



Assessment of nursing knowledge and practice toward infection control study and hygiene standards in hospitals

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Abstract

Studies on nursing knowledge and practice toward infection control and hygiene show that while nurses often have good theoretical knowledge, their practical application can be poor, with common gaps in areas like handwashing and using personal protective equipment (PPE). Factors influencing practice include inadequate supplies, lack of supervision, heavy workloads, and insufficient training, though experience and age can also be factors. Effective infection control requires continuous education, proper equipment, and strong management support to bridge the gap between knowledge and practice. This article covers all key domains of infection prevention from hand hygiene, asepsis, and sterilization to surveillance, waste management, outbreak control, and legal aspects through a nursing lens. It also incorporates audit formats, checklists, and hospital protocols currently used in government and accredited institutions across India, ensuring real-world applicability. This article emphasizes the nurse's central role in infection control: as caregiver, educator, supervisor, and change agent. It reflects the resilience, dedication, and innovation shown by nurses during the COVID-19 pandemic, which has redefined the standards of infection prevention globally. In this article examples have been included to enhance understanding, and annexures provide ready-to-use hospital formats for practical training.

Keywords: Infection control, antimicrobial resistance, NABH, NQAS, sterilization, hygiene, asepsis etc.

Introduction

Infection is a biological process in which harmful microorganisms such as bacteria, viruses, fungi, protozoa, or parasites invade the body's tissues, multiply, and cause cellular injury, disease, or dysfunction. These microorganisms are known as pathogens, and their presence triggers a series of immune responses in the host. Normally, the human body has several defense mechanisms such as intact skin, mucous membranes, cilia in the respiratory tract, and immune cells that act as natural barriers to infection. However, when these defenses are compromised by disease, trauma, poor hygiene, or invasive medical procedures, microorganisms can successfully enter, multiply, and cause infection. Infections can range from mild and self-limiting to severe and life-threatening, depending on the virulence of the organism, the route of transmission, and the immunity of the host. For example, a simple upper respiratory tract infection may resolve spontaneously, whereas infections like sepsis or COVID-19 can cause multi-organ failure if not treated promptly. Colonization refers to the presence and growth of microorganisms on or within the host without causing tissue damage or symptoms. It is often a normal

physiological condition; for instance, the human skin, mouth, and gastrointestinal tract naturally harbor large numbers of commensal organisms that protect against harmful pathogens (A. Gawad, 2017)^[1].

Classification of Infections

Infections can be classified in several ways depending on their source, duration, clinical presentation, and mode of transmission. Understanding these classifications helps nurses recognize the nature of the infection, apply appropriate isolation precautions, and plan individualized patient care. Infection classification is particularly important in hospitals, where differentiating between community-acquired and hospital-acquired infections determines the infection control strategies to be followed (WHO Reports 2021).

Based on Site or Location

- **Local infection:** Confined to a specific body part or organ, showing localized signs such as redness, swelling, pain, and warmth. Example: Abscess, wound infection, otitis media.

- **Systemic infection:** The microorganisms spread via the bloodstream or lymphatic system to the entire body, producing generalized symptoms like fever, chills, and malaise. Example: Septicemia, typhoid fever, malaria.

Based on Sequence or Occurrence

- **Primary infection:** The initial infection occurring in a previously healthy person. Example: Pulmonary tuberculosis caused by *Mycobacterium tuberculosis*.
- **Secondary infection:** Occurs when another infection develops on top of an existing one, usually due to weakened immunity or antibiotic use. Example: Oral thrush following prolonged antibiotic therapy (A.M. Varshney *et al*, 2014)^[2].

Based on Source of Acquisition

- **Community-acquired infection:** Occurs before hospital admission or within the first 48 hours. Example: Influenza, chickenpox, pneumonia.

- **Nosocomial or Hospital-acquired infection (HAI):** Develops after 48 hours of hospitalization or within 30 days post-discharge. These infections are preventable through standard precautions and aseptic practices. Example: Catheter-associated urinary tract infection (CAUTI), surgical site infection (SSI).

Based on Host Response

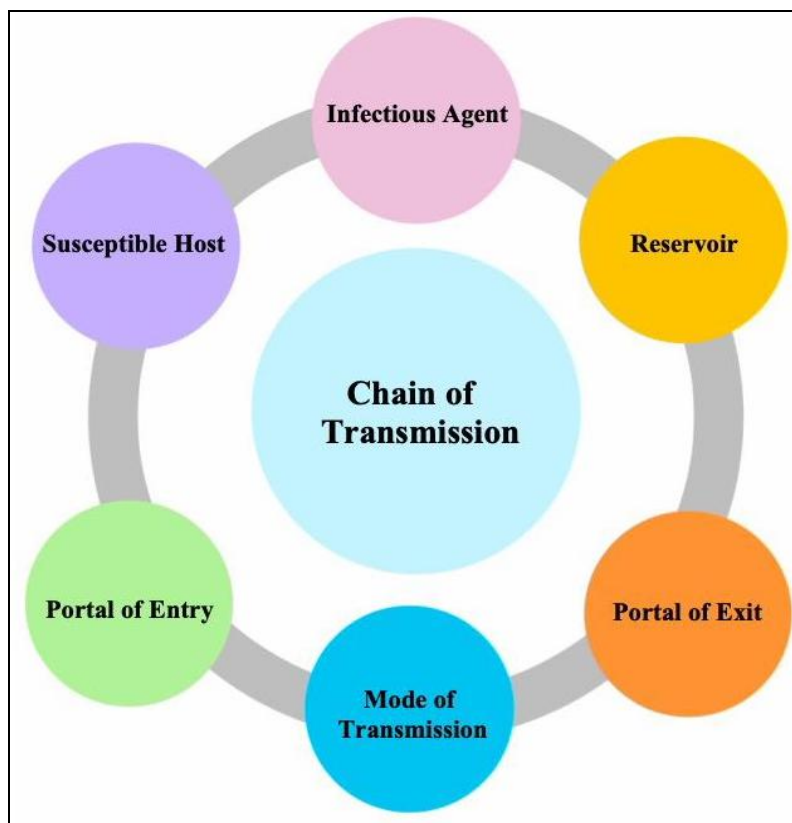
- **Opportunistic infection:** Arises when normal flora or environmental microorganisms cause disease in immunocompromised individuals, such as patients with HIV/AIDS, cancer, or post-transplant conditions. **Example:** *Pneumocystis jirovecii* pneumonia, *Candida* infection.
- **Subclinical or in apparent infection:** Infection without visible symptoms, yet the person can transmit the disease to others. Example: Asymptomatic carriers of Hepatitis A virus (WHO Reports 2020).

Table 1: Classification of Infections

Type of Infection	Description	Common Examples
Local infection	Confined to a specific organ or area	Abscess, wound infection
Systemic infection	Spread via blood or lymph to entire body	Septicemia, typhoid
Primary infection	Initial infection in a healthy person	Tuberculosis
Secondary infection	Follows a primary infection due to weakened immunity	Oral thrush after antibiotics
Nosocomial infection	Acquired after hospital admission (≥ 48 hrs)	Catheter-associated UTI
Opportunistic infection	Occurs in immunocompromised patients	<i>Pneumocystis pneumonia</i>
Subclinical infection	No symptoms but infectious	Hepatitis A carrier

The Six Links of the Chain of Infection

1. **Infectious Agent:** These are disease-causing microorganisms such as bacteria, viruses, fungi, protozoa, or parasites. The likelihood of infection depends on the pathogen's virulence, number, and ability to survive in the environment. Nursing action: Ensure proper sterilization, disinfection, and antibiotic administration as prescribed.
2. **Reservoir:** The reservoir is the place where microorganisms live, grow, and multiply. This may include patients, healthcare workers, medical instruments, food, or water. Nursing action: Maintain cleanliness, decontamination, and waste disposal procedures.
3. **Portal of Exit:** Pathogens leave their reservoir through body fluids such as blood, sputum, urine, feces, or droplets from coughing and sneezing. Nursing action: Practice respiratory hygiene, mask use, and proper disposal of contaminated materials.
4. **Mode of Transmission:** Infection spreads by direct contact, indirect contact through fomites, airborne droplets, or vectors such as insects. Nursing action: Promote hand hygiene, safe injection practices, isolation precautions, and proper use of personal protective equipment (PPE).
5. **Portal of Entry:** Microbes enter the new host through broken skin, mucous membranes, surgical wounds, or invasive devices. Nursing action: Maintain aseptic technique, use sterile dressings, and handle invasive lines carefully.
6. **Susceptible Host:** A person with low immunity, such as newborns, elderly, diabetic, or immunocompromised patients, is more likely to develop infection. Nursing action: Encourage immunization, balanced nutrition, early mobilization, and infection surveillance (D.A. Ariyo *et al*, 2017)^[4].



Six Components of the Chain of Infection: The chain of infection represents the process through which a disease spreads from one host to another, involving six interdependent components. The first component, the

infectious agent, refers to the microorganism such as bacteria, virus, fungus, or parasite that has the potential to cause disease.

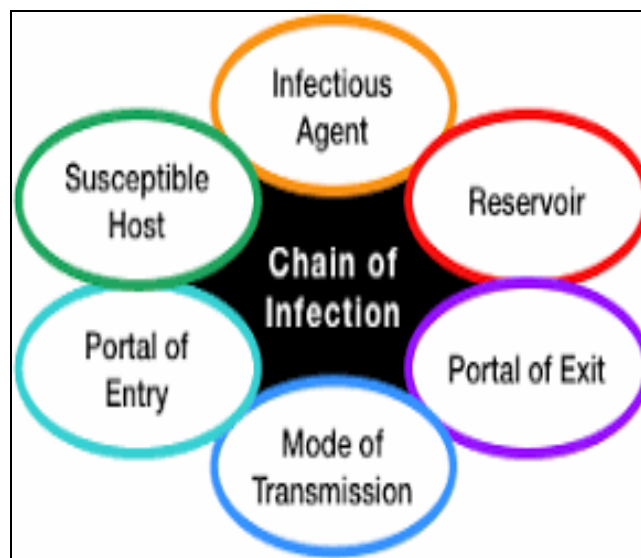


Fig 2: Diagram of the Chain of Infection illustrating the six interconnected links.

The second component, the reservoir, is the natural habitat where the microorganism lives, multiplies, and sustains itself, such as the human body, animals, water, or medical equipment. The third link, the portal of exit, is the route through which the infectious agent leaves the reservoir, for example, through respiratory secretions, blood, or excreta. The fourth component, the mode of transmission, refers to how the pathogen travels from one host to another, which can occur through direct contact, droplets, airborne

particles, or contaminated objects. The fifth link, the portal of entry, is the path by which the microorganism enters a new host, such as through wounds, mucous membranes, or inhalation. The final component, the susceptible host, is an individual who lacks immunity or resistance to the pathogen. If all six links function in sequence, infection occurs. However, by interrupting any one of these links through preventive measures, the spread of infection can be effectively controlled (NABH Reports 2021).

Table 2: Overview of the Six Components of the Chain of Infection.

Component	Description	Example
Infectious Agent	Pathogen capable of causing disease	Bacteria, viruses, fungi
Reservoir	Place where pathogen survives and multiplies	Human body, water, soil
Portal of Exit	Route through which pathogen leaves the host	Respiratory secretions, blood
Mode of Transmission	How pathogen travels to new host	Contact, droplet, airborne
Portal of Entry	Route through which pathogen enters new host	Mucous membranes, wounds
Susceptible Host	Individual lacking immunity or defense	Neonates, elderly, immunocompromised

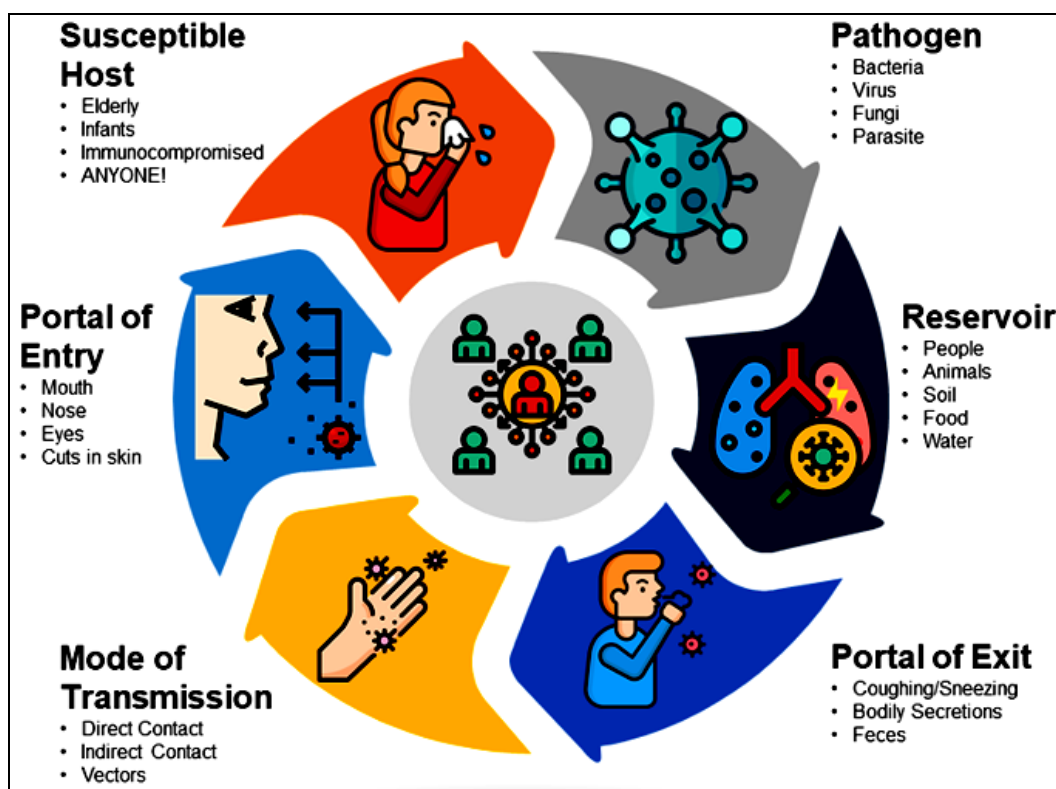
Breaking the Chain through Nursing Intervention

Breaking any link in the chain stops infection transmission. Nurses are at the forefront of this prevention process. Their interventions include:

1. **Hand Hygiene:** The most effective measure. Washing hands before and after patient contact using soap or alcohol-based rubs reduces microbial load.
2. **Personal Protective Equipment (PPE):** Use of gloves, masks, gowns, and goggles to prevent exposure.
3. **Aseptic Technique:** Maintaining sterility during invasive procedures prevents microorganism entry.
4. **Disinfection and Sterilization:** Ensures equipment is

safe for use.

5. **Isolation Precautions:** Implementing standard and transmission-based precautions for infected patients.
6. **Patient Education:** Teaching patients about respiratory hygiene and hand washing.
7. **Environmental Control:** Regular cleaning of patient areas, waste disposal, and linen management.
8. **Safe Injection Practices:** Using sterile needles, avoiding recapping, and proper sharps disposal.
9. **Monitoring and Reporting:** Early identification of infection trends through surveillance (ICMR Reports 2020).

**Fig 3:** Diagram showing nursing interventions at each link of the infection chain.

Role of Nurses in Infection Control

Nurses are the frontline defenders in the fight against infection within healthcare facilities. As they spend the maximum time with patients, nurses act as the vital link between patients, physicians, and hospital systems. Infection control is not just a procedural responsibility; it is a core professional commitment that ensures patient safety, protects healthcare workers, and maintains hospital credibility. Infection control nursing integrates scientific knowledge, clinical skills, and ethical responsibility. Every nurse, regardless of department or designation, contributes to the prevention and control of infections through vigilant

observation, adherence to policies, and patient education (WHO Reports 2022).

The following are key roles and responsibilities of nurses in infection control:

1. Performing Proper Hand Hygiene and Aseptic Techniques

Hand hygiene is the single most effective measure to prevent healthcare-associated infections (HAIs). Nurses must practice hand washing using the WHO's "Five Moments of Hand Hygiene" before touching a patient, before a procedure, after body fluid exposure, after touching

a patient, and after contact with the patient's surroundings. Aseptic technique includes all actions aimed at keeping

areas and equipment free from pathogenic organisms (R. Bibi *et al*, 2022)^[19].

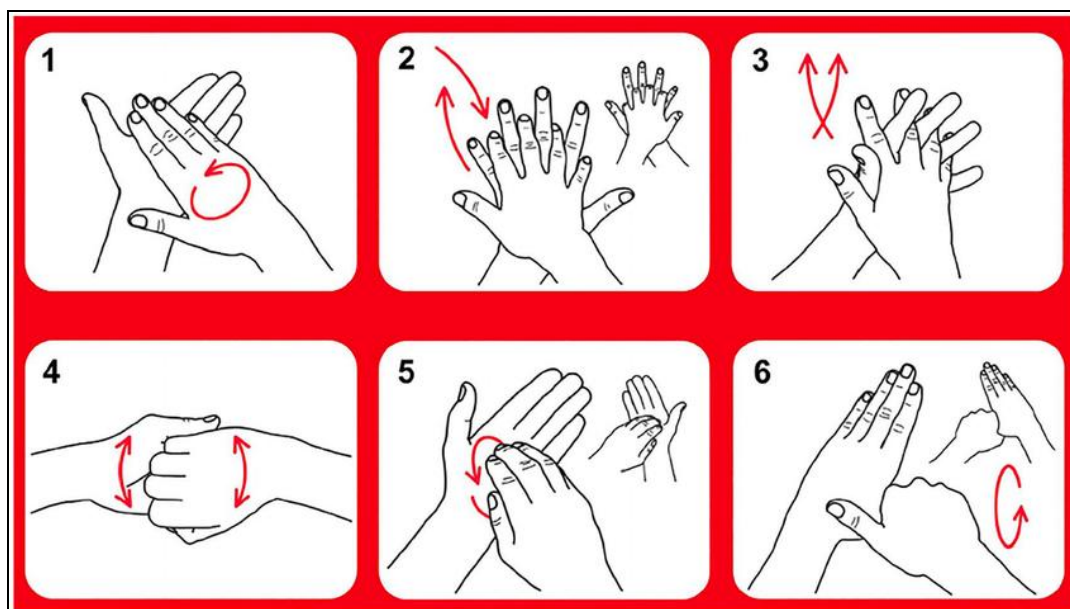


Fig 4: WHO's Six Steps of Hand Washing Technique

Table 3: Six Steps of Hand Washing

Step No.	Technique Description	Main Area Cleaned
1	Palm to palm rubbing	Central palm surface
2	Right palm over left dorsum and vice versa	Back of hands
3	Palm to palm with fingers interlaced	Finger webs
4	Backs of fingers to opposing palms	Nails and knuckles
5	Rotational rubbing of each thumb	Thumbs
6	Rotational rubbing of fingertips on palms	Fingertips and nails

2. Following Standard and Transmission-Based Precautions

Standard precautions apply to all patients, regardless of diagnosis. These include hand hygiene, use of PPE, respiratory hygiene, safe injection practices, and waste segregation (S. Tsolakidis *et al*, 2022)^[20].

3. Educating Patients and Attendants about Hygiene

Health education is a cornerstone of infection prevention. Nurses play an active role in teaching patients and their families about personal hygiene, handwashing techniques, respiratory etiquette, and waste disposal. In wards, nurses can display visual aids and posters to promote awareness. During the COVID-19 pandemic, nursing education at the bedside became crucial in reducing transmission by teaching correct mask use, social distancing, and home isolation procedures.

4. Supervising Cleaning, Sterilization, and Waste Disposal

Environmental hygiene is a collective effort, but nurses have a supervisory and monitoring role to ensure that cleaning staff follow protocols correctly. They must check that disinfectants are prepared in correct concentrations (e.g., 1% sodium hypochlorite for surfaces, 0.5% for spills) and that mops and buckets are disinfected after every use. In the Central Sterile Supply Department (CSSD) and clinical areas, nurses ensure that instruments are properly cleaned,

packed, labelled, sterilized, and stored.

5. Reporting Infection Incidents and Needle-Stick Injuries

Nurses must report any infection incidents or occupational exposures promptly. Needle-stick injuries (NSIs), blood splashes, or cuts must be managed according to the Post-Exposure Prophylaxis (PEP) protocol. Reporting ensures that corrective measures are taken immediately and that trends can be analyzed for preventive action.

6. Conducting Audits and Surveillance under HICC Guidance

Nurses play an essential role in infection surveillance collecting, recording, and analyzing data on HAIs such as CAUTI, VAP, SSI, and CLABSI. Infection Control Nurses (ICNs) participate in monthly audits to track compliance with hand hygiene, PPE use, environmental cleaning, and antibiotic stewardship. Audit findings are presented in HICC meetings, and corrective actions are implemented through staff training and supervision. Surveillance data not only prevent outbreaks but also improve hospital performance indicators for accreditation.

7. Ensuring Staff Immunization and Health Check-Ups

Nurses must ensure that all healthcare personnel, including support staff, receive mandatory vaccinations like Hepatitis B, Tetanus, and COVID-19. Regular health check-ups,

including screening for tuberculosis and other communicable diseases, are essential to prevent cross-infection. As role models, nurses should maintain their own health and immunity through vaccination, adequate rest, and proper nutrition.

8. Maintaining Accurate Records and Reports

Proper documentation is a hallmark of professional nursing practice. Nurses should maintain infection surveillance records, sterilization logs, waste management reports, and patient education registers. Accurate documentation ensures traceability, supports audits, and provides legal protection. Digital tools and infection tracking software can further streamline reporting. Consistent record-keeping also aids in identifying patterns and evaluating the effectiveness of infection control interventions.

9. Acting as Mentors for Junior Staff and Students

Senior nurses serve as mentors and trainers for junior nurses and students in developing infection control competencies. They conduct bedside demonstrations, evaluate practices, and provide constructive feedback. Through continuous supervision and role modelling, they instill a culture of safety and responsibility. Training in infection prevention must be integrated into orientation programs for new staff and reinforced periodically through workshops and simulation-based learning.

10. Promoting a Safety Culture in Wards and ICUs

Creating and maintaining a safety culture is one of the most impactful nursing roles. Nurses encourage teamwork, mutual accountability, and non-punitive error reporting.

They foster an environment where infection control is viewed as everyone's responsibility. In high-risk areas like ICUs, OTs, and maternity units, nurses lead daily safety huddles, ensure adherence to bundles, and report any deviations to the infection control team. Promoting a positive safety culture results in higher compliance, reduced HAIs, and improved patient satisfaction.

Waste Segregation and Color Coding

The color-coding system prescribed under the Biomedical Waste Management Rules is as follows:

- **Yellow bag:** Used for infectious waste such as soiled dressings, pathological waste, human tissues, body parts, expired medicines, and other materials contaminated with blood or body fluids. These wastes are typically incinerated or disposed of through deep burial.
- **Red bag:** Used for contaminated recyclable waste, including intravenous sets, catheters, tubing, gloves, and other plastic materials. Waste in this category is disinfected, shredded, and sent for recycling under authorized supervision.
- **White (translucent) puncture-proof container:** Used for sharps such as needles, scalpels, blades, and other items capable of causing cuts or puncture injuries. These are subjected to autoclaving or dry heat sterilization followed by shredding or encapsulation to prevent reuse.
- **Blue container:** Used for glassware, broken ampoules, and metallic body implants. After disinfection or autoclaving, these materials are either recycled or safely disposed of.



Fig 5: Color Coding System for Biomedical Waste Segregation.

Role of Nurses During COVID-19 Pandemic

The COVID-19 pandemic profoundly transformed the healthcare landscape and highlighted the indispensable role of nurses as frontline warriors in infection prevention and control. Throughout the crisis, nurses displayed extraordinary courage, adaptability, and leadership, working

tirelessly under immense physical and emotional stress to save lives and prevent further spread of infection. One of the primary responsibilities of nurses during the pandemic was to ensure effective triage, screening, and isolation of patients at hospital entry points. They implemented infection control protocols, including temperature screening,

symptom assessment, and segregation of suspected and confirmed COVID-19 cases to minimize cross-transmission. Nurses strictly adhered to Personal Protective Equipment (PPE) use, following proper donning and doffing procedures to avoid contamination. They managed critical patients requiring oxygen therapy, ventilator support, and emergency resuscitation, often working long hours in high-risk environments. Beyond clinical care, nurses played a pivotal role in public health education, teaching patients and families about mask usage, hand hygiene, social distancing, and vaccination. They also provided emotional and psychological support to patients isolated from their loved ones, demonstrating compassion and resilience during times of fear and uncertainty (WHO Reports 2021).

Infection Control Committee (HICC)

The Hospital Infection Control Committee (HICC) is the central body responsible for planning, coordinating, implementing, and monitoring all infection prevention and control activities within a healthcare facility. It ensures that infection control practices are standardized, evidence-based, and in compliance with national and institutional guidelines such as NABH, NQAS, and Biomedical Waste Management (BMW) Rules 2016-2019. The HICC serves as the backbone of the hospital's infection control program, integrating efforts from medical, nursing, laboratory, and housekeeping departments to maintain a safe and hygienic environment for patients, visitors, and staff (WHO Reports 2022).

Composition of HICC

The committee is multidisciplinary in nature and typically includes the following members:

- **Infection Control Officer (ICO):** A medical faculty member, usually a microbiologist or epidemiologist, who leads and supervises infection control activities.
- **Infection Control Nurse (ICN):** A specially trained nurse responsible for daily infection surveillance, audits, and staff training.
- **Microbiologist:** Provides laboratory support, analyzes culture reports, and identifies infection trends.
- **Nursing Superintendent or Matron:** Oversees nursing compliance and ensures adherence to infection control standards across wards.
- **Hospital Administrator:** Facilitates resource allocation, staff coordination, and implementation of committee decisions.
- **Pharmacist and Laboratory Technologist:** Support infection control through antibiotic stewardship and proper specimen handling.
- **Sanitary and Housekeeping Representatives:** Ensure environmental cleaning, waste management, and hygiene maintenance in patient care areas.

Nursing Role in HICC

Nurses play a vital role in the success of the HICC. The Infection Control Nurse (ICN) acts as the link between the committee and clinical areas, conducting surveillance, data collection, and on-the-spot training for staff. Senior nurses ensure compliance, monitor hand hygiene practices, and promote a culture of safety in every ward.

Infection Control Policies in India

1. Ministry of Health & Family Welfare (MoHFW)

The MoHFW, Government of India, provides overarching leadership and direction for infection prevention and control. It issues national guidelines for hospital infection control, hand hygiene, and biomedical waste management. These guidelines emphasize the creation of Hospital Infection Control Committees (HICC), infection surveillance systems, and training programs for healthcare personnel. The ministry also oversees implementation through the National Health Mission (NHM) and its quality certification programs such as Kayakalp and NQAS.

2. National Centre for Disease Control (NCDC)

The NCDC, under the Directorate General of Health Services (DGHS), functions as the national nodal agency for infectious disease surveillance and outbreak response. It has developed the "National Guidelines for Infection Prevention and Control in Healthcare Facilities" (2020), which serve as a cornerstone document for hospitals.

3. NABH / NQAS Accreditation Standards

The National Accreditation Board for Hospitals and Healthcare Providers (NABH) and the National Quality Assurance Standards (NQAS) provide benchmarks for infection control performance in both public and private hospitals. Hospitals accredited under these programs are required to have dedicated infection control nurses (ICNs), maintain documentation, and conduct regular internal audits.

4. Biomedical Waste Management Rules (2016, amended 2018-2019)

Issued by the Ministry of Environment, Forest, and Climate Change, these rules mandate safe segregation, collection, transportation, and disposal of biomedical waste. Nurses must follow the color-coded segregation system and ensure personal safety while handling infectious materials. Non-compliance can lead to legal penalties and environmental hazards.

5. LaQshya Program

The LaQshya (Labour Room Quality Improvement Initiative), launched by MoHFW, focuses on improving infection control and quality of care in maternal and neonatal care units. It sets standards for hand hygiene, environmental cleaning, sepsis during delivery, and waste disposal. Nurses working in labour rooms and neonatal units are directly responsible for implementing LaQshya protocols, ensuring safe childbirth and reducing maternal and neonatal morbidity.

Training, Education and Future Perspectives: Training and education in infection control form the cornerstone of a safe, efficient, and ethically grounded healthcare system. The modern healthcare environment is dynamic and constantly evolving, marked by emerging pathogens, technological advances, and complex patient needs.

Training Programs and Simulation-Based Learning:

Simulation-based learning has emerged as one of the most effective and innovative approaches to infection control

education. It bridges the gap between theory and practice by allowing healthcare workers to experience real-life clinical situations in a controlled and risk-free environment. Unlike traditional classroom learning, which focuses primarily on

knowledge acquisition, simulation emphasizes skill application, critical thinking, and decision-making under realistic conditions.



Fig 6: A training setup with mannequins, PPE stations, and nurse educators supervising practice sessions.

Conclusion

Infection control is the foundation of patient safety and quality nursing care. The rapid advancement of healthcare services in India has been accompanied by an increase in hospital-acquired infections (HAIs), antimicrobial resistance, and occupational exposure among healthcare workers. These challenges highlight the urgent need for every nurse to be well-trained, well-informed, and committed to infection prevention practices. This article, has been developed to provide a comprehensive, practical, and evidence-based guide specifically tailored for Indian nursing students and professionals. It bridges the gap between theory and real hospital practice, integrating content from national standards such as LaQshya, NABH, NQAS, BMW Rules (2016-2019), and Kayakalp programs. Nursing ethics serve as the moral and professional foundation for maintaining infection control in healthcare settings. Nurses are ethically obligated to ensure safe, infection-free, and equitable care for all patients. Ethical responsibility extends beyond technical competence to include honesty, accountability, and compassion in practice. Nurses must protect patient confidentiality, report any breach in aseptic technique, and avoid discrimination toward patients suffering from communicable diseases such as HIV, tuberculosis, or COVID-19. Ethical nursing practice also emphasizes self-protection ensuring that nurses follow all preventive measures, maintain immunizations, and use personal protective equipment (PPE) appropriately to minimize occupational hazards. During public health emergencies, such as the COVID-19 pandemic, nurses uphold moral values by providing continuous care despite personal risks, promoting infection awareness, and ensuring

that every patient receives respectful treatment. Ethical vigilance not only sustains professional integrity but also enhances public trust in the healthcare system.

Conflict of Interest

Not available

Financial Support

Not available

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