Cleaning and decontamination of apparatus for inhalation anesthesia (IA) and artificial ventilation of the lungs (AVL) are important but difficult tasks. Their urgent importance will be obvious because of the steady increase in scope of general anesthesia and resuscitation and with the increase in the range of anesthetic and respiratory machines in use.

This survey does not discuss the problem of when and under what circumstances anesthetic and breathing apparatus may become a source of cross infection of patients. What is important is that conditions may arise under which apparatus for IA or AVL must be disinfected or even sterile, and this means that, first, optimal methods of decontamination of IA and AVL apparatuses must be available, together with the appropriate equipment for carrying out these techniques, and second, the designs of IA and AVL apparatus must facilitate adequate decontamination measures and the materials from which the components and parts of IA and AVL apparatus are made must be resistant to at least one of the methods of disinfection or sterilization used [1-4].

SOME DEFINITIONS

Decontamination is a process leading to the removal of contamination and to a reduction, or even total elimination, of the bacterial population on objects to be treated. Decontamination is thus a general term which embraces cleaning, disinfection, and sterilization. Sterilization is the destruction of all forms of microorganisms, including vegetative forms of bacteria, spores, and viruses. Disinfection is the destruction only of vegetative (nonspore-forming) forms of bacteria. Comparatively recently this term was used to describe the destruction of purely pathogenic microorganisms. More recently, however, the concept of "pathogenic" and "non-pathogenic" microorganisms has lost its absolute meaning. Disinfection is considered to have been achieved if 99.99% of bacteria have been destroyed. Cleaning is the removal of foreign substances from the surface of the object, leading to a reduction in (but not destruction of) bacterial contamination. The most widely used method of cleaning is by the use of aqueous solutions of detergents (washing).

Apparatuses for IA and AVL are relatively complex engineering products which consist of different components, performing independent or interdependent functions, and joined together by mechanical, electrical, hydraulic, and pneumatic connections. When these apparatus are regarded as sources of cross-infection of patients, the role of each component in this process must be differentiated. Naturally attention during decontamination of IA and AVL apparatus must be concentrated principally on components and communications in the respiratory circuit, the part which is most susceptible to contamination of various forms from the air exhaled by the patient. The need for reliable decontamination when various methods of disinfection and sterilization are used has led to insistence that components and parts included in the respiratory circuit can be dismantled.

DECONTAMINATION OF COMPONENTS AND PARTS OF THE RESPIRATORY CIRCUIT

Hand Washing. According to recommendations of the All-Union Scientific-Research Institute of Disinfection and Sterilization (VNIIDiSS) the best results from hand washing are obtained by the use of a 0.5% solution of hydrogen peroxide and a detergent ("Novost," "Progress," "Sulfonol," "Lotos," "Trias-2"), mixed in the ratio of 1:1. Cleaning is carried out by the VNIIDiSS method and reduces the bacterial population a thousandfold. Despite its evident simplicity, the method of hand washing has several disadvantages: high labor content, direct contact between the hands of the personnel and the contaminated parts and detergent solution, and the impossibility of imposing strict rules for the quality of cleaning, which depends on the training and enthusiasm of the personnel.
Machine washing is being increasingly used. It is thus in special washing machines in which the washing process is followed by "cold disinfection" by means of chemical disinfectants. A characteristic example of such machines is the "Sidematic" machine manufactured by the American firm of "Arbrook Manufacturing". It is completely automatic, measures 68 x 91 x 120 cm, and weighs about 180 kg. The substance "Sidex" - a 2% solution of glutaraldehyde - is used as the disinfectant; it is contained in a special reservoir with a capacity of about 60 liters, and after the end of washing and rinsing it is automatically pumped into the washing compartment. At the end of the 10-min disinfection cycle the solution is automatically pumped back into the reservoir for reuse. The washed objects are then passed through four rinsing cycles to remove all traces of "Sidex" and then finally spin-dried. The duration of the complete treatment cycle is programmed for 87 min. During this time the machine cleans and disinfects at least six sets of typical anesthesiologic parts (masks, bags, patient three-way tubes, corrugated hoses, endotracheal tubes, and adapters) [5].

A special machine for mechanical cleaning and disinfection of anesthesiologic equipment is manufactured by the firm of "Miele" (West Germany). This machine provides two stages of decontamination: washing followed by thermal disinfection. Five standard sets of anesthesiologic equipment can be placed in the washing compartment. Parts such as bags, hoses, and intubation tubes are fitted on special nozzles. The circulating pump, with an output of 190 liters/min, supplies a solution of detergents at a temperature of 65°C into the compartment and sprinkles it inside the articles fitted to the nozzles. When washing has ended special substances (weak acids) are introduced to neutralize traces of the alkaline detergents. After cleaning and rinsing, the second stage - thermal disinfection - is started. This consists of the supply of tap water at a temperature of about 100°C into the compartment. In the course of 13.5 min the articles to be disinfected are heated to 95°C, they are then held at that temperature for 3 min, after which the compartment is emptied and the articles dried quickly, because of their high temperature. The whole decontamination process takes about 34 min and is controlled automatically by programmed punched cards and electronic control instruments.

The "Medoborudovanie" Scientific Production Combine (USSR) has developed and organized the large-scale production of an automatic machine for washing surgical instruments [6]. The machine can also be used to wash components of anesthesiologic equipment. However, this machine cannot carry out simultaneous disinfection.

Ultrasonic cleaning and disinfection. As a result of the cavitation which arises under the influence of ultrasound and also as a result of "mixing effect" of solvents parts of anesthesiologic equipment can be cleaned. Ultrasonic washing and disinfecting units are made and used in many countries. In the model RS-500D ultrasonic disinfection washer manufactured by the firm of Tatebe (Japan) a combination of exposure to ultrasound with a power of up to 600W with agitation of the washing compartment eliminates all air from the articles to be cleaned and causes mixing of the washing solution, so that very highly effective washing takes place. A powerful spray with crossed jet ensures rapid and uniform washing. About every 2 min the dirty water is automatically discharged. In the MI-212 medical ultrasonic cleaner made by the firm "Sharpe Corporation" (USA), besides cleaning, disinfection is also carried out by means of a powerful disinfectant - a solution of chlorhexidine gluconate ("Hibitane"). Thorough cleaning and disinfection with this machine takes only 30-60 sec.

A universal ultrasonic apparatus for cleaning various types of contaminated laboratory glassware, medical instruments, and small parts is also manufactured in the USSR.

Because of the cumbersome nature of ultrasonic cleaners and complications of their care and maintenance, they are used almost exclusively in special centralized disinfecting and sterilizing departments.

Methods of Sterilization by Gas. Ethylene oxide is a highly effective sterilizing gas. Its bactericidal action is due to its alkylating effect, and all microorganisms including Mycobacterium tuberculosis and spores are destroyed. Pure ethylene oxide is highly inflammable and explosive*. It is therefore diluted with fluorinated or brominated hydrocarbons or with carbon dioxide. For instance, in West Germany a mixture with the proprietary name of "Kartox," containing 10% ethylene oxide and 90% CO₂, is manufactured. In Hungary, ethylene oxide is diluted with Freon-12. In the Soviet Union, an explosion-proof mixture of ethylene oxide with methyl bromide (OB mixture) is used. The diluents do not affect the bactericidal activity of the ethylene oxide.

*Ethylene oxide is very toxic. It boils at 11°C, and gives off a specific fruity aromatic odor. It is important to know that the odor of the gas can be detected only if its concentration is about 1500 mg/m³ air, i.e., much higher than the maximal allowable concentration of the gas at the work place, the statutory level of which is 1 mg/m³ air.