ISNN 3030-3907

2026
MAY
ISSUE - 5
VOLUME - 7

DEVELOPMENT OF SCIENCE

scientific journal



Development of science

Ilmiy jurnal

MAY 2026
Issue - 5, VOLUME – 7

ISSN 3030 -3907

Ilmiy jurnal OAK rayosatining 2024 yil 27 sentabrdagi 361-son qaroriga asosan 02.00.00 kimyo fanlari hamda 2025 yil 12 fevral 367- son qaroriga asosan 05.00.00 texnika fanlari bo‘yicha falsafa doktori (PhD) va fan doktori (DSc) ilmiy darajasiga talabgorlarning dissertatsiya ishlari yuzasidan dissertatsiyalari asosiy ilmiy natijalarini chop etish tavsiya etilgan milliy ilmiy nashrlar ro‘yxatiga kiritilgan.

BOSH MUHARRIR:
Temirov Alisher Hoshim o‘g‘li – texnika fanlari falsafa doktori (PhD),Dotsent.
TAHRIRIYAT KENGASH RAISI:
Fozilov Sadriddin Fayzullayevich – texnika fanlari doktori, professor
TAHRIRIYAT KENGASH A’ZOLARI

TEXNIKA FANLARI/ TECHNICAL SCIENCES/ ТЕХНИЧЕСКИЕ НАУКИ

Bozorov G‘ayrat Rashidovich
Buxoro Davlat Texnika Universiteti, professor
Abdurahmonov Olim Rustamovich
Buxoro Davlat Texnika Universiteti, professor
Adizov Bobur Zamirovich
O‘zbekiston Respublikasi Fanlar akademiyasi Umumiy va noorganik kimyo instituti, professor
Hayitov Ruslan Rustamjonovich
Buxoro Davlat Texnika Universiteti, professor
Jumayev Qayum Karimovich
Buxoro Davlat Texnika Universiteti, professor.
Berdiyev Dorob Murodovich
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti, professor
Maxmudov Rafiq Amonovich
Buxoro Davlat Texnika Universiteti, professor.
Tilloyev Lochin Ismatilloyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Raxmonov Qahramon Sanakulovich
Buxoro Davlat Texnika Universiteti, dotsent.
Barakayev Nusratullo Rajabovich
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti, professor.
Jo‘rayev Xayrullo Fayziyevich
Buxoro Davlat Texnika Universiteti, professor.
Panoyev Erali Rajabboyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Ataullayev Sherzod Nabiullyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Murodov Malik Negmurodovich
Buxoro Davlat Texnika Universiteti, dotsent.
Axmedova Ozoda Bahronovna
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti.
Safarov Bahri Jumayevich
Buxoro Davlat Texnika Universiteti, dotsent.
Xaydarov Axtam Amonovich
Buxoro Davlat Texnika Universiteti, dotsent.
Safarov Jasur Alijon o‘g‘li
Buxoro Davlat Texnika Universiteti, dotsent.

KIMYO FANLARI/ CHEMICAL SCIENCES/ ХИМИЧЕСКИЕ НАУКИ

Axmedov Voxid Nizomovich
Buxoro Davlat Texnika Universiteti, professor
Umarov Baqo Bafoyevich
Buxoro Davlat Universiteti, professor
Kodirov Abduaxad Abduraximovich
Qarshi davlat Universiteti, professor
Qurbonov Mingniqul Jumagulovich
Qarshi davlat Universiteti, dotsent
Turemuratov Sharibay Naurizbaevich
O‘zbekiston Respublikasi Fanlar akademiyasi Qoraqalpog‘iston bo‘limi Bosh ilmiy kotibi, professor
Tursunov Kaxor Shonazarovich
Qarshi davlat Universiteti, professor
Do‘stov Hamro
Buxoro Davlat Texnika Universiteti, professor
Panoyev Nodir Shavkatovich
Buxoro Davlat Texnika Universiteti, dotsent.
Olimov Bobur Bahodir o‘g‘li
Buxoro Davlat Texnika Universiteti, dotsent.
Kasimov Sherzod Abduazimovich
Termiz Davlat Universiteti, professor.
Aliqulov Rustam Valiyevich
Termiz Davlat Universiteti, professor
Tropov Xamza Tursunovich
Samarqand Davlat Universiteti, professor

IQTISODIYOT FANLARI/ ECONOMICS/ ЭКОНОМИЧЕСКИЕ НАУКИ

Nizamov Aslitdin Badreddinovich
Buxoro Davlat Texnika Universiteti, professor.
Boboyev Akmal Choriyevich
Buxoro Davlat Texnika Universiteti, professor.
Ergashxojayeva Shaxnoza Djasurovna
Toshkent davlat iqtisodiyot universiteti, professor
Saidaxmedova Nodira Ilxomovna
Toshkent davlat iqtisodiyot universiteti, professor
Muxsinov Bekzod Toxirovich
Buxoro Davlat Texnika Universiteti, dotsent.
Shakarov Qulmat Ashirovich
Renessans ta'lim universiteti,dotsent.
Jumaeva Zulfiya Qayumovna
Buxoro Davlat Texnika Universiteti, dotsent.
Norova Salomat Yusupovna
Buxoro Davlat Texnika Universiteti, dotsent.
Avezova Shaxnoza Maxmudjonovna
Buxoro Davlat Texnika Universiteti, dotsent.
Jalilov Jamshid G‘anijonovich
Toshkent davlat iqtisodiyot universiteti, dotsent
Xasanova Gulruh Djumanazarovna
Buxoro Davlat Texnika Universiteti, dotsent.

PEDAGOGIKA FANLARI/ PEDAGOGICAL SCIENCES / ПЕДАГОГИЧЕСКИЕ НАУКИ

Siddiqova Sadoqat G‘afforovna
Buxoro Davlat Texnika Universiteti, dotsent.
Zoyirov Erkin Xalilovich
Buxoro Davlat Texnika Universiteti, DSc, professor
Gaffarov Feruz Hasanovich
Puchon Universiteti, *professor*
Ruziyev Davron Yuldashevich
Buxoro Davlat Universiteti, professor
Muradova Firuza Rashidovna
Buxoro Davlat Texnika Universiteti, professor.
Yunusova Gulandon Samiyevna
Buxoro Davlat Texnika Universiteti, professor.
To‘xtayeva Zebo Sharifovna
Buxoro Davlat Texnika Universiteti, professor.
Navro‘zova Gulchixra Nigmatovna
Buxoro Davlat Texnika Universiteti, dotsent.
Uzoqova Laylo Polvonovna
Buxoro muhandislik – texnologiya instituti, dotsent.
To‘raqulova Marjona Qiyom qizi
Buxoro Davlat Texnika Universiteti, dotsent.
Muradova Zarina Rashidovna
Buxoro Davlat Texnika Universiteti, dotsent.
Murodov Sanjar Aslonovich
Buxoro Davlat Texnika Universiteti, dotsent.
Shodiyev Jahongir Jo‘raqulovich
Buxoro Davlat Texnika Universiteti, dotsent
Gaffarov Laziz Hasanovich
Buxoro muhandislik – texnologiya instituti, dotsent.

Tahririyat a’zolarning to‘liq ro‘yxati jurnalning www.devos.uz saytida keltirilgan.

Tahririyat hay’ati a’zolarining tarkibini o‘zgartirish hamda qo‘shimcha kiritish yoki tahririyat a’zoligidan chiqarish bosh muharrir tomonidan amalga oshiriladi.

ISSN 3030-3907

Development of science ilmiy jurnali 2024 yil 15 aprel kuni №256445 sonli guvohnoma bilan Davlat ro‘yxatidan o‘tgan.

To‘plam elektron ko‘rinishda (pdf formatida) mualliflarga taqdim etiladi. To‘plamga kiritiladigan maqolalarning mazmuni, ulardagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligiga hamda har qanday fikr - mulohazalarga mualliflarning o‘zlari mas’ul hisoblanadilar. Talablarga javob bermaydigan maqolalar to‘plamga kiritilmaydi. Tashkiliy qo‘mita maqola matnini qisqartirish, qisman tuzatish kiritish, seksiyalarga joylashtirish huquqiga ega.

ISSN 3030-3907

ASSESSMENT OF SOLID AND LIQUID MEDICAL WASTE MANAGEMENT

Mamatkulov Talat Toxirovich
Assistant of the Department of Epidemiology, Samarkand State Medical University.
Koyanbaeva Svetlana Xudiyarovna
Assistant of the Department of Hygiene and Environmental Protection, Epidemiology, Karakalpak State Medical Institute.

Abstract. Healthcare waste management remains a major environmental and public health challenge in many developing regions, particularly in Central Asia. In Uzbekistan, rapid urbanization, increasing healthcare demands, and insufficient waste treatment infrastructure contribute to the growing risks associated with improper management of solid and liquid medical waste. Poor segregation, inadequate transportation, unsafe disposal practices, and the absence of effective wastewater treatment systems may facilitate environmental contamination and increase occupational and epidemiological hazards. A cross-sectional analytical study was conducted between June and September 2025 in three multidisciplinary tertiary hospitals located in Tashkent and Samarkand. Data were collected from healthcare workers, sanitation personnel, hospital administrators, waste handlers, patients, and accompanying persons using questionnaires, interviews, direct observations, and document analysis. Solid waste management practices, wastewater disposal systems, and institutional preparedness were assessed according to WHO recommendations. Physicochemical and microbiological analyses of hospital wastewater samples were also performed. Statistical analysis included descriptive statistics and multivariate logistic regression using SPSS 26.0. A total of 480 participants were included in the study. Overall healthcare waste management performance scores ranged from 59% to 67%, indicating unsatisfactory management in all investigated hospitals. Inadequate waste segregation, insufficient staff training, absence of waste management guidelines, poor monitoring systems, and insufficient financial support were significantly associated with poor waste management practices ($p < 0.05$). None of the hospitals operated a fully functional wastewater treatment plant. Elevated levels of biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), suspended solids, and microbial contamination were identified in hospital wastewater samples, exceeding recommended environmental safety limits. Healthcare waste management in tertiary hospitals of Uzbekistan remains insufficient and poses significant environmental and public health risks. Strengthening institutional policies, improving staff training, enhancing monitoring systems, expanding wastewater

ISSN 3030-3907

treatment infrastructure, and implementing standardized waste segregation protocols are necessary to improve environmental safety and infection control in healthcare settings across Central Asia.

Keywords: Healthcare waste management; Biomedical waste; Hospital wastewater; Environmental health; Public health; Infection control; Medical waste segregation; Wastewater treatment; Uzbekistan; Central Asia; Hospital hygiene; Epidemiology.

Annotatsiya. Tibbiy chiqindilarni boshqarish ko‘plab rivojlanayotgan hududlarda, ayniqsa Markaziy Osiyoda, ekologik va jamoat salomatligi bilan bog‘liq dolzarb muammolardan biri bo‘lib qolmoqda. O‘zbekistonda tezkor urbanizatsiya, sog‘liqni saqlash xizmatlariga talabning ortishi hamda chiqindilarni qayta ishlash infratuzilmasining etarli darajada rivojlanmaganligi qattiq va suyuq tibbiy chiqindilarni noto‘g‘ri boshqarish bilan bog‘liq xavflarning ortishiga sabab bo‘lmoqda. Chiqindilarni noto‘g‘ri saralash, tashish tizimining etarli emasligi, xavfsiz bo‘lmagan utilizatsiya usullari hamda samarali oqova suvlarni tozalash tizimlarining mavjud emasligi atrof-muhit ifloslanishiga olib kelishi va kasbiy hamda epidemiologik xavflarni kuchaytirishi mumkin. 2025-yil iyun–sentyabr oylarida Toshkent va Samarqand shaharlarida joylashgan uchta ko‘p tarmoqli uchlamchi darajadagi shifoxonalarda kesimiy analitik tadqiqot o‘tkazildi. Ma’lumotlar sog‘liqni saqlash xodimlari, sanitariya xodimlari, shifoxona ma’muriyati, chiqindi bilan ishlovchi xodimlar, bemorlar va ularning hamrohlari orasida so‘rovnomalar, intervyular, bevosita kuzatuvlar hamda hujjatlar tahlili orqali yig‘ildi. Qattiq chiqindilarni boshqarish amaliyoti, oqova suvlarni chiqarish tizimlari va muassasalarning tayyorgarlik holati JSST tavsiyalariga muvofiq baholandi. Shuningdek, shifoxona oqova suv namunalarining fizik-kimyoviy va mikrobiologik tahlillari amalga oshirildi. Statistik tahlil SPSS 26.0 dasturi yordamida tavsifiy statistika va ko‘p omilli logistik regressiya usullari asosida bajarildi. Tadqiqotga jami 480 nafar ishtirokchi jalb qilindi. Tibbiy chiqindilarni boshqarish samaradorligi ko‘rsatkichlari barcha o‘rganilgan shifoxonalarda 59% dan 67% gacha bo‘lib, qoniqarsiz holatni ko‘rsatdi. Chiqindilarni etarli darajada saralamaslik, xodimlarning etarli o‘qitilmaganligi, chiqindilarni boshqarish bo‘yicha yo‘riqnomalarning mavjud emasligi, monitoring tizimlarining sustligi va moliyaviy ta’minotning etarli emasligi chiqindilarni noto‘g‘ri boshqarish bilan sezilarli darajada bog‘liq ekanligi aniqlandi ($p < 0,05$). Tadqiq qilingan shifoxonalarning birortasida ham to‘liq funksional oqova suvlarni tozalash inshooti mavjud emas edi. Shifoxona oqova suv namunalarida biokimyoviy kislorod sarfi (BKS_5), kimyoviy kislorod sarfi (KKS), muallaq moddalar va mikrobiologik ifloslanish darajalari ekologik xavfsizlik bo‘yicha tavsiya etilgan

me’yorlardan yuqori ekanligi aniqlandi. O‘zbekistonning uchlamchi darajadagi shifoxonalarida tibbiy chiqindilarni boshqarish tizimi etarli darajada emas va bu holat ekologik hamda jamoat salomatligi uchun sezilarli xavf tug‘dirmoqda. Markaziy Osiyodagi sog‘liqni saqlash muassasalarida ekologik xavfsizlik va infeksiya nazoratini yaxshilash uchun institutsional siyosatni kuchaytirish, xodimlarni o‘qitishni takomillashtirish, monitoring tizimlarini rivojlantirish, oqova suvlarni tozalash infratuzilmasini kengaytirish va chiqindilarni standartlashtirilgan saralash protokollarini joriy etish zarur.

Kalit so‘zlar. Tibbiy chiqindilarni boshqarish; Biotibbiy chiqindilar; Shifoxona oqova suvlari; Atrof-muhit salomatligi; Jamoat salomatligi; Infeksiya nazorati; Tibbiy chiqindilarni saralash; Oqova suvlarni tozalash; O‘zbekiston; Markaziy Osiyo; Shifoxona gigiyenasi; Epidemiologiya.

Аннотация. Управление медицинскими отходами остаётся одной из важнейших экологических и санитарно-эпидемиологических проблем во многих развивающихся регионах, особенно в Центральной Азии. В Узбекистане быстрые темпы урбанизатsiи, рост потребности в медицинских услугах и недостаточно развитая инфраструктура по переработке отходов способствуют увеличению рисков, связанных с ненадлежащим управлением твёрдыми и жидкими медицинскими отходами. Неправильная сортировка отходов, недостаточно организованная транспортировка, небезопасные методы утилизатsiи и отсутствие эффективных систем очистки сточных вод могут приводить к загрязнению окружающей среды и повышению профессиональных и эпидемиологических рисков. С июня по сентябрь 2025 года было проведено аналитическое поперечное исследование в трёх многопрофильных больницах третичного уровня, расположенных в городах Ташкент и Самарканд. Данные были собраны среди медицинских работников, санитарного персонала, администратsii больниц, работников по обращению с отходами, пatsиентов и сопровождающих лиц с использованием анкетирования, интервью, прямых наблюдений и анализа документатsii. Практика управления твёрдыми отходами, системы удаления сточных вод и институциональная готовность оценивались в соответствии с рекомендатsiями ВОЗ. Также были проведены физико-химические и микробиологические анализы образцов сточных вод больниц. Статистический анализ включал описательную статистику и многомерную логистическую регрессию с использованием программы SPSS 26.0. В исследование были включены 480 участников. Общие показатели эффективности управления медицинскими отходами варьировали от 59% до 67%, что свидетельствует о неудовлетворительном уровне управления во всех исследованных больницах. Недостаточная

ISSN 3030-3907

сортировка отходов, недостаточная подготовка персонала, отсутствие руководств по управлению отходами, слабые системы мониторинга и недостаточное финансовое обеспечение были статистически значимо связаны с неудовлетворительной практикой обращения с отходами ($p < 0,05$). Ни в одной из больниц не функционировали полностью эффективные очистные сооружения сточных вод. В образцах сточных вод больниц были выявлены повышенные уровни биохимического потребления кислорода ($БПК_5$), химического потребления кислорода (ХПК), взвешенных веществ и микробного загрязнения, превышающие рекомендуемые экологические нормативы безопасности. Система управления медицинскими отходами в больницах третичного уровня Узбекистана остаётся недостаточно эффективной и представляет серьёзную угрозу для окружающей среды и общественного здоровья. Для повышения экологической безопасности и усиления инфекционного контроля в медицинских учреждениях Центральной Азии необходимо укрепление институциональной политики, совершенствование подготовки персонала, развитие систем мониторинга, расширение инфраструктуры очистки сточных вод и внедрение стандартизированных протоколов сортировки отходов.

Ключевые слова. Управление медицинскими отходами; Биомедицинские отходы; Больничные сточные воды; Экологическое здоровье; Общественное здоровье; Инфекционный контроль; Сортировка медицинских отходов; Очистка сточных вод; Узбекистан; Центральная Азия; Больничная гигиена; Эпидемиология.

INTRODUCTION.

The primary objective of healthcare institutions is to ensure the delivery of safe and effective medical services that contribute to improving population health. At the same time, the functioning of hospitals and other healthcare facilities inevitably results in the generation of significant amounts of solid and liquid waste, which, if improperly managed, may pose serious risks to public health and environmental safety.

Healthcare waste, including biomedical waste, municipal-type waste, excreta, and wastewater, remains a critical environmental and sanitary challenge worldwide. Of particular concern is hazardous healthcare waste, which includes infectious, pathological, chemical, and pharmaceutical waste capable of transmitting disease and contaminating natural ecosystems. Biomedical waste typically constitutes 10–25% of the total waste generated by healthcare institutions but represents the most epidemiologically dangerous fraction due to its infectious and toxicological characteristics [1-3].

ISSN 3030-3907

General healthcare waste includes non-hazardous materials such as paper, cardboard packaging, food residues, and wastewater originating from kitchens, administrative units, and sanitary facilities. In contrast, hazardous medical waste consists of sharps, contaminated dressings, pathological materials, laboratory waste, pharmaceutical residues, and chemical substances generated by clinical and diagnostic activities. Large multidisciplinary hospitals, particularly university medical centers, generate substantially higher volumes of such waste due to the diversity and intensity of specialized services provided [4].

The volume of healthcare waste continues to increase globally as a result of population growth, expanding healthcare access, urbanization, and the widespread adoption of disposable medical products. Hospital wastewater, which contains organic matter, pathogenic microorganisms, chemical contaminants, pharmaceutical residues, and suspended solids, is produced in surgical departments, intensive care units, laboratories, laundries, and outpatient clinics. Its composition varies depending on the profile and activity of the healthcare institution [4].

In many low- and middle-income countries, healthcare wastewater management remains insufficiently regulated and often neglected. The absence of standardized operational protocols, weak institutional oversight, limited infrastructure, and inadequate financial investment frequently result in unsafe disposal practices. While developed countries generally operate under strict environmental and sanitary regulations for healthcare waste treatment, many healthcare institutions in developing regions lack formal waste management plans, technical guidelines, reliable monitoring systems, and compliant treatment facilities [5].

These challenges are particularly relevant for Central Asian countries, including Uzbekistan, where rapid urbanization, population growth, healthcare modernization, and increasing pressure on public health infrastructure have intensified concerns related to hospital waste management. In several regions of Uzbekistan, aging engineering systems, insufficient wastewater treatment capacity, inconsistent waste segregation practices, and limited staff training continue to create sanitary and environmental risks [6-10].

The ecological vulnerability of Central Asia further amplifies the significance of this issue. Water scarcity, arid climatic conditions, soil sensitivity, and the legacy of environmental degradation associated with the Aral Sea crisis increase the potential impact of untreated hospital effluents on ecosystems and surrounding populations.

Despite recent healthcare reforms implemented in Uzbekistan, systematic assessments of healthcare waste management efficiency in major medical

ISSN 3030-3907

institutions remain limited. There is insufficient evidence regarding the effectiveness of existing waste segregation systems, transportation logistics, treatment infrastructure, staff preparedness, and compliance with national sanitary standards.

Therefore, this study was conducted to evaluate the current state of solid and liquid healthcare waste management in major multidisciplinary hospitals of Uzbekistan and to identify organizational, technical, and institutional factors affecting safe and sustainable waste management practices in the context of Central Asia.

MATERIALS AND METHODS.

The study was conducted in three large multidisciplinary tertiary healthcare institutions located in Uzbekistan: two university-affiliated hospitals in Tashkent and one regional multidisciplinary medical center in Samarkand. These institutions provide specialized inpatient and outpatient services, including internal medicine, surgery, pediatrics, obstetrics and gynecology, intensive care, diagnostic laboratories, radiology, oncology, infectious diseases, nephrology, and emergency care.

Together, the selected hospitals represent major referral centers serving large urban and regional populations and generate significant volumes of biomedical and municipal healthcare waste.

A cross-sectional analytical and evaluative study was carried out between June and September 2025.

Study PopulationThe target population included: physicians; nurses and midwives; laboratory personnel; sanitation and hygiene officers; waste collection and disposal workers; hospital administrators; heads of clinical departments; patients and accompanying persons.

Additionally, waste storage sites, collection points, wastewater discharge systems, incineration units, septic tanks, and surrounding sanitary infrastructure were inspected.

Participants were included if they: were officially employed by the selected healthcare institutions; were directly involved in healthcare delivery, sanitation, administration, or waste management activities; provided informed consent.

Temporary external staff and absent personnel during data collection were excluded.

Departments were selected using simple random sampling among units directly involved in healthcare waste generation. Healthcare providers were randomly selected within each department.

Administrative managers, waste disposal personnel, and sanitation supervisors were selected purposively based on professional relevance.

ISSN 3030-3907

The minimum sample size was calculated using the Schwartz formula, considering a 95% confidence interval and estimated prevalence of compliant waste management practices.

The principal outcome variable was healthcare waste management effectiveness, assessed through five operational stages:waste segregation; collection; temporary storage; transportation; treatment/disposal.

Each criterion was scored according to compliance with WHO and national sanitary standards. Institutions scoring ≥80% were classified as demonstrating satisfactory management, while those scoring below 80% were classified as unsatisfactory.

Independent variables included:availability of trained personnel; adequacy of PPE and collection equipment; existence of waste treatment infrastructure; financial resource allocation; institutional waste management policies; staff awareness and training frequency; existence of infection control committees.

Data were collected using:structured questionnaires; semi-structured interviews; direct observational checklists; document review of internal regulations and waste management protocols.

Wastewater samples were collected for physicochemical and microbiological analysis, including: temperature; pH; suspended solids; biochemical oxygen demand (BOD_5); chemical oxygen demand (COD); total coliform count; thermotolerant coliform count; fungal contamination indicators.

Laboratory analyses were performed using standard environmental analytical methods.

The study protocol was approved by the institutional bioethics committee of the participating medical university. Written informed consent was obtained from all participants. Confidentiality and anonymity were strictly maintained throughout the research process.

Data were entered and processed using SPSS version 26.0.

Descriptive statistics were calculated for all variables. Logistic regression analysis was performed to identify associations between organizational factors and ineffective waste management, with statistical significance defined at $p < 0.05$.

DISCUSSION.

The present study assessed the management of solid and liquid healthcare waste in major tertiary hospitals of Uzbekistan and identified several deficiencies throughout the waste management chain. The findings demonstrated that overall waste management performance remained below recommended international standards in all investigated hospitals, indicating the persistence of substantial

ISSN 3030-3907

environmental and epidemiological risks within healthcare institutions in Central Asia.

One of the most important findings of this study was the inadequate segregation of healthcare waste at the source. Although color-coded containers were available in some departments, proper separation of hazardous and non-hazardous waste was inconsistent. Mixing of general healthcare waste with infectious waste was frequently observed during field inspections. This significantly increases the volume of hazardous waste requiring specialized treatment and elevates the risk of infection among healthcare workers, waste handlers, patients, and surrounding communities.

These findings are consistent with previous studies conducted in low- and middle-income countries, where insufficient segregation practices remain one of the major barriers to effective healthcare waste management. Poor segregation is commonly associated with limited staff awareness, insufficient supervision, inadequate institutional control, and the absence of continuous training programs.

The study also revealed that organizational and institutional factors strongly influenced waste management efficiency. Hospitals lacking formal waste management plans, infection control committees, operational guidelines, and regular monitoring systems demonstrated significantly poorer waste management outcomes. In particular, insufficient staff training was one of the strongest predictors of ineffective waste handling practices. Healthcare personnel and waste collection workers often lacked adequate knowledge regarding waste categorization, transportation procedures, occupational safety, and infection prevention measures.

These results emphasize the importance of institutional governance and administrative commitment in improving healthcare waste management systems. Continuous professional education, standardized operational protocols, and effective supervision are essential components for achieving sustainable improvements in hospital hygiene and environmental safety.

Another important finding was the insufficient availability and poor condition of waste management infrastructure and protective equipment. In many departments, waste transportation carts, storage areas, and personal protective equipment were either inadequate or improperly maintained. Similar challenges have been reported in several developing regions where healthcare institutions experience financial constraints and competing administrative priorities.

Liquid healthcare waste management represented another major concern identified in this study. None of the investigated hospitals possessed a fully functional wastewater treatment plant capable of secondary or tertiary treatment. Hospital effluents were commonly discharged into septic systems or municipal

ISSN 3030-3907

sewage networks without adequate treatment. In some cases, direct discharge into the environment was observed.

The physicochemical and microbiological analyses of wastewater samples confirmed high levels of environmental contamination. Elevated biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), suspended solids, and coliform counts indicated the presence of considerable organic pollution and microbial contamination. These findings suggest insufficient wastewater treatment efficiency and potential contamination of surrounding ecosystems and water resources.

The environmental implications of untreated healthcare wastewater are particularly significant in the context of Central Asia. Uzbekistan and neighboring countries face increasing environmental vulnerability due to water scarcity, climate change, aging infrastructure, and the ecological consequences associated with the Aral Sea crisis. Under such conditions, improper disposal of healthcare waste may contribute to the spread of pathogenic microorganisms, antimicrobial resistance, and chemical contaminants within the environment.

The findings of this study highlight the urgent need for integrated healthcare waste management strategies adapted to the regional conditions of Central Asia. Such strategies should include modernization of waste treatment infrastructure, development of national guidelines aligned with WHO standards, strengthening of infection control systems, regular environmental monitoring, and sustainable financial support mechanisms.

Despite providing valuable information, this study has several limitations. First, the investigation was limited to tertiary hospitals and may not fully reflect the situation in smaller healthcare facilities or rural medical centers. Second, the cross-sectional design provides only a snapshot of existing conditions at a single point in time. Nevertheless, the study offers important baseline data for future environmental health and hospital hygiene research in Uzbekistan and the broader Central Asian region.

CONCLUSION.

The present study demonstrated that healthcare waste management practices in tertiary hospitals of Uzbekistan remain insufficient at multiple stages, including segregation, collection, transportation, storage, treatment, and disposal of medical waste. Inadequate organizational structures, insufficient financial and material resources, limited staff training, and weak monitoring systems contribute substantially to ineffective waste management practices.

The absence of modern wastewater treatment facilities and the detection of elevated physicochemical and microbiological contamination indicators in hospital effluents indicate significant environmental and public health risks.

ISSN 3030-3907

Improper handling of infectious healthcare waste may facilitate environmental pollution, occupational exposure, and the transmission of infectious diseases.

Improving healthcare waste management in Uzbekistan requires comprehensive institutional and governmental interventions. Priority measures should include:

implementation of standardized waste segregation systems;
regular training of healthcare workers and waste handlers;
strengthening infection control committees;
development of national healthcare waste management guidelines;
modernization of waste treatment and wastewater purification infrastructure;
establishment of routine monitoring and evaluation systems.

Strengthening healthcare waste management systems is essential for improving hospital hygiene, environmental protection, occupational safety, and public health security in Uzbekistan and throughout Central Asia.

REFERENCES

1. World Health Organization Safe Management of Wastes from Health-Care Activities. 2nd ed. Geneva: WHO Press; 2014.
2. World Health Organization. Global Analysis of Health Care Waste in the Context of COVID-19. Geneva: WHO; 2022.
3. Kuchibanda K, Mayo AW. Public health risks from mismanagement of healthcare wastes in developing countries: a review. Journal of Health and Pollution. 2019;9(24):191203.
4. Caniato M, Tudor T, Vaccari M. International governance structures for healthcare waste management: a systematic review of scientific literature. Journal of Environmental Management. 2015;153:93–107.
5. Windfeld ES, Brooks MSL. Medical waste management – A review. Journal of Environmental Management. 2015;163:98–108.
6. Chartier Y, Emmanuel J, Pieper U, et al. Safe Management of Wastes from Health-Care Activities. Geneva: World Health Organization; 2014.
7. Ali M, Wang W, Chaudhry N, Geng Y. Hospital waste management in developing countries: a mini review. Waste Management & Research. 2017;35(6):581–592.
8. Harhay MO, Halpern SD, Harhay JS, Olliaro PL. Health care waste management: a neglected and growing public health problem worldwide. Tropical Medicine & International Health. 2009;14(11):1414–1417.
9. Nemathaga F, Maringa S, Chimuka L. Hospital solid waste management practices in Limpopo Province, South Africa: a case study of two hospitals. Waste Management. 2008;28(7):1236–1245.

ISSN 3030-3907

10. United Nations Children's Fund, World Health Organization. Water, Sanitation and Hygiene in Health Care Facilities: Status in Low- and Middle-Income Countries. Geneva: WHO/UNICEF; 2015.

ISSN 3030-3907