Inhalation Anesthesia

Inhalation anesthesia is one of the options for general anesthesia . In order to achieve this, inhalational (*volatile*) anesthetics, so-called anesthetic gases, are used, which are substances that are redistributed throughout the body after inhalation into the lungs, and their main target is the brain.

Inhalation anesthetics

Inhalation anesthetics are generally referred to as gases, but this is not a completely accurate designation. As such, the gases are only nitrous oxide and xenon. Other anesthetics are in liquid form, so it is first necessary to convert them into a volatile form using special vaporizers. It was possible to define the properties of a hypothetical ideal inhalation anesthetic, which, however, the substances used so far do not fulfill 100%. This **ideal anesthetic** should meet the following conditions:

- fast and pleasant falling asleep and waking up,
- good controllability of the effect and the possibility of quickly changing the depth of anesthesia,
- sufficient analgesic effect,
- attenuation of reflexes and induction of muscle relaxation,
- sufficient safety width,
- no toxic effects at clinical doses.

As has been said, no inhaled anesthetic in use yet meets all the mentioned conditions. For this reason, we usually combine these substances with drugs from other groups, namely with intravenous anesthetics for quick induction, opioids and nitrous oxide to enhance analgesia, and muscle relaxants for complete muscle relaxation. In addition, the combination with other substances reduces the side and unwanted effects of volatile anesthetics.

Properties of volatile anesthetics

Volatile anesthetics allow relatively **easy control of the depth of anesthesia** . Their disadvantages, compared to intravenous ones, include a **longer introduction** to anesthesia and a **longer awakening** . This is due to the necessity of gas exchange in the lungs and their solubility. The higher the solubility of the anesthetic in the blood, the slower the induction and awakening, and vice versa. The magnitude of the effect is the so-called *minimum alveolar concentration* (MAC). MAC is defined as the alveolar concentration at which 50% of patients do not respond to skin incision with defensive movements. The MAC value is different for different anesthetics. It is true that the lower the MAC value, the more effective the anesthetic. However, other factors also influence this value.

MAC (and thus the need for anesthetic)**decreases** :

- with increasing age,
- in hypothermia,
- in pregnancy
- after premedication with opioids and during administration of opioids during anesthesia,
- with simultaneous use of sedatives-hypnotics and anesthetics,
- with severe hypoxia (paO 2 < 4.0 kPa), anemia and hypotension.

On the contrary, the MAC rises :

- with chronic alcohol abuse (does not apply to acute alcohol consumption),
- during fever ,
- when addicted to opioids,
- in hyperthyroidism .

Individual volatile anesthetics

Halothane

Halothane was the first effective and non-explosive inhalation anesthetic when it began to be used clinically in 1956 . However, it is no longer **used** in routine clinical practice .

Isoflurane

Isoflurane is a nonflammable, colorless, clear liquid that smells like ether. This substance has a very low *blood/gas partition coefficient* , which would result in the advantage of rapid induction of anesthesia. However, this advantage is somewhat suppressed by the fact that inhalation of isoflurane causes **depression of breathing** , **breath holding** and **irritation of the airways** . It is therefore not suitable for induction of anesthesia by inhalation, some of the iv anesthetics are used for induction. We determine the depth of anesthesia mainly according to blood pressure values, especially systolic. At the beginning of anesthesia, it is important to remember that BP values can drop significantly, even if we have not yet achieved a sufficiently deep anesthesia. We turn off the isoflurane approximately when the surgeons begin to sew the skin, after several hours of operation it takes about 10 minutes before the patient begins to open his eyes.

Sevoflurane

Sevoflurane is a non-flammable, colorless liquid with a slight ether odor, slightly soluble in fats. Its blood/gas partition coefficient is the lowest after *desflurane* , which leads to a very rapid increase in its concentration in the body and thus to a **rapid introduction** to anesthesia. Good controllability of the depth of anesthesia and quick withdrawal are also related to this. In addition, there is no such irritation of the respiratory tract, so it is also suitable for **inhalation introduction** , e.g. in children. A possible disadvantage of sevoflurane is the release of **inorganic fluoride** , which is contained in its molecule. Inorganic fluoride is nephrotoxic, however, the threshold value for its nephrotoxicity in the case of sevoflurane is not defined. Another potential risk is the formation of compound A (**Compound A**), which forms when in contact with soda lime. Although possible nephrotoxicity in humans has not been verified, in the USA, for example, sevoflurane is allowed only with a fresh gas flow of at least 2 l/min, but in other countries there are no restrictions for low-flow and minimal-flow anesthesia with this substance.

Desflurane

Desflurane is chemically very similar to isoflurane, with a fluorine atom instead of a chlorine atom. For that reason, it has a much less harmful effect on the ozone layer. It is a non-flammable and non-explosive clear liquid with a pungent and irritating odor. It has the lowest boiling point (22.8 °C) of all volatile anesthetics, so a **special vaporizer** is required for its use . Of all inhalational anesthetics, desflurane has the fastest induction and removal from anesthesia, as well as the most prompt controllability of the effect. Compared to the others, however, it has the weakest effect. Its disadvantage is also its higher price

Xenon

Xenon is a rare, inert, non-irritating gas without color and odor, which would have great positives for use in anesthesia. It has the fastest onset and withdrawal, there are no hemodynamic fluctuations, it has an analgesic effect, it has no mutagenic and teratogenic properties and it does not trigger malignant hyperthermia. Since 1990, however, it is still the subject of clinical studies. It is administered in a mixture with oxygen in a volume ratio of 70% xenon and 30% oxygen. Its **availability is currently minimal** due to its high price and as yet unproven cost-effective anesthetic systems and recycling that could reduce its consumption.

Low-flow and minimal-flow anesthesia

This is a technique of inhalation anesthesia in which there is only a **low input of fresh gases** . It is used in semi-closed systems, when the supply of fresh gases, i.e. usually oxygen and nitrous oxide, is reduced to 1 l/min at *low-flow* , or 0.5 l/min during *minimal-flow* anesthesia.

Compared to anesthesia with normal fresh gas flows, it has several advantages:

- the consumption is reduced and the use of volatile anesthetics becomes more efficient,
- reduction of emissions of inhalation anesthetics and nitrous oxide,
- higher humidity and temperature of inhaled gases.

Its administration, however, requires greater experience of the anesthesiologist.

Links

Related articles

- Intravenous anesthetics
- general anesthesia
- Local anesthetics
- Regional anesthesia

References

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