Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

Nosocomial Infections: Epidemiology, Prevention, Control, Diagnosis and the Role of the Microbiology Laboratory

Hetal Chenva[1], Ganesh Parmar[1], Maharsh Upadhyay[1] Priyanka Patel [1], Varda Mehta[1*]

[1]Department of Life Sciences, Hemchandracharya North Gujarat University, Patan, 384265, India.

***Corresponding author(s):** Dr. Varda Mehta

(Received: 25 August 2025 Revised: 27 September 2025 Accepted: 14 October 2025)

KEYWORDS

Nosocomial infections, Epidemiology, Prevention, Microbiology laboratory, Infection control

ABSTRACT:

Nosocomial infections, more commonly known as healthcare-associated infections (HAIs), claim numerous lives annually. These infections are contracted by patients during the course of their treatment for other conditions, leading to a significant increase in patient morbidity and mortality. Furthermore, HAIs impose a substantial direct and indirect financial burden, straining already limited healthcare resources. Combating these infections requires a multidisciplinary strategy that integrates the expertise of healthcare professionals, infection control specialists, and microbiology laboratories to implement evidence-based preventive practices. This scripted review aims to highlight beneficial and important diagnostic techniques for identifying various types of HAIs. The findings from this review are intended to be applicable for guiding further appropriate health services, thereby aiding both clinical practice and societal health outcomes.

Introduction:

According to the World Health Organization (WHO), nosocomial or hospital acquired infections (HAIs) occur in patients receiving medical care in hospitals or other healthcare facilities for conditions that were not present at the time of admission. These infections can develop during treatment for other conditions, after discharge, or even affect healthcare workers in the facility (Khan et al., 2017). In summary, nosocomial infections are acquired within healthcare settings and typically manifest 48 hours or more after hospital admission, or within 2030 days following discharge from inpatient care (Liu & Dickter, 2020) Numerous hospital environmental and procedural conditions encourage the growth and spread of bacteria, which results in a variety of nosocomial illnesses. These infections are not only widespread but also have the potential to be serious, with some even being lethal (Alotaibi et al., 2024) They pose a significant challenge to healthcare systems worldwide, leading to prolonged hospital stays, increased healthcare costs, and heightened morbidity and mortality rates among affected patients. Effective prevention strategies are crucial to reducing the incidence of HAIs, including stringent hygiene protocols, proper sterilization of medical equipment, and comprehensive staff training on infection control practices. Implementing these strategies not only protects patients but also enhances the overall quality of care within healthcare facilities, fostering a safer environment for both patients and staff (Arpan et al., 2020). In addition to these measures, ongoing surveillance and monitoring of infection rates can help identify outbreaks early, allowing for prompt intervention and containment. This proactive approach not only mitigates the risk of HAIs but also contributes to a culture of safety and accountability in healthcare settings, ultimately improving patient outcomes and satisfaction. By prioritizing these initiatives, healthcare institutions can significantly reduce the burden of HAIs, ensuring that patient safety remains at the forefront of their operational goals (Khan et al., 2015). This commitment to safety and quality care not only builds trust between patients and healthcare providers but also sets a standard for excellence that can inspire other institutions to adopt similar practices. Establishing robust monitoring systems and fostering collaboration among healthcare professionals are essential steps in sustaining these improvements, creating a ripple effect that enhances overall public health (Khan et al., 2017; Liu & Dickter, 2020). Studies have shown that the

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

infection rate within Intensive Care Units (ICUs) can reach as high as 51% This alarming statistic underscores the urgent need for comprehensive infection control measures and continuous education among healthcare staff to mitigate risks and protect vulnerable patients. Implementing evidence-based protocols and investing in advanced technologies can significantly reduce these infection rates, ultimately leading to better patient outcomes and a safer healthcare environment.(Lazzari et al., 2004), prioritizing these strategies, healthcare institutions can not only improve their own practices but also set a benchmark for others to follow, fostering a culture of safety and excellence across the entire healthcare system. In addition, collaboration between healthcare providers and public health organizations can enhance surveillance efforts and promote the sharing of best practices, further strengthening the fight against infections in critical care settings(do Amaral Michels et al., 2013).

EPIDEMIOLOGY:

Nosocomial infections affect a substantial number of patients worldwide. According to WHO estimates, approximately 15% of all hospitalized patients are impacted by these infections. This alarming statistic underscores the urgent need for effective infection control measures and continuous education among healthcare professionals to mitigate risks and protect vulnerable populations(Flanagan et al., 2011). Effective strategies, such as implementing strict hygiene protocols and utilizing advanced sterilization techniques, are essential to minimize the incidence of nosocomial infections and safeguard patient health (Sartelli et al., 2023) The microorganisms causing nosocomial infections originated in clinics, hospitals, and medical centres (Joshi et al., 2019).

Routes of Transmission:

Nosocomial infections are transmitted through several key routes within healthcare settings that mentioned in Table no.1 and figure no. 1. The most common is contact transmission, which occur either directly or indirectly. Droplet transmission, airborne transmission, common vehicles transmission and vector borne transmission can cause nosocomial infection. Together, these transmission routes highlight the critical need for strict infection prevention and control practices in healthcare facilities.

Table .1 Several key routes of nosocomial infection transmission.

Serial no.	Route of transmission	Definitions
1.	Direct Contact	Physical interaction between an infectious individual or contaminated object and a susceptible host.
2.	Indirect Contact	Transmission occurs when pathogens are transferred from contaminated surfaces or instruments to patients, often highlighting the importance of rigorous cleaning practices in healthcare settings.
3.	Airborne Transmission	Occurs via airborne droplet nuclei, which are small particles (5 microns or smaller) containing microorganisms that can remain suspended in the air for long periods, or dust particles carrying infectious agents.
4.	Droplet Transmission:	Droplets are produced by sneezing, coughing, and using a bronchoscope. Dust particles indicating the presence of pathogenic pathogens (Krishnaveni et al., 2024).
5.	Common Vehicle Transmission	Microorganisms are transmitted through contaminated items such as food, water, medications, devices, or equipment.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

6.	Vector-Borne Transmission	Vectors like mosquitoes, flies, rats, and other vermin transmit infectious agents. Understanding these modes of transmission is crucial for implementing effective infection control measures and preventing outbreaks in healthcare settings and the community. Proper hygiene practices, vaccination programs, and public health initiatives play a vital role in reducing the risk of transmission and protecting vulnerable populations from infectious diseases (Khan et al., 2015, 2017; Sartelli et al., 2023).

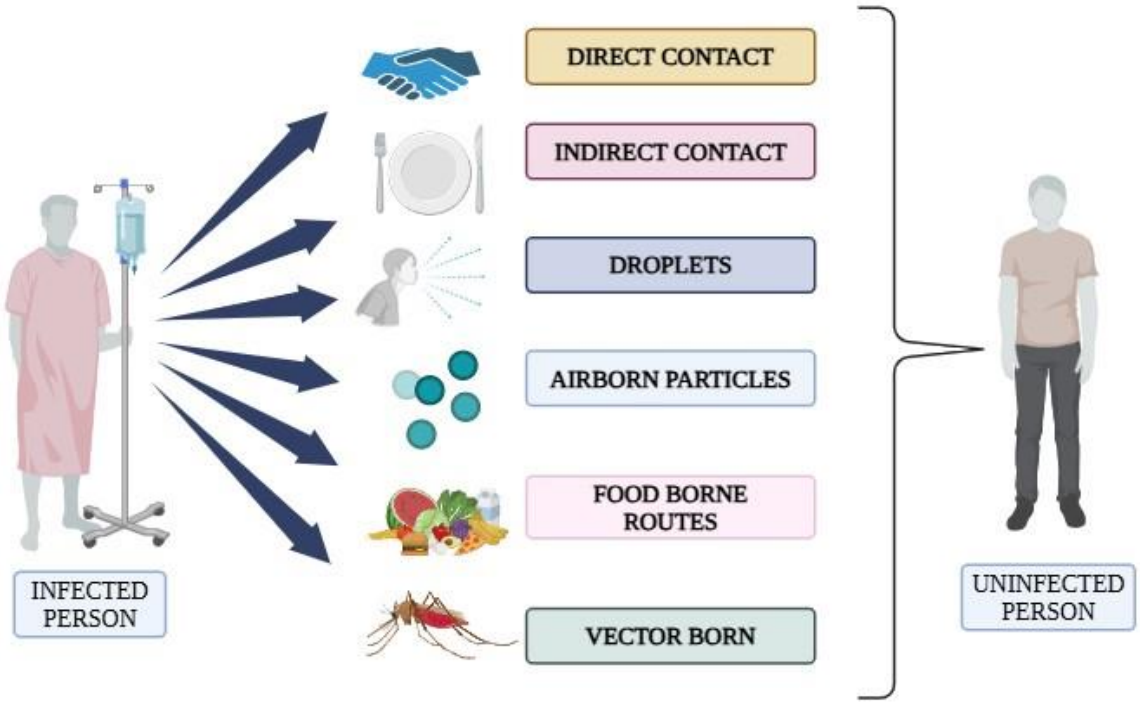

Fig .1 Different routes of transmission of nosocomial infections.

Etiology:

While it is widely acknowledged within the medical community that various microorganisms such as viruses, fungi, and parasites can indeed serve as sources of nosocomial infections, it is crucial to highlight that bacterial agents continue to be the predominant and most frequently encountered culprits behind these infections occurring within healthcare settings. Nosocomial bloodstream infections, which are a significant concern for patient safety and health management, are predominantly instigated by Gram-positive organisms, specifically including notable pathogens such as Coagulase-Negative Staphylococcus, the more virulent Staphylococcus aureus, and the Enterococci species, (Fürnkranz & Walochnik, 2021) . All of which are capable of causing severe clinical complications. Escherichia coli, a well-known bacterium, is frequently implicated in the onset of urinary tract infections, yet it is essential to recognize that a variety of other pathogenic microorganisms, including but not limited to Pseudomonas aeruginosa, Klebsiella species, Proteus mirabilis, Staphylococcus epidermidis, Enterococci, and Candida species, can also play a significant role in the development of such infections. Furthermore, it is important to note that Legionella pneumophila is a

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

recognized pathogen responsible for causing respiratory infections particularly in hospitalized patients, contributing to the overall burden of healthcare-associated diseases. In the case of neonatal patients, bloodstream infections are often caused by a range of bacteria, including Klebsiella species, Pseudomonas species, Proteus species, Escherichia coli, and Staphylococcus aureus, all of which can lead to serious health outcomes in this vulnerable population (Nazir & Kadri, 2014). The escalating utilization of broad-spectrum antibiotics in clinical settings has inadvertently resulted in an increase in nosocomial infections that are attributable to drug-resistant microbes, which include notorious strains such as Methicillin-Resistant Staphylococcus aureus (MRSA), penicillin-resistant pneumococci, Vancomycin-Resistant Enterococci (VRE), and Multi-Drug-Resistant Tuberculosis (MDR-TB), each of which presents a formidable challenge to effective treatment strategies. These resistant strains of microorganisms impose substantial difficulties for healthcare providers in managing infections, thereby underscoring the urgent necessity for the development of new antibiotics and innovative alternative therapeutic strategies aimed at addressing and combating these ever-evolving threats within healthcare environments (Bheemavarapu et al., 2018).

Prevention:

Preventing nosocomial infections necessitates the implementation of a comprehensive, meticulously monitored program that encompasses a variety of critical components, which include but are not limited to: the reduction of transmission between patients through the rigorous enforcement of proper hand hygiene protocols (Navarrete-Navarro & Rangel-Frausto, 1999). appropriate glove usage, strict adherence to aseptic practices, the establishment of effective isolation protocols, thorough sterilization procedures, comprehensive disinfection methods, and efficient management of laundry operations. Additionally, it is imperative to control environmental risks that may contribute to the spread of infections within healthcare settings. Furthermore, protecting patients can be achieved through the appropriate and strategic use of prophylactic antimicrobials, ensuring optimal nutrition, and administering necessary vaccinations to bolster their immune systems. Moreover, it is essential to minimize the occurrence of invasive procedures wherever possible and to actively promote the responsible and judicious use of antimicrobials, which collectively contribute to the reduction of endogenous infections that may arise within the patient population. In conjunction with these measures, monitoring infections vigilantly is of utmost importance, as it allows for the identification and effective control of any outbreaks that may occur, thus safeguarding patient health and well-being. It is also critically important to implement strategies aimed at preventing infections among the healthcare staff, as their health directly impacts the quality of care provided to patients. Moreover, enhancing patient care practices and ensuring that there is a continuous education program in place for healthcare staff is vital for maintaining high standards of infection control. Ultimately, the responsibility of infection control is shared among all healthcare professionals, which includes a diverse array of individuals such as doctors, nurses, therapists, pharmacists, engineers, and numerous other essential personnel who play a role in the healthcare system (Brooks et al., 2021).

The following are some of the aspects that affect nurses' adherence to hand hygiene (Agussalim, 2025).

i. Awareness of infection prevention and attitudes around it.
ii. High workload and time restrictions
iii. the accessibility of hand hygiene resources and facilities.
iv. the backing of hospital administration.
v. A powerful institutional patient safety culture.

Control:

Healthcare institutions must implement comprehensive infection control programs as shown in figure 2. All staff, patients, and visitors should adhere to these infection prevention measures.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

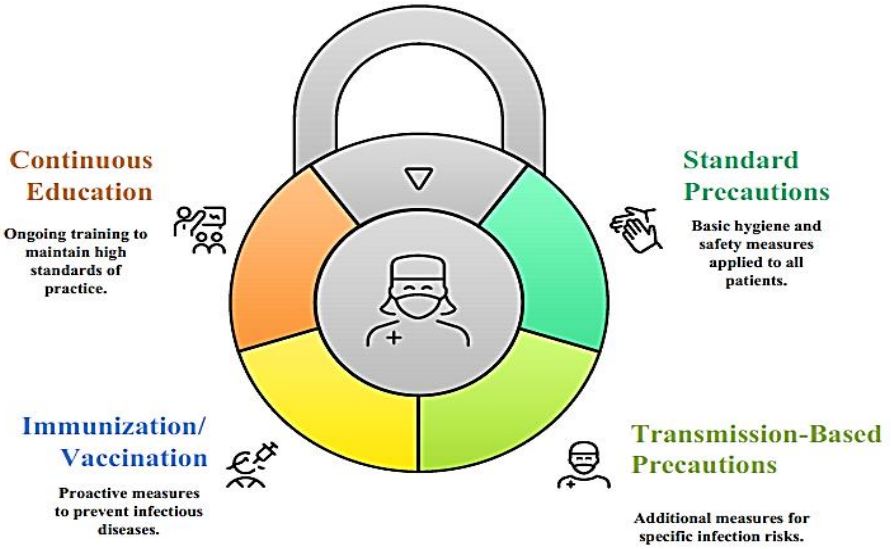

Fig. 2 Core Components of Infection Prevention and Control in Healthcare.

1. **Standard Precautions**: Hand hygiene, respiratory hygiene, use of personal protective equipment, safe injection practices, proper medication storage, cleaning and disinfection of devices and surfaces, and waste management. These measures are crucial in minimizing the risk of infections, safeguarding both patients and healthcare workers while promoting a culture of safety within medical environments.
2. **Transmission Based Precautions**: Contact, droplet, and airborne precautions. These precautions are tailored to specific routes of transmission, ensuring that healthcare settings remain safe and effective in preventing the spread of infections among vulnerable populations.
3. **Immunization/Vaccination:** Ensuring that all staff members, as well as patients who visit the facility, receive the appropriate vaccinations that are necessary for their health and safety is of paramount importance in maintaining a safe and healthy environment for everyone involved.
4. **Education and Training**: Regular and consistent training programs designed specifically for healthcare personnel are essential for ensuring that they remain well-informed and proficient in their skills and knowledge.

Diagnosis of Nosocomial Infections:

The Centers for Disease Control (CDC) and the National Healthcare Safety Network have categorized nosocomial infection sites into 13 categories, out of a total of 50 infection sites. Their specificity is based on clinical and biochemical factors. Urinary tract infections (UTI), surgical and soft tissue infections, gastroenteritis, meningitis, and respiratory infections are among the frequently occurring sites (Raka et al., 2006). The diagnosis of nosocomial infections varies significantly. The technique used is frequently determined by the kind and character of sample. In most cases, the infectious agents of nosocomial infections are identified using efficient and advised techniques (Mbim et al., 2016). The clinical and laboratory characteristics of the most common nosocomial diseases are compiled in Table 2. The review studies (Al-Zamali et al., 2025) that are mentioned in figure.3. covered a range of nosocomial UTI diagnostic methods. Traditional diagnostic techniques have been around for a while and include both culture-based and non-culture-based methods. Standard methods include PCR, isothermal micro-calorimetry, enzyme-linked immunosorbent test (ELISA), flow cytometry, mass spectrometry, multiplex PCR, microfluidics and biosensor and real time microscopy(Kaur & Kaur, 2021) .

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

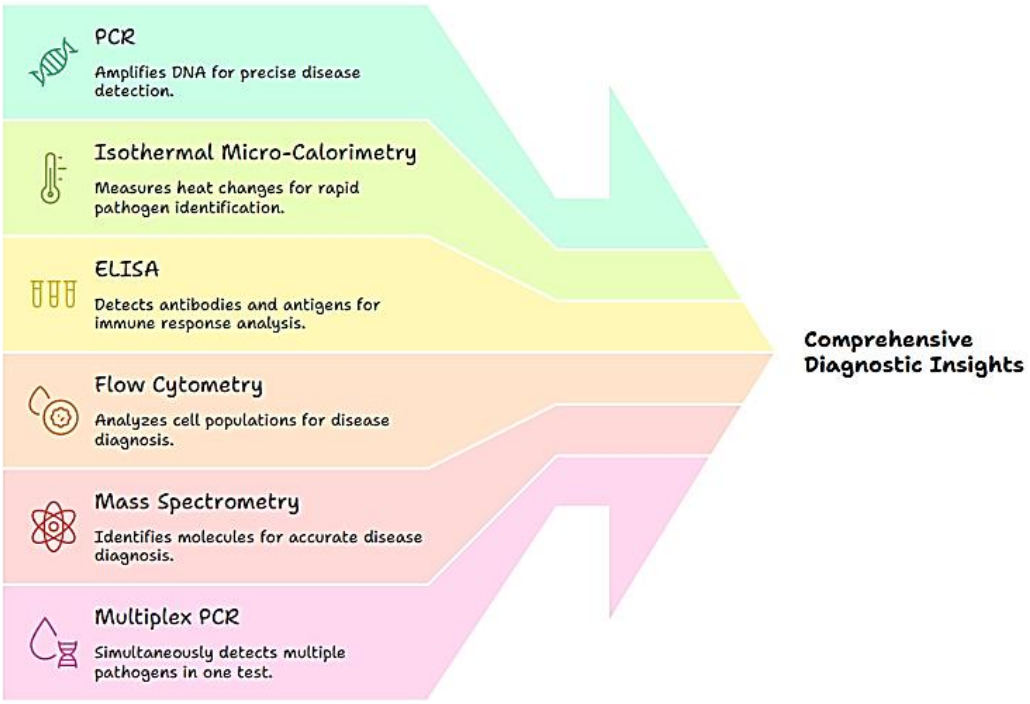

Fig .3 Different nosocomial UTI diagnostic methods.

Table 2. Common nosocomial infections along with their laboratory and clinical characteristics.

Types of nosocomial infections	**Clinical features**	**Laboratory features**
Pneumonia	Decreased intensity of breath sounds, increase in rales, fever and pleuritic chest pain	Leukocytosis, positive sputum culture, sputum for Gram's stain and positive chest X-ray
Gastroenteritis	Fever, change in consistency of stool, increased frequency of stool and dehydration.	Leukocytosis, positive stool culture.
Blood stream infections (BSI)	Tenderness or purulent drainage at the site of insertion of IV access of CVP catheter, Unusual fever with chills and rigor.	Leukocytosis, positive blood culture, positive CVP catheter culture (after catheter removal).
Urinary tract infections (UTI)	Lower abdominal pain, fever, changes in characteristics of urine.	Leukocytosis, positive urine culture.
Meningitis	Headache, fever altered sensorium,	Leukocytosis, CSF-cell count, cell

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

	neck stiffness, vomiting.	type culture, sugar, protein.
Skin and soft tissue infection (SSI)	Swelling, pain, fever, tenderness or inflammation and warmth of skin, purulent drainage from skin.	Smear for Gram's reaction, leukocytosis and positive swab culture.

Role of The Microbiology Laboratory:

The microbiology lab is essential in managing infections linked to hospitals. It serves as a vital part of a successful infection control initiative, aiding in monitoring infections and enabling the infection control team to utilize lab services for epidemiological reasons. The lab's contribution to a hospital-acquired infection control program encompasses: Identifying pathogens involves not only the recognition of harmful microorganisms but also encompasses the crucial skill of accurately classifying various bacteria down to their specific species level, which is essential for effective diagnosis and treatment (Gilligan, 2013). Providing guidance and comprehensive recommendations regarding the meticulous processes involved in the collection of specimens, as well as the appropriate methods and protocols for their safe and efficient transportation to designated laboratories or testing facilities In addition to identification, the laboratory plays a pivotal role in determining antibiotic susceptibility, guiding clinicians in selecting the most effective treatments while minimizing the risk of resistance (Gilligan, 2013; Sato, 2010).

1. Ensuring that healthcare professionals, particularly clinicians, are continuously updated and well-informed regarding the complex and critical issue of antibiotic resistance, as well as their adherence to established antibiotic prescribing guidelines, is of paramount importance in the fight against infectious (Sato, 2010).
2. Continuous education and training programs can empower clinicians to make informed decisions, ultimately enhancing patient outcomes and contributing to the overall effectiveness of antimicrobial stewardship initiatives.
3. Identifying the specific origin of infections, as well as understanding the various modes through which these infections are transmitted, necessitates the comprehensive examination of carriers and the meticulous analysis of environmental samples in order to accurately pinpoint the exact source from which the infection has (Minhas et al., 2011).
4. Promoting and endorsing effective sterilization and disinfection procedures, which encompass rigorous biological monitoring and evaluation of the various sterilization processes to ensure their efficacy and reliability. These measures not only safeguard healthcare environments but also play a crucial role in preventing the spread of resistant pathogens, thereby protecting both patients and healthcare workers (Fortier & Khardori, 2013).

Offering Training for Personnel Involved in Infection Control, Covering:

Best practices for infection prevention, the importance of hand hygiene, and effective use of personal protective equipment (PPE) to ensure a safe healthcare environment. Implementing these strategies not only enhances patient safety but also fosters a culture of accountability and continuous improvement in infection control practices across healthcare settings.

- Basic infection concepts.
- Hazards associated with specific work categories.
- Personal responsibility in infection control.
- Methods to prevent infection transmission.
- Safe laboratory practices.

Conclusion:

The increasing burden of nosocomial infections and the rise of antimicrobial resistance present significant challenges for healthcare administrations and infection control committees. Managing these infections is an ongoing struggle, especially as medical interventions

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

become more invasive and the number of immunocompromised patients grows. Every healthcare facility should establish training programs for staff, patients, and their families to raise awareness about maintaining hygiene and preventing infections. Microbiology laboratories play a crucial and indispensable role within the broader context of infection prevention programs. Comprehensive and appropriate training in essential areas such as biosafety protocols, effective waste management techniques, and best healthcare practices can significantly contribute to the reduction of the incidence and prevalence of these infections in various settings. By enhancing and refining public health measures and initiatives, healthcare institutions possess the capability to not only prevent the emergence of outbreaks but also to effectively control and manage nosocomial infections, thereby safeguarding the health and well-being of patients and the community at large.

References:

1. Agussalim, S. (2025). The role of nurses in preventing nosocomial infections in surgical patients. *Nurse Care Open Acces J*, *11*(1), 43–45.
2. Alotaibi, M. H. M., Alharbi, R. N., saleh Alghamdi, I., Alquraini, B. M., Alshahrani, N. S., Bohassan, A. T., Alotaibi, F. M. F., Alrumaih, F. K., Nouf, R. A., & Almukhaleeb10, N. K. (2024). A Review for Infection Control Measures for The Prevention of Nosocomial Infection. *Journal of International Crisis and Risk Communication Research*, *7*(S9), 3293.
3. Al-Zamali, S. K. S., Alkhafaji, N. T., Anwer, M. I., & Younus, R. W. (2025). Overview of nosocomial urinary tract infections. *Novel Research in Microbiology Journal*, *9*(4), 252–272.
4. Arpan, S., Kalyan, R., Mainak, C., & Karunakaran, G. (2020). Correlation between Antimicrobial Resistance and Nosocomial Infections, their Prevention and Control. *Journal of Young Pharmacists*, *12*(1), 25.
5. Bheemavarapu, H., Arief, M., Ahmad, A., & Patel, I. (2018). Nosocomial infections in India: the unaddressed lacunae. *J Pharm Pract Community Med*, *4*(2), 43.
6. Brooks, S. K., Greenberg, N., Wessely, S., & Rubin, G. J. (2021). Factors affecting healthcare workers' compliance with social and behavioural infection control measures during emerging infectious disease outbreaks: rapid evidence review. *BMJ Open*, *11*(8), e049857.
7. do Amaral Michels, M., Dick, N. R. M., Zimerman, R. A., & Malinsky, R. R. (2013). Auditoria em unidade de terapia intensiva: vigilância de procedimentos invasivos. *Revista de Epidemiologia e Controle de Infecção*, *3*(1), 12–16.
8. Flanagan, M. E., Welsh, C. A., Kiess, C., Hoke, S., & Doebbeling, B. N. (2011). A national collaborative for reducing health care–associated infections: Current initiatives, challenges, and opportunities. *American Journal of Infection Control*, *39*(8), 685–689.
9. Fortier, E., & Khardori, N. (2013). The Role of Microbiology Laboratory in Infection Prevention. In *Hospital Infection Prevention: Principles & Practices* (pp. 67–71). Springer.
10. Fürnkranz, U., & Walochnik, J. (2021). Nosocomial infections: do not forget the parasites! *Pathogens*, *10*(2), 238.
11. Gilligan, P. H. (2013). Identification of pathogens by classical clinical tests. In *The Prokaryotes* (pp. 57–89). Springer.
12. Joshi, M., Kaur, S., Kaur, H. P., & Mishra, T. (2019). Nosocomial infection: source and prevention. *Int J Pharm Sci Res*, *10*(4), 1613–1624.
13. Kaur, R., & Kaur, R. (2021). Symptoms, risk factors, diagnosis and treatment of urinary tract infections. *Postgraduate Medical Journal*, *97*(1154), 803–812.
14. Khan, H. A., Ahmad, A., & Mehboob, R. (2015). Nosocomial infections and their control strategies. *Asian Pacific Journal of*

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(5), 2954-2962 | ISSN:2251-6727

Tropical Biomedicine, *5*(7), 509–514.

15. Khan, H. A., Baig, F. K., & Mehboob, R. (2017). Nosocomial infections: Epidemiology, prevention, control and surveillance. *Asian Pacific Journal of Tropical Biomedicine*, *7*(5), 478–482.
16. Krishnaveni, R., Lavanya, S., Begam, N. N., Harini, S., & Rajeshwari, R. R. (2024). *Nosocomial Infection and Control Measures*.
17. Lazzari, S., Allegranzi, B., & Concia, E. (2004). Making hospitals safer: the need for a global strategy for infection control in health care settings. *World Hospitals and Health Services*, *40*(2), 32–39.
18. Liu, J.-Y., & Dickter, J. K. (2020). Nosocomial infections: a history of hospital-acquired infections. *Gastrointestinal Endoscopy Clinics*, *30*(4), 637–652.
19. Mbim, E. N., Mboto, C. I., & Agbo, B. E. (2016). A review of nosocomial infections in Sub-Saharan Africa. *Br Microbiol Res J*, *15*(1), 1–11.
20. Minhas, S., Kotwal, A., & Singh, M. (2011). Infection Control in Health Care Facilities. *Medical Journal, Armed Forces India*, *67*(1), 7.
21. Navarrete-Navarro, S., & Rangel-Frausto, M. S. (1999). Nosocomial infections and quality of health care. *Salud Publica de Mexico*, *41*, S64-8.
22. Nazir, A., & Kadri, S. M. (2014). An overview of hospital acquired infections and the role of the microbiology laboratory. *Int J Res Med Sci*, *2*(1), 21–27.
23. Raka, L., Zoutman, D., Mulliqi, G., Krasniqi, S., Dedushaj, I., Raka, N., Ahmeti, S., Shala, M., Vishaj, A., & Elezi, Y. (2006). Prevalence of nosocomial infections in high-risk units in the university clinical center of Kosova. *Infection Control & Hospital Epidemiology*, *27*(4), 421–423.
24. Sartelli, M., Bartoli, S., Borghi, F., Busani, S., Carsetti, A., Catena, F., Cillara, N., Coccolini, F., Cortegiani, A., & Cortese, F. (2023). Implementation strategies for preventing healthcare-associated infections across the surgical pathway: an Italian multisociety document. *Antibiotics*, *12*(3), 521.
25. Sato, T. (2010). Infection control in hospitals. *Masui. The Japanese Journal of Anesthesiology*, *59*(1), 56–63.