

## Source and Transmission Pathways of Mold Contamination in Healthcare Facilities

### I · Introduction

In recent years, mold contamination in hospitals and other healthcare facilities has become a significant concern. Mold not only exists in the air but may also lurk in various environments such as water sources, surfaces, instruments, etc. The presence of these microorganisms poses potential threats to patient health and challenges the hygiene standards of medical facilities. Understanding the sources and transmission pathways of mold contamination in hospitals is crucial for developing appropriate prevention and control strategies to ensure the safety of the healthcare environment and patients' health.

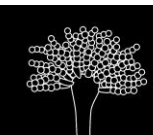
This article will explore the sources of mold contamination, transmission pathways, and relevant prevention and control measures in hospitals and other healthcare facilities, aiming to provide a deeper understanding of this issue and serve as a reference for improving healthcare environmental quality and enhancing medical safety standards.

### II · Literature Review

#### (i) Water Contamination

Water serves as a major source of mold contamination in healthcare facilities. Despite common water treatment methods such as wastewater treatment and chlorine disinfection, water entering hospital systems may still contain various microorganisms including *Aspergillus* spp., *Zygomycota* spp., *Fusarium* spp., etc. These microorganisms can cause severe infections, particularly posing higher risks to immunocompromised patients (Bonadonna L, 2017).

These molds not only exist in the water systems of healthcare facilities but can also form biofilms, including piping systems, hot water tanks, HVAC cooling towers, sinks, showerheads, and faucets. These biofilms not only make it difficult to maintain cleanliness but also make microorganisms difficult to eradicate completely, potentially leading to antibiotic and disinfectant resistance (Bonadonna L, 2017). Additionally, moisture-affected building materials may serve as ideal breeding grounds for mold growth, as they



provide nutrients for mold, leading to rapid proliferation and reproduction (Srikanth P, 2008).

Furthermore, water sources within healthcare facilities themselves may also be contaminated with mold, which can spread to patients through direct contact (e.g., hydrotherapy), indirect contact (e.g., improperly treated medical equipment), drinking, and inhalation (Geehan Suleyman, 2018).

## (ii) Air Contamination

Air quality in healthcare facilities is crucial for safeguarding the health of patients and healthcare workers. However, mold can become a major source of air pollution in healthcare settings and may enter the human body through skin contact, inhalation, or ingestion.

Sources of mold contamination in the air include HVAC systems, patient sputum, ward environments, etc. Airborne particles carry mold, leading to an increase in mold concentration in the air. When these spores are inhaled, they may cause respiratory infections or other health issues.

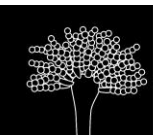
Invasive aspergillosis (IA) is a common nosocomial mold infection, with the most common causative

species being *A. fumigatus*, *A. flavus*, and *A. niger* (陳柏齡, 2022).

Construction, demolition, or renovation projects within or near hospital wards may disrupt dust containing mold and spread mold spores into the air, increasing the risk of infection for immunocompromised individuals (Cristina ML, 2009).

Operating rooms and high-risk infection wards are major hotspots for mold contamination. Common mold species found in these areas include *Aspergillus* spp., *Penicillium* spp., and *Paecilomyces* spp. Operating rooms require a highly sterile environment to ensure the safety of surgical procedures; however, mold spores in the air may pose infection risks to surgical patients. High-risk infection wards, such as intensive care units, infectious disease wards, bone marrow transplant wards, and pediatric oncology wards, often admit immunocompromised or susceptible patients, making them more susceptible to mold contamination and increasing the risk of patient infection (Caggiano G, 2014).

## (iii) Personnel and Item Contamination

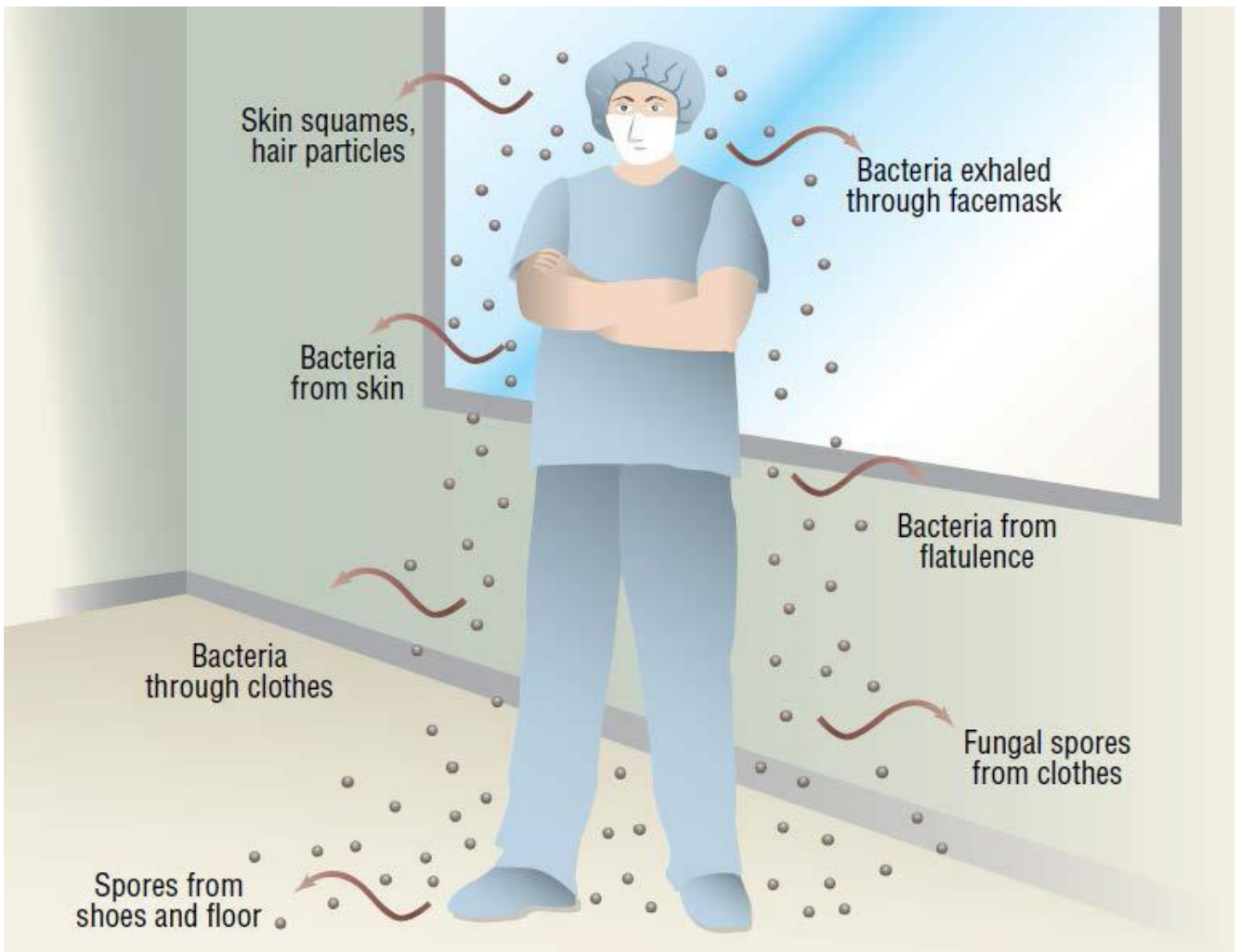
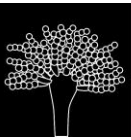


In healthcare facilities, **medical equipment, surfaces, and personnel** can all serve as potential sources for mold growth and transmission, thereby increasing the risk of patient infection. The presence of mold in these areas necessitates enhanced cleaning, disinfection, and hand hygiene practices to prevent its spread.

Firstly, medical equipment and surfaces may serve as hiding places for mold. For example, medical devices such as blood pressure cuffs, stethoscopes, electronic thermometers, infusion pumps, and hemodialysis machines may harbor mold, which can be transmitted to patients through healthcare workers' hands, especially in the absence of proper hand hygiene. Additionally, healthcare workers' clothing, hands, and masks may also serve as breeding grounds for mold, especially in hospital environments where these surfaces may become contaminated by contact with individuals or environments (Geehan Suleyman, 2018).

Secondly, personnel themselves may be one of the primary sources of introducing mold into the healthcare facility environment. Healthcare workers' hands may become contaminated directly from patient contact or indirectly from contact with contaminated environmental surfaces. Studies indicate that **healthcare workers' hands play a significant role in mold transmission within healthcare facilities and may contribute to 20% to 40% of nosocomial infections** (Geehan Suleyman, 2018).

Furthermore, when healthcare workers enter and exit the healthcare environment, their clothing, shoes, and other items may carry mold spores into patient rooms and the air (Fig.1). This contamination can lead to an increase in mold concentration in patient rooms, increasing the risk of patient infection, especially in high-risk wards, posing a health hazard to immunocompromised patients.



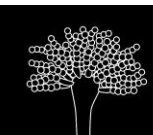
**Figure 1. Sources of Contamination on Healthcare Personnel** (Kowalski, 2007)

#### **(iv) Prevention and Control Measures**

To effectively prevent the proliferation and transmission of mold in hospitals and other healthcare facilities, a series of prevention and control measures can be implemented. Air and surface disinfection are crucial measures for maintaining hospital environmental hygiene. Regular

disinfection of hospital air is essential and can be achieved through measures such as the use of **disinfectants or ultraviolet germicidal irradiation (UVGI)** (Kowalski, 2007). Additionally, surfaces of various medical equipment also need to be regularly cleaned and disinfected to prevent mold growth and transmission.

In addition to air and surface



disinfection, management of hospital water sources is also crucial. **Regular inspection and maintenance of pipeline systems are necessary to ensure water quality meets standards.**

Furthermore, periodic disinfection of water systems should be conducted to reduce the presence of mold and other microorganisms, thus ensuring the safety of patient water consumption.

**Enhanced cleaning and hygiene measures** are vital for preventing mold transmission. Healthcare workers should strictly adhere to hygiene standards, practice regular handwashing, and wear appropriate protective equipment. Hospital cleaning staff should also regularly perform deep cleaning of various areas, especially places prone to mold growth, such as toilets, bathrooms, and damp environments.

Finally, **establishing a mold monitoring system** is crucial for early detection and resolution of potential problems. Hospitals should regularly monitor and assess air, water sources, and surfaces to promptly identify potential contamination sources and issues and take effective measures to

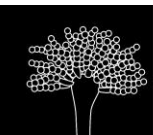
address them, thereby protecting the health of patients and healthcare workers.

---

### III - Conclusion

In summary, mold contamination in healthcare facilities poses certain health risks, particularly to immunocompromised patients. **Water and air contamination are two primary pathways for mold transmission, facilitating proliferation within hospitals.** Water contamination sources include hospital water systems and moisture-affected building materials, while airborne mold in the air may originate from HVAC systems, ward environments, etc. Additionally, **personnel and item contamination are also significant factors, as healthcare workers and medical equipment usage may lead to mold transmission.** To effectively prevent and control mold proliferation and transmission, healthcare facilities should implement a range of prevention and control measures, including air and surface disinfection, water source management, enhanced cleaning and hygiene measures, and the establishment of a mold monitoring





system. Implementation of these measures can effectively reduce the risk of patient infection and ensure the health

and safety of patients and healthcare workers.

#### IV 、 Reference

1. Kowalski, W.J. (2007). Air-Treatment Systems for Controlling Hospital-Acquired Infections. *HPAC Engineering*, January 2007, 1-16.
2. Caggiano G, Napoli C, Coretti C, Lovero G, Scarafile G, De Giglio O, Montagna MT. Mold contamination in a controlled hospital environment: a 3-year surveillance in southern Italy. *BMC Infect Dis*. 2014 Nov 15;14:595. doi: 10.1186/s12879-014-0595-z. PMID: 25398412; PMCID: PMC4236478.
3. Bonadonna L, Briancesco R, Coccia AM. Analysis of Microorganisms in Hospital Environments and Potential Risks. *Indoor Air Quality in Healthcare Facilities*. 2017 Mar 24:53–62. doi: 10.1007/978-3-319-49160-8\_5. PMCID: PMC7120946.
4. Suleyman, G., Alangaden, G. & Bardossy, A.C. The Role of Environmental Contamination in the Transmission of Nosocomial Pathogens and Healthcare-Associated Infections. *Curr Infect Dis Rep* 20, 12 (2018). <https://doi.org/10.1007/s11908-018-0620-2>
5. Srikanth P, Sudharsanam S, Steinberg R. Bio-aerosols in indoor environment: composition, health effects and analysis. *Indian J Med Microbiol*. 2008 Oct-Dec;26(4):302-12. doi: 10.4103/0255-0857.43555. PMID: 18974481.
6. Cristina ML, Sartini M, Spagnolo AM. Health care-acquired aspergillosis and air conditioning systems. *J Prev Med Hyg*. 2009 Mar;50(1):3-8. PMID: 19771754.
7. 陳柏齡、李南瑤 (2022)。常見的院內黴菌感染－侵襲性麴菌感染的診斷。感染控制雜誌，32(2)，99-106。 [https://doi.org/10.6526/ICJ.202204\\_32\(2\).0004](https://doi.org/10.6526/ICJ.202204_32(2).0004)