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REVIEW ARTICLE

Occupational Hazards and Diseases Related to the Practice of Anesthesiology

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Abstract
Background and objectives: The practice of anesthesiology is not without risks to the anesthesiologist. The operating room (OR), in which anesthesiologists spend most of their time, is regarded as an unhealthy workplace due to the potential risks it offers. In this review, we propose an analysis of the occupational hazards that anesthesiologists are exposed in their daily practice.
Content: We present a classification of risk and its relationship to occupational diseases.
Conclusion: Control of occupational hazards to which anesthesiologists are exposed daily is necessary in order to develop an appropriate workplace and minimize risks to the good practice of anesthesiology. This contributes to decrease absenteeism, improve patients' care and quality of life of anesthesiologists.

Introduction

The practice of anesthesiology is not without risks to the anesthesiologist. The operating theatre in which anesthesiologists spend most of their working time is regarded as an unhealthy workplace due to the potential risks it offers.

Hospital medical activity is classified, according to a Brazilian Norm number 4 (NR-4) - Specialized Services in Safety Engineering and Occupational Medicine - Ordinance No. 3214, of June 8, 1978, as grade 3 risk for work accidents and occupational diseases [1].

In this review, we propose an analysis of the risks and diseases to which anesthesiologists are exposed in their daily practice.

Classification of occupational hazards

Occupational hazards are divided into five groups according to their nature: 1) physical risks, related to exposure to noise, ionizing radiation, and temperature; 2) chemical risks, related to exposure to gases, vapors, fumes, and chemicals; 3) biological risks that include exposure to viruses, bacteria, blood and blood products; 4) ergonomic risks, relate to the

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requirement of improper posture, monotony, repetitiveness, work shifts, and situations causing stress; and 4) risks of accident that include arrangement of inappropriate work environment, insufficient lighting, potential accidents with electricity and fire [1,2].

Physical risks

This group of risks is constantly present at work in OR, responsible for a large number of occupational diseases, such as hypertension, stress, and cancer [3,4].

Federal Law, in Brazil, does not allow noise of intensity greater than 85 decibels (dB) at work in shifts of eight hours, continuously and without the use of hearing protectors [5]. The noise in the OR can reach over 100 dB when associated with normal tone conversation and noise from air conditioning, electrocautery and mechanical ventilation equipments. Because the noise is intermittent, there is no need to use hearing protectors, but awareness of reducing OR noise is necessary [4]. OR walls contribute to increase the noise level as they reflect and amplify the sound. Excessive noise is a cause of distraction and difficulty concentrating of professionals, which may lead to possible errors related to anesthesia [5].

Noise exposure is associated with stress-related disorders, respiratory conditions, and behavioral changes, resulting in sleep disorders and involving endocrine and neurological systems, thus becoming a causative agent of disease [4,5].

The emergence of minimally invasive surgical techniques, endoscopic procedures, interventional radiology, and need for anesthetic care during radiological examinations was followed by increased exposure to ionizing radiation and its consequences. Ionizing radiation is emitted by X-rays and radioactive isotopes that release gamma rays or α and β particles [2]. It differs from the non-ionizing radiation - represented by a laser beam - and may cause changes as a result of the heat it produces.

Ionizing radiation promotes the formation of free radicals in irradiated tissues, ionized molecules, and cell destruction, as well as the possibility of chromosomal changes and development of malignant tumors. There are changes in the DNA double helix, which can be point mutations, chromosomal translocations and gene fusions. All these changes are related to the onset of malignancy [6].

Exposure to ionizing radiation is cumulative and requires constant dosimetry measurements. There is no knowledge of a safe dosage below which the induction of malignancy does not occur [6]. Thus, preventive measures regarding radiation exposure should be established.

Protection from radiation is mandatory through measures such as education about the risks related to radiation; use of barriers such as lead aprons down to the knees, which provide gonadal protection, glasses with protective lenses to protect the retina and cervical collars to protect the thyroid. Maintaining a minimum distance of 90 cm from the primary source of ionizing radiation emission promotes a complete reduction of primary radiation exposure [6].

Working environment temperature is another risk that increases the possibility of physical accidents caused by exposure to both low and high temperatures, leading to discomfort with thermal effect on the ability of concentration and attention of anesthesiologists, impairing patient monitoring.

Chemical risks

The presence of waste anesthetic gases and vapors in the OR was associated with several diseases and occupational discomfort [7]. Several factors are related to OR contamination by waste inhalational anesthetics (Box 1) [8].

The halogenated volatile anesthetics in OR atmosphere contribute to the pollution of the place and are related to occupational diseases, although investigations of its effects are not yet conclusive [9]. Chronic exposure has the potential to develop sensitivity to hepatitis, headaches, nausea, drowsiness, fatigue, and irritability [3].

In a recent systematic review, related studies reported no occupational risks associated with exposure to inhaled anesthetic waste when evaluating genotoxic, neurobehavioral, and immunological effects. Studies reporting a potential risk for anesthesiologists' health ignored the modern exhaust systems and environmental regulation of inhaled anesthetic residue [10].

Occupational exposure to inhaled anesthetics may be related to oxidative stress in the population working at OR. Plasma and erythrocyte antioxidant activity was found in blood samples of workers chronically exposed to inhaled anesthetics compared to the control group [11].

Environmental limits for inhaled anesthetic concentrations are listed in parts per million (ppm). The upper limits of nitrous oxide (N_2O) are 25 ppm, halogen are 2 ppm and when combined with N_2O it is reduced to 0.5 ppm [3].

The used electrocautery and non-ionizing radiation emanate into the OR atmosphere smoke composed of organic waste matter, such as DNA viral infectious particles with pathogenic potential [4].

Handling of drugs such as antibiotics may induce bacterial resistance through drug micro-dose chronic contact with the skin and mucous membranes. Thus, it is recommended that the manipulation of these drugs be done with gloves.

Biological risks

Anesthesiologists are exposed to the risk of infection transmission during contact with the patients and their secretions [12].

The main diseases with risk of transmission into the OR environment are hepatitis B and C, herpes virus and HIV. Glove contamination during venipuncture procedures occurs in 18% of cases, which represents a high risk of exposure to infectious agents if gloves are not used [13].

The Brazilian National Agency for Sanitary Vigilance recommends the adoption of universal precautions to avoid contamination with infectious agents (Box 2) [14].

Box 1 Causes of Operating Room Contamination.

- Failure to disconnect flow control valves
- Misfitting masks - flushing breathing circuit - Filling vaporizers
- Tracheal tubes without cuffs
- Pediatric respiratory systems
- Sidestream sampling of gas analyzers
- Occlusion of hospital disposal system (vacuum)
- Leakage in the low pressure circuit (absorbing CO_2 reservoir), gaskets, and hoses

Box 2 Universal Precautions to Avoid Contamination with Infectious Agents.

- Using gloves, wash hands after removing them
- Using masks, goggles, aprons, and boots
- Do not reinsert needle into their covers, put them in appropriate containers after use
- Re-sterilization of all material used in anesthesia in 2% solution of sodium hypochlorite/water
- Avoid mouth-mouth resuscitation, use AMBU
- Professionals with exudative lesions or scaly dermatitis should not have direct contact with the patient or with the equipment used
- Transport all material with blood in suitable container that does not allow leakage
- Isolate bodily substances, using barriers to avoid possible contact
- Make precise indications for transfusion of blood and derivatives, preferring, whenever possible, autologous blood

Regarding accidents with the risk of HIV contamination, the recommended measures such as rapid HIV testing and use of chemoprophylaxis should be performed. The latter with a combination of zidovudine and lamivudine and, possibly, nelfinavir or indinavir [15].

The use of universal precautions, educational programs of accident prevention and training must be constant activities for hospital infection control committees.

In 2007, the Hospital Infection Control Practices Advisory Committee published recommendations regarding healthcare workers's prevention of occupational exposure and contamination with biological materials [16]. The use of universal precautions in procedures in which the potential contact with biological material is present is recommended as good practice.

In Brazil, the NR-32 Norm (Work Ministry– Norma Regulamentadora 32 – Safety and Health at Work in Health Services) seeks to implement measures to protect the safety and health of healthcare professionals, promoting all preventive forms available to seek safe and healthy workplace, protecting and preserving the professionals [17].

Ergonomic risks

Workplace adequacy to the anesthesiologist consists of ergonomically adjusting the OR. The height of the anesthesia machine, operating table, side tables, and monitors should be adjusted to the anesthesiologist's height.

Awkward postures during work are responsible for developing spinal diseases such as herniated discs and lumbar muscle contractions, which may lead to absence from work [18]. Attitudes such as the adequacy of the operating table height for performing vascular punctures, neuraxial anesthesia, and tracheal intubation, among others, minimize the risk of developing these diseases [18].

Thus, the ergonomic design of the workplace is relevant to reduce the risk of accidents and occupational diseases.

Risks of accidents

The use of a greater number of electrical appliances in the OR increased the risk of accidents with electricity [2].

Inappropriate electrical installations increase the possibility of electric shocks, which can have fatal magnitudes. Correct planning of the number and distribution of electrical outlets, and avoiding extensions and outlet plugs minimize the occurrence of such accidents. For electrical accident prevention, OR grounding should be adequate for the number of devices used simultaneously.

The use of these devices promotes the generation of a low frequency electromagnetic field in the OR. Although there is not enough evidence between such exposure and the origin of occupational diseases, measurements indicated that anesthesiologists are exposed to a magnetic field higher than the recommended by the Swedish Board for Technical Accreditation, which should be less than 2 mG [2].

The risk of fire, although not reduced by the non-use of flammable anesthetics, is still present nowadays with the use of material with oxidizing elements triggering spark. Occurrence of fire with a combination of oxygen and laser, electrocautery and intestinal gas or gauze and bandages are reported in the literature [20].

Occupational diseases

The Industrial Revolution began in England in the eighteenth century and inaugurated an era focused on occupational disease. The first publication associating work and disease dates back to 1700, which not only listed diseases that occurred in more than 50 occupations, but also introduced the question "What is your occupation?" during clinical appointments [21].

Anesthesiology is a medical specialty that has potential for developing occupational diseases related to the risks discussed above.

The requirement of extended working hours and short interval between shifts are associated with stress, hypertension, depression, and abuse of illicit drugs [3,4].

Exposure to certain products increases the risk of diseases, such as latex allergy, as several materials commonly used by anesthesiologists have this component [22]. Reaction may occur by three clinically distinct types: irritant contact dermatitis, Type IV delayed hypersensitivity and Type I immediate hypersensitivity mediated by IgE [23]. Latex sensitivity varies from 12.5-20%, making anesthesiologists vulnerable to allergic reactions either as patients or during their professional activity. This sensitivity may lead to physical disability to perform their work and exchange of medical field [23,24].

Stress generated by situations found in OR activities, intense level of responsibility, and irregular working hours represent important risk factors for the development or worsening of various cardiovascular diseases [25].

Systemic hypertension is associated with an extra-auditory effect caused by noise [4]. Exposure to high levels of noise triggers similar cardiovascular responses to acute stress, with increased blood pressure and in plasma levels of catecholamines, cholesterol, triglycerides, and free fatty acids [26].

Risk factors for occupational diseases are associated with work-related psychiatric disorders, such as chronic fatigue syndrome, depression, and abuse of drugs and alcohol, which are frequent in the anesthetic activity [27].

The definition of *burnout* is "feelings of depression, fatigue, and lack of energy caused by stress or overwork". Burnout syndrome was identified in 1974 and describes a

sense of failure and exhaustion caused by excessive waste of energy [28]. Consisting of a well-defined framework, this syndrome is characterized by emotional exhaustion, depersonalization, and reduced personal accomplishment. Physical symptoms include headache, gastrointestinal disorders, and insomnia. The consequences are discouragement, frustration, depression, and drug addiction. Burnout is also reflected in family and professional relationships, leading to their severance, a significant reduction of work productivity, and increased absenteeism [29].

This syndrome can be observed in all professions, especially those involving high levels of stress, such as health care. Overall, it affects one in two physicians, with one third of them affected moderately and one tenth severely with irreversible characteristics. This syndrome affects about 40% to 50% of the physicians working with emergency medicine and infectious diseases and 56% of oncologists [28].

The Joint Commission identifies fatigue as a factor associated with the occurrence of adverse events, reduced productivity, increased risk of accidents, and diminished quality of life for health professionals [30].

Anesthesiology is among the specialties affected by this problem [31]. The responsibility imposed on it can be considered a stress factor for the professional on duty, generating malaise, sleep disturbances, excessive tiredness, irritability, restlessness, low tolerance to frustration, impatience, feelings of depression, and depersonalization, leading to affective detachment and apathy [32,33].

In the field of anesthesiology, there are other factors that also cause high stress, such as time constraints, interference in personal and family life, medical legal aspects, miscommunication with colleagues, possibility of clinical complications in the perioperative period, little professional recognition, prolonged work shifts, responsibility for any complications, and unrealistic professional expectations [34].

Recognition and diagnosis of the invites reflection upon what needs to be done to continue exercising our profession with dignity, attention to our patients, and in search of a healthy routine for professional practice and quality of life. The implementation of policies aimed at the quality of the practice in facilities, as well as personal reassessment in search of innovation, professional retraining, motivation and leisure alternatives is a factor that may contribute to the improvement of activity and life of anesthesiologists [34].

Substance abuse among anesthesiologists is a current concern of the Brazilian Society of Anesthesiology. Anesthesiology is the highest risk group among medical specialties to develop addiction [35]. While in the United States only 3% of doctors belong to the specialty, they make up between 13% to 35% of physicians treated for substance abuse [36,37]. Current figures indicated that doctors in training in this specialty have twice the risk of dying from addiction than doctors from other specialties [38]. Although there is no established reason identified for this phenomenon, research suggests substance abuse as an early symptom of depression [38,39].

The causes of substance abuse among anesthesiologists include occupational stress, easy access to dugs, physical or emotional pain conditions, low self-esteem, and genetic predisposition [39].

Regarding alcohol abuse, the prevalence (in values) is similar to other professions. One study assessed the profile of 83 anesthesiologists among 697 physicians from other specialties admitted to rehabilitation programs and concluded that alcohol abuse is greater in other medical specialties (52%) than in anesthesiology (28%) ($p < 0.01$). The study suggested anesthesiologists were less likely to be referred to rehabilitation programs due to alcohol abuse (OR 0.4 [95% CI: 0.2-0.6] $p < 0.001$) than other specialty doctors [39].

These professionals are also more vulnerable to develop addiction to medications, particularly opioids. In 2005, a study reported that fentanyl and sufentanil are the most used [40]. Other agents, such as propofol, ketamine, thiopental, lidocaine, nitrous oxide, and volatile anesthetics, are less frequent, but have potential for addiction described in literature [41-43].

There is withdrawal from family, friends, and leisure activities; mood swings; episodes of anger; irritability and hostility; longer permanence at the hospital even when off-duty; more duty calls and extra calls; refusal towards rest breaks; frequent restroom visits; weight loss; pallor and request of increasing or inappropriate amounts of opioids for specific cases [39,44,45].

Addiction and alcohol abuse typically take years to become apparent [31,35,36]. For this reason, it is recommended that professionals with a high degree of suspicion be handled by psychiatrists specialized in substance abuse, in terms of diagnosis and treatment [45].

Most studies agree that admission to rehab programs with a protocol consisting of detoxification, abstinence monitoring, intensive education on the subject, insertion in psychotherapy and support groups is essential. Medical discharge associated with periodic contact with the assistant team and frequent monitoring of abstinence through urine testing is critical, as well as the support of self-help groups such as Alcoholics Anonymous and Narcotics Anonymous [39,45]. It has been shown that 25% of anesthesiologists in treatment will present at least one recurrence episode [38,37,46].

Prognosis of these professionals was studied in 1990, with 180 cases of addiction among anesthesiologists. Of these cases, 13 (7%) died from brain injuries. Of the 167 cases remaining, 113 (67%) were able to return to anesthesiology. The opioid dependent cases had only 34% success in returning to the profession. Of the remaining 66%, 25% died. The users of alcohol and other drugs had recovery rates of 70%, and of the remaining 30%, 13% died [47]. Thus, there is a need for diagnosis, treatment and support for the anesthesiologist at risk for or already with addiction [48].

Conclusion

Control of occupational hazards to which anesthesiologists are exposed daily is necessary to prevent the development of injury and/or disease often disabling.

The joint effort of anesthesiologists and hospital managers is of vital importance for the development of an appropriate workplace, with reduced risks to the good practice of anesthesiology, which contributes to decreased absenteeism, improved care provided to patients, and quality of life of anesthesiologists.

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