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OCCUPATIONAL AND ENVIRONMENTAL SAFETY IN THE TREATMENT OF PERITONEAL METASTASES USING THE PRESSURIZED INTRAPERITONEAL AEROSOL CHEMOTHERAPY METHOD: A SCOPING REVIEW

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Abstract

Peritoneal metastases are a common manifestation of malignant tumor progression in various locations. Despite the availability of systemic therapy and surgical approaches, many patients continue to face unmet clinical needs, reduced quality of life, and unfavorable outcomes. In response to these limitations, pressurized intraperitoneal aerosol chemotherapy was developed in the early 2000s. While this technique has generated increasing clinical interest, concerns remain regarding potential occupational and environmental risks, particularly due to aerosolized exposure to cytotoxic agents.

This scoping review aimed to explore and summarize current evidence on occupational risks and safety measures implemented during pressurized intraperitoneal aerosol chemotherapy sessions for the treatment of peritoneal metastases. Based on available data, we also sought to identify clinical recommendations to ensure the protection of healthcare personnel and the operating room environment.

Materials and methods. Relevant publications were identified through a systematic search of PubMed, Scopus, and eLibrary databases. Eligible studies described the pressurized intraperitoneal aerosol chemotherapy method, personal and collective protective measures, or organizational recommendations for safe handling of cytostatic aerosols in the surgical setting.

Results. The search identified 185 publications, of which 37 met the inclusion criteria. The included studies mainly consisted of observational reports, experimental simulations, and institutional guidelines. Key safety measures included the use of closed aerosol delivery systems, high-efficiency ventilation, personal protective equipment, and standardized decontamination protocols. Evidence of long-term occupational risk was limited, but most studies emphasized the necessity of strict adherence to safety procedures.

Conclusions. This review contributes to the evidence base supporting the occupational and environmental safety of pressurized intraperitoneal aerosol chemotherapy sessions. The synthesized findings can inform the adaptation and standardization of multilayered protection strategies and training protocols for healthcare workers, thereby minimizing risks to staff and the operating environment.

Keywords: *aerosol, peritoneal neoplasms, occupational exposure, environmental monitoring, biological monitoring, operating room.*

Introduction

Peritoneal metastases (hereinafter – PM) represent a common and clinically significant manifestation of tumor progression across various malignancies. They are most often found in ovarian, gastric, and colorectal cancer [1]. The high propensity for peritoneal dissemination is attributed not only to the biological characteristics of these tumors but also to the unique anatomical and physiological features of the peritoneal cavity

[2]. A Dutch nationwide population-based study revealed the development of peritoneal metastases in 1835 (45.1 %) of 4072 patients with gastric cancer [3]. The frequency of peritoneal metastases in neoplasms of gynecological organs reaches almost 90 % of ovarian cancer cases, 10 % of endometrial cancer, and 5 % of cervical cancer. In colorectal cancer, peritoneal involvement is seen in 10-20 % of cases [1].

The development of PM poses a major clinical and therapeutic challenge. It is consistently associated with poor prognosis, limited therapeutic options, and high recurrence rates [4]. Despite advances in systemic therapies and surgical interventions, many patients continue to face substantial unmet clinical needs, compromised quality of life, and persistently unfavorable outcomes [2; 4-7]. These challenges underscore the urgent need to explore and integrate alternative therapeutic strategies that could improve disease control and patient survival.

Kuchen (2018), referencing the pioneering work of Reymond et al. (2000), reported that a novel technique – pressurized intraperitoneal aerosol chemotherapy (hereinafter – PIPAC) – was developed in Germany in the early 2000s, with the first experimental sessions conducted in pig models [8; 9]. This method was subsequently applied in humans with inoperable peritoneal carcinomatosis in November 2011. These initial clinical applications demonstrated its safety and facilitated its dissemination to other countries [10].

Since then, numerous studies have investigated the therapeutic potential of PIPAC in managing peritoneal carcinomatosis of various oncological origins [11-14]. A recent systematic review and meta-analysis concluded that, despite heterogeneity in the available data, PIPAC offers promising outcomes for selected patients with peritoneal metastases. Pathological regression was observed in 68 % of the studies, serving as an indirect indicator of its therapeutic efficacy [15]. Comparable findings were reported by Mohammad et al. (2022), who emphasized the need for developing standardized strategies and tools for objective response assessment [16]. Such measures would enable the rational integration of PIPAC into clinical practice as its evidence base continues to expand.

Despite growing interest in the PIPAC method, concerns persist about the potential occupational risks to healthcare workers and the environment associated with inhalation exposure to aerosolized cytostatics. Electrosurgical smoke and the risk of contact with cytostatics negatively affect the health of healthcare workers involved in cytoreductive surgery and hyperthermic chemotherapy. Meanwhile, the actual extent of the risk and the long-term consequences of toxic effects are not fully understood, but their presence cannot be ruled out [17]. Vyas et al. 2014 in their work report the importance of using tools to measure the toxic effects of cytostatics in order to understand occupational and environmental risks. It is recommended to measure occupational exposure through biological monitoring of healthcare workers (urine mutagenicity analysis, cytogenetic monitoring, and urine monitoring) and environmental monitoring at the workplace (taking samples of swabs from surfaces and air).

Additionally, it is essential to utilize various technologies to minimize exposure to cytostatics [18]. Several studies have reported the importance of developing a safety protocol and strictly adhering to it when performing PIPAC sessions [17; 19-21]. In this context, it is particularly important to analyze the set of protective measures at both individual and environmental levels within the framework of the PIPAC method.

According to the National Cancer Registry of the Ministry of Health of the Republic of Kazakhstan, cancer incidence in 2024 increased by nearly 6 % compared to the previous year. Each year, approximately 40,000 new cases of malignant neoplasms are registered, while annual cancer-related mortality exceeds 12,000 cases [22]. These figures underscore the urgent need to introduce innovative therapeutic strategies, including pressurized intraperitoneal aerosol chemotherapy, into national clinical practice.

Despite progress in the development of oncology services in Kazakhstan, access to advanced technologies such as PIPAC remains limited. This is primarily due to the absence of standardized protocols, certified treatment centers, and sustainable funding mechanisms. Currently, PIPAC is available only in selected clinics as part of scientific research initiatives. Since 2024, the National Research Oncology Center (hereinafter – NROC) has launched a scientific and technical project aimed at introducing PIPAC for the treatment of peritoneal carcinomatosis in advanced gastric cancer. To date,

23 PIPAC sessions have been performed. Although it is too early to draw definitive conclusions regarding the clinical effectiveness and occupational safety of this technique, its introduction represents a promising step forward – both in the management of peritoneal carcinomatosis and in the treatment of advanced gastric cancer in Kazakhstan [23].

The objective of this review was to analyze occupational risks and summarize the current safety measures applied throughout all stages of the surgical process during PIPAC sessions for patients with peritoneal metastases. Based on the available evidence, we aim to propose clinical recommendations that ensure the protection of healthcare workers and the environment.

Methods and Materials

Search strategy

The review was reported in accordance with the PRISMA-ScR (hereinafter – Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) checklist [24]. A comprehensive literature search was performed in PubMed, Scopus, and eLibrary databases. The search strategy incorporated the following Medical Subject Headings (MeSH) terms: «aerosol», «peritoneal neoplasms», «occupational exposure», «environmental monitoring», «biological monitoring», and «operating room». In addition, manual searches of the reference lists of relevant papers were conducted to ensure completeness. The time frame was limited to publications from 2003 to 2025, and the review included articles published in English and Russian. The review included publications of observational clinical and cohort studies, preclinical experimental works, pilot clinical studies, registration and descriptive studies, consensus studies, systematic reviews, as well as guidelines and standards on the handling of cytostatics.

Study selection

All retrieved citations were imported into Zotero 6.0.37 (Corporation for Digital Scholarship, USA), and duplicates were removed [25]. Titles and abstracts were independently screened by two reviewers against the inclusion criteria. Full-texts of potentially relevant studies were assessed for eligibility. Any disagreements were resolved by consensus or consultation with a third reviewer.

Results of search

A total of 185 publications were identified. After removal of duplicates and screening, 37 studies met the eligibility criteria and were included in this review. The selection process is summarized in the PRISMA flow diagram (Figure 1) [26].

Brief description of the PIPAC method

The PIPAC method involves laparoscopic administration of cytostatics into the abdominal cavity using two standard balloon trocars. The most commonly used drugs are cisplatin (7.5 mg/m²) in 0.9% sodium chloride (150 ml) and doxorubicin (1.5 mg/m²) in 0.9% sodium chloride (50 ml) as an aerosol under a pressure of 12 mm Hg with an exposure of 30 minutes at a temperature of 37°C. After the exposure period, the toxic aerosol is released through a closed system [13; 27; 28]. Studies show that PIPAC can significantly improve the delivery of cytostatics to tumor tissue, especially in cases of micrometastatic lesions, due to the uniform distribution of aerosol under pressure and its penetration into tissue to a depth of 500–1000 μm [29-31]. Advantageously, multiple replications of the procedure, up to 6 times, with an interval of 4-6 weeks, are allowed, allowing the integration of PIPAC sessions into cyclic therapy regimens [32; 33].

Results

Professional and environmental risks during PIPAC sessions

This review synthesized evidence on professional and environmental risks associated with PIPAC sessions. The analysis focused on the toxicity of commonly used cytostatics, potential sources of occupational exposure, and findings from both clinical and experimental studies evaluating the safety of healthcare workers.

Cytostatics administered during PIPAC are highly toxic to humans. Cisplatin is known to cause anaphylactic reactions and irritation of the mucous membranes of the eyes, skin, and respiratory tract, while also accumulating toxic metabolites in the kidneys, bone marrow, and inner ear. Doxorubicin may induce mucosal inflammation, leukopenia, dilated cardiomyopathy, DNA mutations, and is classified as carcinogenic to humans [9]. Occupational exposure can occur through multiple routes, including handling contaminated vials, maintaining and cleaning pharmaceutical isolators, contact with biological fluids containing cytostatics, inhalation of aerosols, direct administration of drugs, and accidental spills [18].

Survey-based evidence highlights gaps in awareness and practice regarding the safety of

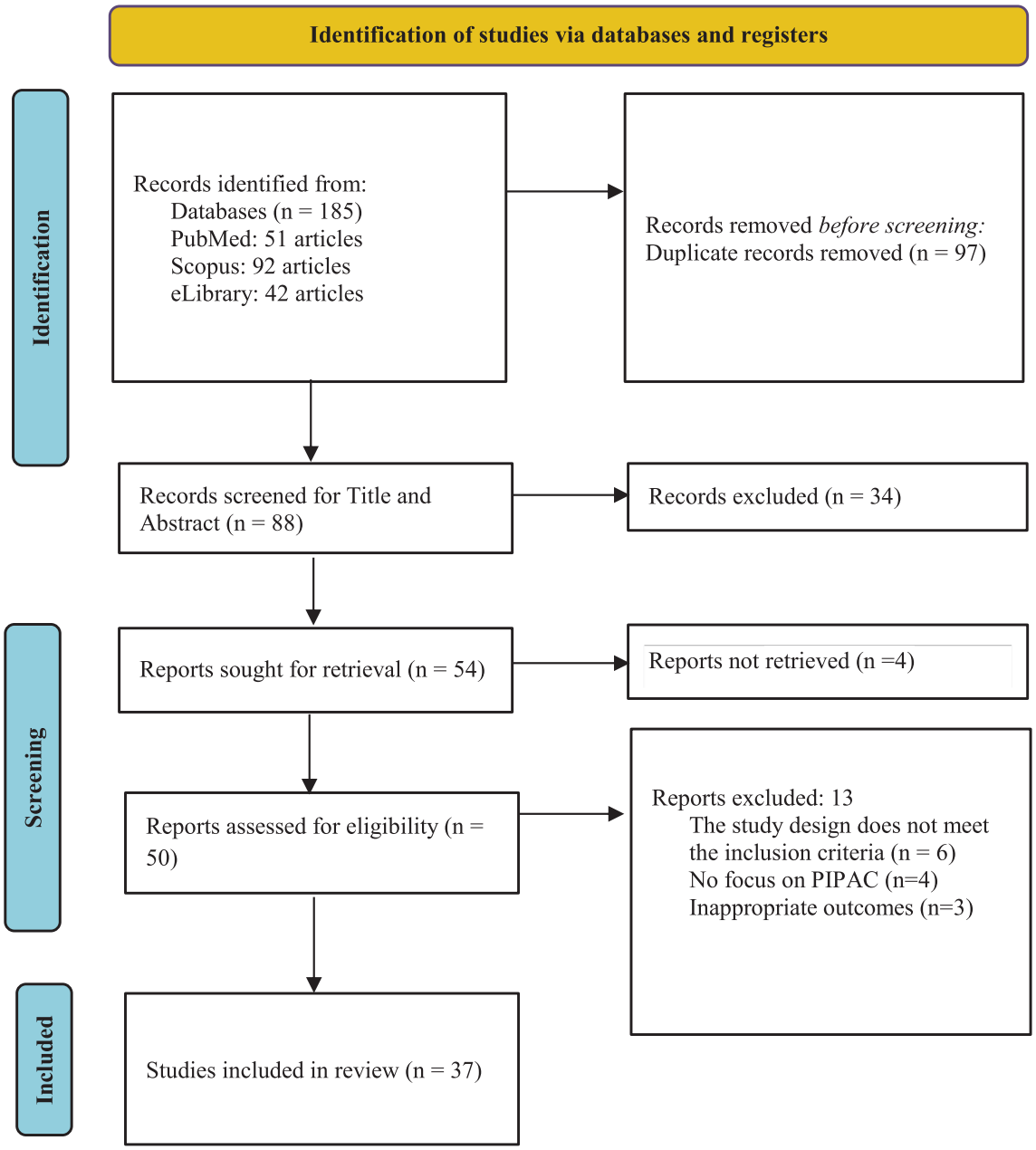

Figure 1. Search results and study selection and inclusion process [26]

cytostatics. Among 51 healthcare professionals involved in hyperthermic chemotherapy, 8 (15.7 %) believed that all cytostatics carry the same toxicity regardless of the drug, while 21 (41.2 %) reported lacking knowledge of appropriate measures in the event of exposure. In a separate cohort of 38 staff directly engaged in PIPAC sessions, 22 (57.9 %) perceived the toxic risk as low. Only one participant (2.6%) reported symptoms such as headache or skin manifestations during a session, and three (7.9%) noted accidental contact with cytostatics without clinical consequences [34].

Findings from a multicenter international survey among surgical teams with extensive PIPAC experience further emphasize perceived risks and safety practices. In this study, 63% of respondents identified cytostatic spillage as the primary intraoperative hazard, yet only 51.7% reported implementing at least five of the 12 recommended safety precautions. On average, the perceived safety level of PIPAC was rated 7.37 on a 10-point scale, while the perceived risk of occupational exposure was 3.84. Overall, respondents viewed PIPAC as less hazardous compared with other forms of intraperitoneal chemotherapy [35].

In a German pilot study of the PIPAC meth-

od, which for the first time analyzed the adequacy of safety measures, conditions (closed abdomen, laminar air flow, controlled aerosol extraction and protective curtain) and the risks to healthcare workers in a real clinical setting, air analysis did not detect traces of cisplatin in either the surgical or anesthesia work area (detection limit < 9 ng/m3) [21]. At a university hospital in France, during the first two PIPAC sessions using cisplatin and doxorubicin, without laminar airflow but with an additional plastic cover and smoke extraction system, all air samples were negative for cisplatin and doxorubicin (detection limit < 0.00002 mg/m³). Of 26 swab samples, only 1 (4 %) was positive for cisplatin on the surgeon's outer pair of gloves. However, swabs from the inner pair of gloves and from the surgeon's hands were negative [36]. A study conducted by Belgian scientists showed the absence of platinum during an extended toxicology analysis. In addition to standard samples, swabs from surfaces before and after PIPAC sessions using cisplatin, doxorubicin, and oxaliplatin were included in the extended toxicology analysis. As a result, even with a highly sensitive method, platinum was not detected in any of the samples (detection limit: 0.02 ng/cm²) [19]. Two studies were found that recorded the following incidents during PIPAC sessions. In one study, it was found that the surfaces of the connecting devices in 5 out of 51 cases (9.8 %) were contaminated with high concentrations of the cytostatic (the maximum reached 181.07 ng/cm 2). Contamination occurred due to leakage caused by imperfect sealing of the connections [37]. According to another study, leakage of cytostatics was observed in 2 out of 86 PIPAC sessions, which was associated with human error, insufficient sealing, and high pressure. Despite recorded cases of cytostatic leakage, they did not lead to environmental contamination or affect the safety of medical personnel, which is attributed to the use of an effective double protection system that covers the connecting tubes with a protective film [20].

A systematic review of biological monitoring for occupational exposure to cytostatics revealed that, despite the implementation of preventive and protective measures, a certain proportion of healthcare workers showed positive results for the presence of cytostatics in biological fluids [38]. Biological monitoring in two surgeons after 50 PIPAC sessions did not reveal traces of platinum in blood samples [20]. In a larger sample of healthcare workers (n = 10) participating in a controlled study, the concentration of platinum in urine was below the limit of quantification (<10 ng/L) in over 50% of cases. However, the detected values did not show statistically significant differences compared with the control group [39]. Roussin et al. (2021) presented comparable values for analyzing urine samples from healthcare workers [40]. In other biomonitoring studies with a control group, no statistically significant changes in platinum concentrations in blood and urine were recorded before and after the sessions, despite the presence of platinum in 25% of urine samples from participants exposed to PIPAC. In addition, no significant differences were found between the main and control groups [41]. Thus, subject to established safety standards and the use of high-quality equipment, along with the appropriate level of training for the operating team, the risk of toxic effects from cytostatics on medical personnel and contamination of the operating environment during PIPAC sessions is assessed as minimal. However, the need for further research to study the potential long-term consequences of occupational exposure remains relevant.

Safety measures during PIPAC sessions

Occupational safety during PIPAC sessions can be broadly divided into three stages: preoperative (drug preparation, transportation, and operating room setup), intraoperative (use of personal and collective protective equipment, staff isolation during cytostatic aerosolization, and remote monitoring), and postoperative (contamination control, staff health monitoring, and cleaning and disposal of medical waste).

Preoperative stage. The preparation and dilution of cytostatics carry a particularly high risk of toxic exposure for medical staff [42]. For this reason, drug handling must be performed in a specially designated and isolated environment, such as a pharmaceutical laboratory or oncology pharmacy. These facilities should be equipped with negative pressure systems, a separate entrance, and no access to food areas [43]. According to Yoshida et al. (2009) and Easty et al. (2015), the use of a laminar flow cabinet (Class II, type B2) is considered the gold standard for cytostatic preparation (Figure 2) [44; 45].

According to the NIOSH standard, when preparing and diluting cytostatics, a specialist must wear protective equipment, including a waterproof

Figure 2. Laminar flow cabinet for diluting cytostatics
Source: compiled by the authors

gown with cuffs, double nitrile or latex gloves (inner and outer), glasses or a mask to protect the eyes/face, and an FFP-3/N95 respirator mask [46]. Additionally, it is recommended to use syringes with a Luer-lock system and needle substitutes when collecting cytostatics from vials to minimize splashes and aerosols [47, 48]. Capoor et al. (2017) suggest using a rigid, impact-resistant, sealed container labeled «cytostatic agents» with an absorbent pad inside to transport ready-made cytostatics to the operating room; moreover, not to use pneumatic pipelines and not to expose the contents to mechanical stress [49]. One study demonstrated, for the first time, the safety of the PIPAC method without equipping the operating room with a laminar flow ventilation system, but by covering the spray area with a plastic cover and utilizing a smoke extraction system [36]. However, the results of a two-stage Delphi study showed a strong positive recommendation for conducting PIPAC sessions under an advanced ventilation system (91.5 %). At the same time, a weak positive recommendation was found for activating laminar airflow (48.9%) and providing additional protection with a plastic cover featuring smoke filtration (55.3%) [50]. The CAWS (Closed Aerosol Waste System) connection ensures the safe removal of aerosols and gases from the abdominal cavity at the end of the PIPAC session. This sealed system has proven effective in preventing air pollution and biological exposure to healthcare workers - no traces of platinum were detected in the air or blood [51; 52].

Before performing a PIPAC session, it is necessary to check the technical condition of the microirrigator for intracavitary nebulization of cytostatics, including checking the integrity of the spray head, the tightness of the system, compliance of the operating pressure with the parameters set by the manufacturer, and an assessment of the uniformity of liquid supply. Additionally, the primary requirements are the use of disposable tips and ensuring that the equipment operates within a closed system to prevent environmental aerosol contamination [14; 29]. Safety precautions include checking the integrity of hoses and connections, ensuring the complete tightness of trocar ports, verifying the connection to CAWS, and adjusting the settings of injector parameters, such as pressure, spray rate, and timer [10; 20].

During PIPAC sessions, the operating team must adhere to strict safety protocols and use the appropriate personal protective equipment (hereinafter – PPE). The recommended set of PPE includes: (1) protective eye gear (plastic goggles or face shield), (2) an FFP3 or N95 respirator, (3) an AAMI level 4 sterile gown, (4) double-layer gloves

resistant to cytostatics (inner and outer), and (5) plastic shoe covers (Figure 3) [50; 53].

Among available options, surgical gloves made of nitrile, polyurethane, neoprene, or synthetic rubber copolymers provide the greatest resistance to cytotoxic drug penetration. Both sterile and non-sterile powder-free gloves may be used to minimize contamination of the work environment. In contrast, vinyl gloves are discouraged because of their poor chemical resistance and higher permeability to cytostatics. To further reduce the risk of contamination, gloves should be changed every 30 minutes, even in the absence of visible damage or defects [54].

During the cytostatic nebulization phase, all medical and non-medical personnel must leave the operating room and remotely monitor the exposure time for biosafety purposes (Figure 4) [20; 50].

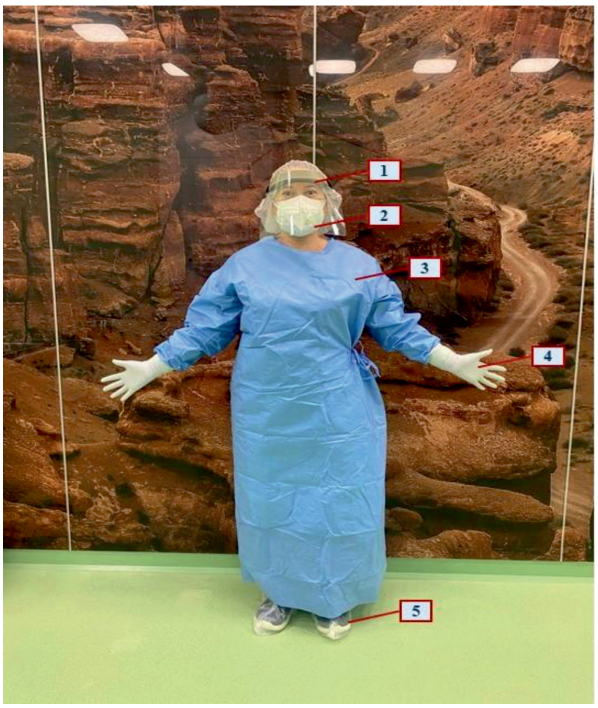

Figure 3. Personal protective equipment for the operating team during a PIPAC session
Source: compiled by the authors

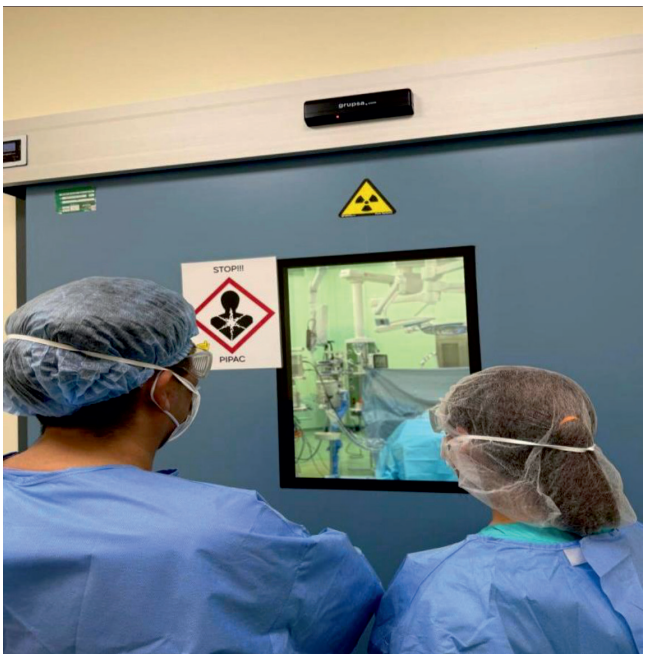

Figure 4. Remote monitoring during cytostatic nebulization
Source: compiled by the authors

However, PIPAC experts recommend several additional measures to ensure protection of the operating environment (Figure 5). These include covering the operating room floor with absorbent sheets (95.7% agreement), placing a clearly labeled container beneath the injector head to collect potential spills (95.7%), and wrapping the high-pressure line with transparent film to minimize the risk of leaks (89.4%) [50]. Comparable recommendations for maintaining environmental safety during PIPAC sessions have also been reported by [37].

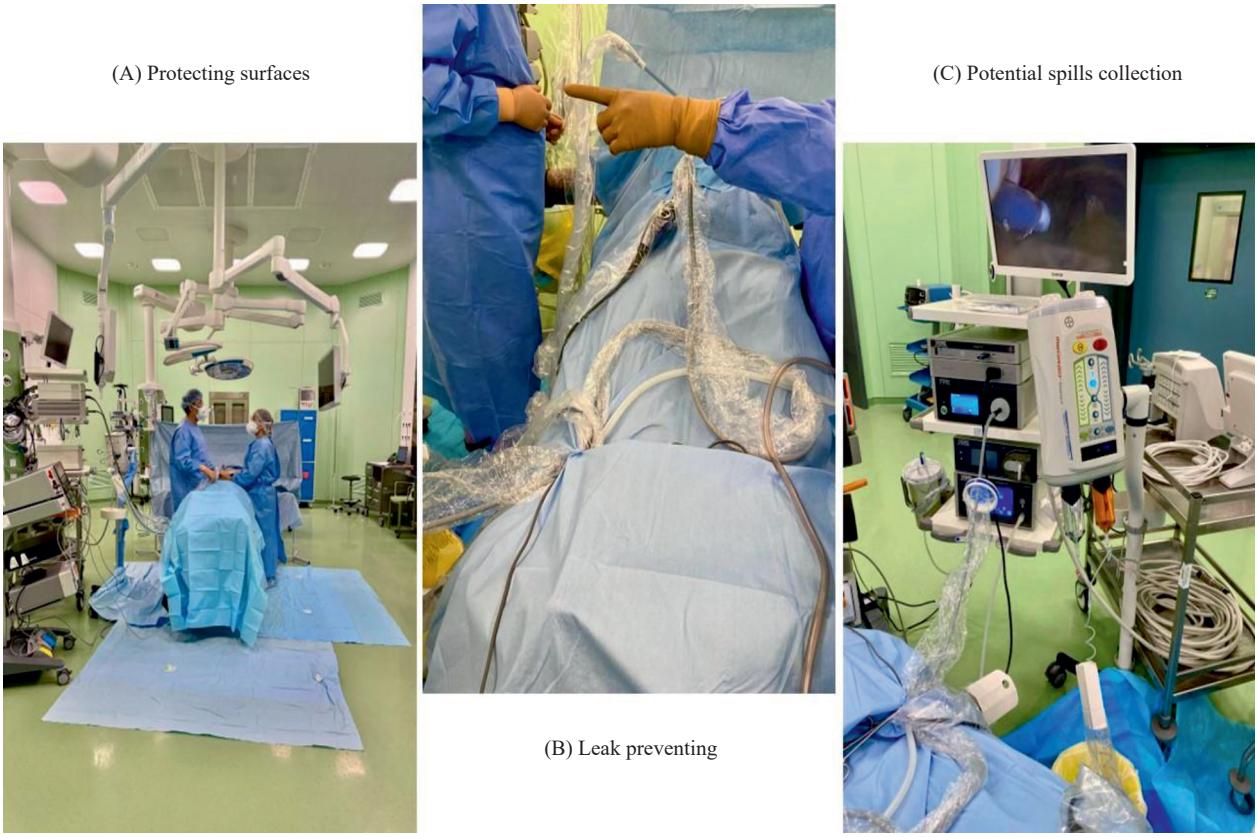

Figure 5. Measures to protect the operating environment during a PIPAC session
Source: compiled by the authors

Figure 6. Kit for removing cytostatic spills
Source: compiled by the authors

Managing cytostatic spills during hyperthermic chemotherapy procedures is essential to ensure the safety of healthcare workers and patients. Healthcare organizations should develop and implement policies for handling such incidents. In addition, operating rooms where PIPAC sessions are performed should be equipped with specialized spill containment and cleanup kits for timely and safe spill containment and cleanup (Figure 6) [55]. The kits are equipped with appropriate personal protective equipment and spill cleanup materials depending on the potential type and size of the spill. Cytostatic spill management should also include the Keiler et al. (2021) reporting system [56].

Postoperative stage. Contamination control and cleaning of the operating room are the final steps in minimizing the risk of toxic effects of cytostatics. All waste generated during the PIPAC session,

including cytostatic residues, contaminated personal protective equipment, and consumables, must be collected, temporarily isolated, and disposed of in rigid, sealed containers labeled «chemical material» [46]. Patient biological fluids are considered contaminated from 48 to 72 hours after the last administration of a cytostatic; therefore, they must be treated and disposed of as a biohazardous material in accordance with the current environmental and sanitary legislation of the healthcare organization [17]. Sanitary treatment of the operating room is recommended to be performed three times using a soap solution or 70 % isopropyl alcohol. The use of bactericidal cleaning agents is inappropriate, since they can potentially react with cytotoxic agents and do not ensure their inactivation. Employees involved in cleaning the operating room must also comply with personal protective measures [55].

Checking for traces of chemotherapy drugs on surfaces (such as injectors, trocars, and the operating table) is carried out by sampling with a napkin (wipe control) [41; 57]. Each center practicing the PIPAC method must have an approved protocol for handling medical waste, cleaning and disinfecting the environment from hazardous drugs, adapted to its material and technical conditions and sanitary and epidemiological safety requirements, but consistent with the main recommendations listed [55; 58].

General recommendations. All staff involved in the preparation, transportation, administration, cleaning, and disposal of cytostatic drugs must undergo structured training [55]. Training should be completed prior to initiating work and followed by regular re-certification at least every 2-3 years, or whenever new technologies or procedures are introduced. Importantly, all training activities must be formally documented [59]. Evidence suggests that regular training sessions and simulation exercises on the safe handling of cytostatics enhance team preparedness, strengthen competencies for working under high-risk conditions, and reduce the likelihood of medical errors [35; 60].

Equally critical is the systematic monitoring of the health status of the operating team before and after each PIPAC session, enabling early detection of potential exposure to cytostatics [39; 61; 62].

Discussion

This scoping review synthesized 37 publications that addressed occupational and environmental safety in the context of pressurized intraperitoneal aerosol chemotherapy (PIPAC). The available evidence encompasses observational clinical studies, pilot experimental reports, multicenter surveys, and consensus guidelines [19-21; 34-36; 38-41; 50]. Across these sources, several consistent themes emerged. First, biological and environmental monitoring studies generally demonstrate minimal or undetectable levels of platinum or other cytostatics in air, surfaces, or biological samples when recommended protective measures are implemented [19-21; 36; 39-41]. Second, surveys highlight persistent gaps in awareness and variability in adherence to safety precautions among surgical teams, suggesting that knowledge translation and staff training remain critical [34-35]. Third, organizational measures such as specialized drug preparation rooms, laminar flow cabinets, CAWS, and structured spill management protocols appear central to minimizing risks [20; 42-46; 50; 55]. Collectively, these findings support the feasibility of conducting PIPAC safely, provided that comprehensive technical, environmental, and personal protective strategies are in place.

Importantly, this review links directly to its objective: to evaluate occupational risks and synthesize protective measures throughout the perioperative process. The evidence confirms that PIPAC can be performed with a high safety margin when protocols are adhered to, while also underscoring the central role of operating room nurses and multidisciplinary teamwork in sustaining these standards [50; 53; 55].

Several limitations must be considered when interpreting these findings. First, most of the included studies were small, single-center reports or pilot analyses, which limited the generalizability of the results [19; 21; 36]. Few studies provided long-term follow-up of healthcare workers, leaving uncertainty about potential cumulative effects of repeated exposure [38-41]. Second, heterogeneity in study designs, safety measures, and monitoring methods precluded direct comparison or quantitative synthesis [34-36; 39-41]. Third, as this was a scoping review, no formal critical appraisal of study quality was undertaken; therefore, the robustness of the evidence cannot be fully assessed [24]. Finally, the review was limited to publications in English and Russian, which may have excluded relevant studies in other languages.

Conclusions

In conclusion, the current body of evidence suggests that, when performed under strict technical and organizational standards, PIPAC carries a low occupational and environmental risk for healthcare professionals. Nevertheless, variability in practice and knowledge gaps highlight the need for harmonized protocols, regular staff training, and standardized monitoring approaches. For countries such as Kazakhstan, where PIPAC is being newly introduced, these findings provide a foundation for developing national safety guidelines and capacity-building initiatives. Future research should prioritize large, multicenter evaluations of occupational exposure, assessment of long-term health outcomes, and refinement of international consensus standards to further strengthen the safe integration of PIPAC into routine oncology care.

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ПЕРИТОНЕАЛЬДІ МЕТАСТАЗДАРДЫ ҚҰРСАҚІШІЛІК ҚЫСЫМДЫ АЭРОЗОЛЬДІ ХИМИОТЕРАПИЯ ӘДІСІМЕН ЕМДЕУДЕГІ КӘСІБИ ЖӘНЕ ЭКОЛОГИЯЛЫҚ ҚАУІПСІЗДІК: АЛДЫН АЛА ШОЛУ

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Аңдатпа

Перитонеальды метастаздар қатерлі ісіктердің әртүрлі локализацияларында аурудың үдеуінің кең таралған көрінісі болып табылады. Жүйелік терапия мен хирургиялық әдістерге қарамастан, науқастардың едәуір бөлігі клиникалық қажеттіліктерінің қанағаттандырылмауы, өмір сапасының төмендеуі және қолайсыз нәтижелермен бетпе-бет келеді. Осы шектеулерді еңсеру үшін 2000-жылдардың басында қысым арқылы құрсақ қуысына аэрозольді химиотерапия әдісі енгізілді. Дегенмен, бұл технологияға деген қызығушылықтың артуына қарамастан, цитостатиктердің аэрозольді түрлерінің ингаляциялық әсерімен байланысты кәсіби қауіп мәселесі өзекті болып отыр.

Бұл шолу зерттеуінің мақсаты перитонеальды метастаздарды емдеуде құрсақішілік қысымды аэрозольді химиотерапия сеанстары кезінде операциялық үрдістің барлық кезеңдерінде жүзеге асырылатын кәсіби қауіптер мен қауіпсіздік шаралары жөніндегі қазіргі деректерді талдау және қорыту. Бар деректер негізінде медицина қызметкерлері мен қоршаған ортаны қорғауға бағытталған клиникалық ұсынымдар әзірлеу көзделді.

Әдістер мен материалдар. PubMed, Scopus, және eLibrary дерекқорларында жүйелі іздеу жүргізілді. Іріктеу критерийлеріне құрсақішілік қысымды аэрозольді химиотерапия әдісін сипаттайтын, жеке және ұжымдық қорғаныс шараларын қарастыратын, сондай-ақ операциялық ортада цитостатикалық аэрозольдермен қауіпсіз жұмыс жүргізу жөніндегі ұсынымдарды қамтитын жарияланымдар енгізілді.

Нәтижелер. Іздеу нәтижесінде 185 жарияланым табылды, олардың 37-сі іріктеу критерийлеріне сәйкес келді. Қамтылған зерттеулер негізінен бақылау есептері, эксперименттік модельдеу және институционалдық нұсқаулықтардан тұрды. Қауіпсіздіктің негізгі шараларына аэрозольдерді беру үшін жабық жүйелерді пайдалану, жоғары тиімді желдету, жеке қорғаныс құралдары және дезактивацияның стандартталған хаттамалары кірді. Ұзақ мерзімді кәсіби қауіптер жөніндегі деректер шектеулі болды, алайда зерттеулердің көпшілігі қауіпсіздік ережелерін қатаң сақтаудың маңыздылығын атап көрсетті.

Қорытындылар. Бұл шолу құрсақішілік қысымды аэрозольді химиотерапия сеанстарын жүргізу кезінде еңбек пен қоршаған ортаның қауіпсіздігін дәлелдейтін деректер базасын толықтырады. Қорытылған нәтижелер көпдеңгейлі қорғаныс стратегиялары мен медицина қызметкерлерін оқыту хаттамаларын бейімдеуге және стандарттауға пайдаланылуы мүмкін, бұл өз кезегінде қызметкерлер мен жұмыс ортасы үшін тәуекелдерді азайтуға мүмкіндік береді.

Түйін сөздер: *аэрозоль, ішперде ісіктері, кәсіби әсер ету, қоршаған ортаны мониторингілеу, биологиялық мониторинг, операциялық зал*

ПРОФЕССИОНАЛЬНАЯ И ЭКОЛОГИЧЕСКАЯ БЕЗОПАСНОСТЬ ПРИ ЛЕЧЕНИИ ПЕРИТОНЕАЛЬНЫХ МЕТАСТАЗОВ МЕТОДОМ ВНУТРИБРЮШИННОЙ АЭРОЗОЛЬНОЙ ХИМИОТЕРАПИЕЙ ПОД ДАВЛЕНИЕМ: ПРЕДВАРИТЕЛЬНЫЙ ОБЗОР

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Аннотация

Перитонеальные метастазы представляют собой распространённое проявление прогрессирования злокачественных опухолей различных локализаций. Несмотря на существующие системную терапию и хирургический подход, значительная доля пациентов продолжает сталкиваться с неудовлетворенными клиническими потребностями, низким качеством жизни и неблагоприятным прогнозом. В ответ на эти ограничения в начале 2000-х был разработан новый метод внутрибрюшной аэрозольной химиотерапии под давлением. Вопреки растущему интересу к данному методу, вызывает обеспокоенность потенциальный профессиональный риск для медицинского персонала и окружающей среды, связанный с ингаляционным воздействием аэрозольных форм цитостатиков.

Целью данного обзорного исследования было изучение и обобщение современных данных о профессиональных рисках и мерах безопасности, реализуемых на всех этапах операционного процесса при проведении сеансов внутрибрюшной аэрозольной химиотерапии под давлением для лечения перитонеальных метастазов. На основе существующих данных разработать клинические рекомендации по обеспечению защиты медицинских сотрудников и окружающей среды.

Методы и материалы. Соответствующие публикации были найдены путем систематического поиска в базах данных PubMed, Scopus и eLibrary. Критериями включения были публикации, описывающие метод внутрибрюшной аэрозольной химиотерапии под давлением, меры индивидуальной и коллективной защиты, а также рекомендации по организации безопасной работы с цитостатическими аэрозолями в условиях операционной.

Результаты. В результате поиска было выявлено 185 публикаций, из которых 37 соответствовали критериям включения. Включенные исследования в основном состояли из отчетов наблюдений, экспериментального моделирования и институциональных руководств. Ключевые меры безопасности включали использование закрытых систем подачи аэрозолей, высокоэффективной вентиляции, средств индивидуальной защиты и стандартизированных протоколов дезактивации. Данные о долгосрочном профессиональном риске были ограничены, но большинство исследований подчеркивали необходимость строгого соблюдения правил безопасности.

Выводы. Данный обзор вносит вклад в доказательную базу, подтверждающую безопасность труда и окружающей среды при проведении сеансов внутрибрюшной аэрозольной химиотерапии под давлением. Обобщенные результаты могут быть использованы для адаптации и стандартизации многоуровневых стратегий защиты и протоколов обучения медицинских сотрудников, тем самым минимизируя риски для персонала и рабочей среды.

***Ключевые слова**: аэрозоль, новообразования брюшины, профессиональное воздействие, мониторинг окружающей среды, биологический мониторинг, операционная*

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