Chapter 1

one

Introduction

The term *anesthesia* was first used in the first century AD to describe the narcotic-like effects of the plant mandragora. The term subsequently was defined as "a defect of sensation" and "privation of the senses." Oliver Wendell Holmes in 1846 was the first to propose the use of the term to denote the state that incorporates amnesia, analgesia, and narcosis to make painless surgery possible. Generally, *anesthesia* is characterized by sensory deprivation and reversible inhibition of the function of central and/or peripheral nervous system caused by drugs and techniques.

In the United States, use of the term *anesthesiology* to denote the practice or study of anesthesia was first proposed in the second decade of the twentieth century to emphasize the growing scientific basis of the specialty. Although anesthesia now rests on scientific foundations comparable to those of other specialties, the practice of anesthesia remains mostly a mixture of science and art. Moreover, the field of anesthesiology has been far beyond the scope of a word in the aspects of anesthesia (Table 1-1). The development of modern anesthesiology can be divided into three connected stages with different characteristics.

Table 1-1 Definition of the practice of anesthesiology within the practice of medicine

1. Assessment and preparation of patients for surgery and anesthesia.
2. Prevention, diagnosis, and treatment of pain during and following surgical, obstetric, therapeutic, and diagnostic procedures.
3. Acute care of patients during the perioperative period.
4. Diagnosis and treatment of critical illness.
5. Diagnosis and treatment of acute, chronic, and cancer-related pain.
6. Cardiac, pulmonary, and trauma resuscitation.
7. Evaluation of respiratory function and application of treatments in respiratory therapy.
8. Instruction, evaluation of the performance, and supervision of both medical and paramedical personnel involved in perioperative care.
9. Administration in health care facilities, organizations, and medical schools necessary to implement these responsibilities.
10. Conduct of clinical, translational, and basic science research.

Data from the American Board of Anesthesiology Booklet of Information, February 2012.

Anesthesia Since 1840s, the initial stage of the development of modern anesthesiology has been nearly 100 years. At this stage, the main task of anesthetic workers was to solve pain caused by the operation, focus on the development of narcotic drugs and methods of anesthesia,

innovation and clinical application. As many theoretic and clinical problems were solved in the development process, the theory of anesthesiology was accumulated and enriched. It also laid the foundation for the development of disciplines.

Clinical anesthesiology This is an essential stage that anesthesia was rapidly transformed into anesthesiology. Anesthesiology was endued with distinctively clinical and theoretical characteristics: assessment and preparation of patients for surgery and anesthesia; implementation and management of anesthesia; anesthetic management for special patients; anesthetic management for critically ill patients; prevention and treatment of anesthetic accidents and complications. At this stage, anesthesiology not only trended to improve and perfect its features, but also played a significant role in promoting the development of surgery and became an important branch of surgery in clinical medicine.

Anesthesia and Critical Care Medicine Since the mid-twentieth century, anesthesiology has entered a rapid developing stage. Anesthesiology has absorbed relevant theory and technology from basic medicine, clinical medicine, biomedical engineering and several edge disciplines in the long term practice to generate and change its own theory and technical system, thus becoming an important and independent discipline in clinical medicine.

Recently, work domain of anesthesiology has been expanded from operation room to outpatient and ward. The scope of anesthesiology covers clinical anesthesiology, critical care medicine (CCM) and pain management. Emphases of clinical anesthesiology have been transferred to monitoring, maintaining and improving vital function in patients. Establishment and management of postanesthesia care unit (PACU) and intensive care unit (ICU) not only provided a strong guarantee for the safety of critically ill patients and patients undergoing major surgery, but also became a necessary symbol of hospital modernization. Pain management has expanded a novel way in which the theory and technology of anesthesiology were applied to patients with pain. Today anesthesiology has become a wide range of discipline that investigates clinical anesthesia, critical care medicine , resuscitation, and the mechanisms, diagnosis and treatment of pain. Furthermore, the ability to manage systems for the efficient operation of a medical center also makes the field of anesthesiology extremely rewarding. It has often been said that the hospital does well if the anesthesia department does well, and vice versa. The two are so interlinked that one cannot succeed without the support of the other. Anesthesiology has become one of the most rapid developing and dynamic disciplines.

1 History of anesthesiology

1.1 The development of ancient anesthesiology

In the Stone Age, humans began to use stone needle, spicules for analgesia and treatment. In China, a wide variety of drugs such as black henbane, marijuana, aconitum, monkshood, pepper were used for anesthetic and analgesic function in *shennong bencaojing*. In the han

dynasty, Hua Tuo performed laparotomy with the assistance of *mafeisan*.

Ancient Egyptians used the combination of opium poppy (containing morphine) and hyoscyamus (containing scopolamine), which is a similar combination(morphine and scopolamine) as nowdays preoperative medication. Regional anesthesia in ancient times were consisted of compression of nerve trunks (nerve ischemia) or the application of cold (cryoanalgesia). The American indians may have practiced local anesthesia as their surgeons chewed coca leaves and applied them to operative wounds, particularly prior to trephining for headache.

1.2 The initiation and development of modern anesthesiology

1.2.1 Inhalational anesthesia

In 1540, Diethyl ether (known at the time as "sulfuric ether" because it was produced by a simple chemical reaction between ethyl alcohol and sulfuric acid) was originally prepared by Valerius Cordus. Ether was used for frivolous purposes ("ether frolics"), but not as an anesthetic agent in humans until 1842, when Grawford W. Long and William E. Clark independently used it on patients for surgery and dental extraction, respectively. However, they did not publicize their discovery. Four years later, in Boston, on October 16, 1846, William T.G. Morton conducted the first publicized demonstration of general anesthesia for surgical operation using ether, when was recorded as the beginning of modern anesthesiology. In 1847, chloroform was introduced into clinical practice by the Scot Sir James Simpson, who administered it to his patients to relieve the pain of labor. In 1844, Gardner Colton and Horace Wells were credited with having first used nitrous oxide as an anesthetic for dental extractions in humans.

After ether, chloroform, nitric oxide were brought into clinical, the development of inhalation anesthesia is relatively slow. Chloroform could cause arrhythmia, respiratory depression and liver toxicity, so it was abandoned. Even after the introduction of other inhalation anesthetics (ethyl chloride, ethylene, divinyl ether, cyclopropane, trichloroethylene, and uroxene), ether remained the standard inhalational anesthetic until the early 1960s. In 1920, Guedel published papers about ether. The same year, Magill introduced the application of endotracheal intubation in inhalation anesthesia to solve the management problems of respiratory tract. In 1927, Ralph waters invented to use sodium lime to absorb carbon dioxide. In 1956, halothane is available, but the side effects of halothane include inhibitiong of respiratory cycle, liver poisoning and increased sensitivity of myocardium to the adrenaline after extensive used, which causes arrhythmia. In 1959, methoxyflurane was used, but its metabolites have renal toxicity. Enflurane, isoflurane and sevoflurane were available in 1972, 1981, 1990 respectively. The development of contemporary anesthesia can be embellished by introducing the improvement in anesthetic apparatus and monitoring systems toward greater safety or, on the pharmacologic side, the continued research for the basis of narcosis at the molecular level. In this connection, a useful clinical yardstick was the concept of minimum alveolar concentration (MAC), which correlates closely with lipid solubility of anesthetics. Also, measurements of MAC permitted comparison of studies on the physiologic effects of anesthetics in terms of their relative potencies. Parenthetically, there is the

seemingly heretical suggestion that nitrous oxide should once and for all be abandoned due to the ever-present liability of hypoxemia, its adverse effect on essential bone marrow metabolic enzymes, and its well-known nonpharmacologic properties in relation to air-containing body cavities.

1.2.2 Intravenous anesthesia

Intravenous anesthesia appeared after the injection syringe and syringe needle were manufactured. Since the second half of the nineteenth century, pioneers tried to perform intravenous anesthesia with chloral hydrate, chloroform, ethyl ether, morphine, scopolamine, and so on. Later barbiturates appeared, in 1934, Lundy and Waters used thiopental sodium to replace for the inhalation anesthesia induction with ether. Methohexital, another type of barbital drugs, was available in clinical practice in 1957. Sodium thiopental is still one of the choices of intravenous anesthetics, and then benzodiazepines appeared, such as diazepam in 1959, lorazepam in 1971, midazolam in 1976 etc. Currently midazolam is widely used in pre-anesthesia medication, general anesthesia induction, sedation or part of compound anesthesia. Some other intravenous anesthetics, such as sodium hydroxybutyrate, ketamine, etomidate, and propofol, remain available depends on different levels of medical center. The clinical application of propofol is considered to be a great advancement of intravenous anesthesia, for its rapid onset, rapid emergency, short duration, good controllability and wide range of application, especially suitable for ambulatory surgery or some kinds operations.

Opioids Morphine, isolated from opium in 1805 by Sertürner, was also tried as an intravenous anesthetic. The high morbidity and mortality which was associated with high dose of opioids in early reports caused many anesthetists to avoid opioids and favor pure inhalational anesthesia. In 1969, Lowenstein rekindled performed "pure" opioid anesthesia by reintroducing the concept of large doses of opioids as complete anesthetics, which are rarely used now. Morphine was the first agent so employed, but fentanyl, sufentanil and alfentanil have been preferred by a large margin as sole agents. As several new opioid analgesics had minor effects on heart like volatile anesthetics, they have been widely used in clinical practice. Efficiency of sulfentanil in anesthesia is strong; duration of alfentanil is short with a better controllability. Remifentanil, an opioid subjects to rapid degradation by nonspecific plasma and tissue esterases, permits profound levels of opioid analgesia without worries about prolonged postoperative ventilation, so it has been widely used in clinical settings.

Neuromuscular blocking agents The introduction of curare by Harold Griffith and Enid Johnson in 1942 was a milestone in anesthesia. Curare greatly facilitated tracheal intubation and muscle relaxation during surgery. For the first time, operations could be performed without relatively deep large doses of anesthetic to produce muscle relaxation. After that, the new muscle relaxants are developed. Succinylcholine, the only depolarizing muscle relaxant today, was synthesized by Bovet in 1949 and released in 1951; it has become a standard agent for facilitating tracheal intubation during rapid sequence induction. Until recently, succinylcholine remained unchallenged in its rapid onset of profound muscle relaxation, but its side effects (such intraocular pressure and gastric internal pressure elevation, hyperkalemia, muscle pains, and

prolonged paralysis) prompted the search for a comparable substitute. Moreover, the malignant hyperthermia syndrome (MHS), often fatal, seemed to be triggered by a genetically determined response to agents such as succinylcholine and halothane. In contrast to depolarizing muscle relaxants, there is a wide selection of nondepolarizers, such as mivacurium, vecuronium, rocuronium. Mivacurium, as a new kind of muscle relaxants, has a rapid onset of action and fewer side effects, but its onset is still slower than succinylcholine and the duration of action is longer. Atracurium is so extensively metabolized that its pharmacokinetics are independent of renal and hepatic function, and less than 10% is excreted unchanged by renal and biliary routes, it's called Hoffmann elimination. Like atracurium, cisatracurium undergoes degradation in plasma at physiologic pH and temperature by organ independent Hofmann elimination. We can choose the appropriate anesthetic according to the patient's circumstance.

1.2.3 Local anesthesia

At the same time of general anesthetics development, local anesthetics were developed. The original application of modern local anesthesia is credited to Carl Koller, an ophthalmologist, who demonstrated topical anesthesia of the eye with cocaine in 1884. Cocaine was isolated from coca leaves in 1855 by Gaedicke and was purified in 1860 by Albert Niemann. Later in 1884 William Halsted used cocaine for intradermal infiltration and nerve blocks. Ferdinand Cathelin and Jean Sicard introduced caudal epidural anesthesia in 1901. Lumbar epidural anesthesia was described first in 1921 by Fidel Pages and again in 1931 by Achille Dogliotti. August Bier was credited with administering the first spinal anesthetic in 1898; he used 3 mL of 0.5% cocaine intrathecally. He was also the first to describe intravenous regional anesthesia (Bier block) in 1908. Procaine was synthesized in 1904 by Alfred Einhorn and within a year was used clinically as a local anesthetic by Heinrich Braun. Braun was also the first to add epinephrine to prolong the duration of local anesthetics. Additional local anesthetics subsequently introduced include dibucaine (1930), tetracaine (1932), lidocaine (1947), chloroprocaine (1955), mepivacaine (1957), prilocaine (1960), bupivacaine (1963), and etidocaine (1972). Ropivacaine and levobupivacaine are newly-developed agents with the same durations of action as bupivacaine but less cardiac toxicity.

1.3 Characteristics and development direction of clinical anesthesiology since 1980s

Since the 1980s, the characteristic of clinical anesthesiology is prominent anesthesia monitoring and anesthesia safety, and now are moving towards securing patients safety. Real-time continuous monitoring enables anesthesiologist to detect changes in the patient's condition and instantaneous trends, which isconducive to the patient's early diagnosis and timely treatment. Anesthesiologist should choose appropriate monitoring programs according to the specific circumstances of the patients. American society of Anesthesiologists (ASA) has proposed to the five basic anesthesia monitoring project (temperature, arteriovenous blood pressure, ECG, pulse oxygen saturation and pressure of end-tidal carbon dioxide) as a reference to assess the patient's condition during anesthesia. We also can consider other appropriate monitoring projects that depends on the patient's condition. For example, in patients who use

neuromuscular blocking agents, the muscle relaxant effect(onset, maintenance and recovery) monitoring should not be ignored, and the most commonly used monitoring method is the train of four (TOF). The intraoperative awareness issues are getting more and more attention and monitoring the depth of anesthesia is helpful to prevent this phenomenon, such as the analysis of bispectral index (BIS) and spectral edge frequency (SEF) and auditory evoked potential (AEP) monitoring; for certain cardiovascular surgery patients, some complex surgery patients and severe trauma surgery patients often require invasive hemodynamic monitoring including Swan Ganz Catheter, urine also need to be monitored.

With the advent of new equipment, new drugs and new technologies anesthesiologists have more and more choice. For further improve the anesthesia quality and its safety, the domestic many places have always been establishing the anesthesia quality control mechanism in order to make anesthesia well-organized, more standardized and reasonable, and achieve better outcomes. In addition, many hospitals are taking measures to improve the quality and safety of anesthesia, such as emphasizing and strengthening the assessment of the patient's condition before anesthesia, good preparation before anesthesia, appling the drugs and methods which are the most harmless to the patients. For example, to reduce the incidence of anesthesia side effects or complications, all kinds of nerve block guided by nerve stimulator has been more widely and reasonable application. Otherwise, the monitoring methods have been enhanced, especially the noninvasive or minimally invasive monitoring method. For example, transesophageal echocardiography (TEE) and Transesophageal Doppler color-flow mapping are two newly-developed non-invasive methods to monitor cardiac function, valvular function and intracardiac shunt. Last but not least, the key to improve the quality and safety of anesthesia is to improve the self-quality of the anesthesiologist.

In this information era, the development of information technology is very rapid. It has become a trend that information technology is introduced into anesthesia equipment, monitoring instruments, anesthesia management system, and the level of its intelligent in all aspects is increasing. In the future, we believe that the clinical anesthesia work is bound to be a completely new face. Since anesthesiology covers the range of clinical anesthesiology, critical care medicine and pain treatment, anesthesia discipline will become one leading subject within the hospital.

2 The scope of anesthesiology

The practice of anesthesia has changed dramatically since the days of John Snow. The modern anesthesiologist is now both a perioperative consultant and a primary deliverer of patients care. In general, anesthesiologists manage nearly all "noncutting" aspects of the patient's medical care in the immediate perioperative period. The surgeon and anesthesiologist must function together as an effective team, and both are ultimately answerable to the patient rather than to each other.

The modern practice of anesthesia is not confined to rendering patients insensible to pain. Anesthesiologists monitor, sedate, and provide general or regional anesthesia outside the

operating room for various imaging procedures, endoscopy, electroconvulsive therapy, and cardiac catheterization. Anesthesiologists have traditionally been pioneers in cardiopulmonary resuscitation and continue to be integral members of resuscitation teams. Construction and development of anesthesiology is a gradual process, the scope of anesthesiology are as follows:

2.1 Clinical anesthesiology

Clinical anesthesiology remains the main content of anesthesiology. Before anesthesia, anesthesiologists' missions are to evaluate, prepare and medicate for patients to acquire the patients' physical and mental condition, select adequate anesthesia technique and relieve anxiety; during the operation, anesthesiologists should provide analgesia or amnesia for patients to eliminate discomfort, induce sedation, promote hemodynamic stability, and alleviate surgery-related adverse reflection and stress response; after the operation, physical function of patients should be measured and monitored in PACU to regulate and correct abnormal condition, ensure the safety of patients and prevent postoperative complications. Quality of anesthesia management has a considerable influence on the safety of patients and success of operation. Moreover, advances in clinical anesthesia also offer necessary condition to new operations. The practice of anesthesia is not confined to operation room but expanded to several fields to implement anesthesia and sedation, such as endoscopic measurement, lithotripsy, magnetic resonance imaging, computed topography scan, fluoroscopy, electroconvulsive therapy.

2.2 Resuscitation

The anesthesiologist has often been seen as one who is best prepared to manage emergency situations (shock, coma, severe arrhythmia and hyperthermia). Accordingly, and because of their expertise in airway management, the anesthesiologist is part of the cardiac arrest team in most major medical centers. Upon arrival at the scene, the anesthesiologist's role is not only to ensure an airway but to help direct the resuscitative measures for that patient. But the role of the anesthesiologist in the area of resuscitation is even greater. The anesthesiologist has special information that he can impart to other members of the medical center. In many situations , anesthesiology departments are responsible for teaching both basic and advanced life support (cardiopulmonary resuscitation, CPR) to others in the hospital. Often the anesthesiologist is the chair person responsible for the emergency services committee in a hospital. In fact, it is the responsibility of the anesthesiologist to ensure that the hospital's personnel are up to date and that the equipment for resuscitation is maintained. This is one example of how information from the operating room can be applied to areas outside of the operating room.

2.3 Critical care medicine

The changes in the PACU, as related to the growing demands in the care of critically ill patients, were the foundation on which intensive care unit (ICU) was first started. The initially delivery of only respiratory support changed into total body support for patients. This

type of support has required full-time services of anesthesiologists, surgeons and internists. Initially the anesthesiologist's role was to provide adequate ventilation for the patient and to determine when weaning from the ventilator was possible. It became obvious that respiratory function was only one feature of the critically ill patient and therefore the anesthesiologist became knowledgeable in cardiovascular support, nutrition, infection, and various diagnostic procedures that needed to be done in these critically ill patients.

Acute physiology and chronic health evaluation (APACHE), which has been exactly applied to assessment of the severity of the disease and prediction of prognosis, is used to guide and assist ICU physician's diagnosis and treatment. Even so, the judgment criterion of the severity of the disease should be constantly revised in practice to be perfect. Specialists in other fields have seen that their expertise can also be used in critical care units. Certainly the anesthesiologist has an extremely broad view of surgical patients in these units and should be able to apply these skills in the postoperative management of these patients. This recognition of the anesthesiologist's role has not been an easy road to travel.

Critical care, however, is not only practiced in critical care units. More and more frequently PACUs are substituting for the insufficiency of critical care beds. Medical management of these patients while they are either awaiting a bed in the ICU or for definitive treatment will often occur in the PACU. Appropriate resources and personnel must be available therefore in the PACU to serve these patients in a manner that is similar to what would be done in a well-defined unit.

2.4 Pain management

Pain is described as an unpleasant somatesthesia and emotional experience associated with (potential) tissue damage. The anesthesiologist's role in treating pain remains at the crux of the specialty. For many years departments used varying degrees of resources to provide medical care for patients with chronic pain. A small number of specialists in the field of anesthesiology established their careers based upon the treatment of patients with chronic pain. As our knowledge about pain mechanisms and ways to alter nociception have increased, so is the influx of other specialists in pain therapy.

The more recent development of an acute pain service is another example of the expanding role of anesthesiologists in the medical center. Our knowledge of pain control both in the operating room and in the PACU was extended into the postoperative period. The introduction of intrathecally or epidurally administrated pain relieving drugs and the introduction of patient-controlled analgesia (PCA) required that an acute pain service be developed. Again, management skills were required to optimize the management of postoperative pain.

As society changes, the demands for health care change as well. Although generally patients do not fear anesthesia, they still fear postoperative pain. The anesthesiologist's role in controlling postoperative pain by the appropriate use of drugs and devices is frequently seen as a very positive aspect of our specialty. It would be a great disservice to our specialty if we were to fail to develop additional expertise in this area in an effort to manage postoperative pain

within the purview of the anesthesiologists, not only in the recovery room but at all times.

2.5 Others

The ability to attract intelligent young people into anesthesiology is related to its ability not only to care for patients but also to update knowledge in a variety of areas. The breadth of the anesthetic experience can range from patients' consultation in the preoperative admission unit t, the intraoperative management of the most critically ill patients, to the care of patients in critical care settings. Furthermore, the field allows for basic mechanisms responsible for pain to be explored and to apply this knowledge to patients both in acute and in chronic pain. The ability to manage systems for the efficient operation of a medical center also makes the field of anesthesiology extremely rewarding.

Some would say that anesthesia is defined as taking patients to the extremes of life, holding them at that point and then bringing them back to the preanesthesia state. Such a broad definition allows our research not only to investigate the drugs and techniques that we currently use but to be much broader in our base. Certainly our role in neurologic function monitoring and the ability to protect the CNS should be enhanced. Some would suggest that our ability to monitor pain is still woefully inadequate and still others would suggest that the pharmacologic hammers that we use to induce general anesthesia are exactly that lunt instruments wielded with little finesse.

The information explosion that exists around us applies to the field of anesthesiology as well. We should be able to take information from other fields and apply it to our own. We need to share the information in our field with other specialities, who can use that information to improve their fields. It is the expanding role of the anesthesiologists, not only in the operating room but in all the other environments, which will keep the field vigorous.

Anesthesiologists are actively involved in the administration and medical direction of many ambulatory surgery facilities, operating room suites, intensive care units, and respiratory therapy departments. They have also assumed administrative and leadership positions on the medical staffs of many hospitals and ambulatory care facilities. They serve as deans of medical schools and chief executives of health systems.

3 Classification of anesthesia

Anesthesia can be classified by its approaches and subspecialties of anesthesiology. The former refers to classification based on approaches used in clinical anesthesia, while the latter one is classified by disciplines that anesthesiology itself covers and pathophysiological characteristics of different patients.

3.1 Classification by anesthesia approaches

If anesthetic enters body by inhalation, intravenous/intramuscular injection, or rectal perfusion, the central nervous system will be inhibited, which makes patients unconscious and

analgesia for the whole body, this approach is called general anesthesia. Get local anesthetic to targeted region in order to inhibit spinal nerves, nerves plexus, or cord and finer peripheral never ending, this is called local anesthesia. If local anesthetic is injected into subarachnoid space and epidural space, which blocks nerves inside, these two belong to local anesthesia theoretically. However, generally we call these two ways intraspinal anesthesia, which is a relatively independent anesthesia, because of their own characteristics in clinical applications and basic theory. In some articles, they are called neuraxial anesthesia. Besides, terms used in different classifications of anesthesia vary a lot, and each kind of nerves block has a regional anesthesia effect, thus they are generally called regional block or regional anesthesia in some monographs. It is probably better to explain the word regional as section to prevent confusion between regional block and long-used field block. Or call it surgical field block owning to their closet definitions. The definition of field block in quite few monographs differs from traditional ones because of includingthe superficial nerve block, like superficial cervical plexus block.

Generally, the combination of two or more aforementioned kinds of anesthetics is called balanced anesthesia; likewise, it is called combined anesthesia when they are different anesthesia approaches. The purpose is to make the best of their advantages, overcome their disadvantages to manage anesthesia easily and obtain the perfect effect, and reduce their side effects. Sometimes, applications of these two terms have no absolute distinction, so idiomatic usage is adopted. For example, Basic narcosis , which maintains patients asleep, is usually inadequate for surgery or invasive operation. Basic narcosis practically used in children as preparation for general anesthesia or assistance for local anesthesia. If anesthetic is inhaled trough endotracheal tube, it is called endotracheal anesthesia. Likewise, if it is medicated trough endobronchial tube, it is called endobroncheal anesthesia. If it is only an intubation without medication via tube, it is called endotracheal intubation or endobroncheal intubation.

3.2 Classification by subspecialty of anesthesiology

There are two explanations of classification by subspecialty of anesthesiology. In terms of anesthesiology, it is actually the perspective introduction of each subspecialty of anesthesiology. This classification is based on pathophysiologial changes of specific patients and special anesthesia it needs. Generally, this method is commonly used in major medical centers, teaching hospitals and specific hospitals. If it is available to adopt this classification, it is beneficial to enhance the quality and efficiency of anesthesia as well as the development of research of specific anesthesia, additionally contributes to improve specific anesthesiologists' skills. It includes anesthesia for cardiac surgery, anesthesia for vascular surgery, anesthesia for thoracic surgery, neurosurgical anesthesia, anesthesia for organ transplantation, anesthesia for endocrine surgery, obstetric anesthesia, pediatric anesthesia, geriatric anesthesia, anesthesia for orthopedic surgery, anesthesia for abdominal surgery, anesthesia for trauma and so on.

From the overall perspectives of anesthesiology, anesthesiology can be classified into

clinical anesthesiology, critical care medicine, pain management. Critical care medicine and pain management are multidisciplinary and involve so many knowledge of other disciplines. Anesthesiologists still need further study and trainning before they take these two kinds of jobs, even though they have been well educated.

4 How to learn anesthesiology well

Anesthesiology is an independent specialty of clinical medicine. As mentioned above, the scope of anesthesiology encompasses: clinical anesthesiology, emergency and resuscitation, critical care medicine, diagnosis and treatment of pain and other associated subspecialties. All of these subspecialties is related to or based on all respects of basic medicine and their developments, such as anatomy, physiology, biochemistry, pharmacology, pathophysiology, biophysics, biomedical engineering, which are all closely associated with anesthesiology. Anesthesiology is also inseparable from other subjects of clinical medicine. Given that anesthesiology serves for patients in any specialties who can be male or female, infant or elderly patients, who can represent co-morbidities or severe complications besides the diseases required operations or conservative treatments, only be familiar with anesthesia-relevant details of basic and clinical medicine, can anesthesiologists do well in daily work. Anesthesiologists should cooperate with doctors of other specialties to manage and treat patients.

Time is crucial in clinical work. Time is life, there is no much time to analyze and discuss. Judgements and managements should be taken at once. to perform anesthesia for critically ill patients, the anesthesiologist should have a well-regulated mind, dealing with every detail of the cases with confidence and caution, observing the patients intensively. Besides maintaining a stable anesthesia procedure, anesthesiologists should also consider progression of diseases, support and amelioration of organ functions, reasonable medication, and preservation of internal environment. In this sense, anesthesiologists are also intensivists, internists or clinical pharmacologists, thus it explains why anesthesiologists need a comprehensive and thorough understanding of medical knowledgeto deal with the emergency calmly.

Keep in mind the following tips during anesthesiology learning:

4.1 Integrate basic medicine with clinical medicine

Basic medicine and clinical medicine should be learned well together, requirement of “mastered” and “understood” contents should be achieved. Review of basic courses is necessary during the learning of clinical medicine. Pay attention to the unique characteristics of clinical courses and the relationships between them. Integrate basic medicine with clinical medicine to establish a comprehensive understanding of medical knowledge stepwise, whichcan enhance medical services and help further learning and self-development. The one who underestimate basic medicine could suffer significant losses. For example, someone conducts mechanical ventilation for a CHD patient resulting in cardiac arrest due to excessive ventilation;

because she/he ignores or forgets that low CO_2 level could induces spasm of coronary artery and consequent cardiac ischemia, which has already been taught in physiological courses. During learning anesthesiology, you should also train the clinical thinking. For instance, if a patient presents tachycardia, you may understand all the diseases or situations that can cause tachycardia, now you need to figure out and analyze all the etiological factors of it, so that you can take adequate treatment in time. Patient's outcome depends on the clinical thinking; a tiny distinction can lead to tremendous mistakes.

4.2 Integrate theories with practice

Anesthesiology highlights practice with its own theoretical system and technological system. Theories should be guidance during treatment, management of patients and conducting various technical operations. Serious practice can further enrich and perfect theories. As someone addressed, "knowledge is power, but the power will vanish without being taken into practice". The one who knows well about theories but cannot conduct the operations is just a theorist; and the one who addicted to operations but far away from guidance of theory is at best an "anesthesia craftsman", she/he may face difficulties in predicting disease progression and treating it reasonably.

4.3 Keep learning, progressing and innovating ceaselessly

Anesthesiology is a burgeoning and booming subject. Many new theories, technologies, drugs and new instruments are often applied in anesthesia first. Besides, medical science contains numerous uncertainties, there is no single textbook or monograph can answer all the questions, then leaving plentiful space remained for thinking and innovations. So we need to keep learning, progressing, innovating, and carrying experiments and clinical researches ceaselessly.

(WANG Guolin)

Suggested Reading

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