BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

THE ROLE OF BACTERIOLOGICAL CONTAMINATION OF THE HOSPITAL AIR ENVIRONMENT IN THE DEVELOPMENT OF HEALTHCARE-ASSOCIATED INFECTIONS

Axmadjonova Sadoqatxon Ismoiljon qizi
Ismoilov Dilmurod Tavakkalovich
Fergana Medical Institute of Public Health
Fergana, Uzbekistan
doi:https://doi.org/10.5281/zenodo.23468707

ABSTRACT: Healthcare-associated infections remain an important challenge for patient safety. This narrative review examines the microbiological condition of hospital air, sources and pathways of airborne microbial dissemination, factors influencing contamination, approaches to bacteriological assessment, and preventive measures. Airborne transmission is relevant for selected respiratory pathogens and fungal spores, while microorganisms deposited on surfaces may also contribute to subsequent contact transmission. The review highlights the importance of ventilation, filtration, environmental cleaning, disinfection, hand hygiene, appropriate respiratory protection, risk-based patient placement, and targeted environmental sampling. Detection of microorganisms in air should not, by itself, be interpreted as proof that transmission has occurred through the airborne route. Results must be assessed in relation to the organism identified, clinical and epidemiological circumstances, room function, ventilation performance, and the sampling method. A coordinated infection-prevention programme is therefore more effective than relying on isolated air samples or a single microbiological indicator.

Keywords: healthcare-associated infections; hospital air; bacteriological contamination; bioaerosols; ventilation; environmental sampling; infection prevention and control.

INTRODUCTION

Hospitals provide essential diagnostic, therapeutic, and rehabilitative services, but they also bring together patients with different infections, healthcare workers, and visitors in shared environments. As a result, infectious agents may be transmitted between patients, from patients to staff, or from the environment to susceptible individuals. Healthcare-associated infections (HAIs) are infections acquired in connection with the provision of healthcare that were not present or incubating at the time of admission. They may prolong hospital stays, increase treatment costs, and cause serious complications.

Transmission can occur through several routes, including direct or indirect contact, contaminated hands and equipment, respiratory particles, and, in some circumstances, environmental sources such as water or food. Hospital air is particularly relevant to pathogens capable of airborne or respiratory-particle transmission and to fungal spores that may become aerosolized during construction or maintenance. Airborne microorganisms may also settle on surfaces and subsequently be transferred by hands to the eyes, nose, or mouth.

However, the detection of microorganisms in an air sample does not automatically demonstrate that a patient acquired an infection through the air. The significance of an environmental finding depends on the organism, its viability and concentration, particle characteristics, ventilation, room occupancy, patient susceptibility, clinical procedures, and the epidemiological context. This article reviews these relationships and describes practical approaches to reducing air-associated infection risks in healthcare facilities.

MATERIALS AND METHODS

This article was prepared as a narrative review based on the source manuscript provided for revision. The manuscript's discussion of hospital air contamination, bioaerosols, potential microbial sources, environmental sampling, ventilation, cleaning, disinfection, and infection-prevention practices was translated into English and reorganized using an IMRAD-style structure. The material was thematically synthesized under four main domains: (1) the relationship between hospital air and HAIs; (2) sources and factors affecting airborne contamination; (3) microbiological assessment and interpretation; and (4) prevention and control measures.

No original patient-level data, laboratory measurements, or statistical analyses were supplied in the source manuscript. Accordingly, this article does not report new experimental findings or quantitative estimates of contamination. The Results section presents a structured synthesis of the themes described in the source material rather than results from a newly conducted empirical study. The references section follows the seven bibliographic entries requested by the user; those entries are not all direct sources for every statement in the article.

RESULTS

Relationship between hospital air and healthcare-associated infections

Bioaerosols are airborne particles that contain microorganisms or material associated with them, including respiratory droplets, droplet nuclei, and dust particles. Particle size affects how long particles remain suspended and how they move through indoor air. Larger droplets tend to settle more quickly, whereas smaller particles may remain airborne longer and travel with air currents. Depending on the pathogen and exposure conditions, inhalation may lead to infection. Airborne particles can also deposit on nearby surfaces and contribute to indirect contact transmission.

The importance of air varies by pathogen and clinical setting. Mycobacterium tuberculosis is a well-recognized example of a pathogen that can be transmitted through inhalation of infectious airborne particles. Influenza and other respiratory viruses may spread through particles released during breathing, speaking, coughing, or sneezing. Aspergillus spores can present a particular hazard to severely immunocompromised patients, especially when construction or maintenance work increases airborne dust. Staphylococcus aureus is commonly associated with colonization of skin and the nose and is often spread by contact, although contaminated particles and dust may also be relevant in some circumstances.

Intensive care, surgical, neonatal, haematology, and other units caring for highly vulnerable patients may require enhanced attention to infection prevention. Invasive procedures, mechanical ventilation, catheters, surgical wounds, and reduced host immunity can increase the consequences

of exposure. Air quality must therefore be evaluated as one component of a broader risk assessment rather than as an identical risk across all hospital departments.

Sources and determinants of airborne contamination

Potential sources of microorganisms in hospital air include patients and carriers, healthcare workers and visitors, dust and contaminated surfaces, ventilation or air-treatment systems, moisture-associated sources, and construction or renovation activities. Coughing, sneezing, speaking, and breathing can release respiratory particles. Poor hand hygiene, inappropriate use of masks or respirators, and attendance at work while symptomatic may facilitate transmission. Dry sweeping, vigorous handling of bed linen, and activities that disturb settled dust can resuspend particles.

Ventilation performance, filtration, room volume, occupancy, movement of people, temperature, relative humidity, and cleaning practices may influence the concentration and distribution of airborne particles. Insufficient air exchange can allow particles to accumulate. Conversely, poorly designed airflow can move contaminants into unintended areas. Ventilation and pressure relationships must therefore be appropriate to the function of the room. Operating theatres, airborne-infection isolation rooms, and protective environments may have specific engineering requirements and should not be managed using a single ventilation approach.

Construction and maintenance activities deserve particular attention in units containing immunocompromised patients. Drilling, demolition, or disturbance of ceilings and walls can disperse fungal spores and dust. Risk assessment, physical barriers, separation of work areas, and appropriate post-work cleaning should be planned before such activities begin.

Bacteriological assessment of hospital air

Environmental air sampling may be used to investigate a suspected transmission event, assess a specific environmental hazard, or evaluate the effectiveness of an infection-control intervention. Active air samplers draw a measured volume of air through a collection system or onto a culture medium. Passive settle-plate methods collect particles that deposit from the air onto exposed culture media. Passive methods are relatively simple but do not directly provide a complete measure of the concentration of microorganisms suspended in a known volume of air.

When culturable organisms are recovered, colonies may be counted and, where relevant, identified using appropriate laboratory procedures. Results from active sampling are often expressed as colony-forming units per cubic metre (CFU/m^3). Interpretation requires documentation of the sampling location and time, room occupancy, ventilation status, sampling method, and laboratory conditions. The method selected should match the question being investigated.

There is no single universal numerical threshold that can be applied identically to every hospital room and every microorganism. Applicable criteria depend on national regulations, room purpose, clinical risk, and the sampling method. An isolated positive sample does not, on its own, establish that a room is unsafe or identify the source of an infection. Routine sampling without a defined purpose may yield results that are difficult to interpret. When cases increase or an

environmental source is suspected, sampling should be guided by epidemiological assessment and coordinated with infection-prevention, microbiology, and engineering specialists.

A focused investigation should review the timing and distribution of cases, shared locations and procedures, ventilation performance, construction activities, and other plausible transmission routes. Where appropriate, comparison of organisms recovered from clinical and environmental specimens may help assess a possible link, although interpretation depends on the quality and resolution of the laboratory methods used.

DISCUSSION

The reviewed material indicates that hospital air is an important but context-dependent element of healthcare-associated infection prevention. Air may act as a transmission pathway for selected pathogens, while airborne particles can also contribute indirectly by depositing microorganisms on surfaces. Nevertheless, the mere presence of microorganisms in air should not be equated with proof of airborne transmission. Environmental findings need to be interpreted alongside clinical information, epidemiological patterns, the characteristics of the organism, and the performance of the building's ventilation systems.

A practical implication is that infection prevention should prioritize measures matched to the specific hazard. Appropriate ventilation and filtration can reduce the accumulation or spread of airborne particles, while cleaning, disinfection, and hand hygiene address environmental and contact-related risks. Respiratory protection, patient placement, and isolation precautions should be selected according to the suspected route of transmission and applicable guidance. Construction-related dust control is particularly important where vulnerable patients may be exposed to fungal spores.

Microbiological monitoring is most useful when it answers a defined question. Sampling may support an outbreak investigation, evaluate a suspected environmental hazard, or assess a targeted intervention, but it should not substitute for routine infection surveillance or established prevention practices. A single sample provides only a limited snapshot and may not reflect exposure over time. Standardized sampling, clear documentation, and collaboration between epidemiologists, microbiologists, clinicians, environmental-services staff, and engineers improve the usefulness of the findings.

A limitation of this article is that it is a narrative synthesis of the submitted manuscript, not a systematic review or an original laboratory study. No new measurements, patient data, or statistical comparisons were available. Therefore, the article supports general practice-oriented observations but cannot quantify the contribution of hospital air to HAIs in a particular facility. Future local assessments could combine structured epidemiological surveillance, engineering checks, and targeted environmental sampling where indicated by a clearly defined risk or investigation question.

REFERENCES

1. Oltinboy, S., & Tavakkalovich, I. D. (2026). COLLECTION OF WATER SAMPLES FOR LABORATORY TESTING. BG pulse journal, 2(10), 659-663.
2. Tavakkalovich, I. D. (2026). SHAHAR SHOVQININING AHOLI SALOMATLIGIGA TA ‘SIRI VA UNING HUDUDIY XUSUSIYATLARI. ACTIVIST SCIENCE, 3(3).
3. Tavakkalovich, I. D. (2026). SUV RESURSLARINING KIMYOVIY VA SANOAT CHIQINDILARI BILAN IFLOSLANISHI SANITARIYA-GIGIYENIK TAHLIL VA NORMATIV TALABLAR. ACTIVIST SCIENCE, 3(3).
4. Ashurova, M. D., Mo’ydinova, Y., Atadjanova, D., Muhammadova, G., & Ismoilov, D. (2023). Pedagogical efficiency of integrated learning in the organization of hygiene classes in medical universities. In BIO Web of Conferences (Vol. 65, p. 10016). EDP Sciences.
5. Umaralievich, A. R., Ugli, I. D. T., Qizi, U. F. U., & Ugli, U. H. N. (2021). Hygienic assessment of working conditions and environmental protection at glass production plants.
6. Tavakkalovich, I. D. (2026). HYGIENIC ASSESSMENT OF FOOD PRODUCT QUALITY. BG pulse journal, 2(10), 310-312.
7. Tavakkalovich, I. D. (2026). METHODS FOR TESTING AND EVALUATING ARTIFICIAL LIGHTING PARAMETERS IN ROOMS. BG pulse journal, 2(10), 306-309.
8. Tavakkalovich, I. D. (2026). THE WIND ROSE AND ITS HYGIENIC SIGNIFICANCE. BG pulse journal, 2(10), 606-610.
9. Zilolaxon, R., & Tavakkalovich, I. D. (2026). HYGIENIC ASSESSMENT OF THE COMPLEX EFFECT OF METEOROLOGICAL FACTORS ON THE HUMAN BODY. BG pulse journal, 2(10), 544-549.
10. Abdusattorova, B., & Tavakkalovich, I. D. (2026). THE SIGNIFICANCE OF SANITARY INSPECTION AND THE DESCRIPTIVE METHOD IN HYGIENIC RESEARCH. BG pulse journal, 2(10), 670-675.
11. Tolibjon o‘g‘li, M. O., & Tavakkalovich, I. D. (2026). HYGIENIC ASSESSMENT OF INDOOR MICROCLIMATE PARAMETERS. BG pulse journal, 2(10), 642-645.