THE HISTORY OF SANITARY AND HYGIENIC STANDARDS FOR PATHOLOGISTS IN RUSSIA

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There are many hazards a pathologist is exposed to professionally, including biological (pathogens), chemical (preservatives, reagents), physical (radiation, noise) factors, psycho-emotional stress, and ergonomic risks. Historically, the standardization of these factors and risks has lagged significantly behind practice. The digitalization of pathology (digital microscopy, telemedicine) mitigates some traditional hazards but generates new risks: visual stress, sedentary working conditions, exposure to electromagnetic fields, and psycho-emotional stress from using digital platforms. The history of standardization reflects progress in understanding the unique risks of the profession and the value of medical workers' health. Technological advances necessitate the continued updating of regulations. Thus far, too few studies have been conducted on the evolution of adverse factors and their sanitary and hygienic standardization in the work of pathologists. This review analyzes the development of a system of professional sanitary and hygienic standards for pathologists in Russia.

Keywords: occupational hygiene, pathologists, adverse factors, sanitary and hygienic standards, historical development, digitalization

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ИСТОРИЯ САНИТАРНО-ГИГИЕНИЧЕСКОГО НОРМИРОВАНИЯ УСЛОВИЙ ТРУДА ВРАЧЕЙ-ПАТОЛОГОАНАТОМОВ В РОССИИ

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Профессия патологоанатома связана с многочисленными опасными факторами — биологическими (патогены), химическими (фиксаторы, реактивы), физическими (излучение, шум), а также с психоэмоциональными нагрузками и эргономическими рисками. Исторически нормирование этих рисков существенно отставало от практики. Цифровизация патологии (цифровая микроскопия, телемедицина) снижает воздействие некоторых традиционных вредностей, но порождает новые риски — зрительную нагрузку, гиподинамию, электромагнитные поля и повышенное психоэмоциональное напряжение от работы с цифровыми платформами. История нормирования отражает прогресс в понимании уникальных рисков профессии и ценности здоровья медработника, требуя постоянной актуализации правил в ответ на технологические изменения. В настоящее время исследований, посвященных изучению вопросов эволюции неблагоприятных факторов и их санитарно-гигиеническому нормированию в работе врачей-патологоанатомов, недостаточно. В обзоре представлен анализ становления и развития системы санитарно-гигиенического нормирования условий труда врачей-патологоанатомов на территории России.

Ключевые слова: гигиена труда, врачи-патологоанатомы, неблагоприятные факторы, санитарно-гигиеническое нормирование, историческое развитие, цифровизация

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Pathologists occupy a unique, critically important place in both healthcare and justice systems [1–3]. This is a profession at the intersection of medicine, biology, and law; the work of pathologists is crucial for establishing cause of death, diagnosing diseases, controlling treatment quality, and providing evidence for investigators [3, 4]. There is a complex set of specific, potentially hazardous workplace factors to which pathologists are exposed [3, 4]. These include biological agents (e.g., highly pathogenic microorganisms), toxic chemicals (preservatives like formaldehyde and Sulema; reagents like lead salts and picric acid), physical factors (ionizing radiation from radioactive materials; noise), pronounced psycho-emotional stress, and ergonomic risks [4]. Due to constant contact with pathological materials, pathologists belong to a high-risk group for occupational morbidity (infectious, toxic-chemical, and oncological hazards). With time, the profile of the respective occupational risks has changed significantly, from infectious threats and the toxic effects of crude chemicals in the past to the hazards associated with high-tech research methods, complex synthetic reagents, the challenges and the psychosocial stress of the digital age [3–5]. However, even with the said risks and hazards recognized, the development and implementation of adequate, scientifically proven sanitary and hygienic workplace standards (SanPiN, GOSTs, methodological guidelines) for this profession has always lagged behind the realities of regular practice and scientific and technological progress. Historically, working conditions in pathology departments often failed to meet even basic sanitary standards. Currently, there are significant gaps in both the sanitary and hygienic and historical aspects of the work of pathologists. The evolution of the Russian system of sanitary and hygienic standards applicable to their operations has not been sufficiently studied. Generally, the way the said standards have been developed reflects the transformation of medical science and practice as well as shifts in the public attitude towards the protection of health of pathologists. Understanding how past approaches have evolved, along with their successes and failures, underpins efforts to devise effective occupational safety strategies for today and the future, especially in the context of rapid digitalization of pathology practice (telemedicine, electronic archives, etc.) and the associated new types of risks (electromagnetic, visual, psycho-emotional, and cybersecurity risks) [4–8].

This study traces the history and development of sanitary and hygienic workplace standards for pathologists in Russia. It covers key milestones from early challenges in the first anatomical theaters and morgues to modern issues in the digital transformation of pathology.

Methods

We analyzed the literature indexed in the international PubMed database and the Russian RSCI database. The sources were selected using keywords "pathologists" + "sanitary and hygienic standardization" + "historical development." The search depth was 10 years (2015–2025).

Among Russian sources, we preferred papers published in the journals included in the RSCI core.

A search for the keywords "pathologists + sanitary and hygienic standardization" returned 2345 foreign publications and 456 Russian papers. A further search for "pathologists + sanitary and hygienic standardization + historical development" brought 1212 works.

The number of publications for 2015-2025 found in the RSCI database for the keywords "pathologists + sanitary and hygienic standardization" was 374, and for the keywords "pathologists + sanitary and hygienic standardization + historical development" — 115 works. Ultimately, we selected 38 papers published over the past 10 years for the analytical review; the choice was based on the quality of the sources in terms of coverage of the history of development of sanitary and hygienic standards for pathologists and the current state of affairs in this field.

The origins of pathology and the first steps without supporting sanitary and hygienic standards: anatomical theaters and the first morgues

The practice of autopsies for scientific and educational purposes began in Europe during the Renaissance: anatomical theaters emerged as public venues for dissections and became a staple of medical education [9]. In the 15th–16th centuries, the first anatomical theaters appeared in Italy, and Mondino de Luzzi (Bologna) systematized knowledge about organs. The first famous theater was built in Padua (Italy) in 1594. Such venues symbolized the transition from medieval dogmas to the scientific study of the body. They opened throughout Europe; in 1706, Peter the Great studied in one of such theaters in Leiden, Holland, under the guidance of Professor F. Ruysch [10–12]. Morgues as body storage for forensic medical investigations appeared later, in the 18th century, mainly in universities and hospitals. At the outset, they were unsanitary: there was no proper ventilation or refrigeration equipment (the first cold boxes with refrigerants were installed in the early twentieth century), and the microbial nature of infections had yet to be discovered. All these factors promoted the spread of diseases among doctors and students [10].

In Russia, practical pathology as the systematic examination of deceased bodies to determine causes of death and disease characteristics emerged in the 18th century. Its evolution is inextricably linked with the development of medical education and the creation of the first secular hospitals [11–13]. The history of this profession began in 1698–1707, when Peter the Great issued "General Regulations on Hospitals" that prescribed autopsies of the deceased in hospitals to determine the causes of death. These regulations can be considered the first legitimate basis for pathology in Russia; although individual autopsies were conducted earlier (e.g., under the Pharmacy Order), the practice became systemic only with their publication. The first anatomical theaters appeared at hospital schools, including the Moscow Hospital School founded in 1707 by decree of Peter the Great, as well as the first universities (Moscow University, 1755). Initially, anatomical theaters were spaces — often just basements or separate hospital wings — adapted for the purpose, with a central autopsy table and an amphitheater for the audience [11–13]. The equipment was primitive (stone or wooden tables, a minimal set of knives and saws), and ventilation either poor or non-existent. As for heating, there were irregularly lit stoves. In general, during that time, the working environment of a pathologist was basically unregulated in the sanitary and hygienic aspects, which meant extremely dangerous conditions that seem unthinkable today [11–13]. At the dawn of pathoanatomic science, unsanitary conditions were the norm. This led to widespread issues like a lack of sewerage and running water, inadequate wet cleaning and disinfection, poor waste disposal, insufficient ventilation, improper corpse storage (due to a lack of refrigeration units), lapses in personal hygiene (no showers, protective clothing, or handwashing facilities), high physical demands and injury risks, and significant psychological stress. As forensic medicine developed and the number of hospitals (especially military ones) increased, mortuaries, previously used for educational purposes only, became places where mandatory autopsies of the deceased in hospitals were conducted. Functionally, the first morgues were a continuation or copy of anatomical theaters, but even less suited for regular operation. They were located in the most inconvenient and remote parts of hospital complexes: basements, ground floors, and backyards, often next to outbuildings or barnyards, which significantly worsened the existing problems [12–15]. One small room often combined the functions of storing corpses (sometimes dozens), conducting autopsies, and preparing bodies for burial. It lacked separate contaminated and clean zones. The bodies used in anatomical theaters were mostly unclaimed corpses of "beggars, tramps, rootless and unidentified," as well as executed criminals. The high prevalence of infectious diseases (plague, cholera, typhus, smallpox) meant morgue workers had constant contact with highly pathogenic material — without understanding infection mechanisms or protective equipment — which increased their infection rates [12–15]. It should be noted that the profession of a pathologist was not clearly defined, autopsies were often performed by surgeons or hospital internists, and there were no special instructions on their occupational safety.

With the development of medical science — in particular, microbiology and histology — and technology (microscopes, fixatives since the late 19th century), the range of negative factors has expanded and partially changed. Chemical agents became widespread, including formalin (a 40% formaldehyde solution). This dramatically improved tissue safety but introduced a new hazard: a powerful irritant that affects mucous membranes, triggers allergies, and potentially causes cancer. Advancements in the study of biological hazards and better understanding of infection mechanisms made the hemocontact pathway obvious, even though hepatitis and HIV had not yet been discovered. Gradually, there appeared the simplest exhaust ventilation systems (often ineffective), electric lighting (which improves visibility, but creates new risks of visual fatigue with poor light quality), primitive personal protective equipment (rubber gloves, aprons, sometimes glasses), and refrigerating equipment (reducing odor and decomposition rate). Despite the obvious risks, the sanitary and hygienic standards have not yet been introduced. In pre-revolution Russia, there were no regulations covering the work of pathologists. Moreover, occupational hygiene as a whole was in its infancy [11–15]. The improvements were only local, and they depended on the equipment available at a particular institution and the conscientiousness of its managers.

The origins and development of sanitary standards and the struggle against adverse factors

The first attempts to regulate the work of pathologists were made in the late 19th and early 20th centuries. In the second half of the 19th century, Pasteur, Robert Koch, and others established the infectious causes of many diseases and the value of asepsis. This laid the groundwork for advances in pathology, especially in large cities and university clinics. The emergence of more effective disinfectants (carbolic acid, sulema), use of fans, and improved lighting (kerosene lamps, gas, and electricity) contributed to a gradual improvement in conditions, but there was still no systematic approach to sanitary standards for pathologists [14–18]. The first sanitary rules for hospitals were developed in that era, and they indirectly regulated morgues. The rules required mortuaries to be located in separate buildings or isolated wings. They also prescribed arranging sewerage removal and water supply systems (in new buildings), painting walls and ceilings with oil paint for easy cleaning, installing exhaust ventilation, disinfecting the rooms on a regular basis, performing autopsies in separate rooms, and disposing of waste properly. However, these requirements were advisory or partial in nature, and were often ignored due to lack of funds, lack of oversight, and common practice. Retrofitting old buildings was difficult and expensive, and there were no special standards of work for pathologists (permissible concentrations of harmful substances, requirements for special clothing and personal protective equipment (PPE), working hours, medical examinations). Occupational safety for pathologists wasn't considered a separate issue. Recognition of the unique hazards specific to this medical specialty and the need for special sanitary and hygienic standards to protect doctors' health came much later, during the Soviet period [14–18].

After the 1917 revolution, greater attention was given to protecting workers' health and safety, including that of medical professionals. The first general regulatory documents appeared, and general sanitary rules for medical institutions concerning ventilation, lighting, and cleaning were developed. However, they rarely detailed the specifics of the pathology departments. The milestone document — first of its kind — that introduced standards to address occupational hazards faced by pathologists was Resolution No. 298 of the Council of People's Commissars of the USSR, dated March 11, 1939, "On Measures to Improve the Work of Pathology Departments" [18]. For the first time ever, this document:

- clearly outlined the health risks pathologists and lab technicians are exposed to;
- established a shortened working day (6 hours) and an additional vacation (up to two weeks) as compensation for working in harmful conditions;
- prescribed mandatory provision of special work clothes, shoes, and rubber gloves;
- formulated the requirements for equipping morgues with exhaust ventilation and refrigeration units;
- described the procedure for the disposal of biological waste.

This document became the first real legislative act regulating the sanitary and hygienic standards for morgue staff. For decades, all subsequent standardization efforts were based thereon.

In the post-war period, further detailing of the requirements was done through building codes and regulations (SNiP) for designing pathology departments and bureaus (regulation of areas, zones, ventilation, lighting, water supply, sewerage), industry instructions and methodological recommendations of the USSR Ministry of Health, as well as standards for equipping workplaces (microtomes with protective screens, efficient fume hoods for work with formalin and volatile reagents) [19–21]. Standards mainly concerned combating the effects of various (chemical, biological, physical, and psycho-emotional) factors. The maximum permissible concentration (MPC) of formalin in workplace air, along with ventilation requirements and work duration with fixatives, has been established. Further, the documents introduced regulations for handling infectious materials, instrument disinfection and sterilization, waste disposal, and requirements for lighting (general and local at histological workstations), microclimate (temperature and humidity in dissecting rooms, and especially in histological labs where low humidity is key for high-quality tissue embedding), and equipment noise. Although no standards were developed to mitigate psychoemotional stress, a shortened workday and extra vacation time provide indirect compensation [19–21].

Currently: systematization and new challenges

The collapse of the USSR and the formation of the Russian Federation necessitated updates to the regulatory framework to reflect new realities and scientific data. For example, SanPiN 2.2.4.548-96 "Hygienic Requirements for the Microclimate in Workplaces," established strict standards for temperature, humidity, and air velocity in various morgue rooms (dissecting room, histological laboratory, doctor's office). Special attention is paid to maintaining a low temperature in the dissecting room (16-18°C) for the comfort of workers in overalls, and optimal humidity in the histological laboratory [22]. SanPiN 2.1.3.2630-10 "Sanitary and epidemiological requirements for organizations engaged in medical activities" [23] (and later editions, including SP 2.1.3678-20) [24] cover pathology departments/bureaus and specifically provide and regulate:

- requirements for architectural and planning solutions (isolation of contaminated and clean zones, separate pathways for bodies, staff, visitors, materials);
- engineering equipment, forced supply and exhaust ventilation with excess exhaust in contaminated zones, local exhaust devices above autopsy and histology tables, air conditioning in histological laboratories and offices;
- requirements for workplace illumination levels (especially important for microscopy), use of non-glare fixtures;

• sanitary regime, cleaning, disinfection, sterilization using modern effective means, as well as utilization of class B and C (highly hazardous and epi-hazardous) medical waste;

• mandatory use of PPE (robes/suits, caps, masks/respirators, safety glasses/shields, gloves (several pairs of different types), special shoes), as well as their replacement and cleaning/disposal;

• work and rest conditions, medical examinations, vaccination (hepatitis B, etc.).

The hygienic standard GN 2.2.5.3532-18 "Maximum permissible concentrations (MPC) of harmful substances in the air of the working area" establishes the current MPC of formaldehyde and other chemicals used in practice (xylene, toluene, paraffins, etc.). The emergence of highly pathogenic infections (HIV, viral hepatitis transmitted parenterally) and resistant bacterial strains made countering the biological hazard an urgent task. At the same time, PPE (FFP3 respirators, aerosol shields) and disinfection methods have improved. The growing volume of macroscopic examinations of surgical material has necessitated standardizing workplace conditions (lighting, ergonomics, and ventilation for formalin-related work). In addition, standards have been set for the heights of worktables (such as sectional and histological ones), microtomes, and adjustable microscopes to avoid awkward, prolonged static postures [18–25].

The era of digitalization has created both new opportunities and new risk factors, and led to the transformation of previously existing adverse factors. Traditional occupational hazards are mitigated by modern technology [25–27]:

• digital microscopy reduces examination time, easing strain on the eyes and musculoskeletal system from static postures;

• telemedicine lowers the need for trips, which significantly reduces labor costs and mitigates the risk of professional burnout;

• dangerous steps (dewatering, degreasing, and paraffin impregnation) are fully automated and performed in a sealed module, which eliminates the need for manual operations with reagents and their evaporation into the air of the work area.

Latest research papers report the emergence of new adverse factors, both directly and indirectly related to the widespread adoption and use of digital technologies. Prolonged use of high-contrast, high-resolution monitors, the need to focus on the details of digital images necessitate regulation of work-related screen time, monitor quality (brightness, contrast, refresh rate, resolution), workplace lighting levels (glare control) [28–30]. Currently, microclimate requirements for rooms with computers (e.g., doctors' offices and digital pathology labs) emphasize comfortable conditions for mental work: 22–24°C temperature, 40–60% humidity, and good ventilation to remove excess heat from equipment; this is different from standards for traditional "wet" morgue areas [32–35]. Prolonged computer work in a sitting position requires limiting work hours, optimizing the workspace (e.g., ergonomic chair, desk, monitor/keyboard stands), and scheduling breaks with physical warm-ups. This helps prevent musculoskeletal disorders and physical inactivity [25, 28–30]. Regular use of numerous electronic devices (monitors, servers, network equipment) leads to prolonged exposure to electromagnetic fields. Although following general rules makes immediate danger unlikely, monitoring and further study of the consequences, especially long-term effects, of such exposure are still required [28–32]. Another reported problem involves shifting psychophysiological stressors. These include the high concentration of attention required, responsibility for analyzing complex digital images, the need to master new software, information overload, and the routine review of numerous similar images — all of which lead to excessive intellectual and emotional strain [32–38].

CONCLUSION

Sanitary and hygienic standardization of the work of pathologists in Russia has gone through a thorny path from no rules in the era of the first anatomical theaters to a complex, detailed system of requirements in modern SanPiN regulations. This transformation reflects the progress of medical science, technology and, most importantly, the understanding of how valuable health of a medical professional is. While the first regulatory steps (the 1939 Resolution of the Council of People's Commissars) targeted obvious physical and chemical threats in harsh working conditions, modern standards address a wide range of factors — from traditional chemical (e.g., formaldehyde) and biological hazards to physical parameters like microclimate, lighting, noise, ergonomics, and psycho-emotional stress. The widespread introduction of digital technologies both reduces the impact of some classic hazards and sets new tasks for hygienists to standardize visual load, physical inactivity, and intellectual and emotional stress when working with digital platforms. The constant updating of sanitary rules, informed by scientific data and technological innovations, is an effective measure for safeguarding health and ensuring pathologists' productivity.

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