Methicillin-Resistant *Staphylococcus aureus* (MRSA) Prevalence in Clinical and Hospital Environmental Samples: A Review

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A thesis submitted to the Department of Mathematics and Natural Science in partial fulfillment of the requirements for the degree of

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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing a degree at Brac University.

2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The thesis does not contain material that has been accepted, or submitted, for any other degree or diploma at a university or other institution.

4. I/We have acknowledged all main sources of help.

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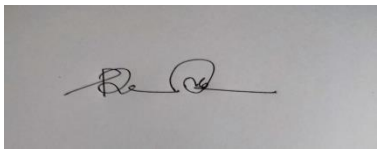

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Approval

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Abstract:

The potential function of polluted ambient surfaces as a methicillin-resistant *Staphylococcus aureus* (MRSA) reservoir in medical facilities is the topic of discussion in this paper review. The *Staphylococcus aureus* bacteria is known as methicillin-resistant *Staphylococcus aureus*. Multiple-resistant *S. aureus* is distinguished by its resistance to the antibiotic methicillin and to related semi-synthetic penicillin. Over the years, especially in the past decade, the infection rate of MRSA has become prevalent. In this review, the main focus was on the colonization of MRSA on clinical and nosocomial surfaces. Maximum MRSA colonization occurred on the equipment doctors and health care personnel used. Like scissors, syringes, injections, etc. On the other hand, patients with different diseases and different injury cases are infected by MRSA. So, in health care units (ICUs), there are bed rails, bedside tables, door knobs, handle locks, and many other different materials that have been colonized with MRSA. MRSA infection affected patients' lungs, urethra, wounds, genitals, urine, blood, body fluids, eye sights etc. Then, country-based infection was most prevalent in Bangladesh, Pakistan, Germany, India, Brazil, Ukraine, Japan, the UK, and the USA, and the prevalence rate was increasing in these countries. Different samples from patients were also collected for MRSA screening, like blood, sputum, and a nasal swab. Then a compare-and-contrast study has been documented to determine if only methicillin-resistant *Staphylococcus aureus* is responsible for the infection or if any other antibiotics like rifampicin, vancomycin, oxacillin, or erythromycin can also become resistant to *S. aureus.* The prevalence rate was then demonstrated among those countries and samples. A few risk factors are discussed as MRSA is globally affecting hospital environments, which is harmful for the patients along with the doctors, nurses, and other staff. Prevention can be done properly by maintaining cleanliness, sterilizing, and washing equipment. Mostly, MRSA causes infection. As MRSA becomes a great threat to us, we should be more careful and concerned about it.

Keywords:MRSA, Nosocomial, hospital environment, patient sample

Dedication

Dedication is the expression of a friendly connection or thanks by the author towards another person. Huge support from parents and respective faculty members.

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Chapter 1

INTRODUCTION:

1.1 Background and Development of MRSA Treatment

MRSA, broadly known as methicillin-resistant *Staphylococcus aureus* or multidrug-resistant *S. aureus*, is basically a bacterium in the genus Staphylococcus that is resistant to methicillin and similar semi synthetic penicillin. MRSA is a strain of *S. aureus* bacteria that was initially discovered in the early 1960s, shortly after the introduction of the antibiotic methicillin. Despite the fact that, methicillin is no longer used, more than 50 million people worldwide are infected with MRSA. It is usually detected on the skin, in the nose, in the blood, and in the urine. MRSA lives on surfaces for months, making it easy to

Colonization in homes and healthcare settings has become an important source of nosocomial infections as hospital medicine expands. The blaZE, lactamase gene was responsible for the development of penicillin resistance in the 1940s. Around 1960, the first semi synthetic anti staphylococcal penicillin were created, and *S. aureus* (MRSA) was identified within one year of first clinical use. In fact, genetic data indicate that methicillin resistance existed before the emergence of antistaphylococcal penicillin. (Rogers.K, 2023). Methicillin resistance is mediated by mecA and obtained by horizontal transfer of mobile genetic material known as the staphylococcal mec chromosome cassette (SCCmec3). Almost any object that comes in contact with the skin, from a white coat and ties to a pen and cell phone, can act as a host for MRSA transmission. (Britannica, 2023). Colonies can last for a long period of time. MRSA can also exist in the home setting, making elimination more difficult. It has been shown that strains can

change and even be substituted in the same host, proving that the colonization process is not static. Because MRSA can infect almost any site in the body, the most effective treatment depends on the site of the infection. In *S. aureus* sepsis, echocardiography and infectious disease counseling have well-established functions. Various new antimicrobials against MRSA, including cefazoline, ceftobiprole, dalbavancin, oritavancin, iclaprim, and delafloxacin, are currently under clinical trials. MRSA continues to be an important pathogen with persistently high mortality, despite the continued discovery of new drugs, active surveillance efforts, and breakthroughs in infection prevention. The introduction of antibiotics reduces mortality from bacteremia caused by *S. aureus.* (Rogers, K. 2023,)

1.2 Severity of MRSA

S. aureus, sometimes called the "Staph" bacteria, is commonly found in the skin or nose of about one-third of the population, which is highly sensitive. Usually, these antibiotic-resistant bacteria cause mild skin infections in people who are physically fit and healthy. When *S. aureus* bacteria are able to create resistance, they can cause serious infections or other opportunistic diseases. According to a study conducted by the Centers for Disease Control and Prevention (CDC) in the United States, about 5% of the population contains the MRSA strain. In 1961, MRSA was initially identified. It is resistant to several antibiotics, including methicillin, penicillin, oxacillin, cloxacillin, cefazolin, and cefoxitin. MRSA can be transmitted through intimate contact with an infected person. (Britannica, 2022). It can cause infection or colonization from an object contaminated with MRSA to a person or from a host to another person. Hospital-acquired infections are generally infections acquired in hospitals and other healthcare settings. HA-MRSA refers to MRSA infections that occur in a hospital or health care

facility. CA-MRSA stands for MRSA infections that occur in associated community settings. It is easily transmitted by skin-to-skin contact between healthy people. CA-MRSA can infect elderly or disabled people living in crowded environments. MRSA infections can be resistant to many commonly known antibiotics; therefore, they are more difficult to treat. MRSA infections can affect the blood circulation, heart, bones, lungs, and joints of MRSA victims. Infections are declared "priority pathogens" by the World Health Organization (WHO) due to their efficient replication and potentially fatal transmissibility. Clinically isolated strains of *S. aureus* with MRSA ranged from 28% in Indonesia to 55% in the Philippines. In 2008-2009, two multicenter studies in India showed MRSA prevalence rates of 41% and 45%, respectively. According to a trial published in 2020, MRSA usually affects sensitive tissues and skin. Bacteremia, which is caused by *S. aureus*, is associated with a mortality rate of 15% to 60%. MRSA can also harm children and adults of all ages. Patients died in the United States in 2005, and the number of deaths was greater than the number of HIV/AIDS deaths. In 2011, a risk stratification-based surveillance (RSS) program showed that the proportion of clinically isolated failures to promptly detect and treat MRSA bacteremia can lead to sudden death. Some assessments conducted in the United States show that up to 30% of young adults have MRSA on their skin or nose. Most children and adults are not aware they are carrying MRSA; therefore, germs that live on their skin and nostrils create serious consequences in the event of opportunistic health problems. (Turner, N. et al.2019)

1.3 Recent MRSA risk

In every country in the world, the spread of MRSA has been documented. MRSA is now common in the majority of hospitals worldwide. MRSA has been considered a major hazard by the CDC after analyzing a variety of variables, including its impact on healthcare infrastructure and populations, prevalence, and increasing trends in prevalence. Drug resistance, treatability,

mortality, prevention, and transmissions are the main concerns. The annual healthcare costs associated with the treatment of MRSA infections are estimated at $3 billion per year. Due to its successful clones, CA-MRSA is known as the most common strain of MRSA in the past 10–20 years. According to a study by the Asian Network for Surveillance of Drug-resistant pathogens (ANSORP), the prevalence of MRSA infection in 2004–2006 was 38.1% in the Philippines, 57.0% in Thailand, and 74.4% in Vietnam. Another piece of data shows that 18,000 strains of *S.aureu*s carrying MRSA ranged from 28% in Indonesia to 55% in the Philippines. In 2008-2009, two multicenter studies in India showed MRSA prevalence rates of 41% and 45%, respectively. According to a trial published in 2020, MRSA usually affects sensitive tissues and skin. Bacteremia caused by *S. aureus* is associated with a mortality rate of 15% to 60%. MRSA can also harm children and adults of all ages. Failure to promptly detect and treat MRSA bacteremia can lead to sudden death. Some assessments conducted in the United States show that up to 30% of young adults have MRSA on their skin or nose. Most children and adults don't know they are carrying MRSA, so germs that reside on their skin and nostrils create serious consequences when there are opportunistic health problems. (Iglesius B. et al. 2019)

Chapter 2

Methods:

Methicillin Resistant *Staphylococcus aureus* (MRSA) Prevalence in Hospital Environment and Patients was the title selected. We finally selected over 40 papers out of 200 papers that are relevant to our selected topics. Very few papers only described and made research about the methicillin-resistant *Staphylococcus aureus*, which can infect patients in hospitals in different organs like the nostril, sin, vagina, lungs, etc., but in this paper review we only included papers from PubMed and Google Scholar. These websites are well known for publishing papers on variety of topics. Firstly, all the sources were screened, and then we finalized the articles and sources that were included in our final review article. Then analyzed surveys, calculation graphs, and charts which were constructed in the review article. Since the topic is methicillin, identified with *Staphylococcus aureus,* we made a part about a comparison of the resistance of methicillin and other antibiotics. In this paper review, we only discussed the nosocomial infection of MRSA. That means only MRSA infection-related hospital environment papers will be selected.

2.1. Study selection

After screening through the papers, we selected 40 that were infected and seemed relevant to that topic. In these 40 papers, 13 were review articles, and 27 were published papers of different authors. Exclusion and inclusion criteria were followed. Then we went through the process for exclusion. In this exclusion criteria, we excluded those articles where the Community acquired MRSA, MRSA infection in veterinary hospitals, MRSA infection in athletes and households.

Many papers were excluded because they only asked about patients who were infected with MRSA. But the main target of the paper review was to compile the information and calculations about nosocomial infections; most recorded cases were in hospital environments like door knobs, door handles, beds, railings, and stair cases. On the other hand, scissors, needles, cups, syringes, and injections—these medical elements are also infected with MRSA. So, in inclusion criteria, the papers which were related nosocomial and clinical environmental infection are selected.

2.2. Analysis

In this part, all the papers and journals from the years 2010–2022 are chosen for the paper review. But some journals were from the 90s. Basically, the review paper will contain systematic graphs and tables of yearly spread and infection. Then, globally and country-wise, it spread along with the spread rate of Bangladesh. The graphs tables will symbolize the prevalence and decrease. The calculation will be formatted in percentages or exact numbers. The review article is based on a global survey of Saudi Arabia, India, Kenya, Brazil, Ukraine, Japan, Germany, Switzerland, France and many more countries. Then other antibiotics which were compared with the resistance of methicillin in *Staphylococcus aureus.* Risk factors of MRSA colonization and way of prevention were discussed briefly.

Chapter 3:

MRSA Colonization

3.1 Infected patients among countries:

MRSA infection took place mostly over the decades after 9the 1990s. ut most of the infections occurredd among patients in different organisms in different time periods. Sometimes there is a long interval of infecting MRSA. But most MRSA infections took place in hospital environments. SA infections or the spread of MRSA between countries have been described in several articles or journals over the years. But the spread of hospital components In Chicago, between 1991 and 1993, eight CICU patients were diagnosed with MRSA infections. Eighty patients had acquired or nosocomial MRSA infections, and 56 patients hospitalized with CA-MRSA were found over a three-year period. After implementing barrier isolation, there was only one outbreak (eight cases in the CICU) caused by type-related isolates. The annual incidence of new MRSA in hospitals has also decreased. Another 35 in-hospital MRSA cases occurred in 1992 and 1993 that were unrelated to epidemiology or caused by different isolates. After the isolation barrier was placed in place for all patients (with and without MRSA) to enter and be admitted to the unit, the CICU outbreak was halted. (AI Hartestein et al.1995) Six SICU personnel with colonies were discovered. Therefore, it can be said that during the first three years of the 1990s, patients had more localized MRSA infections than nosocomial infections. Within three days of admission, patients found to have intranasal MRSA were enrolled. Patients were excluded if mupirocin or chlorhexidine shower gel had been used intra-nasally in the previous month and an ongoing MRSA infection was suspected. MRSA-PCR was positive in 82 people. The number of MRSA colonies in the nostrils and the CT value were found to be

moderately negatively correlated. Lower levels of MRSA bacteria in the nose were associated with current antibiotic use; patients with environmental pollution had lower CT values (28.0 vs. 30.2; P 0.01) and a higher mean number of MRSA nostrils (3.9 vs. 0.01) (2.5, P = 0.01) (J. Livorsie et al. 2015). In 2012, at Miriam Hospital, which is famous for hip and knee replacements, after screening for MRSA, 749 knee replacements and 431 hip replacements were performed out of a total of 1129 patients. 64% of female patients underwent these procedures, and 36% were male. The mean ages were 66 and median ages were 67, respectively. For 81% (951) of these procedures, 38 test results were obtained by using MRSA screening (2 were positive) and not detecting SASM, which were not mentioned in the data analysis. For 191 procedures, no preoperative *S. aureus* testing was obtained. The mean interval was for 26 days, but basically the mean interval was 24.7 between culture and surgery. Nasal cultures were positive for *S. aureus* and those were 199(21%). Of these, 26 (13%) are MRSA, and the others are MSSA. Hospital-wide antibiotics contained 362 strains of S. aureus; 164 (45%) of these are MRSA. Among 951 patients with intranasal *S. aureus* inoculation, only 2.7% were diagnosed with MRSA (A. F. Crawford et al. 2020). At Massachusetts Eye and Ear Hospital, 75 cases of MRSA were detected, and the source was eye location, as well as the period from January 2014 to June 2016. But the rate was 25.9% to 267%. It is a condition for an increase. In 2015, at an orthopedic department in France, eight patients were listed because they were infected with MRSA in multiple specimens, and the diagnosis was also different in 2017. One of them was diagnosed with SSTI after an erection in 2016, and the other two were also diagnosed with SSI after an erection in 2017. Another patient had a urinary tract infection. The hot part should also belong to the erection type in 2016. On September 17, 2015, a young man who was 21 years old had been taken to the hospital with a wound in his right knee. The patient underwent endoscopic

anterior cruciate ligament reconstruction on the sixth day after admission. On January 29, 2016, the patient was performed from the hospital. His right knee got swollen and sore for a month after he was discharged from the hospital. The patient was readmitted to the hospital for treatment on February 24, 2016. When MRSA was initially separated from wound secretions, the patient received no anti-MRSA therapy and was discharged 13 days later. The patient was taken to hospital for the third time on April 19, 2016, due to a rupture in the front of the right knee joint. During admission, the patient's MRSA test was consistently positive, and teicoplanin was administered. Steel plates and screws were then removed from the patient's right knee during surgery, along with a debridement. However, after surgery, MRSA continued to be found in the synovial fluid of the knee. On May 6, 2016, a 20-year-old man with a broken ankle was admitted to the hospital. Six days later, a surgery was done on his right ankle which was performed by Dr. D. Following surgery, linezolid is used to treat MRSA strains that are routinely isolated from exudates around surgical wounds. Meanwhile, a 21-year-old man was admitted to the hospital on February 1 with an ankle and clamp fracture. On March 6, 2017, Dr. D operated on him to treat the traction of the bones in his right ankle. The patient was internally immobilized, and his right ankle fracture was amputated four days later. Discharge from the surgical wound included MRSA two weeks later. Resection was done by medical professionals, and vancomycin bone cement was used. (S. Jiang, et al., l.02) By 2015, this rate had dramatically decreased to 22.3%. But during the sampling period, it increased in 2016 at a rate of 37.7% (Paulo J.M. et al. 2020). A community survey was conducted in Jordan, where patients and others were infected with MRSA. EMS patients and staff share limited space in the ambulance cabin in an EMS environment, which increases the risk of MRSA transmission between patients, EMS staff, and inside the ambulance. MRSA settlements have been found in the cabins. According to Han et al.

(2015), nosocomial infections (HAIs) are the leading cause of morbidity and mortality globally and nationally. HAIs are thought to affect 1.7 million people each year in the United States and cause about 100,000 deaths (Klevens et al., 2007). One in twenty patients develops pneumonia in acute care hospitals in the United States, with methicillin-resistant *Staphylococcus aureus* (MRSA) being the most common pathogen. At two hospitals: University Hospital Zurich in Switzerland and Michigan Medical Hospital in Ann Arbor, Michigan, from November 2018 to July 2019. Ten adult patients infected with or infected with MRSA gave oral consent as a convenience sample and were brought in. Within three days of admission to the room, patients who were identified as carriers of MRSA in their nasal passages following hospital policy were enrolled. Patients were excluded if they had used either nasal mupirocin or chlorhexidine body-wash in the previous month or if there was suspicion of a current MRSA infection. Four environmental sites, six body areas, and any present wounds were cultured using pre-moistened swabs. (Chaberny, IF. et al. 2008) In the hospitals in Zurich, Switzerland, and Ann Arbor, Michigan, USA, ten patients were colonized and infected with MRSA, and 40 hand and 240 surface samples were collected. MRSA was found on 30% of hands and 20% of high-touch surfaces at the outset. At the follow-up time, 8 (27%) of 30 patient hands and 10 (6%) of 180 environmental locations were positive. Seven of ten environmental samples were examined by the patients. In the hospital in Switzerland, the first hospital, 3 of 5 (60%) patients' hands and 12 of 30 (40%) environmental cultures tested positive for MRSA. At the hospital, neither hand nor environmental cultures were positive initially. The overall contamination percentages at each site are shown. On nine polluted environmental samples, the median CFU count was determined. Except for the hand of patient one at the hospital, which grew MRSA in the enrichment culture, all control cultures following disinfection at baseline of patient hands and high-touch surfaces

remained MRSA-negative. The dominant hands of three patients (30%) tested positive for MRSA at baseline. Despite hand hygiene at the beginning of each successive observation period, in the follow-up visits, 27% of hands tested positive, Most data on hand contamination in patients with MRSA is emerging, with three studies (including 25–115 patients) describing hand contamination rates between 29% and 82%. MRSA carriage on hands can be interpreted as a transient phenomenon driven by touching more persistently colonized body sites and potentially contaminating them.

3.2. MRSA Colonization (Nosocomial)

MRSA colonization is another thing which occured in the hospital environment besides infection in patients . Between 1991 and 1993, in the surgical intensive care unit (USIC), 80 patients with nosocomial MRSA were identified. After fence isolation, only one outbreak (eight CICU cases) was caused by type-related isolates. The annual incidence of new nosocomial MRSA has also decreased. Another 35 in-hospital MRSA cases occurred in 1992 and 1993 that were unrelated to epidemiology or caused by different isolates. (A. I. Hartestein et al. 1995) *Staphylococcus aureus* (MRSA) occurred. The two hospitals were assumed to be Hospital A and Hospital B. Localization or MRSA infections over 18 months (June 1993 to November 1994). Hospital A has 48 hospital MRSA cases, and Hospital B has 22 hospital cases. Most hospital cases in both settings were either epidemiologically unrelated or included isolates with distinct CPE types. By demonstrating that epidemiologically relevant isolates (by time and clinical department or hospital unit) had a variety of ECPs, translators were shown to exist. RSA outbreaks in hospitals, including those detected by prospective surveillance and verified by typing PFGE, can be managed with a number of additional precautions and actions. Although the public continues to

accept MRSA-positive individuals, it is still possible. (A.I. Hartestein et al., 1997). Environmental contamination and transmission by methicillin-resistant *Staphylococcus aureus* (MRSA) have been reported in dental facilities. National professional dental groups recommend using disposable barriers or disinfectants to reduce surface contamination. Five minutes after being dispersed, five suspensions of the 20 samples of MRSA strains were aerosolized, resulting in a density of 10 colony-forming units per cm2 of MRSA on the dental chair. Over 99% of MRSA Surface load on dental chairs, the residual densities are 0.030 0.010, 0.029 0.09, and 0.030 0.011. (Stefano Petti, et al. 2013) In 2015, a dental clinic in Egypt was infected with methicillin-resistant *Staphylococcus aureus* (MRSA). In 2015, a dental clinic in Egypt was infected with methicillin-resistant *Staphy*

lococcus aureus (MRSA). Environmental surfaces were tested. Patients, nurses, and dentists had manual MRSA transport rates of 9.8%, 6.6%, and 5%, respectively. In each case, the percentages of colonies in the nose were 11.1%, 6.7%, and 9.7%. MRSA was present in 1.3% of environmental isolates. Among MRSA isolates, strong and moderate biofilm-forming strains accounted for 23.5% and 29.4%, respectively. In the dental setting, MRSA can be spread in several ways. They can combine some of the following: exposure to bacterial aerosols emitted from the oral cavity. Also, Direct contact with blood or saliva; indirect contact with infected instruments or surfaces as a result, dental clinic and oral health care (DHCP) staff surfaces can potentially contribute to the spread of MRSA to clients or other DHCPs. A total of 1300 swab samples were collected from six different departments of a dental clinic in Egypt, including 1030 (79.2%) environmental surface samples and 270 (20.8%) hand samples (n = 182) and anterior nostril (n = 88) of the patient and DHCP. These 1030 specimens from environmental surfaces are divided into two categories:

those intended for clinical contact surfaces (n = 602) and those intended for sanitary surfaces (n = 428). Therefore, from a number of specimens observed in the hospital at this dental clinic, out of a total of 1300 specimens, 34 MRSA-positive strains were detected. The specimen locations are surface personnel and the environment. 6 from the patient's hand, 4 from the nurse's hand, and 3 from the dentist's hand In addition, 3 came from the patient's nostril, 2 from the nurse, and another 3 from the dentist's nostril. On the surface, we have 13 specimens, of which the dental lamp arm has 1, the dentist chair has 3, the dental drill has 2, the patient sink faucet has 3, the door handle also has 3, and the floor has 1 (Ahmed S. Khairalla et al. 2017). 100 swab samples were collected in the Chittagong region of Bangladesh from various hospitals and sources. The majority of samples were obtained from patients with skin infections, hospital staff, instruments (including forceps, samplers, trays, and various items used in the operation theater), and drain water from the hospital's drainage system. Out of a total of 66 samples, 43 strains of nosocomial MRSA were detected. Of these 43 environmental samples, 7 were due to skin infections; 3 hospital staff were infected with MRSA; 15 utensils and equipment were contaminated with MRSA; and 18 samples of MRSA were found in hospital drains. (Islam T., et al., 2018). At Dr. Saiful Anwar Hospital in Malang, Indonesia, active surveillance cultures, including contact tracing, isolation, and barrier measures with environmental disinfection and selective decontamination of non-symptomatic transport, are widely used to protect health workers (HCs) and their inherent environment. The study was conducted in two operating rooms at Dr. Saiful Anwar Hospital in Malang, Indonesia, a tertiary care teaching hospital with 810 beds. Here are the basic features: Room One: male general operating room for 50 adult patients, with a nurse-to-patient ratio of 1:5 to 10 and two sinks; Room B: female general operating room for 22 adult patients, with a nurse-to-patient ratio of 1:3-6 and a sink. Each room has two 500-ml bottles of

alcohol-based liquid in a wall dispenser in the center. This Indonesian hospital survey divided MRSA screening and hospital spread rates into three phases. These are the pre-invention stage (July 2012 to January 2013), the intervention phase (February 2013 to March 2013), and the post-intervention phase (April 2013 to August 2013). Seven of the patient's ten MRSA strains were available for clonal and identical DNA typing. In the early stages of the outbreak, a healthcare worker was found to be a carrier of the disease in the nose and was successfully decontaminated with intranasal mupirocin. However, new MRSA infections continue to occur despite strict adherence to the isolation of MRSA-positive patients (a special precaution). The epidemic was quickly extinguished after implementing measures to prevent epidemics for all patients at the hospital. By wearing new, clean gowns and gloves when in physical contact with the patient or their environment. Although 25% of all hospital-acquired *S. aureus* strains isolated from our hospital were methicillin-resistant, rates of endemic MRSA and infections in burn departments were still very low , there is no need to screen staff for MRSA carriers to prevent nosocomial MRSA infections in this highly vulnerable population. In 2010, 5-methicillin-resistant *Staphylococcus aureus* (MRSA) was perhaps the best example of a prevalent and important MDR bacterium that has evolved from a de facto sole nosocomial bacterium to a ubiquitous bacterium in the population. Epidemiology of community-associated MRSA (CA-MRSA) in 1982, his CA-MRSA outbreak was documented in Detroit. More than half of the patients in this epidemic were injecting drug users, and the remainder had a variety of comorbidities that put them at risk. It was noteworthy that there were 18 strains in this epidemic. No other actual CA-MRSA epidemic was documented until the early 1990s. These outbreaks occurred in communities with no identifiable risk profile. An emergency services (EMS) facility and its staff were also colonized with MRSA. EMS personnel are at risk of ingesting pathogens

in the community, and pathogens can be transmitted to patients during medical emergencies. The patient and paramedics cover a small area in the ambulance cabin, increasing the risk of MRSA infection for the patient. Some ambulance systems have limited time available for cleaning ambulance cabins and equipment and facilitating transmission between patients. The first 71 ambulances in the Chicago metropolitan area were colonized with antibiotic-resistant bacteria. Moreover, a July study published in a Spanish journal isolated MRSA in two of the 17 ambulances studied. Lorin et al. (2007) and Brown et al. (2010) found MRSA in over half of the west coast and southern Maine ambulances surveyed. According to an Egyptian study, 46.1% of S. aureus strains detected in early 2016 in 25 ambulance cabins were identified as MRSA. Another study in Germany also claims to have been conducted in 2009 on stretchers of patients carried by MRSA, and the number was 9 out of 89 ambulances. Similarly, in California, USA, Kei and Richards (2011) analyzed.40 samples have been taken since 2006 from various surfaces and equipment in the emergency department for the presence of *S. aureus*, and only one (2.5%) was found positive for MRSA. According to the World Health Organization, MRSA infections seriously affect patients' health and significantly impact the healthcare system. When talking about TWO, MRSA often comes up as an important co-relator. MRSA is one of the most common bacteria in HAIs, and it has serious health effects, especially in patients with weakened immune systems, such as infants and intensive care patients. MRSA can be transmitted through the air by droplets and direct (skin-to-skin) or indirect contact. MRSA was the most resistant to polyester, persisting for up to 56 days. However, the viability of the bacteria was much lower on cotton than on polyester. For example, MRSA lasts a week on pure cotton, two weeks on cotton, and less than a week on polyester-cotton blends. These results have important implications for infection control. For example, polyester is widely used to produce privacy curtains, blends, and

wear. Due to the frequency of use and longer lifetime of MRSA, polyester screens are a source of and spread dangerous MRSA. MRSA lives the shortest on polyester-cotton blends, if they exist. Another study found that 31% (75/240) of bedroom surfaces used by patients with MRSA invading their genitals were infected, compared with just 3.6% (27/760) of the bedroom surfaces of MRSA-positive patients whose groin is MRSA-free. Not surprisingly, contaminated surfaces in the patient's environment were more likely to be found if MRSA had been removed from the patient's palm. However, MRSA can be detected in the immediate environment of HIV-negative patients, and visitors or healthcare workers can transmit the infection (Villamaria et al. 2015) isolated 202 and a total of 1830 MRSA from 32 non-MRSA-exposed and 68 MRSA-exposed hospital rooms, respectively. Multidrug-resistant bacteria, such as methicillin-resistant *Staphylococcus aureus* (MRSA), have been identified in hospital wastewater. Antibiotic resistance genes and pathogens can spread faster in the natural environment if they are present in wastewater. Therefore, the objective was to isolate MRSA from wastewater from three hospitals in northern Portugal and identify isolates according to their genetic lineage and antibiotic resistance. Within six months, a total of 96 wastewater samples were collected. In Portugal, as previously reported, 98 samples were from the ambulance environment, and 33 samples were from staff (ambulance nurses, laboratory technicians, and ancillary staff) at two central Lisbon hospitals, producing 68 biological samples, 38 from the first hospital. In addition, 25 biological samples were collected from primary health care centers (PHCCs). MRSA was identified in 98 environmental samples taken from 12 ambulances at two fire stations, only one of which was contaminated with MRSA. In the study, 48.5% of the 33 firefighters were infected with *S. aureus*, 24% had MSSA, and 21% had MRSA. At Hospital 1, 42.2% of the 38 medical staff were infected with S. aureus, of which MSSA accounted for 18.4% and MRSA accounted for 23.7%.

In a population of 30 healthcare workers, the prevalence of MRSA infection at Hospital 2 was 43.3%. MRSA was not found in the nasal swabs of 25 staff members participating in the primary health care center study. (Viegas, C. et al 2021) Temperature effects of MRSA development in house flies in a hospital setting 400 house flies were collected from four hospital-related sites in Mymensingh, Bangladesh, during winter and summer. There have been no studies on the prevalence of antibiotic resistance and the effect of temperature on the presence MRSA in houseflies in a hospital setting. During the winter and summer, 400 house flies were collected from four hospital-related sites in Mymensingh, Bangladesh (A. Sobur et al., 2022). Each patient's dominant hand was also checked for MRSA infection. In addition, for the hospital, samples for culture were obtained from four frequently touched surfaces in each patient's room: The bedside table, interior bathroom door handle, toilet seat, and bed's remotes were obtained from the remote controls of the television and telephone in the room. At follow-up visits, the patient's dominant hand, the previously mentioned strongly tactile surfaces, and the first hospital room atmosphere were all sampled (Ludlam H et al., 2019). Evidence from a UK university hospital shows that, MRSA is mainly transmitted through the hands of healthcare workers. (J Hosp Infect et al 2010 ;) At the hospital, 3 out of 5 (60%) of the patient's hands and 12 out of 30 (40%) cultures were positive for MRSA. In the hospital, both the hand and the environmental culture were not positive in the first place. Overall contamination rates at each site were shown in nine contaminated environmental samples, and the average number of CFUs was determined. With the exception of the hand of patient 1 from the primary hospital that developed a preliminary culture, each control culture after initial patient cleaning and commonly touched surfaces remained intact, indicating a well-maintained environment for MRSA. (Diekema DJ, et al 2019) .In laboratory-based studies, the recovery of MRSA from two common hospital settings

was evaluated using wild-type MRSA strains and six different sampling methods. A 100-cm2 mattress area and bench surface area were contaminated with known MRSA inoculums. Bacteria were sampled 30 min after inoculation using either saline-moistened swabs supplemented with tryptone soy broth, neutralizing buffer swabs, electronic swabs, or macrofoam swabs, or were plated in direct contact or obtained by sampling an inorganic chromogenic stretch plate. Each method's sensitivity (the minimum number of bacteria inoculated on a surface that subsequently gave a positive result) was determined for each surface. The most sensitive methods are electronic swabs and macrofoam swabs, which require 6.1 10(-1) and 3.9 10(-1) MRSA/cm (2), respectively, for positive results on laboratory surface bottom. The least sensitive swabbing method was saline-moistened cotton swabs, requiring 1.1 MRSA per mattress. For the bench surface to yield a positive result, the MRSA concentration needed to be 3.9 10(-1) MRSA/ccm2 Cotton swabs soaked with saline were the least sensitive swabbing technique, requiring 1.1 10(3) MRSA/cm (2) of mattress. In 2012, in a hospital in Indonesia, the anterior nares, pharynx, and skin lesions, if present, were sampled to screen for MRSA transmission in patients and HCWs. Bed rails, bedside cabinets, thermometers, stethoscopes, blood pressure cuffs, nurses' tables, door handles, telephone receivers, sink handles, the intravenous line stands, and trolley handles were all sampled. In the sputum sample, 28% MRSA was detected, but a large amount of MRSA was found in the urine sample, and it was 41.8%; in the blood sample, 24.9% MRSA was found, but it also contained MRSA, and the urethral swab had 1.1. In the 27 S. aureus, 15 (55.6%) were MRSA, and 12 (MSSA) were MSSA. From urine (75%, 3/4), sputum (66.7%, 4/6), and pus (66.7%) MRSA were found. Thus, a higher number of MRSA recovered. (Gaire, U. et al., 2021) and (Njar, M., 2021)

Chapter 4

MRSA Infection: Samples collected from patients in different body sites

Country	No. of MRSA isolates						Reference
	Detection method	Urine	Blood	Sputum	Wound swab	Body fluid	
Nepal	Cefoxitin disc diffusion method	57	24	30	12	1	(Dhungel et al., 2021).
Egypt	PCR and microarray experiments	1	2	1	4	-	(Monecke et al., 2023)

India	Catalase tests, slide and tube coagulase tests, and growth on Mannitol salt agar were also performed for the antimicrobial substituting, which was performed by the Kirby-By disc diffusion method.	12	2	-	49	1	Pai, V et al. 2017).
Pakistan	phenotypic (Cefoxitin disc and ORSAB) and Molecular (*mecA* detection) based MRSA screening	-	40	-	-	5	(Ullah et al., 2016)
Brazil	*The mecA* gene was detected by PCR. SCC*mec* was detected by multiplex PCR, and the clonal profile was analyzed by PFGE.	39	41	-	-	0	(Pereira et al., 2014)
		-	41	-	-	2	
Iran	Kirby-Bauer disk diffusion	3	22	-	36	6	(Mehdi Goudarzi, 2016)

Table -1: MRSA Isolates in Various sample

From Table 1, In Nepal, with the purpose of detecting MecA and VerA genes and determining whether it has the antibiotic resistance gene *S. aureus* among cardiac patients, from urine 57 isolates, from blood 24 isolates, from sputum 30, 12 in a wound swab, and 1 in body fluid (Dhungel, S. et al., 2021), in an Egyptian tertiary care center, 1 was from urine, 2 from blood, 1 from sputum, and another 4 were from blood samples. (Rezk, S., et al. 2023) In India, while detecting antimicrobial susceptibility, 12 MRSA isolates were collected from urine, 2 from blood, 49 from wounds, and 1 from body fluid. In Pakistan, for determining the frequency of MRSA, 40 MRSA were colonized in blood and 5 in body fluid. (Ullah, A. et al., 2016). In Brazil, neonatal intensive care units had 39 MRSA samples in their blood. But in their pediatric intensive care unit, 41 were found in blood and body fluid. (Pereira, V.V., et al., 2011). Lastly, in Iran, when there was sp-typing of MRSA isolates, 33 MRSA isolates were from urine, 222 were from blood, and 36 were from bloods and 6 were from body fluids.

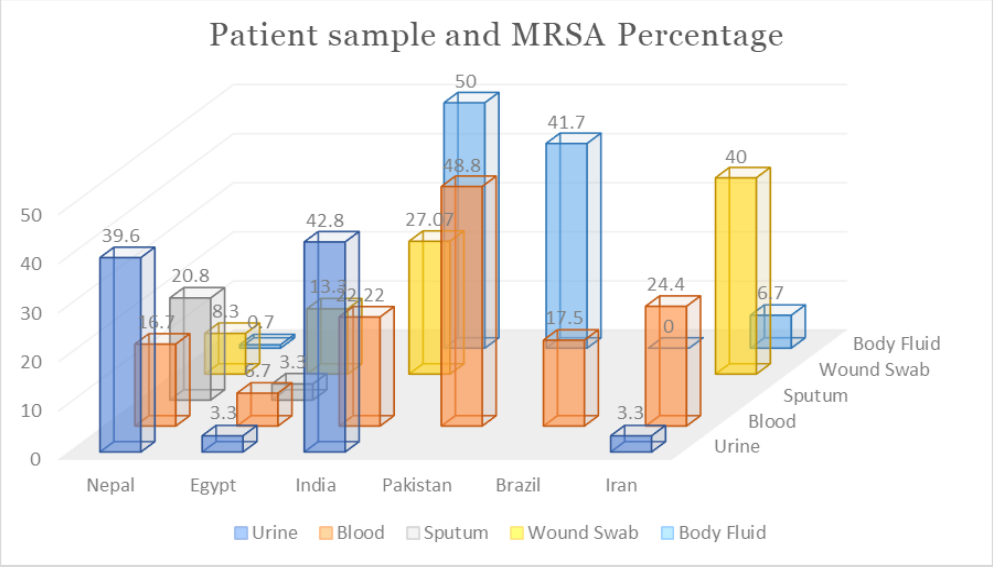

Figure 1: *Patient Sample Type and MRSA percentage from Previous Table*

Chapter 5

MRSA Prevalence

5.1. MRSA Prevalence among Patients in different countries

There was a moderately strong negative association between the CT score and the number of MRSA colonies within the nares. Current antibiotic use was associated with lower levels of MRSA nasal colonization (CT score: 30.2 vs. 27.7; P 0.01). Mean log nasal MRSA levels were higher in patients with environmental contamination (3.9 vs. 3.9). 2.5, P = 0.01), and CT scores were lower (28.0 vs. 30.2; P 0.01). (Ellingson, K., 2011). In a study conducted in Iran, the authors found that among other hospital food samples, chicken had the highest prevalence of MRSA, up to 32.43%. In this study, MRSA was more common in *S. aureus* isolated from chicken samples than in the United States (26%), Canada (1.2%), Germany (25.0%), and Brazil (23.30%). (Rodorgez-Lazarus D et al 2012) A statistical analysis of Indonesian hospitals from 2012 to 2013 found that 1,937 patients were included in the study shown to be covered. However, 817 patients were transferred to another room or ward within 48 hours before and after the intervention (3 of 426, 0.7%; 1 of 305, 0.3%) and were discharged for personal reasons. Requests in the preintervention phase (1/426, 0.2%), admission (27/426, 6.3%; 9/86, 10.5%; 25/305, 82%), and discharge (395/426, 92.7%; 77/86, 89.5%; 277/305, 90.8%) in all phases, therefore, included 1,12**0** subjects in the statistical analysis. To determine the detection rate of MRSA, 246 LTCF and hospital specimens were collected. Overall, the MRSA incidence was 23.8% (39/164) in Changhua City and 23.2% (19/82) in Chayi City. LTCF samples from Changhua City showed a higher MRSA prevalence (25%, 33/132) than hospital samples (18.8%, 6/32). For Chiayi City, samples from hospital communities were more frequently provided (25%,

8/32) than samples from LTCF settings (22%, 11/50). MRSA was detected in 22.2% (10/45) and 18.4% (7/38) of wet samples from his LTCF environment in Changhua City and Chiayi City, respectively. His MRSA was absent in his Changhua wet LTCF samples, whereas 33.3% (4/12) of the Chiayi samples were dry. In Chiayi City hospitals, MRSA volume and duration were higher in occupied ward samples than in vacant ward samples (n = 10, n = 10, and 11.1%, respectively, n = 9). In addition, 63 surgical tubes from LTCF residents in Changhua City underwent MRSA testing. (Su B. et al., 2021. Environmental molecular and antimicrobial resistance (AMR) profiling of methicillin-resist Since MRSA is known to be gram-positive, only 19.2% (34/177) of 177 culture-positive specimens were sent to foreign hospitals. (V. Silva et al., 2022).

Country	Patient with MRSA	Total num of patient	Culture no	Prevalence %	Reference
Bronx, New York	Respiratory	122	2	5.7	(Punjabi et al., 2020)
UK	Cystic fibrosis and chronic MRSA	405	-	-	(Wood et al., 2016)

German	Newborn	658		0.5	(Heigl et al., 2020)
Brazil	Burn unit	367	9	24.0	(M. Vinicius et al. 2013)
Europe	Pneumonia	32	-	-	(Cross J, 2006)
America	Ocular sites	75	7	37.7	(M. Bi spo et al., 2020)
Germany	Neurological rehabilitation	569	-	-	(Rollnik, 2014)

Table 2: Methicillin-Resistant Staphylococcus aureus (MRSA) Prevalence during Different Stages of Hospital Stay

From Table 2, the prevalence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) is shown according to country and area wise, so in Bronx , New York , patients were infected with MRSA in their respiratory tracts , also the prevalence was 5.7%. In the UK 405 patients, which is a huge amount, were infected with MRSA, and it infected the cystic fibrosis area. in. On the other hand, Germany had 658 newborns who were infected, and the rate was 0.5%. In Brazil, there were 367 patients infected with these viruses, which were cultured, and the prevalence rate was like 24%.

In Europe, 32 pneumonia patients were infected with MRSA; in America, 75 patients had MRSA in the ocular site; among them, 7 were cultured, and the rate is 37%. Also in Germany, 569 patients in meteorological rehabilitation were affected by MRSA.

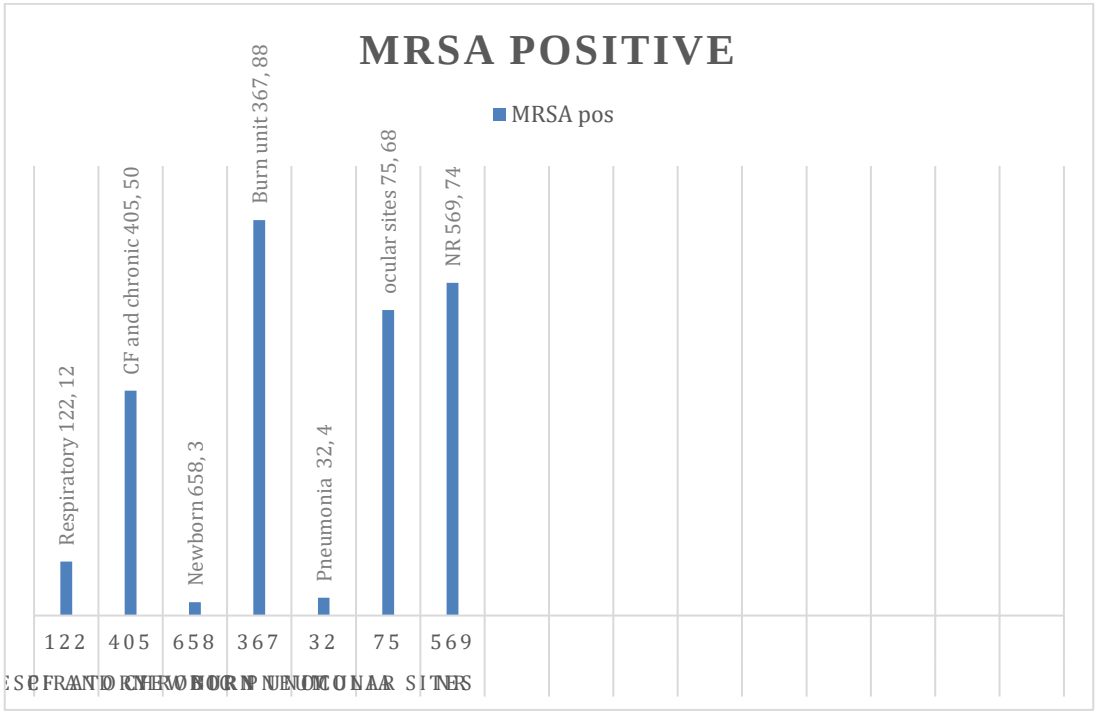

Figure 2: *Patients Infected with MRSA infections in different body sites.*

5.2 Prevalence of MRSA from various clinical environmental samples

MRSA infection was prevalent among specific countries where the increase and decrease rate were shown.The prevalence varied from the infection sight among patients.Also in some particular clinical environmental samples were highly infectious for MRSA . In Changhua, Taiwan, 30% in Changhua and 31% in Chayi had moist samples, followed by 18% of MRSA in

an arid sample in Chayi, and also in Chayi, 14.3% of MRSA were present on the outpatient floor. In Changhua, 28.6% of MRSA and 50% of MRSA were present on the inpatient floor. For Chapresent, 57.17.1 of the used wards were infected with MRSA, and in Chayi, 30% of the used wards were infected. But in their vacant ward, Chayi was infected with 11.1% MRSA. In Chittagong, in the hospital environment, 16.279% MRSA was found in samples. .66.97 hospital workers were infected with MRSA, 34.88% were found in utensils, and 41.86% were found in hospital water. In Zurich, Switzerland, by baseline hand environment, 20% MRSA was found in the bathroom inside the door handle. In Arbor, Michigan, US, 3% % MRSA were found and 3% MRSA was discovered in the bin, bathroom, and handle. The bedside table contained 10% MRSA, 10% in Zurich, and the bedside table had 3% MRSA in Arbor.

Source of sample	Sample location	Sample type	Sample number (%)					Reference	
Hospital environment	Changhua city And Chiayi city, Taiwan	Moist samples	6 (30%)	5 (31.3 %)				(Pereira et al., 2014)	
		Arid samples	0 (0) %	3 (18.8 %)					
		Outpatient floor	0 (0%)	1 (14.3 %)					
		inpatient floor	2 (28.6%)	3 (50%)					

		Ward (used)	4 (57.1%)	3 (30%)					
		Ward (vacancy		1 (11.1 %)					
	Chittagong, Bangladesh	Skin infection			7(16.279%)			(Tarequl I. et al. 2018)	
		Hospital workers			3(6.97 %)				
		Utensils and equipment			15(34.88%)				
		Hospital drain water			18(41.86%)				
Hospital 1 (Baseline hand environmental contamination)	Zurich, Switzerland And	Bed remote control				0%	0 %	(Wolfensberger et al., 2021)	
		Bathroom inside door handle				20 %	3 %		
		Toilet seat				30 %	17 %		
		Bedside table				10 %	3 %		

Hospital 2 (Continued with hand, environment, and air contaminants)	Arbor, Michigan, United States	Bed rail				40 %	13 %		
		The patient room inside handle				20 %	0 %		
		Television remote				30 %	3 %		

Table 3: Prevalence of MRSA from various clinical environmental samples

Chapter 6

Antibiotic Resistance of *Staphylococcus aureus* in Comparison of Methicillin Resistance:

Along with methicillin ,other antibiotics acts resistant to *Staphylococcus aurues.* Penicillin is the most known antibiotic and Staph infections became resistant against penicillin.Patients act as reservoirs for MRSA, with healthcare workers often acting as mediators. 32 Previous studies have documented that a high severity of sickness on admission is a predisposing factor for nosocomial infections of MRSA. This may help to explain why there was a high prevalence of MRSA (16.4%) in our study's intensive care units, possibly as a result of the patients' weakened immune systems. On the other hand, all MRSA strains that arose in this study were completely resistant to penicillin G, similar to the previous study. 35 Erythromycin and gentamicin had an increased resistance pattern; a previous report by Orrett and Land36 claimed that MRSA resistance was less than 70% of MRSA isolates to these two antimicrobials in the years of 1997–1998, and possible reasons for the sustained growth rate are increased hospitalizations and unworthy infection control measures and procedure. It is obvious that many of the positive specimens in the present study are still susceptible to the standard antibiotics that function against MRSA in the hospital, namely rifampicin and fusidic acid. But there are some useless drugs, such as co-trimoxazole and ciprofloxacin, with no resistance activity. As quinolones have worldwide use, a positive growth in *S. aureus* resistance to ciprofloxacin has been reported. The results confirm that vancomycin-resistant *S. aureus* has not yet been established in HUSMs, unlike HUSMs. Few institutions in Japan, 38 in the United States, 12 in Europe, and 39 in the Far East, made outcomes in antibiotic resistance, let alone methylene Judicious antibiotic use

should be limited to only when absolutely necessary, and patients at high risk of carrying MRSA should be actively monitored on admission. (Girou E F. et al 1998) At University Saints Hospital Malaysia, from January 1, 2002, to December 31, 2007, 1979 patients were isolated for MRSA from specimens during the time when they were hospitalized. The prevalence of or the risk of MRSA infection is 10.0 per 1000 hospitalizations, and the annual infection rate ranges from 5.0 to 19.5 per 1000 hospitalized patients. The incidence of new MRSA infections during the study period was 1.8 per 1000 patient days, with annual rates ranging from 0.95 to 3.47 per 1000 patient days. The highest number of patients infected with MRSA was in 2002, but the difference between years was not significant (P = 0.99). Multiple logistic regressions were used to analyze the significance of risk factors in patients with MRSA and SASM. The length of hospital stays, previous use of antibiotics, and invasive bedside procedures are important risk factors for MRSA infection. The mean age of patients infected with MRSA and MSSA was similar (42.3 and 41.7, respectively). The excessive hospital stay was significantly longer (P = 0.034) in patients with MRSA (mean [SD], 27 days) compared with patients with SASM (13.8 days). Patients who had previously taken antibiotics and those who had undergone invasive bedside procedures were 10 and 20.5 times more likely to be infected with MRSA than with SASM infections, respectively. The orthopedic department had the highest number of MRSA infections (25.3% of the total in HUSM), followed by the surgical department (18.2%), the intensive care unit (16.4%), the internal medicine department, and the pediatric wards (11.6%), neurosurgery (10.7%), and obstetrics (6.2%). (Lavocat MP, et al.2003) Antibiotic susceptibility testing revealed that MRSA strains were more resistant to ciprofloxacin than other antibiotics, and 50% of them were associated with MDR. MRSA in a hospital setting is more likely to be MDR (multi-resistant) than in an LTCF environment. Additionally, the prevalence of MDR-

MRSA in Changhua City was higher than in Chiayi city, and it was mainly HA-MRSA strains, followed by CA-MRSA from hospital environmental samples and samples of LTCF residents, this is consistent with a previous report. Twenty-six out of 30 MDR-MRSA strains were identified in Changhua City, and among them, seven strains were resistant to six antibiotics. (Lee, T et al.2015)Antibiotic susceptibility testing of all colonized MRSAs to different antibiotics was performed using the Kirby-Bauer disc diffusion method as recommended by the Institute of Clinical Laboratory Standards. The turbidity of the nutrient broth suspension was compared with McFarland's standard 0.5 turbidities and was evenly smeared on the surface of Mueller-Hinton agar with a sterile cotton swab. Then place antibiotic plates for tetracycline, ciprofloxacin, gentamicin, clindamycin, cotrimoxazole, erythromycin, and penicillin. The plates were then incubated at 37°C overnight. After incubation, microorganisms with zone diameters were reported as resistant, moderate, or susceptible. Based on the susceptibility profiles of isolates, bacteria resistant to three or more antibiotics are considered to be multidrug-resistant(MDR).In Ukraine, methicillin-lactamase resistance was found in32.4% of *Staphylococcus aureus* (MRSA) strains and in 28.9% of enterococci (ERV). Resistance to third-generation cephalosporins was detected in 48.4% of Enterobacterales and resistance to carbapenems in 19.1%. Overall, 37.4% of MDROs had broad-spectrum -lactamase genes, including broad-spectrum -lactamases XA-like (29.7%), AmpC (25.1%), KPC-like (25.7%), and metallo--lactamases including IMP-like (5.7%), VIM-like (31.7%), and NDM-1 (21.3%). (A Salanov, 2022). So basically, from this discussion, not only methylic-resistant *S. aureus* but also other antibiotics that are resistant to *S. aureus* can be used to infect or colonize nosocomial samples or patients.

Chapter 7

Risk Factors of MRSA infection among community and environments

Several risk practices and factors have also been found to be highly associated with the prevalence of nosocomial infections. Also, the use of contaminated needles and forceps, improper disposal of antibiotics in the environment, placement of contaminated trash bins next to patient beds, accumulation of hospital wastewater in hospital sewage systems, and lack of public awareness. Various behaviors have been observed, including the use of non-sterile instruments and a defective hospital drainage system. These practices are highly associated with independent risk factors for MRSA transmission in hospital settings. The mode of transmission of MRSA is very similar to that of other *S.aureus* strains, but the host colonization effects are different. It is known that MRSA can be transmitted from animals to humans, from humans to animals, and from humans to humans. Gram-positive strains, and 80.8% (143/177) had gram-negative isolates. Strain growth was demonstrated. *S. aureus* dominated the gram-positive category of the coagulase-negative *Staphylococcus aureus* (CoNS) population with 15.3% (27/177). Approximately 7,000 deaths in the European Union and European Economic Area are directly attributable to over 150,000 MRSA infections annually. Furthermore, the incidence of MRSA in Europe varies greatly between the north and south of the continent, with above-average MRSA incidence reported in the south and east. Between 2015 and 2019, there was a statistically significant decrease in MRSA cases in Portugal (from 46.8% to 34.8%), but the prevalence is still higher than in other European countries. In recent decades, MRSA in chromosome group CC22 has become one of the most common infections in Portugal. **(**Islam T, et al. 2018) There are risk factors for spreading MRSA at an increasing rate in clinical and patient samples.

Chapter 8

Prevention of MRSA infection:

Prevention of MRSA infection can be happened by following precautionary manners .Various research article has discussed about the prevention technique of MRSA in various studies.

A study in Indonesia, MRSA screening and nosocomial infection rates were evaluated in three phases: pre-invention (July 2012 to January 2013), intervention (February 2013 to March 2013), and post-invention, divided into preventive stages. Intervention Phase (April 2013–August 2013) In the pre-intervention phase, the wall next to the sink had a poster by the infection control team outlining proper hand washing techniques according to WHO guidelines. There is no organized long-term educational program. However, the current poster is dated during the intervention and post-intervention stages of the Middle Ages. Two large posters were put up on the walls of each study area. The front of each medical record listed "5 ways to sanitize hands." All medical professionals working at research stations were required to read the Hand Hygiene Protocol Fact Sheet. Weekly presentations were given to the study ward nurses, nursing assistant**s,** pharmacists, and nutritionists. Two of his 500-mL bottles of alcohol-based liquid were placed in the center of the study area and dispensed via wall-mounted dispensers beforehand sanitization. However, during the intervention-to-medieval phase and post-intervention, a bottle containing 500 ml of hand glycerol alcohol containing chlorhexidine 0.5% was placed on each bed. In the pre-intervention phase, he used seven different days for hand hygiene to monitor and measure compliance. However, compliance was observed and measured seven times during the intervention phase. On the other hand, in the post-intervention phase, compliance was observed and measured 15 times. MRSA-positive patients were separated from MRSA-positive patients and placed in specific locations behind a screen. Decolonization therapy includes dermatological

mupirocin cream 2% (Bactoderm cream, PT. IkafarmindoPutramas, Indonesia) administered with iodine 4%, applied to both nostrils twice daily for 5 days, in patients with MRSA detected on admission and in MRSA-positive health care workers.The body was washed for 7 days with a soap containing 10 mg (Hibis scrub, AstraZeneca). Patients and caregivers with MRSA in the throat can also receive oral treatment with trimethoprim, sulfamate, or sulfamethoxazole (iced daily for 7 days). Cleaned and disinfected surfaces once a week should be washed with 0.05% sodium hypochlorite. Instruments were washed frequently with 70% alcohol after two weeks of use by MRSA-positive patients and before use by MRSA-negative patients. (Santosaningsih, D et al. 2019.) Clonal differences and disruptive quality determinants in dental clinics within regions, including Egypt, are rare. Fundamentally, MRSA infection frequency, biofilm forming and antimicrobial resistance profile are known independently of these conditions. Subsequently, a Center for MRSA Infections in Dental Facilities was established in Egypt. Current research goals are:

(i) Determining the prevalence of these boundaries in disparate dental departments;

(ii) Investigating carriage rates in patients, health care workers, dentists, and natural surfaces;

(iii) Determining genetic ancestry using SCC mec and SP genotyping methods;

Cleaning hands properly , disposing households and keeping trashes separately. Wounds and used equipments which used in surgery must be sterilized .

Chapter 9

Conclusion

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a known gram-positive bacterium. In this review article, the MRSA infection rate in different countries over various spans of time is briefly discussed. MRSA mostly infects clinical samples and patients through hospital materials also, hospitals had different sectors of health care units, and ambulances that were affected by MRSA. The prevalence of MRSA was the topic of discussion. From various studies and surveys, the prevalence gradually increased, mostly in the years between 2014 and 2016, and in 2016, with COVID, the prevalence rate of MRSA seemed to be paralleling that of recent years. But after 2020–21, the increase seemed to be increasing, but in a very slow process. MRSA infection in hospital environments has risk factors, such as severe infections by bacteria. MRSA infection can be prevented, but in a specific environment, it can be spread. Lungs, eyes, and wounds are all other parts and human organs that may contain MRSA. Though other antibiotics can affect nosocomial infections, they are more noticeable in the intestinal tract

Patients identified as MRSA nasal carriers following hospital protocol were recorded within 72 hours of room arrival. On the site of nosocomial infections, 80 patients were detected in Spain in 1991 and 1993. In 1993–1994, to identify MRSA infection, two hospitals were selected and found 48 nosocomial cases from Hospital A and 22 nosocomial cases from Hospital B. Other than that, to identify MRSA infections in the dental hospital, 1300 swab specimens were collected from six different hospitals in Egypt. From there, 34 MRSA-positive isolates were detected. For detecting MRSA from the sample, there are bed rails, bedside cabinets, thermometers, stethoscopes, blood pressure cuffs, nurses' tables, door handles, telephone

receivers, sink handles, intravenous line stands, and trolley handles. All these are samples and the way to find out the MRSA. In this investigation of a hospital in Indonesia, nosocomial spread and MRSA screening were examined through the pre-invention, intervention, and post-intervention prevention phases. Following the intervention, patients who tested positive for MRSA were separated, and hand hygiene was tracked and measured. The decolonization protocol included oral trimethoprim/sulfamethoxazole therapy, chlorhexidine body washing, and mupirocin dermatological cream. With 70% alcohol, surfaces and instruments were cleaned once per week. In the Tableau tab, here we present nosocomial samples from various samples. Here, we select different locations for samples. We selected Changhua and Chayi cities in Taiwan, Chittagong city in Bangladesh, Zurich from Switzerland, and Arbor from the United States. Samples are selected from the hospital's outpatient floor, inpatient floor, ward in the hospital, from the patient's skin, hospital workers, utensils and equipment, hospital drain water, bed remote control, bathroom inside door handle, toilet seat, table, bed rail, and television remote. After selecting all these samples, we get different percentages from those samples for these different countries and cities. In table 4, we select 122 patients from the Bronx, New York, and 405 patients from the UK and see that MRSA attacks the respiratory system in New York's patients and also attacks cystic fibrosis and chronic MRSA in UK patients. We also selected 658 patients from Germany; these are newborn babies. There are also 367 people from Brazil, and they are from the burn unit. Pneumonia patients are from Europe, and the number of patients is 75; 75 patients are selected from America, and they are affected by ocular sites. All these patients are affected by MRSA, and there are also different cultural prevalence’s for all these different patients. The next table shows different types of samples from different countries where MRSA colonization took place. We take samples from Nepal, Egypt, India, Pakistan, Brazil, and

Iran, and from these countries, MRSA isolates different samples from our body, like urine, blood, sputum, wound swabs, and body fluid. We collect various categories for MRSA colonization. From Nepal, we see MRSA is colonized in neonatal cardiac patients to detect the mecA and vanA genes that confer resistance. In Egypt, MRSA is isolated in a tertiary care center. In Pakistan, the frequency of MRSA is determined. From Brazil, neonatal intensive care Pediatric intensive care units are the way to find out MRSA isolate results, and from Iran, SP typing of *Staphylococcus aureus* strains is the way to isolate MRSA.

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