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Prevention and Control towards Hospital- Acquired Infections, Mixed-Methods Systemic Review

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Abstract

Background: Hospital-acquired infection is one of the leading causes of morbidity and mortality among hospitalized patients. It directly cause massive increase in costs and health risks. The transferrable antibiotic pathogens made this more complicated, such as *methicillin-resistant Staphylococcus aureus*, which transmitted by direct contact. *Salmonella spp,* air droplet-borne *Mycobacterium tuberculosis, Staphylococcus aureus, Brucella,* and *Shigella* are the most common laboratory infections causes.

Method: Mixed-Methods Systemic Review was used in this study. Search Strategy: A search was carried out in PubMed, Science Direct, Scopus, National library of medicine, Scientific reports-nature online using the keywords- Hospital-Acquired Infections, Infection Control, Transmission-Based Precautions (TBP), Laboratory-Acquired Infection, Environmental Contamination in the Transmission of Nosocomial Pathogens, Nosocomial Infections.

Results and Conclusion: The epidemiological rates of healthcare-associated infections (HAIs) are closely linked to infection control measures implemented in each healthcare system. Urgent need to improve the control of pathogens responsible for hospital-acquired infections. In addition to the limitation of the new article sources on the issue, sharing best practices between hospitals. More infection transmission methods studies to avoid hospital-acquired infection spread, and innovative new devices that reduce infection.

Keywords*:* Hospital-Acquired Infection (HAI), Infection control, Air drop, Laboratory- Acquired infection (LAI)

1. Background

A hospital-acquired infection (HAI) is generally defined as a clinically identifiable microbiological disease affecting patient as a result of hospitalization or infect health workers as a result of their work, whether or not symptoms of the disease appear (Currie et al., 2018). HAI is currently one of the leading causes of morbidity and mortality among hospitalized patients (Wang et al., 2021). This infection directly or indirectly leads to a massive increase in hospital care costs and new patient health risks (Cabral & Ag, 2019). Although it is challenging to manage primarily because it is widespread and antibiotic resistance, certain advancements have been made (Lemiech-Mirowska et al., 2021).

The World Health Organization (WHO) is very concerned about this situation, and the European Regional Office has stated that laboratories play an essential role in the prevention and control of hospital-acquired infections and that in recent years several laboratory tests have been conducted for the detection and classification of infectious diseases. A survey of laboratory infections indicates that *Staphylococcus aureus* (S. aureus)*, Pseudomonas aeruginosa,* and *Mycobacterium tuberculosis* (MTB) *(Samia et al., 2022) Brucella, Shigella, Salmonella*, and *Meningococcus* are the most common causes (AlMogbel et al., 2022). Infections with bloodborne pathogens (BBP) (*hepatitis B virus* (HBV)*, hepatitis C virus* (HCV), and *human immunodeficiency virus* (HIV) remain the most common viral infections (Hammoud et al., 2021).

Local infection control policy manuals should be developed in individual settings to guide staff in implementing the necessary measures and procedures. In addition, national and local regulations or guidelines must be documented and followed where applicable. Failure to follow guidelines may increase the risk of infection for patients and staff (Efendy & Hutahaean, 2022). This review will focus on an occupational health and safety review

for the control of antimicrobial-resistant organisms and diseases pervasive in healthcare, which are expected to have a significant impact on cost and morbidity in the foreseeable future by investigation the previous study.

2. Methods

2.1 Study Objectives

1) Assessment of Current Prevention Measures: Evaluate the effectiveness of existing strategies and protocols in place for preventing hospital-acquired infections (HAIs) across different healthcare settings.
2) Examine healthcare provider adherence to infection prevention protocols, barriers to compliance, and strategies for improving healthcare worker practices to mitigate the risk of HAIs.
3) Recognize the risks associated with working with pathogens.
4) Identify numerous hazardous microorganisms that have caused laboratory-acquired infections (LAI).
5) Improving knowledge about infection in hospitals and presenting the reasons for its spread by Offering evidence-based recommendations for enhancing HAI prevention and control efforts.

2.1 Study Design

Mixed-Methods Systemic Review was used in this study. For this systematic review we searched PubMed, Science Direct, Scopus, National library of medicine, Scientific reports-nature online using the keywords- Hospital-Acquired Infections, Infection Control, Transmission-Based Precautions (TBP), Laboratory-Acquired Infection, Environmental Contamination in the Transmission of Nosocomial Pathogens, Nosocomial Infections. All qualitative, quantitative and mixed-methods studies whose aim was to explore prevention and control towards hospital- acquired infections. Evidence was narratively synthesized into group of themes.

2.2 Search Strategy

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2.3 Inclusion Criteria

1). Studies focusing on hospital-acquired infections (HAIs), including healthcare-associated infections (HAIs) and nosocomial infections.

2). Research articles addressing interventions, strategies, or protocols aimed at preventing or controlling HAIs within healthcare settings.

3). Studies utilizing mixed-methods approaches, including qualitative, quantitative, or a combination thereof, to investigate HAI prevention and control.

4). Systematic reviews, meta-analyses, randomized controlled trials, observational studies, qualitative studies, and mixed-methods studies are eligible for inclusion.

5). Studies published in peer-reviewed journals within the specified timeframe and languages relevant to the research team's capabilities.

2.4 Exclusion Criteria

1). Studies not related to the prevention or control of hospital-acquired infections.

2). Research articles focusing solely on community-acquired infections or infections outside of healthcare settings.

3). Studies lacking a clear focus on interventions, strategies, or protocols for HAI prevention or control.

4). Publications that do not employ a mixed-methods research design or fail to provide sufficient methodological detail to ascertain the use of mixed methods.

5). Conference abstracts, editorials, commentaries, letters, and opinion pieces will be excluded.

6). Studies not available in full-text or those lacking sufficient data for analysis will be excluded.

2.5 Screening

Execute the search strategy in selected databases. Screen search results based on title, abstract, and full text according to inclusion and exclusion criteria established for the systematic review.

2.6 Data Extraction

Data on studies that met the inclusion criteria were extracted by one reviewer (HA), and a standardized data extraction form was developed that included the following headings: author/year, main focus of the study, method, country, sample, outcome measures and the study results.

3. Results

3.1 Hospital-Acquired Infections

HAIs are an important reason for raising the economic cost of hospitals, in along with the fact that acquiring them is one of the greatest causes of concern for health workers (Manoukian et al., 2018). Every single person involved in the design, administration, and operation of hospitals should work together proactively to prevent HAIs. In these situations, microbiologists have a crucial role due to their training and experience, which should have exposed them to the causes of infectious diseases as well as the sources and modes of transmission of pathogenic bacteria (Parker, 1978). Risk factors for HAIs are many, including improper infection control practices, the frequency of different pathogens within the community, immunosuppression, older age, prolonged hospital stays, several underlying comorbidities, multiple visits to medical facilities, mechanical ventilation assistance, recent invasive procedures, use of a urinary catheter, and stays in intensive care units (ICU) (Nair et al., 2017).

Concerns have been raised regarding the effect on patients with multidrug-resistant (MDR) organism infections who have increased resistance to antibiotics. As a result, many researchers have examined the clinical outcomes of patients infected with these pathogens, revealing greater mortality and frequent treatment failure among them compared to those infected with the susceptible isolates (Tseng et al., 2018). The whole cost burden of HAI is subdivided into direct and indirect costs. Direct costs are signified primarily by an additional hospital stay, drug treatment, and medical and surgical procedures, and indirect costs are represented by the patients' salary loss, relatives time, and infirmity (Barbaro et al., 2020).

Successful protection of healthcare workers also depends on predicting future accidents and potential factors and applying Occupational Safety and Health (OSH) interventions. As occupational hazards in their workplaces are many and varied, the application of rules plays an essential role in reducing hospital accidents and injuries (Koklonis et al., 2021). For instance, medical laboratories include a place where workers and their employers team up to adopt constant improvement processes that protect and promote safety, well-being, and good health among medical-laboratory staff and ensure medical laboratories sustainable development (Tait et al., 2019).

HAIs may be acquired in almost all hospital departments, such as dental clinics, dialysis, intensive care, bedridden patients, and clinic laboratories in particular. In dental clinics, infectious microorganisms can be transmitted from patients to dental team members as well as the other way around, as with dentist gloves (Upendran & Geiger, 2020). In dialysis clinics, the access site is related to 48–73% of all bacteremia hemodialysis patients, indicating that it is a significant source of infection (Shikha & Mishra, 2021). Water presents one of the greatest risks to dialysis patients if not adequately monitored. In contrast to the 14 liters of water the typical healthy person consumes each week, a single hemodialysis session requires nearly 500 L of water to make pyrogen-free dialysis water (Geremia et al., 2019).

In ICU, the incidence of hospital infection is high and causes mortality at a high rate. According to a report based on data for 2017 retrieved from The European Surveillance System (TESSy) on 26 April 2019 highlighted HAIs in ICU, 8.3% of patients who spent more than two days in ICUs had at least one ICU-acquired healthcare-associated infection (pneumonia, bloodstream infection, or urinary tract infection). In case of ICU-acquired pneumonia, *Pseudomona aeruginosa*, oagulase- negative *Staphylococc*i, and *Escherichia coli* (*E.coli*) were the most frequently identified microorganisms (Salmanov et al., 2019).

A study was performed in which all wards of the Jimma University Medical Center (JUMC) got involved, in which the rate of HAIs was determined, as biological samples were collected from all patients suspected of having infection in the hospital and the outcomes were as shown in Figure 1, which demonstrated the highest infection rate in the ICU and the lowest infection rate in the ophthalmology ward (Ali et al., 2018).

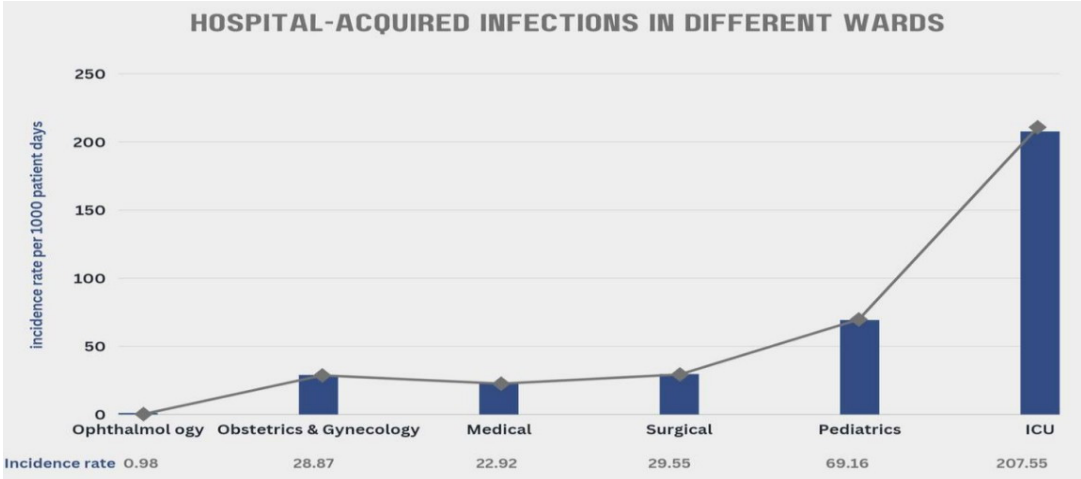

Figure 1. The rate of HAIs incidence in different wards at Jamma University Medical Center

According to statistics from the European Union (EU), the most prevalent HAI are caused by about ten bacterial species, as shown in Figure 2, and they affect more than 4 million patients, murdering 37,000 of them (Szabo et al., 2022).

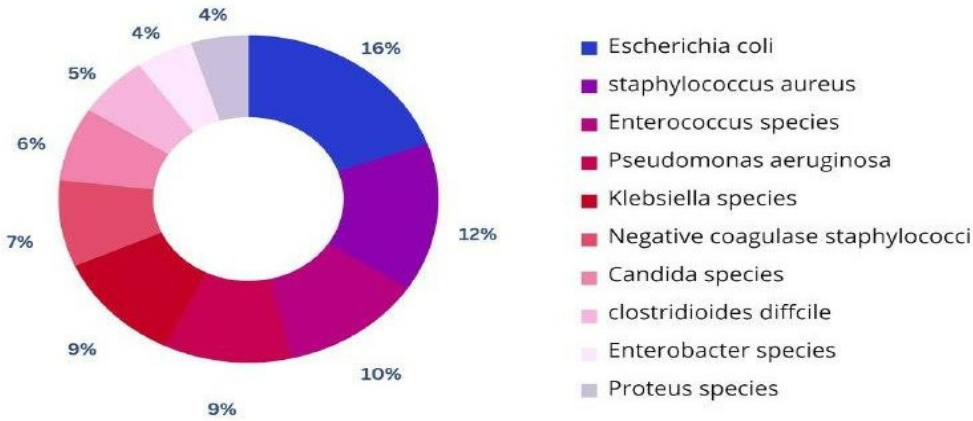

Figure 2. Representation of the most frequent isolated bacteria in the EU that cause HAI

The results were as shown in Figure 3, with ICUs reporting the highest rates of HAI (48.4%) and *Acinetobacter baumannii, Clostridioides difficile, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *S. aureus* being the five most common HAI bacteria (Voidazan et al., 2020).

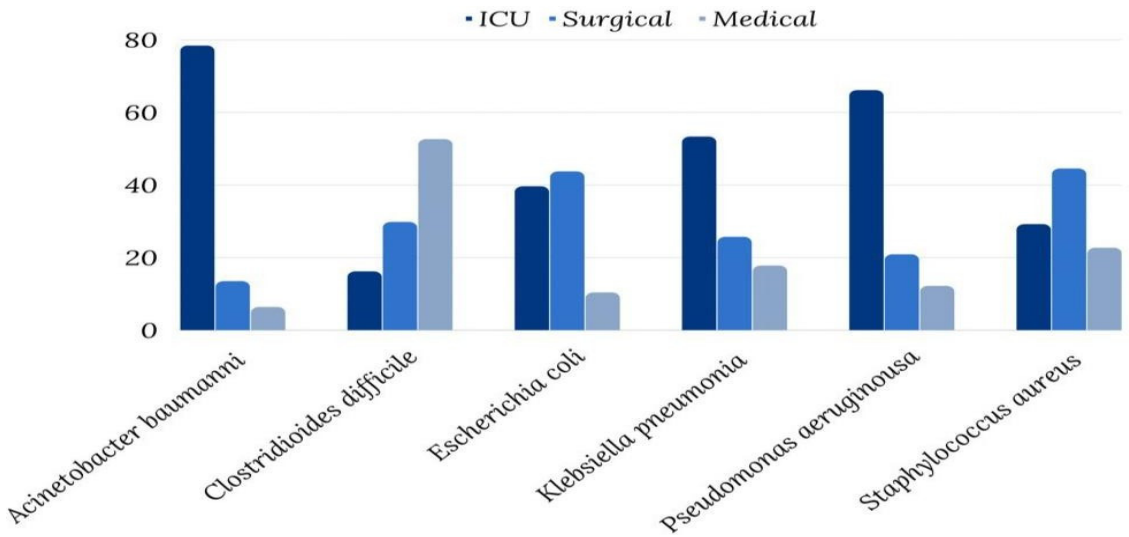

Figure 3. The pathogen rate depending on the type of hospital department

3.2 Laboratory-Acquired Infection

Clinical laboratories, especially in the microbiology section, still face the risk of laboratory- acquired infections (LAIs). Most laboratory workers who handle biological specimens are exposed to a multitude of infectious materials as well as susceptible to hazards from clinical specimens and cultures. This is especially true of research involving pathogenic agents like viruses, parasites, fungi, bacteria, or genetically modified organisms. **(Figure 4)** (Coelho & Díez, 2015).

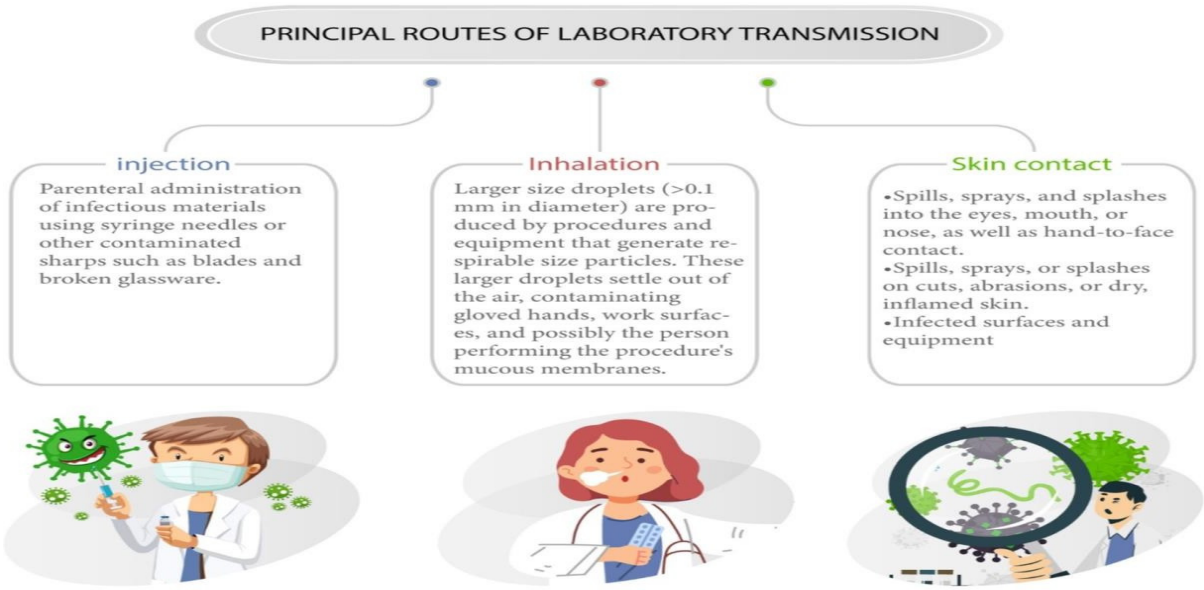

Figure 4. The common route of exposure and accidental inoculation

Symptomatic and asymptomatic illnesses can be considered LAIs, defined as any infection contracted in a laboratory through laboratory actions. The literature describes LAIs brought on by many different microorganisms. In 1976, Pike announced the results of the largest infection survey, which uncovered 4079 LAIs caused by 159 biological agents. However, just ten agents were responsible for infections in 50% of instances, the most common infections are shown in clinical laboratories (Table 1) (Wurtz et al., 2016).

Table 1. Most common laboratory-associated disease and risk of LAI in microbiologists versus the general population

Organism	Risk per 100,000 Microbiologists	Risk per 100,000 General Population	References
Brucella species	641	0.08	**(Baron & Miller, 2008)**
Mycobacterium tuberculosis	NA	NA	**(Coelho & Díez, 2015)**
Neisseria meningitidis	25.3	0.62	**(Baron & Miller, 2008)**
E. coli O157	8.3	0.96	**(Baron & Miller, 2008)**
Coccidioides immitis/posadasii	13.7	12	**(Baron & Miller, 2008)**
Shigella species	6.6	6.6	**(Baron & Miller, 2008)**
Salmonella species	1.5	17.9	**(Baron & Miller, 2008)**
Clostridium difficile	**0.2**	**8**	**(Baron & Miller, 2008)**

Early surveys of laboratory-acquired tuberculosis (TB) found a three to nine times higher incidence of TB among laboratory personnel than in the general population (Singh, 2009). The greatest risk of LAI for laboratory personnel handling TB is associated with aerosol generation. Cases of TB associated with inadequate isolation procedures and large volumes of specimens handled have been reported (Kao et al., 1997). To avoid the possibility of LAI, TB should be handled in grade II or III Biological Safety Cabinet (BSC) (Singh, 2009).

Carry-out bags, as well as primary specimen containers, were a potential source of infection for laboratory workers who had to collect them for trash. Furthermore, contamination from these items may have spread to other areas of the facility. Such as, specimen carrier bags were opened and unpacked on laboratory benches, primary containers were handled, sticky labels were affixed to the containers for lab information system registration, and laboratory employees were at risk of being unintentionally exposed to biohazardous chemicals. Bag opening/unpacking methods may cause specimens to spill (Wong et al., 2020).

Working with infectious materials on a daily basis poses a health hazard to laboratory workers as well as those involved in sample collection and transportation. Dealing with pathogenic microorganisms requires good laboratory practices, risk assessments, and biosafety measures. Reports indicate that 43% of LAIs occur in clinical laboratories and 39% occur in research laboratories (Siengsanan-Lamont & Blacksell, 2018). An HIV infection survey between 2007 and 2012 indicated 94 cases, 23% of these cases were caused by *Salmonella spp*, and 16% by MTB. According to Sewell finding the most common pathogens that lead to LAIs are bacteria (*Shigella spp., Salmonella spp., E.coli, Francisella tularensis, Brucella spp.,* and MTB), viruses (such as HBV and HIV), and a dimorphic fungus. In addition to many viruses that posed a risk due to its wide spread recently (such as SARS*, influenza, West Nile virus,* and *Ebola viruses*), are important potential pathogens for LAIs (Peng et al., 2018).

Determining the source of infection in a laboratory worker can be difficult because the causative agent is sometimes present in the laboratory and outside the workplace in the population. Therefore, training and education are necessary to avoid outbreaks (Risi et al., 2010). Avoiding work-related infections requires acquaintance with basic microbiological protocols and techniques, as well as the use of confinement devices, facilities, and protective barriers (Coelho & Díez, 2015). These days, most biological hazard threats may be mitigated through well-established protocols, well-designed containment systems, and well-trained personnel (Wurtz et al., 2016).

3.3 Infectious Agent's Modes of Transmission

At the onset of coronavirus disease 2019 (covid-19), caused by *severe acute respiratory syndrome coronavirus 2* (SARS-CoV-2), the mitigation strategies used to prevent covid-19 from becoming a global epidemic were insufficient (Choudhary, 2020), as the rate of infected people was increasing with high mortality due to the limited clarity of information on the transmission of the virus (Guzman, 2021). Considering the pathogen spreads from an infected person to another host through the air or by touching a contaminated surface (Williams, 2020). Hence, there are two types of transmission according to the transmission modes (direct transmission (direct contact and droplets) and indirect transmission (airborne and vehicle-borne)) (Figure 5) (Wynn, 2021). To eliminate gaps, we must know the transmission modes for the infection agent, and reference instructions should be put in place on this basis to break the chain of infection spread.

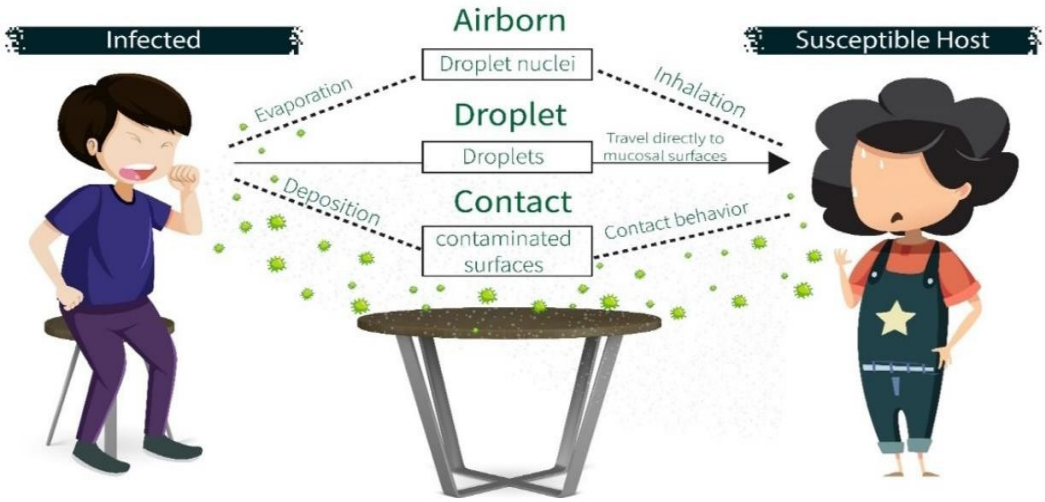

Figure 5. Transmission modes

When an infected person experiences defensive reflexes such as sneezing and coughing, the emit pathogen-containing particles spread in the air based on their physical and chemical forms, which can determine the mode of transmission. Such as, in cases of sneezing, the liquid containing the microbe evaporates, it becomes a droplet nucleus like (A), and some of them remain the same size, which is called a droplet. (B) Gravitation plays a role in pulling the droplet to the surface, where it becomes contaminated. As a result, a susceptible host can hold the contaminated surface and be exposed to the pathogens this is called indirect contact, like (C).

3.3.1 Direct Transmission

Physical contact that person-to-person contact transfers the pathogen between susceptible hosts and infected (Asadi et al., 2020). The majority of HAI instances result from contact transmission of the disease (Protano et al., 2019).

3.3.2 Droplets

Most respiratory infections are to be spread by large droplets than 5 μm (Fennelly, 2020a), which are released by talking or sneezing. It spreads over short periods and is infected over short distances, about 1 m. Sneezing occurrences are simulated in such settings. On the other hand, larger droplets were shown to transport more than 2 m at a velocity of 10 m/s when reordered at the point of departure, replicating coughing sessions. The mode of transmission of SARS-CoV-2 is still a matter of debate. Some studies indicated that in the isolation room for SARS-CoV-2 patients, the aerosols did not have any SARS-CoV-2 genome. In contrast, the toilets used by the infected people contained a percentage of the virus. They indicated that the temperature and humidity levels in the surrounding area play a crusher in the spreading of the virus. In addition, bubbles that rupture can also spread the infection through the droplets (Figure 6) (Liu et al., 2020). We holed at the view that transmission-based precautions (TBP) must be used to prevent droplets and aerosols.

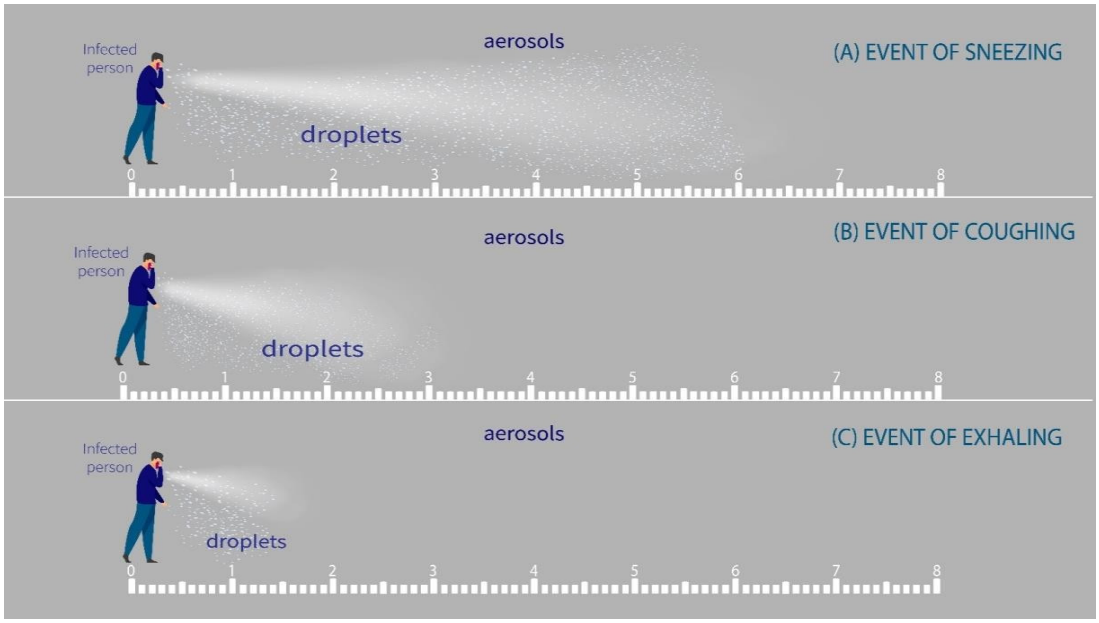

Figure 6. An infected patients droplet and aerosol trajectory

3.3.3 Direct Contact

It involves close contact, oral care, or skin care. It was mentioned earlier that the mechanism of infection is more prevalent in dental clinics. During the SARS-CoV-2 epidemic, MRSA has been recognized as an increasing problem (Samia et al., 2022). The danger lies in it is resistance to many antibiotics. Further, the possibility of infection is lower in dental clinics, unlike the rest of the hospital departments, due to the shorter period the patient stays (Volgenant & de Soet, 2018). Another microorganism commonly associated with HAIs and the most common cause of diarrheal infection is *C. diff* (Tschudin-Sutter et al., 2018). A contaminated hospital environment promotes its spread to patients (Durovic et al., 2018). Additionally, transmission occurs when droplets containing infectious agents come in contact with the hands and are transferred (Table 2) (Ai et al., 2020).

Table 2. The most common bacterial infection that occurs through direct contact.

Agent	Disease	Environment	Transmission Pathway	TBP	Mood of transmission	Reference
Methicilli resistant Staphylococus aureus (MRSA)	Skin infections Lung infection	Dental medical, Surgery, medical devices inserted in their body	Skin scales of various sizes Nasal mucosa (Anterior nares)	Hand hygiene Hand wash Gloves, Gowns	Aerosol, direct Contact.	**(Lee et al., 2018)**
Clostridium difficile (C.diff)	**Diarrhea**	**Hospital environment contaminated Interaction with carriers who are symptomatic**	**Fecal-oral route contaminated hands**	**Hand hygiene Gloves, Gowns**	**Direct contact Indirect contact**	**(Durovic et al., 2018) (Tschudin -Sutter et al., 2018)**

3.3.4 Indirect Transmission

Transmission involves a susceptible person coming in contact with a contaminated surface, such as a contaminated instrument (Suleyman et al., 2018).

3.3.5 Airborne

Inhalation droplet nuclei from air contaminants when suspended in the air, they dry and produce particles called aerosols ranging less 5 µm, these particles can float in the air for a long time, especially when bound to dust particles (Fennelly, 2020b). It is also influenced by environmental variables such as temperature, relative humidity, airflow, and ventilation. Dental procedures can spread infectious illnesses in three ways, as shown in (Figure 7) (Shajahan et al., 2019).

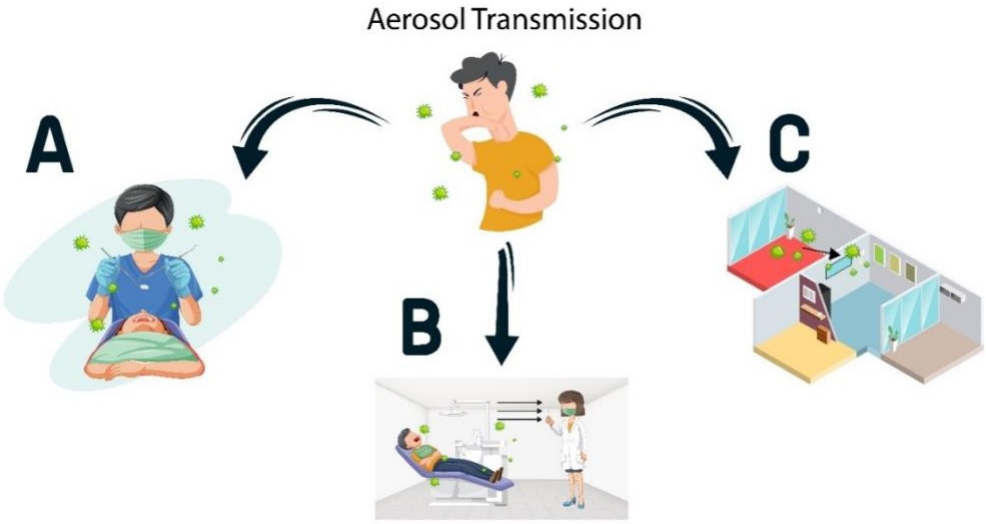

Figure 7. Level of infection transmission in dentistry

The transmission mode is further classified as obligate, preferential, or opportunistic. Agents are only naturally transmitted through obligate diseases like MTB (Bussi & Gutierrez, 2019). Preferential airborne transmission applies to pathogens such as (measles) that are transmitted by aerosols but can also be transmitted by other routes (Milton, 2021). Other pathways usually spread opportunistic airborne infections, but in favorable circumstances, especially when aerosol-generating procedures like intubation are carried out, transmission can happen; examples include influenza (Milton, 2021).

Measles is considered disease It is caused by *RNA paramyxovirus* found in the nose and throat that has a vaccine, but it is affected by the herd immunity of the medical staff among of those elderly doctors and nurses around pregnant women can be highly infected. A recent study confirmed a new measles outbreak in two healthcare institutions in South London and the United Kingdom in pediatricians office and ICU as result of poor ventilation which contributed to the spread of measles through the air (Kutter et al., 2018). Chickenpox is caused by the *varicella-zoster virus* (VZV). Which might spread to patients and other susceptible coworkers, VZV infection is regarded as an occupational danger for susceptible healthcare workers (HCWs) (Yang et al., 2019). TB is a serious disease that attacks the lungs and is transmitted by MTB, which caused a problem of TB from one person to another through droplets (Table 3) (Bussi & Gutierrez, 2019).

Table 3. The most common Indirect infection agent that occurs through Airborne

Agent	Disease	Environment	TBP	Mood of transmutation	Reference
RNA paramyxovirus	Measles	Pediatricians' offices intensive care unit	Report suspected cases within Vaccination Mask	Airflow Coughing	**(Kutter et al., 2018)**
Varicella-zoster virus (VZV)	Chicken pox	Different wards and units	Mask	Airborne Droplets or direct contact (coughing and sneezing)	**(Yang et al., 2019)**
Mycobacterium tuberculosis (MTB)	**Tuberculosis**	**Different wards and units**	**Mask**	**Airborne (Coughing and sneezing)**	**(Bussi & Gutierrez, 2019)**

3.3.6 Transmission-Based Precautions (TBP)

In some cases, standard precautions (SP) are insufficient to combat the transmission of infection, so you have to resort to TBP (Table 4) (Jesus et al., 2019).

Table 4. Control infection according to transmission-based precautions

TBP	Precautions	Reference
Airborne	Maintain routine precautions Negative pressure chamber Use specialized tools. Use the proper PPE. respirator masks (N95)	**(Liu et al., 2020) (Long et al., 2022) (Chen et al., 2022)**
Droplet	Standard precautions also used with proper PPE. Surgical masks. Patients should be confined in a separate room with the door closed or with sufficient ventilation with other patients afflicted with the same infectious agents. Use specialized tools	**(Chen et al., 2022)**
Contact	**Standard precautions also used with proper PPE.** **HCWs must wear a clean, non- sterile disposable gown and clean, examination gloves.** **Use good hand hygiene before and after any patient encounter (Rosa, Listiowati, and Sari** **2019)**	**(Rosa et al., 2019)**

3.3.7 Vehicle-Borne

BBPs referred to any microorganism such as viruses, bacteria and parasites that are transmitted from the blood which leads to result in life-threatening diseases (Castillo et al., 2019). The most common BBPs are the HIV, HCV, HBV (Asmr et al., 2019). HBV or HIV, can live outside the body for more than a 6 week (Terrault et al., 2018). In particular, nurses are usually close to patients and hence more likely to be exposed to microbes than other healthcare professionals (Kasatpibal et al., 2016). Following blood exposure, several factors, including the quantity of the virus in the blood, the length of the contract, the existence of skin lesions, and the immunological status of healthcare workers, might increase the likelihood of bloodborne viral transmission (Kasatpibal et al., 2016). A key element of risk reduction is avoiding contact with potentially contaminated tissues, bodily fluids, and blood and taking precautions when infected, and hands must be washed immediately and thoroughly disinfected to

avoid cross-infection.

4. Discussion

4.1 How Long Can HAI Pathogens Survive on Textiles?

There is a direct relationship between the duration of the microbes stay on the surface and the infection rate in others. The majority of gram-positive bacteria, including MRSA, can survive on dry surfaces for months (Laheij et al., 2012). Many gram-negative bacteria may persist for months on inert surfaces (Zahornacký et al., 2022). MTB and *C. diff*, may persist on surfaces for months (Fabiana Meijon Fadul, 2019; Martinez et al., 2019). Gram-negative bacteria have been shown to survive longer than gram-positive bacteria (Jamal et al., 2018).

4.2 Infection Control

The success of an infection control depends on being up to date with the most recent information on how pathogens spread and how to avoid them (Peters et al., 2020). Guidelines for reducing infections have recently been released by the Centers for disease Control and Prevention, WHO and surgical site infections (SSIs). However, there is a substantial gap between clinical practice and the best evidence when it comes to knowledge, attitude, and awareness of infection prevention and control methods regularly fall short. Evidence-based procedures and methods that have been shown to lower the frequency of infections are frequently underutilized in daily practice (Melnyk, B. M., & Fineout-Overholt, 2022).

4.3 Transmission from Environment

Unhygienic environment is the ideal source for the pathogenic organism to prevail. Food, water, and the air can all become contaminated and spread to the patients receiving medical care (Medher et al., 2019). Airborne bacterial contamination can be eliminated with proper ventilation and fresh, filtered air (Mohammad et al., 2022). Infections contributed to water are caused by the inability of healthcare institutions to satisfy the accepted standards. Separate baths must be supplied to infected patients. Food borne infections may result from improper food management. The area must be hygienic, and the food must pass minimum standards (Khan et al., 2017).

4.4 Transmission from Staff

there is a risk of infection spread by medical professionals. Healthcare practitioners have a responsibility to participate in infection control. Staff members need to practice good personal hygiene, thus they should do (Ghafoor et al., 2021). Hand hygiene, sterilized tools and safe injection techniques should be applied. For the delivery of healthcare, the use of masks, gloves, headcovers, and/or appropriate uniforms is crucial (Youssef et al., 2021).

4.5 Hand Hygiene

Labarraque, Semmelweis, and Wendell Holmes worked to prevent HAIa that patients acquire in hospitals. That is practicing proper hand hygiene is an essential component of providing effective medical services (Birgand et al., 2018). There is a lot of epidemiological evidence to indicate a role for hand hygiene in lowering HAI, even though the fact that interventions are typically multimodal and direct causal benefits are challenging to demonstrate. MRSA and *methicillin-susceptible staph* (MSSA), two kinds of *S. aureus* bacteria common in hospitals, decreased by 63% with hand hygiene application (Haque et al., 2020). Hand washing is a crucial component of HAI prevention programs and a reliable sign of a hospital's safety and quality management systems (Mclaws, 2015).

4.6 Vaccinations

The purpose of vaccinations is to provide immunity against a particular disease. By giving the host a small amount of the disease-causing virus or bacteria, vaccines encourage the development of the host's own natural immunity. Due to the extensive use of vaccines, the spread of several illnesses, such as polio, mumps, whooping cough, and rubeola (measles), has been delayed or in some cases entirely eradicated (Mizan-aman et al., 2015). Anyone who receives a vaccination will almost certainly be protected against the disease against which they are immunized. The most common and necessary vaccines include HBV, Influenza, Measles, Mumps, Rubella (MMR), HIV, and Varicella (Chicken Pox). Also, there is a vaccine for covid- 19 which provide a protection against corona disease (von Linstow et al., 2019).

4.7 Hospital Waste Management

Hospital waste has the potential to operate as a pathogen reservoir and must be handled carefully. Hazardous waste is defined as 10–25% of the waste produced by healthcare facilities, and the waste that are infectious should be kept in a place with limited access (Ferronato & Torretta, 2019). The hazards of waste and how to manage it properly should be made clear to healthcare professionals and cleaners to follow the rules properly (Khan et al.,

2017).

4.8 Improving Social Determinants

Another essential component of controlling infectious diseases is addressing and enhancing socioeconomic determinants of health within societies (Snyder-Mackler et al., 2020). WHO has identified three "typical mediations" for advancing medical issues globally. Education: There is a significant link between education and health. Social Security: Having access to social security and cheap healthcare can have an impact on a community's health and behavior. Urban Development: The layout of our towns, villages, and cities can have a big impact on how diseases are spread and how people stay healthy (Fashafsheh et al., 2015).

5. Conclusion and Future Direction

In conclusion, healthcare-associated infections (HAIs) continue to persist to the present day, causing significant economic and individual losses. The epidemiological rates of HAIs are closely linked to infection control measures implemented in each healthcare system. Therefore, innovative solutions must be developed to decrease the infection rate. We have designed several innovations aimed at reducing the possibility of HAIs, including the automatic blood-drawing chair. This chair ensures a high level of protection through automatic sterilization and self-discharg. In addition to an anti-penetration glove that reduces the possibility of injuries from sharp materials, there is also a droplet and aerosol sensor that can help detect the presence of pathogens.

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The data that support the findings of this study are available on request.

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The authors declare that there are no competing or potential conflicts of interest.

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