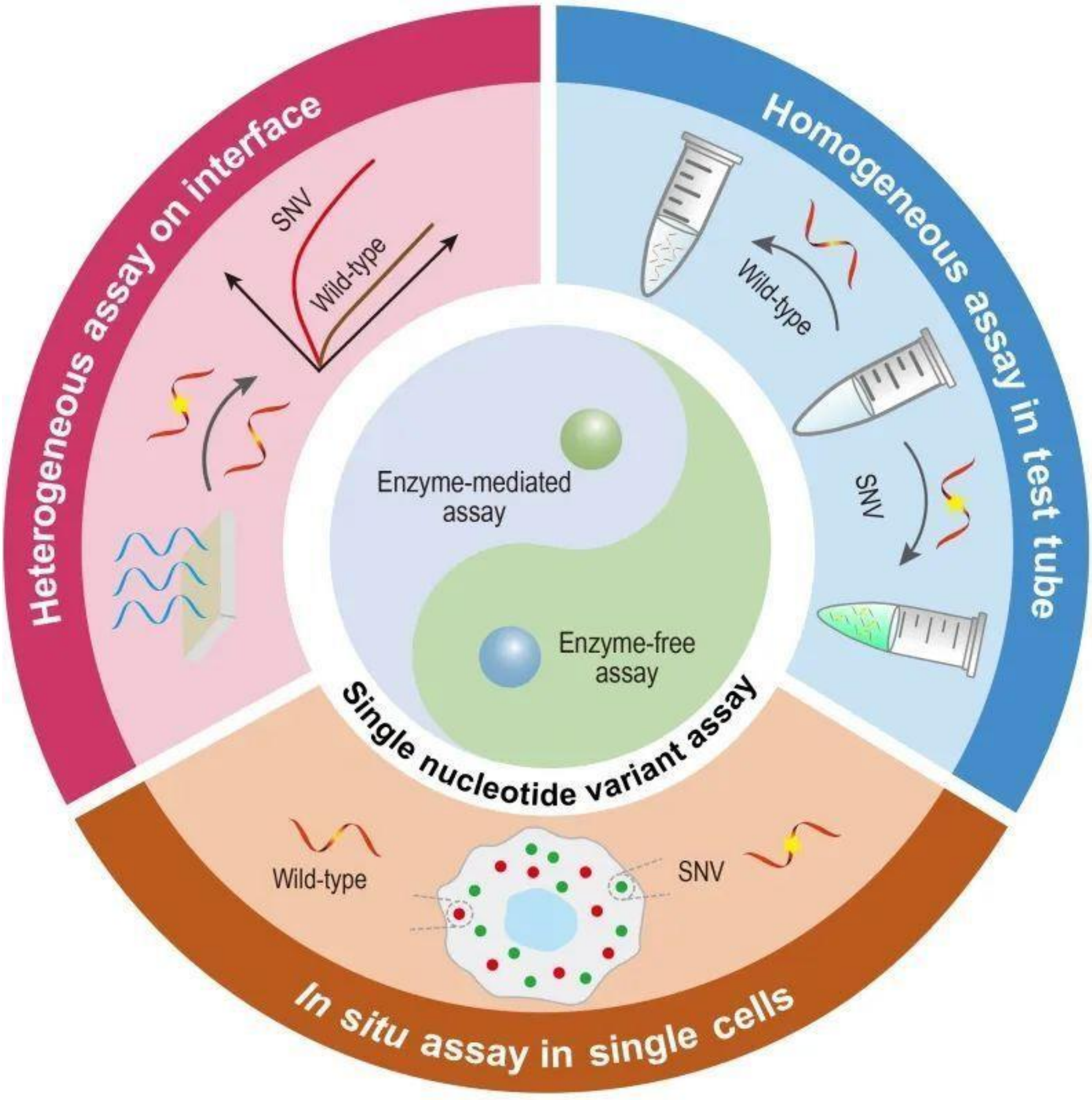

Figure 3: For Future Genomics

Future advances in genomics will provide unprecedented opportunities and tools for precision anesthesia. Through genome-wide association studies (GWAS), scientists can identify genetic variants associated with anesthesia response and develop personalized anesthesia protocols for individual genotypes. For example, certain genetic variants may cause patients to metabolize specific narcotic drugs at different rates, which directly affects the effectiveness of the drugs and the risk of side effects. With this information, anesthesiologists can adjust the types and dosages of anesthetics in advance to maximize effectiveness and reduce risk.

In addition, genomic studies will reveal more genetic markers associated with pain perception and response to pain. These findings will help develop better pain management strategies to ensure patients receive effective pain relief during and after surgery, while reducing opioid dependence and associated side effects. By incorporating this genetic information into anesthesia practice, we hope to achieve truly personalized anesthesia and improve surgical safety and patient satisfaction in the future.

However, the application of genomics in precision anesthesia also faces challenges. For example, access to and analysis of genetic data require a high level of technical support and resource input, and the interpretation of genetic information requires professional bioinformatics knowledge. Further research and validation are needed to rationalize the use of this genetic information in clinical practice to ensure its safety and efficacy. However, advances in genomics will undoubtedly open up new avenues for precision anaesthesia and push it into a new era[20].

8. Conclusion

Looking ahead, the development direction of precision anaesthesia includes further technological innovation and the popularization of clinical practice. First, advances in genomics and bioinformatics will continue to provide new tools and methods for precision anesthesia to help doctors better understand individual differences and anesthesia responses. Secondly, the application of AI and big data technologies will contribute to the intelligence and personalization of anesthesia, optimizing anesthesia scheme and improving the safety and effectiveness of surgery through real-time data analysis and feedback. In addition, interdisciplinary cooperation will be an important way to achieve precision anesthesia, integrating knowledge and technology in genetics, clinical pharmacology and pathophysiology to provide comprehensive, personalized medical services to patients.

Future research needs include: (1) development of more efficient and safe genetic testing and biomarker analysis techniques to ensure their application in clinical practice; (2) establishment of integrated data data integration analysis platforms to support multi-source data data integration and complex data analysis; (3) development of standardized technical guidelines and operating procedures to promote standardization and popularization of precision anesthesia; (4) enhancement of medical education and training to improve interdisciplinary capabilities and technology for physicians and medical practitioners; and (5) development of comprehensive policies to protect privacy and clinical data safety. Through these efforts, precision anaesthesia will gradually realize its potential to provide quality medical care to more patients.

References

[1] Peng Jiaomei, Wang Kai, Zhou Bin, et al. Effect of precision anesthesia strategy on perioperative hemodynamics, cognitive function and pain in patients undergoing general anesthesia for breast cancer [J]. Contemporary Medicine in China, 2024, 31 (28): 89-92.

[2] Lu D , Zhou C , Zhang Y , et al.Minimally invasive surgery, precise anesthesia and effective analgesia are crucial for walking within 1 hour after lung surgery.[J].Journal of thoracic disease, 2024, 16(9):5792-5801.

[3] Zhang Li, Wang Yi, Zeng Heng, et al. Effect of precision anesthesia intervention in the perioperative period of non-cardiac surgery in patients with high-risk cardiovascular disease [J]. Contemporary Medicine in China, 2024, 31 (14): 59-62.

[4] H. F K , H. B T , M. G G , et al.Precision Anesthesia in 2050[J].Anesthesia & Analgesia, 2024, 138(2):326-336.

[5] Estilita B J , Marcolino I , Radtke M F .Patient-centered precision care in anaesthesia - the PC-square (PC)2 approach.[J].Current opinion in anaesthesiology, 2024, 37(2):163-170.

[6] Gao S .Observations on the safety of precision anesthesia techniques in surgery for elderly patients[J].MEDS Clinical Medicine, 2023, 4(7):

[7] Tao Dan art. The effect of precise intercostal nerve block on the analgesic effect and anesthetic medication in elderly patients after pulmonary surgery [J]. Medical Theory and Practice, 2023, 36(19):3303-3306.DOI:10.19381/j.issn.1001-7585.2023.19.022.

[8] Gu S , Luo Q , Wen C , et al.Application of Advanced Technologies—Nanotechnology, Genomics Technology, and 3D Printing Technology—In Precision Anesthesia: A Comprehensive Narrative Review[J].Pharmaceutics, 2023, 15(9):2289-.
[9] R J S , Olivier E .Multi-omic molecular profiling and network biology for precision anaesthesiology: a narrative review.[J].British journal of anaesthesia, 2023, 131(1):26-36.
[10] Gao Yuchen, Wang Yuefu, Wang Jianhui, et al. Effect of precision anesthesia on postoperative delusion in patients undergoing cardiovascular surgery [J]. Journal of Clinical Anesthesiology, 2020, 36 (11): 1082-1085.
[11] Li Hongming, Diao Dechang, Ke Yisen, et al. Two reports of colon cancer patients treated with NOSES in combination with ERAS [J]. Chinese Electronic Journal of Colorectal Diseases, 2020, 9 (05): 521-524.
[12] Wang Bingbing, Liu Nannan. Effectiveness and safety of precision cardiac anesthesia in patients undergoing cardiac surgery [J]. Psychology Monthly, 2020, 15(15):198.DOI:10.19738/j.cnki.psy. 2020.15.167.
[13] Jiang Liangjiu, Li Kai, Jiang Yun, et al. Accurate visualization of anesthesia techniques in the rapid rehabilitation of orthopaedic patients [J]. Jiangxi Medicine, 2019, 54 (11): 1441-1444.
[14] Liu Bing, Wang Shoutian, Song Bin. Application of the EEG dual-spectral index monitor in precision anesthesia [J]. Medical Equipment in China, 2019, 16 (01): 93-95.
[15] Li Min, Liu Ge, Cai Zhiming, et al. To explore the effect of precise closed-loop target-controlled propofol infusion in elderly patients undergoing laparoscopic surgery [J]. Chinese-Foreign Medical Research, 2018, 16(36):17-19.DOI:10.14033/j.cnki.cfmr. 2018.36.007.
[16] Li Yong. Observation of precise closed-loop target controlled infusion of propofol for anesthesia for orthopedic surgery in elderly patients [J]. Worlds Lest Medical Information Abstract, 2018, 18(31):28-29.DOI:10.19613/j.cnki.1671-3141.2018.31.015.
[17] Wu Fan, Tao Xiaosan. Application and prospect of the concept of precision anesthesia in clinical practice [J]. Jiangxi Medicine, 2018, 53 (02): 185-187.
[18] Yan Jinjia, Zeng Zhimin, Sun Jiaxi, et al. Observation of precise closed-loop target-controlled infusion of propofol for anesthesia of orthopedic surgery in elderly patients [J]. Chinese Journal of Minimally Invasive Surgery, 2018, 18 (01): 11-14.
[19] Christopher Spencer, Yang Jianjun, Zuo Zhiyi. Perioperative precision medicine helps anesthesiologists improve patient outcomes: the genetic variability of β -blockers and opioids (English) [J]. Journal of Clinical Anesthesiology, 2017, 33 (09): 918-924.
[20] Qiu C , Nguyen T V , Desai V .Precision Anesthesia: Fiction or Reality?[J].Anesthesiology Communications, 2017, 1(1):1-2.