

Policy and practice of Hand hygiene and Biomedical Waste Management in Tertiary care units in India : A Review of knowledge, attitude and practice of Health Workers

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Abstract

Introduction:

Hospital-acquired infections, also known as Nosocomial infections, are infections occurring in a patient in a hospital or other healthcare facility in whom the infection was not present or incubating at the time of admission or infection may also develop within thirty days of the discharge of the patient. Practicing Hand hygiene and biomedical waste management rules are considered as the most effective measures which reduce the rates of nosocomial infections in the long run. Preventive measures such as continuous monitoring and evaluation of knowledge, attitude, and practices of the health care workers and assessing the gaps in the implementation of infection control practices can ensure containing nosocomial infections.

Objective:

To study the policies which guide to the infection control and identify lapses via knowledge, attitude, and practice studies on hand hygiene and biomedical waste management in tertiary care unit in India.

Methodology: A total of 37 article were reviewed based on a search performed independently using an electronic search as well as manual method. The electronic search was done with PubMed and Google scholar databases by using Boolean operators.

Results:

The policy on hand hygiene and biomedical waste management was not effectively due to lapses in the knowledge, attitude, and practice.

Conclusion:

There is no establishment of the Health Management Information System for Nosocomial Infection at the National level. Regular and continuous monitoring, evaluation, and training programs for hand hygiene and Biomedical Waste Management amongst the health care professionals in India could prove effective in reducing the rates of Hospital Acquired Infection.

Acknowledgement

This project is dedicated to providing a review on knowledge, attitude, and practice of hand hygiene and biomedical waste management in last 10 years. This would not have been possible without the support of my esteemed advisor professor Dr. Neetu Purohit. Madam provided clarity of the thought for moving forward in the project.

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Introduction

Hospital-acquired infections, also known as Nosocomial infections, are infections occurring in a patient in a hospital or other healthcare facility in whom the infection was not present or incubating at the time of admission or infection may also develop within thirty days of the discharge of the patient. Almost all hospital-acquired infections develop within 48 hours of admission. “At any one time, up to 7% of patients in developed and 10% in developing countries will acquire at least one HAI. These infections also present a significant economic burden to the society” (1). Infections are one of the most preventable causes of morbidity and mortality. Hospital-acquired infections can be effectively prevented with proper implementation of the guidelines issued by evidence-based practices. Intensive care units in the hospital setting are one of the major breeding sites of the Nosocomial infections, where vulnerable populations such as old age, immunocompromised, or cancer patients are at increased risk of acquiring the infection. Vulnerability is due to antimicrobial resistance, reduced host defenses, dysregulated immune responses, multiple procedures, and the use of invasive devices such as endotracheal intubation, central venous cannulations, mechanical ventilation, and urinary catheterizations which breaks the protective barriers. The highest incidence rate of the nosocomial infection is in the ICU(20–30 percent of all ICU-admissions). An enormous impact on morbidity, hospital costs, and often survival(2). Patients safety and Cost of care are two problems that need to be taken into consideration. There are many variations within the hospital settings, between hospitals or city by city.

Nosocomial infections include Ventilator-Associated Pneumonia, Surgical Site Infections Catheter-Associated Urinary Tract Infections, and Central line-based Bloodstream Infections. Several studies have shown that VAP, SSI, and CAUTI as the most common nosocomial infections

in ICU. The duration of the length of ICU stays and the duration of the Mechanical ventilation are prolonged significantly. Intubation longer than seven days, urinary catheterization more than seven days, duration of mechanical ventilation more than seven days, and ICU length of stay longer than seven days act as independent risk factors for Nosocomial infections. Diabetes mellitus, intubation, surgical drains, poor health status, lack of using gloves and lack of hand hygiene practices, irregular and inappropriate debridement, and wound bandage can also serve as other independent risk factors. In developing countries such as India, the magnitude is much higher than in developed countries with available statistics. Practicing Hand hygiene and biomedical waste management rules are considered as the most effective measures which reduces the rates of nosocomial infections in the long run. The need of the hour is that every health-care institution must develop and implement its own infection control policy with regular monitoring and evaluation with antibiotic stewardship program which should be based on the national policy and guidelines. Such steps ensure the cost-effectiveness of the treatment, improved outcomes in terms of health, and reducing the length of the stay in the hospital. Preventive measures such as continuous monitoring and evaluation of Knowledge, Attitude, and Practices (KAP) of the health care workers and assessment of the gaps in the implementation of infection control practices can ensure containment of nosocomial infections in the long run.

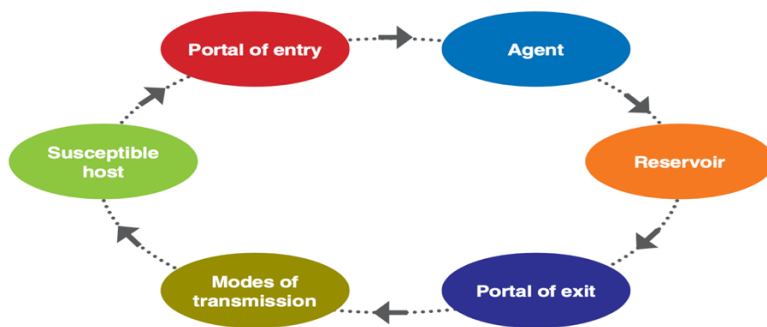


Figure 1: Mode of the transmission of the infection

The most important measure is to understand the mode of the transmission of Hospital-Acquired infections in health care facilities. Such measures can aid in the decrease of spread of the infection.

Various mode of the transmission are:

1. Firstly, Contact by hand directly or indirectly by an inanimate object- most of the multidrug resistance organisms transmit via hand.
2. Droplet transmission by sneezing, coughing, or talking.
3. Airborne transmission.
4. Common vehicle such as food served.
5. Inoculation means needle stick injury-causing Hepatitis B or HIV.

Two of the most important measures of the infection prevention and control which are been given utmost importance in the Post COVID scenario are Hand Hygiene and Biomedical Waste Management.

Rationale

Research studies based on hand hygiene suggests that the hands of health care workers are the single most vehicle of healthcare-associated pathogens from health care worker-patient, amongst health care workers, and patient-health care worker and thus facilitating cross-contamination. Maintaining the hand hygiene amongst the health care workers would remove organic material, dust, microorganisms from the skin. Hand hygiene is one of the most effective ways to reduce the Hospital-acquired infection rate in the tertiary care unit or the tertiary referral centre where ICUs are also fully functional. Tertiary care centres are the centres at which the patient load is high with overcrowding into the wards and the chances of the cross-contamination compared to

primary and secondary level hospitals are high. There has been a lot of studies in which hand hygiene protocol has been tested, the evidence says that an increase in the hand hygiene adherence rate shows a direct correlation with the decrease in the rate of the hospital-acquired infection(1).

COVID-19 pandemic has increased the importance of hand hygiene and Biomedical Waste Management. In the COVID 19 pandemic, the burden on the health care workers' during inpatient care has increased. Quality care of the patients in the hospitals gives utmost importance to hand hygiene and biomedical waste management. The challenge for the health care centers lies in the ability of caregivers in the resource-limited hospital setting to abide by it (3). One of the positive implications of the pandemic is that there is an increased importance given to hand hygiene and biomedical waste management. Non-hazardous non- infected waste along with different types of medical infected waste such as gloves and infected masks are being generated in the high volumes in this pandemic. Lack of proper hand hygiene practices and lack of proper disposal of biomedical waste poses a significant risk in the transmission of the coronavirus in the hospital as well as in the community(3). Increasing Knowledge, Attitude, and Practice of health care workers in the identification, collection, separation, storage, transportation, treatment, and disposal must be a part of the effective management of biomedical waste in the hospital. India is estimated to generate 775.5 tons per day of biomedical waste by 2022 from 550.9 tons per day back in 2019. Needlestick injuries occurring due to improper handling of the syringes can cause HIV and Hepatitis B in the health care workers. The most affected group of people due to biomedical waste management are health care workers. There were apprehensions about the data regarding Nosocomial infections previously before the COVID era, now it has become more difficult to collect data on the infection prevention as all the resources would have been diverted to research in COVID-19 (4). A similar

observation has been made in the National Patient Safety Implementation Framework under prevention and control of Hospital-acquired infection, “There is no system of reporting HAI at any level and there is no authority in place to collect, analyzed report HAI at country level” pg. 6 (5). CDC estimates that one third of the hospital acquired infections are due to lack of the adherence to the infection control practices and policy(6).

Objectives

- To know the status of policy implementation for hand hygiene and biomedical waste management in tertiary care units in India
- To know about the reasons behind lapses in the hand hygiene and biomedical waste management in infection control tertiary care units in India
- To assess the knowledge, attitude, and practice of Hand Hygiene by health care workers in tertiary care units in India
- To assess the knowledge, attitude, and practice of Biomedical Waste Management of health care workers in tertiary care units in India

Methodology

Policies reviewed for the study purpose and as per the research question:

1. National Guidelines for Infection Prevention and Control in Healthcare Facilities, 2020 includes :
 - Hand Hygiene Guidelines
 - Biomedical Waste Management Guidelines
2. National Patient Safety Implementation Framework

Search Strategy

The paper reviewed and selected were the ones which measured knowledge, attitude and practice of the hand hygiene and biomedical waste management.

A search was performed independently using an electronic search as well as manual method. The electronic search was done with PubMed and Google scholar databases.

Keywords: Knowledge, attitude and practice of hand hygiene in India, Knowledge, attitude and practice of Biomedical Waste management in India, health care workers, hand hygiene compliance, hand hygiene adherence rates, tertiary care unit.

Boolean operators such as “AND,” “OR” were used for making various combinations of keywords.

A total of 1319 articles were reviewed were the results of combining all the keywords and Boolean operators were applied with 10 years filter in PubMed Search.

40 articles were selected with inclusion criteria of hospitals of tertiary care level in India and exclusion criteria involved dental institutions in India

A total of 37 articles were reviewed : 23 of hand hygiene and 14 of Biomedical Waste Management.

Results

Policy of hand hygiene and Biomedical Waste Management

“Patient safety is an issue of global importance. The government of India has taken the initiative for patient safety. National Patient Safety Implementation Framework 2018-2025 positions safety as the fundamental element of healthcare” (Welfare, 2019).

National Patient Safety Implementation Framework’s fourth strategic objective is to prevent and control healthcare-associated infections. Key priorities of this framework are a national level strategic plan for infection prevention and control will be developed by the Ministry of Health & Family Welfare and provide a safe and clean environment via improving hygiene and management of healthcare waste in healthcare facilities(5).

Table : National Patient Safety Implementation Framework for Infection Prevention and Control

Priority area	Interventions	Responsible organizations/Institutions	Short/Medium/Long term	Expected output
To improve the understanding and application of risk management and patient safety	Include patient safety principles and practice in all service like education/on job training for all professionals of healthcare workers	Academic institutions	Short term	Curricula/ Modules developed
To strengthen the infection prevention and control structure and programs across all levels of care	Raising the awareness of the Infection Prevention and control having a better scope	Patient Safety Unit	Short term Medium term	Activities of awareness implemented
Provide safe and clean environment via improving hygiene and management of healthcare waste in healthcare facilities.	Conduct hand hygiene program in the medical and nursing curricula and in service training at all level of the health care with training and awareness.	MCI	Ministry of health and environment	Uniform adherence to and compliance with BMW rules in place

The National Health Policy 2017 says the key principle is the performance of the workforce. It would be best only with the appropriate person with both skills :

1. Motivation for the right job right place
2. Working with the right professionals and incentive environment.

The simplest yet most effective measure to prevent hospital-acquired infection is hand hygiene. Through contact with the patient, things surrounding the patient and environment, or other health care workers hand become contaminated. Therefore, proper hand hygiene techniques can effectively remove all the infectious microorganisms and reduces the risk of cross-contamination. Health care workers such as the nurses are 24x7 available for the patients into the hospital, hands of the healthcare workers are found out to be the commonest cause of the transmission of the healthcare-associated pathogens within the hospital environment. There is a direct correlation between a decrease in hospital-acquired infection with an increase in the hand hygiene adherence rate.

Decontamination of the Hand can be done in the hospital settings in two ways:

- Routine hand hygiene

Type	Preferred
Washing hands with soap and water	Hand are visibly dirty, after using toilet, contaminated with blood or other fluids of the body

Hand rubbing with Alcohol based preparation	Routine antisepsis, if hands are not clean visibly
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Handwashing with soap and water :

Indicated when there is heavy contamination of the hands by blood or proteinaceous material or the other body fluids. Follow the 5 moments of hand hygiene chart and poster for hand rub using alcohol-based rub published by WHO which is also adopted by the national guidelines of infection prevention and control of hospital-acquired infection India.

Hand rubbing using alcohol-based preparation

Indicated when hands are not visibly not clean or tap and running water is not available

The advantages of the alcohol-based rub are that it can be easily carried to places, that's why it is easily accessible at the point of care.

The disadvantages of the alcohol-based rub are it has no definite antimicrobial activity against norovirus which are non-enveloped. Also, no significant activity against protozoans' oocysts and bacterial spores.

The World Health Organization has described a concept for the hand hygiene which is known as Five Moments of Hand Hygiene wherein the first two moments (1 and 2) are the "before" indications and are followed to protect the patients from the risk of getting an infection from the health care workers and "after" indications (moments 3,4, and 5) are followed to protect the health care workers from microbial transmission from the environment or the patients. The concept of the Five moments for hand hygiene is the moments where health care workers should follow. These moments are evidenced-based, field-tested, logical, and applicable in a wide range of

settings including the tertiary care referral hospital. The WHO states that hand hygiene protocols should be mandatory, there is no value in partial hand hygiene. The gold standard method to monitor hand hygiene compliance is by direct observation. However, one of the studies does not agree with the gold standard practice to monitor hand hygiene is that they haven't found a correlation between mean product usage and observed hand hygiene adherence. The limitations to the direct observations are if the staff is aware that we are taking observations than the Hawthorne effect, it required more manpower, time-consuming, and does not do continuous monitoring (7).

In 1998 biomedical waste management rules were published by the Central Pollution Control Board and at that time most of the hospitals failed to adopt the desired standards even after a considerable amount of time. The problem increased with the scavenger workers who dealt with the biomedical waste without any protective gear. In Gujarat, 240 individuals became infected with Hepatitis B as a result of the reuse of unsterilized syringes(8). The Biomedical waste management rules were improved drastically in 2016 compared to 2000, 2003, and 2011. The earlier guidelines in 1998 included the ones who generate, collect, receive, store and transport biomedical waste, but the improved rules in 2016 also involve the vaccination camps and blood donation camps and all the health care facilities. There were ten categories in 1998, then they brought it down to eight categories in 2011, and in 2016 guidelines they have only four categories which actually helps in the easing of the segregation of biomedical waste and helps to remember properly. Also, in 2016 guidelines for biomedical waste management included the bar code system for the bags and containers which further increases the cost of waste management. The standards of the emissions from the incinerators had been stricter than 2011 rules which is 50mg/nm³. All

the health care facilities should make available annual reports on its biomedical waste management within two years of the amendments of 2018.

Refer to the annexure for more detailed guideline approach to hand hygiene and biomedical waste management issued by Ministry of Health and Family Welfare(1).

Lapses in Knowledge of Hand hygiene

A study conducted at the intensive care units of the tertiary care hospital discussed that health care workers had poor knowledge when it comes to infection control measures(9). The study emphasized on a multimodal engagement to improve Hand Hygiene compliance carried out in Pondicherry, India at the tertiary level center found that the views or the perceptions and credence needed to be changed to improve Hand Hygiene practice amongst the health care workers. This study emphasized on the multimodal engagement to hand hygiene suggested by the national guidelines of the infection prevention and control. The health care workers lacked basic knowledge of when to wash their hands while attending the patients, what is the method of hand washing and cleaning hands by alcohol rubs, and lastly about the appropriate use of the gloves while inpatient care(10). Here the hospital doesn't follow the policy of the National Patient Safety Implementation Framework which states that the healthcare workers should be trained and raise awareness of the hand hygiene technique to improve adherence. Recent studies have shown a significant association between mobile phones and colonization of the antibiotic-resistant strains of the bacteria. Mobile phones are potential carriers of the bacteria and can be a source of cross-infection between health care workers, doctors, and ICU patients(11). Knowledge of correct steps as per the WHO "Five moments of Hand hygiene" guidelines adopted in the National Guidelines for infection prevention and control in healthcare facilities was not adequate on pre-training evaluation of medical students

in Meerut, UP, India(12). A regular training program of short term needs to be conducted in the healthcare facility to bring out the best results in the long run(5).

Lapses in Practices of Hand hygiene

The national patient safety implementation framework guides us about promoting the positive environment for best practices in the health facility but there was no positive environment promoting such hand hygiene norms in the hospital(10). The Compliance of the hand hygiene practice dropped drastically in the night shifts and that was concluded assuming the fact that there was no monitoring and supervision in the night shifts. Since the patient load and contact with the patients are more in the day shift the compliance is better. Also, women were the ones who had better compliance than men (10).

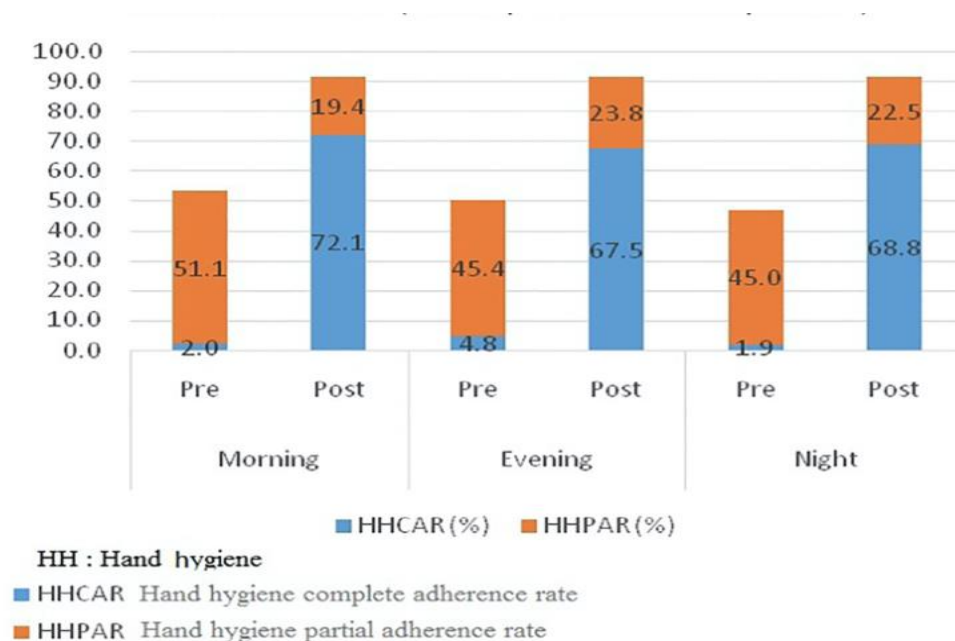


Fig : Variations in the shift showing Hand Hygiene Compliance, JIPMER, Pondicherry 2018(10)

One of the cultural behavior was observed was that the health care workers maintained hand hygiene compliance more when they thought of contraction microorganisms the most from such patients(13). The persistence and perseverance are important in maintaining infection control in the long run. This Knowledge, Attitude, and Practices study show the importance of the educational intervention in the medical students, but it fails to be certain about the improved practices to assess the long term implications of the intervention(12). Factors affecting the hand hygiene compliance are knowledge of hand hygiene practice, training, availability of the logistics, and the presence of the infection prevention committee. It was also found that a high workload was mentioned as one of the reasons for non-compliance by 38 percent of the 100 health workers, a study conducted in Pune(14). Despite the clear guidelines in the WHO hand hygiene 5 moments, variations within the process. Also in hand hygiene compliance was better followed by the women's health care workers than men(10). Even though the knowledge of the medical student was better but the Nursing staff practiced hand hygiene more comparatively(12,13). One of the most crucial observations regarding why doctors had poor compliance of hand hygiene than nursing staff made by authors in their study was increased workload or pressure, absence of training on infection control, "following monkey's rule (why should I follow when others are not following)", superiority complex(we are doctors and we know everything). Such a thought process makes the junior doctors learn less from practicing nurses(13). A similar study which studies the hand hygiene adherence pointed out the reasons why adherence to hand hygiene has no chance of improvement are workload pressure, unavailability of the alcohol hand rub at a clinical area, and nurse shortages(7,15,16).

Lapses in Biomedical Waste management India

Biomedical waste management is a cooperative and collaborative work and any shortcomings in one of the parts of the process lead to failure of the whole process. The reasons why Biomedical waste management rules are not being implemented or followed are that even in a well-developed Biomedical waste management system the knowledge of the housekeeping staff was lacking, and 32 percent health care personnel were unaware of the problem regarding the segregation of infectious waste from non-infectious waste. A similar study that happened back in 2015 had the same results that 32 percent of all the health care workers did not understand to differentiate non-infectious waste from infectious waste. And the worrisome part was that health care workers were unaware of the prerequisite of the treatment of laboratory waste before sending it to the facility. It was observed that there was a general lack of education among housekeeping staff(17). Poor knowledge about waste management and legislation among class four employees, a similar study of hospital medial personal in Agra, which said that awareness towards the legislation of biomedical waste was one of the barriers to proper implementation of the rules(18). Along with the lack of training of the staff, the availability of the color-coded bins, charts that shows categories are influencing the biomedical segregation(19). Government hospitals are facing challenges in biomedical waste management due to a lack of availability of sufficient funds to implement the new rules in Biomedical Waste Management rules 2016. The cost to eliminate chlorinated gloves, blood bags, and plastic bags is very high, also this has to be done with the establishing of the bar code framework for containers and bags(20). With the increasing generation of biomedical waste and high cost, it poses a threat to the health of the health care workers as well as the patients and the visitors coming along with the patients in the hospital settings. Biomedical waste treatment facilities are limited, eight states and union

territories are yet to develop the treatment plants(11). In spite of having quality managers, doctors, and nurses with knowledge of biomedical waste management the housekeeping staff did not do well(19). In the study conducted at Jammu and Kashmir, they observed that although the knowledge and practice of medical students were better than the nursing students, the practice of biomedical waste management was not up to the mark. Compliance is always at the question, segregation of the general waste from medical waste and disposing it into the color-coded bins accordingly was low(21).

Hand hygiene

To improve quality care and practices when it comes to reducing the risk of nosocomial infection and increasing antimicrobial resistance, audit/monitoring practices of the hand hygiene and biomedical waste management can achieve a behavioral change in the tertiary care hospital setting. There was a study that was conducted on the basis of the multimodal intervention to improve hand hygiene compliance in 2 ICUs with the 12 beds each at the tertiary care hospital where the study was conducted in three phases : preintervention, intervention, and post-intervention. The multimodal concept includes audits of hand hygiene, questionnaires, training of the health care workers to increase hand hygiene compliance and thus reduce hospital-acquired infections. This study recorded 6350 hand Hygiene opportunities and the results were 34.7 percent, 35 percent, and 69.7 percent for hand hygiene complete adherence rate, hand hygiene partial adherence rate, and hand hygiene adherence rate respectively. In the prevention phase, good compliance was seen in Moments 2 and 3 of WHO five moments of hand hygiene and in post-intervention 3,4, and 5 Moments were seen with good compliance. The Hand Hygiene Complete Adherence was calculated by no. of times hand hygiene followed completely divided by the no. of opportunities

of hand hygiene moments available(10). A similar cross-sectional observational study at the tertiary hospital at Pune observed that out of all the average compliance, most of the compliance was seen with moment 3 i.e. staff were careful about the contact with the bodily fluids of the patient and for the moment 5 i.e. after touching the patient's surroundings, poor in all the staff(22). On the observational studies which took different cohort and cross-sectional studies where mobile phones of the health care workers in the ICU were taken into consideration, both smartphones with the touch screens and keypad phones. It was found that 13 percent to 50 percent of the mobile phones of the health care workers carried pathogenic micro-organisms with a large number of them had multi-drug resistance organisms. Not just mobile phones but also in the hand of the health care workers(23). Some of the multi-drug resistance organisms which causes invasive hospital-acquired infection leading to prolonged ICU stay and even death with the increased cost of health care. The second outcome of this study was that many of the health care workers did not clean their mobile phones often(11). Studies have shown that medical students are having four times higher odds of having heavy growth of the microorganisms on their mobile phones(6). There is a significant amount of the studies that support the observation that with proper hand hygiene significantly reduces the risk of cross-contamination in the hospitals. The medical students move from one ward to another, and one clinic to another, hence hand hygiene is to be followed with utmost importance. After the intervention, it was seen that there is a significant positive attitude towards practicing the WHO five movements(12). The hand hygiene compliance was studied in 23 tertiary new-born care units and 9 tertiary level labor rooms in Andhra Pradesh and Telangana where overall compliance of hand hygiene in the new-born care units of the tertiary level facility was better than the secondary level facility and in the labor rooms hand hygiene compliance before conducting the delivery was 26 percent in a public health facility than 100 percent in private

facilities and the levels were similar in both secondary and tertiary level care. Also, the compliance of 33 percent in newborn care tertiary level facilities was reported (14) which was lesser than one of the similar studies conducted in New Delhi where compliance of hand hygiene was 46 percent(24). One of the studies shows the evidence that through hand hygiene audits they measured the hand hygiene compliance in the tertiary care teaching hospital. With the increase in the hand hygiene adherence rates, there is a significant decrease in device-associated infections. Also, the authors have considered WHO five moments of hand hygiene approach for measuring the adherence rates. However, there is small amount of the variations in the results like WHO moment 3 and 4 had statistically significant compliance rates(13) than moment 1,2, and 5. Poor hand hygiene practices in the hospital do not reduce the hospital-acquired infection and thus won't help to reduce the financial cost in the increased length of stay in the hospital for treatment. In the study 194 health professionals where the participants were assessed on the basis of the knowledge attitude and practices. 88.7% had good hygiene practice and 11.3% had poor hand hygiene practice. Hand hygiene is extremely important, especially, in the time of the COVID 19(25).

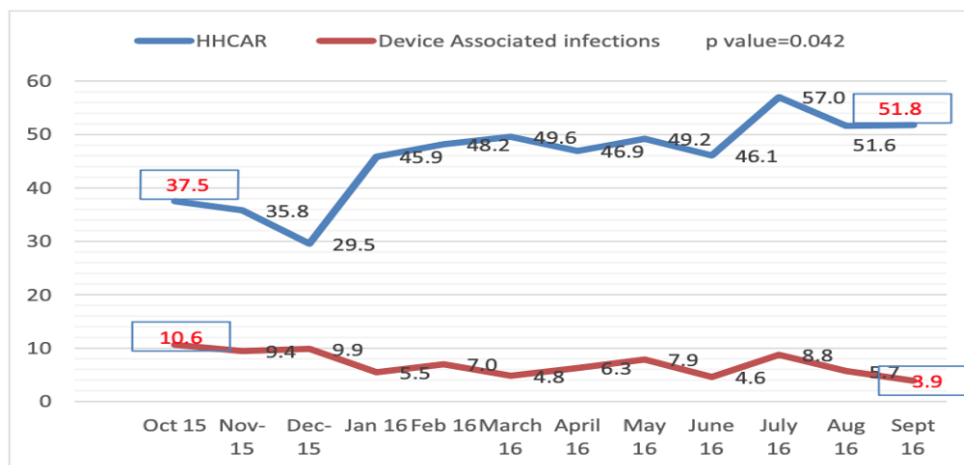


Figure: Decreasing rate of the Device associated infection with increasing Hand hygiene complete adherence rate, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry, India ,2017(13)

The Department of Pulmonary and Critical care medicine in Rohtak, Haryana conducted a study which measured the impact of the educational and training program on knowledge of the medical students regarding hand hygiene, the results of the pre-test mean score of 9.88 and the post-test mean score of 12.54 tells us that there is a positive impact on the knowledge of the health care workers(26). One another study that gave an insight into the impact of the educational on the hand hygiene on the nursing staff members, a total of 34 nurses were enrolled which were a part of the ICU team of the hospital in Eastern India. The assessment results were captured immediately post-intervention, 3 months after the intervention, and 6 months after the intervention. The non-compliance immediately after the intervention reduced but it gradually increased with the passing time over 3 months and 6 months. The percentage of noncompliance towards hand hygiene raised to 51.75 percent 6 months post-intervention(27). A study conducted in the AFMC, Pune back in 2012 has said that 21 percent of the health care workers were missing hand hygiene opportunities 1 in 5 times(16). The Practice among the nursing staff and nurses is always better in practices than medical students and knowledge among medical students and nurses was moderate with poor attitude with hand hygiene, in a study conducted in Raichur, India(28). Similar findings were observed in Navi Mumbai, where overall participants who had good knowledge were only 7.5 percent i.e. 15 out of 198, and because of that less than 40 percent hardly knew that it takes 20 seconds for alcohol hand rub for hand hygiene(29).

Biomedical waste management

An observational study (cross-sectional) in the non-NABH accredited tertiary care hospital in Rajasthan, showed that out of 165 responses to the questionnaire, 70 percent of the health care workers had a good idea about the knowledge of the various different waste material and segregation into various bins and boxes. Most of the health care workers were well versed with the Biomedical Waste Management operations except the housekeeping staff who did not do well in the barcoding, pre-treatment of the anatomical and biotechnological waste, knowledge of the sewage treatment plant, hazmat, and signage. Housekeeping staff of seventy-four only 35 percent had the knowledge of the needle prick injury protocol where the laboratory in charge is informed and prophylaxis treatment is started immediately. Also, only 12 percent knew about Hepatitis B vaccination(19). Most of the staff of the hospital (Doctors and nurses) more than 30 percent and more than 20 percent respectively knowledge about biomedical waste management. This shows that people with higher education were more aware of biomedical waste management guidelines(31). Contrary to this, one of the cross-sectional studies conducted in Nagpur, India in year 2013, found out that 63.10 percent and 82.14 percent of the interns had difficulty in defining biomedical waste and were unaware of waste handling and management act respectively. 83.33 percent correctly said about hospital-acquired infection but only 44.64 percent knew about the infection control measure to prevent hospital-acquired infection. Less than 45 percent had poor knowledge of waste disposal. Most of the interns in the study admitted that they have read all the material on biomedical waste management in the hospital but only 40.48 percent scored more than 20. None of the interns scored more than 31 in the total knowledge, attitude, and practice score(32). But the results of the study conducted in a teaching hospital at Jammu and Kashmir which included seventy final year MBBS students and 70 third-year nursing students showed that the knowledge of the rules of the biomedical waste management was up to the mark and all had a good attitude

towards the same but only 38-55 percent of the students were able to segregate and disposal of waste properly in color-coded bins, which signifies that there is a huge gap in the knowledge and practice of the rules(21). Similar findings were given by a cross-sectional study at Karnataka, 2013 which showed that although knowledge and attitude are inadequate among the health care professional and class four waste handlers were amongst the worst. Also, only 36 percent of the doctors, 43 percent of the nurses, 30 percent of the lab technicians and 13 percent of the class four workers were segregating the waste according to the color-coded bins(33). Training of the health care workers is very crucial so that it can lead to a better quality of the practices in the hospital but only 44.3 percent of the study participants received training in biomedical waste management, a study conducted in tertiary care hospital in Rajkot, Gujarat(34). A significant difference in the knowledge score between the pre-test and the post-test training program was observant in the tertiary care hospital in Haryana, North India. A total of two fifty participants were a part of the training program on Biomedical waste management (Management and Handling) rules, the mean knowledge score of the participants in pre-test was 14 and post-test knowledge score was 19.94 which was 80 percent of the total achievable score(35). A study conducted in the Bangalore city medical college and hospital showed that the knowledge of technical personals like doctors, nurses was good but much less in housekeeping staff. Low level of knowledge attributes to poor training facilities(36).

A detailed review of the papers with results have been attached in the annexure pg. 43-63.

Discussion

The emphasis of the individual studies leads to the approach on how to sustain and continue good hand hygiene practices and biomedical waste management practices in the tertiary care unit in India.

Hand hygiene

Mobile phones being one of the indispensable things, it is really important to take care of hand hygiene with the cleaning of the mobile phones. One of the studies in India showed results that all the health care workers bring mobile phones to the hospital but only 10 percent clean their phones. Big companies like Apple and Samsung gave guidelines that 70 percent of alcohol wipes can be used to disinfect the mobile screen when the screen is turned off. In the times of the COVID-19 pandemic, there is a significant association between the mobile phones and viral pathogens that have been found on their surface. Doctors treating the COVID patients are the bridge between the COVID positive patients in the ICU and to the external world. Mobile hygiene is said but not done by all the health care workers(11). A complete restriction in the use of mobile phones would be difficult to maintain, instead, health care facilities should encourage to adhere to the hand hygiene protocols and disinfecting mobile phones and accessories with alcohol swipes. Compliance with hand hygiene is poor in both private and public hospitals. The suggested methods for improved hand hygiene are direct supervision and feedback and display of written hand hygiene protocols(14). Measuring the hospital-acquired infections can help us know that there is a strong association with good hand hygiene practices(13). A qualitative study with focus group discussion was conducted at 530 bedded rural teaching hospital at Ujjain, India, which discussed questions such as origins of the hospital-acquired infection, adherence to hand hygiene guidelines, and what are the suggestions on how to improve adherence rate of hand hygiene practice. The results

suggested by medical students and doctors regarding the mode of transmission were contaminated hands but in the focus group of nurses, the mode discussed was food. The reasons for the non-compliance to hand hygiene practice were found out to be interrupted water supply, fewer number of washbasins, and there was a shortage of the cleaning staff and the nurses and there was inadequate behavioral change communication between hospital management and staff(41). Continuous monitoring and conducting a hand hygiene audit regularly maintain the hand hygiene practice in the high-risk areas such as the ICUs(25). When it comes to reducing the risk of nosocomial infection and antimicrobial resistance, to improve quality care, audits or monitoring practices of hand hygiene and biomedical waste management can achieve a behavioral change in tertiary care hospital setting. Studies that measure the knowledge, attitude, and practices of the hand hygiene and biomedical waste management addresses the behavioral component of the health care facility. To evaluate, the operating indicators are taken into considerations such as compliance rate and adherence rates of the hand hygiene and biomedical waste management rules. Such operating indicators give us an idea of the outcome indicators such as hospital-acquired infection rates. Prior to exposure to the hospital, the nurses must be trained for an infection control program. A mandatory policy should be there so that the adherence rate is high with a low hospital-acquired infection rate. The training sessions on the infection control policy and practice should be done as a part of the curriculum in the internship period of medical students and nurses. This approach should be incorporated with the induction training of the upcoming doctors at the teaching tertiary care hospitals. Implementation of the practice of hand hygiene should be mandatory in the infection control practice of that hospital(12). Hand hygiene audits and the presence of the infection control manager in the hospital is something to be considered in the policy-aspect of the

hospital acquired infection. The behavioral change communication intervention is much needed in the hospital settings to bring out the best in hospital-acquired infection rates.

Biomedical waste management

Biomedical Waste Management is the process in which there are various levels of healthcare workers and the administrators working for this single process of waste management and the difficulty in one of the areas can affect the whole chain of waste management. Thus, continuous monitoring and feedback work really well for such processes. Good knowledge about biomedical waste management was due to the induction training, motivation, and constant repetitive training of the nurses and laboratory staff by the quality managers(19). The appropriate use of the reusable items made of the glass and metals can lead to waste minimization. The training of the health care workers in terms of knowledge of proper use and disposal of the waste should be integrated with environmental information with the changing ailments and diseases. The use of environment-friendly products such as blood pressure gauges and mercury thermometers with mercury-free ones. The key frontline professionals contribute to the successful implementation of the Infection Prevention and Control guidelines. The programs should focus on the retention of the training and knowledge of hand hygiene and biomedical waste management rules.

The training professionals should demonstrate a habit of hand hygiene developed by WHO's Five moments of Hand hygiene. The health care workers must learn the concept of the Five moments for Hand hygiene by WHO and should know the importance of it so as to decrease the rate of the Hospital-acquired infection in the long run(10). The WHO blue book 2014 and WHO guidelines on the safe management of the wastes from health care activities suggested that every administrative department of the institution and facilities generating biomedical waste shall pre-

test the laboratory waste, microbiological waste, blood samples, and the blood bags through sterilization and disinfection onsite(42). Full time or part-time experts with behavioral change communication skills must be employed by the tertiary care facilities to handle the biomedical waste(20)

Conclusion

There is no establishment of the Health Management Information System for Nosocomial Infection at the National level. Regular and continuous monitoring, evaluation, and training programs for hand hygiene and Biomedical Waste Management amongst the health care professionals in India could prove effective in reducing the rates of Hospital Acquired Infection.

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Annexure

Guidelines of Hand hygiene

The WHO guidelines on hand hygiene in healthcare (2009) suggest that hand hygiene is the single most important measure for prevention of infection. Hands can become contaminated with infectious agents through contact with a patient, patient surroundings, the environment, or other HCWs. Hand hygiene removes dust/soil, organic material and transient microorganisms from the skin and reduces the risk of cross-contamination. Evidence suggests that the hands of the HCWs are the most common vehicle for the transmission of healthcare-associated pathogens from patient to patient and within the healthcare environment. Studies show a direct correlation between an increase in adherence to hand hygiene with decrease in HAIs.

- Routine hand hygiene
 - Hand washing with soap and water is preferred when hands are visibly dirty or soiled with blood or other body fluids or after using the toilet.
 - Hand rubbing with an alcohol-based preparation is the preferred method for routine hygienic antisepsis if hands are not visibly soiled.
- Surgical hand scrub

Hand washing with soap and water

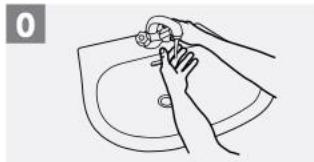
Indications: when there is visibly heavy contamination, e.g. with proteinaceous material, blood or body fluids.

- After attending to a patient with suspected/confirmed *C. difficile* infection
- After using toilet
- Before and after having food
- Adequate number of sinks with running water and soap should be available in the haemodialysis unit to facilitate hand washing.

How to Handwash?

WASH HANDS WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB

 Duration of the entire procedure: 40-60 seconds



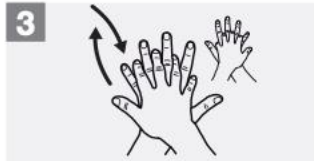
Wet hands with water;



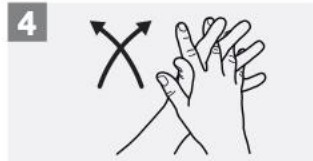
Apply enough soap to cover all hand surfaces;



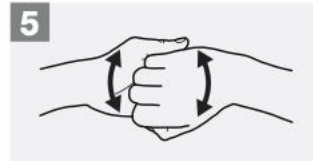
Rub hands palm to palm;



Right palm over left dorsum with interlaced fingers and vice versa;



Palm to palm with fingers interlaced;



Backs of fingers to opposing palms with fingers interlocked;



Rotational rubbing of left thumb clasped in right palm and vice versa;



Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;



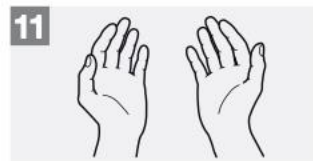
Rinse hands with water;



Dry hands thoroughly with a single use towel;



Use towel to turn off faucet;



Your hands are now safe.



World Health Organization

Patient Safety

A World Alliance for Safer Health Care

SAVE LIVES

Clean Your Hands

Hand rubbing using alcohol-based preparation

- Use alcohol-based hand rubs (ABHR), when hands are not visibly soiled or tap and running water is not available.

How to handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS ONLY WHEN VISIBLY SOILED!



Figure33: Poster for hand rub using alcohol-based hand rub

Source - WHO Guidelines on Hand Hygiene in Healthcare

Note important points to keep in mind when using an alcohol-based hand rub:

- Take adequate quantity to wet all surfaces of both hands
- Apply to dry hands. Do not apply to latex gloves
- Dry the solution by rubbing the hands following the steps shown above
- The solution should remain wet on the hands for at least 20-30 seconds for adequate disinfection.

Advantages of ABHR

- Easily accessible at point of care
- Excellent antimicrobial activity against Gram-positive and Gram-negative vegetative bacteria, *M. tuberculosis* and a wide range of fungi.
- Generally good antimicrobial activity against enveloped viruses

Disadvantages of ABHR

- Lesser and/or variable antimicrobial activity against non-enveloped viruses (such as norovirus)
- No activity against protozoan oocysts and bacterial spores (such as *Clostridium difficile*)

Improving the implementation of hand hygiene

- **System change:** ensuring that the necessary infrastructure is in place to allow HCWs to practise hand hygiene. This has two essential elements:
 - Access to a safe, continuous water supply as well as to soap and towels;
 - Readily accessible alcohol-based hand rub at the point of care.
- **Training/education:** providing regular training on the importance of hand hygiene, based on the “My 5 moments for hand hygiene” approach, and the correct steps for hand rubbing and handwashing, to all HCWs.
- **Evaluation and feedback:** monitoring hand hygiene practices and infrastructure, along with related perceptions and knowledge among HCWs, while providing performance and results feedback to staff.
- **Reminders at the workplace:** prompting and reminding HCWs about the importance of hand hygiene and about the appropriate indications and procedures for performing it.
- **Institutional safety climate:** creating an environment and perceptions that facilitate raising awareness about patient safety issues while guaranteeing improvement of hand hygiene as a high priority at all levels, including
 - active participation at both the institutional and individual levels;
 - awareness of individual and institutional capacity to change and improve (self-efficacy); and
 - partnership with patients and patient organizations.

WHEN? Your 5 moments for hand hygiene

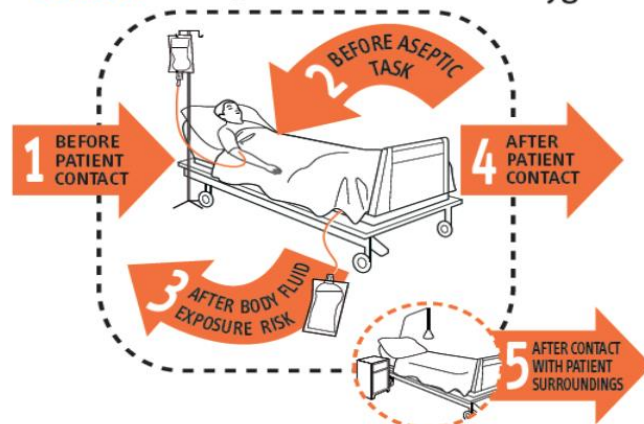


Figure32: Five moments of hand washing

1 Before Patient Contact	When: Clean your hands before touching a patient when approaching him/her Why: To protect the patient against harmful germs carried on your hands Example: Shaking hands, helping a patient to move around, clinical examination
2 Before Performing Clean/Aseptic Procedure	When: Clean your hands immediately before performing a clean/aseptic procedure Why: To protect the patients from harmful germs, including patients' own, from entering his/her body Example: Oral/dental care, secretion aspiration, wound dressing, catheter insertion, preparation of food and medications
3 After Body Fluid Exposure Risk	When: Clean your hands immediately after an exposure risk to body fluids and after glove removal Why: To protect yourself and healthcare environment from harmful patient germs Example: Oral/dental care, secretion aspiration, drawing and manipulating blood, cleaning up of urine, faeces, handling of waste
4 After Touching a Patient	When: Clean your hands after touching a patient and his/her immediate surroundings, when leaving the patient's side Why: To protect yourself and healthcare environment from harmful patient germs Examples: Shaking hands, helping a patient to move around, clinical examination
5 After Touching Patient Surroundings	When: Clean your hands after touching any object or furniture in the patient's immediate surroundings when leaving – even if the patient has not been touched Why: To protect yourself and healthcare environment from harmful patient germs Example: Changing linen, perfusion speed adjustment

HANDWASHING TECHNIQUE

World Health Organization (WHO) recommends six main steps of hand washing both through use of soap and water hand wash and also by use of alcohol-based hand rub. Both these techniques of hand washing are depicted in following educational posters:

Guidelines of Biomedical Waste Management

National Rules for biomedical waste management

The Ministry of Environment, Forest and Climate Change published the Biomedical Waste Management Rules on 28 March 2016. These rules superseded the Biomedical Waste (Management and Handling) Rules, 1998. The 2016 Rules have been amended in 2018 and 2019.

- These Rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle biomedical waste in any form including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, Ayush hospitals, clinical establishments, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first-aid rooms of schools, forensic laboratories and research laboratories.
- Safe and proper identification, handling, storage, and disposal of biomedical waste from laboratories and related facilities is the responsibility of every occupier. "Occupier" means a person having administrative control over the institution and the premises generating biomedical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, HCF and clinical establishment, irrespective of their system of medicine and by whatever name they are called. Duties of the Occupier/HCF.

- **Yellow:** for human anatomical waste, animal anatomical waste, soiled waste, expired or discarded medicines, chemical waste, chemical liquid waste, discarded contaminated beddings and microbiology, biotechnology and other clinical waste;
- **Red:** for contaminated plastic waste;
- **White sharps bin:** for metallic sharps; and
- **Blue sharps bin:** for glass sharps.

Management of biomedical waste

Waste segregation at point of generation

- HCF/ laboratory waste requires management at every step from generation, segregation, collection, transportation, storage, and treatment to final disposal.
- Of the waste generated in healthcare settings, approximately 10% to 25% is hazardous but if not segregated properly, the entire waste becomes infectious thereby escalating the overall cost of waste management. The most practical approach to the management of

biomedical waste is to identify and segregate infectious waste, which would in turn drastically reduce the cost of waste disposal in healthcare settings.

- Biomedical waste should be segregated into containers or bags at the point of generation. This includes placing different types of waste in different colour-coded-bags and containers at the site of generation.
- Proper segregation should identify waste according to type of waste and type of disposal/disinfection.
- Colour-coded bags as per national norms need to be placed in appropriate containers with the appropriate label/ logo. For example, using a biohazard symbol for infectious waste.
- Puncture-proof containers made of plastic or metal with a biohazard symbol, in blood collection areas, injection trolleys, nursing stations and OTs should be made available for collecting metallic wastes.
- Syringes should be either mutilated or needles should be cut and/ or stored in tamper-proof, leak-proof and puncture-proof containers for sharps storage.
- Ensure segregation of liquid chemical waste at source and ensure pre- treatment or neutralization before mixing with other effluent generated from HCFs.

BIOHAZARD SYMBOL



CYTOTOXIC HAZARD SYMBOL



HANDLE WITH CARE

Note: Label shall be non-washable and prominently visible.

Collection bags

Solid waste is collected in leak-resistant heavy-duty bags. Coloured bags made of non-chlorinated plastic with biohazard sign and labels mentioning date and details of waste are to be used. The bags are tied tightly after they are three-fourths full.

Pre-treatment, packing, storage and transport

Laboratory waste, microbiological waste, blood samples and blood bags must be pre-treated through disinfection or sterilization on site in the manner as prescribed by the WHO guidelines on safe management of wastes from healthcare activities and then sent to a common biomedical waste treatment facility for final disposal. Standards for autoclaving are as given in Schedule II

of the Biomedical Waste Management Rules 2016. The bags or containers used for waste segregation shall be labelled as per Schedule IV of the Rules.

Provision must be made within the premises of an HCF for a safe, ventilated and secured location for storage of segregated biomedical waste in coloured bags or containers, inaccessible to scavengers and protected against insects, birds, animals and rain, to ensure that there is no secondary handling, pilferage of recyclables, or inadvertent scattering or spillage by animals. The biomedical waste from such places or premises should be directly transported to the authorized common biomedical waste treatment facility for the appropriate treatment and disposal.

Transport of biomedical waste to common biomedical waste treatment facility will be done only in vehicles having appropriate label as provided in Part A of Schedule

Waste category Number	DayMonth Year
Waste quantity.....	Date of generation
Sender's Name and Address	Receiver's Name and Address
Phone Number	Phone Number
Fax Number	Fax Number
Contact Person	Contact Person
In case of emergency please contact Name and Address: Phone Number:	

IV of the Biomedical Waste Management Rules 2016, along with necessary information as specified in part B of the Schedule IV of the Biomedical Waste Management Rules 2016. Label shall be non-washable and prominently visible.

The vehicles used for transportation must comply with conditions, if any, stipulated by the State Pollution Control Board or Pollution Control Committee in addition to the requirement contained in the Motor Vehicles Act, 1988, if any, or the rules for transportation of such infectious waste.

Untreated human anatomical waste, animal waste, soiled waste and biotechnology waste shall not be stored beyond a period of 48 hours.

Treatment and disposal

- The HCF shall hand over segregated waste as per Schedule I to the common biomedical waste treatment facility for treatment, processing and final disposal: provided that the laboratory and highly infectious biomedical waste generated shall be pre-treated by equipment such as autoclave or microwave.
- The HCF shall treat and dispose the biomedical waste in accordance with Schedule I and in compliance with the standards provided in Schedule II of the Biomedical Waste Management Rules 2016.
- On-site biomedical waste treatment and disposal facilities are not to be established unless a common biomedical waste treatment facility is not available within a distance of 75km.
- The duties of the common biomedical waste treatment facilities are given in Annex 8.3.
- In cases where service of a common biomedical waste treatment facility is not available, the HCF shall set up requisite biomedical waste treatment equipment such as an incinerator, autoclave or microwave, shredder before commencement of its operation, as per the authorization given by the prescribed authority.
- Every operator of the common biomedical waste treatment facility shall set up requisite biomedical waste treatment equipment such as an incinerator, autoclave or microwave, shredder and effluent treatment plant as a part of treatment before commencement of its operation. The standards for treatment and disposal of biomedical wastes in Schedule III of Biomedical Waste Management Rules 2016 must be complied with.
- Every HCF shall phase out the use of chlorinated plastic bags within two years from the date of publication of the Biomedical Waste Management Rules 2016. Bags used for storing and transporting biomedical waste shall be in compliance with the Bureau of Indian Standards. Till the Standards are published, the carry bags shall be as per the Plastic Waste Management Rules, 2016.
- The handling and disposal of all the mercury waste and lead waste is to be done in accordance with respective rules and regulations.

Biomedical waste handlers

- Immunize all HCWs and others, involved in handling of biomedical waste for protection against diseases including hepatitis B and tetanus which are likely to be transmitted by handling of biomedical waste, in a manner as prescribed in the National Immunization Policy or the guidelines of the Ministry of Health and Family Welfare issued from time to time.
- Ensure occupational safety of all HCWs and others involved in handling of biomedical waste by providing appropriate and adequate PPE.
- Conduct health check-up at the time of induction and at least once in a year for all HCWs and others involved in handling of biomedical waste and maintain the records for the same.

Annual report

- Every HCF has to submit an annual report to the prescribed authority in Form- IV, every year on or before the 30 June. The prescribed authority is the state pollution control board for states and pollution control committees for Union Territories. For establishments under the Ministry of Defence, the prescribing authority is Director General, Armed Forces Medical Services.

Maintenance of records

- Maintain and update on day-to-day basis the register for biomedical waste management and display on the website the monthly record of the biomedical waste generated in terms of category and colour coding.
- Records related to the generation, collection, reception, storage, transportation, treatment, disposal or any other form of handling of biomedical waste must be maintained for a period of 5 years.
- All records must be available for inspection and verification by the prescribed authority or the Ministry of Environment, Forest and Climate Change at any time.
- Maintain all records for operation of incineration, autoclaving, etc. for a period of 5 years.

Reporting of accidents

- Any major accident at any institution or facility or any other site while handling biomedical waste must be intimated immediately to the prescribed authority and a report forwarded within 24 hours in writing regarding the remedial steps taken in Form I of the Biomedical Waste Management Rules 2016.
- Information regarding all other accidents and remedial steps taken shall be provided in the annual report.

Training

- All workers involved in handling of biomedical waste must be provided training at the time of induction and at least once a year thereafter.
- Records of the training programmes conducted, number of personnel trained and number of personnel who have not undergone any training must be maintained.

Biomedical Waste Management

S.No.	Title	Author	Year	Context	Type	Methodology	Instrument description	Results	Conclusion
1	Knowledge, attitude and practices about bio-medical waste management system in a tertiary care 60 bedded hospital	Dr Virender Verma et. al	2020	India	Observational Study (Cross sectional)	An observational (cross-sectional) study using questionnaires was carried out at one of the non-NABH accredited tertiary care hospitals of Rajgarh City in Rajasthan, India (19).	Questionnaires	The senior nursing staff and sisters in charge of the ward are given the responsibility for implementation of the BMW management rules by the authorities. Lack of training in staff result in less knowledge in BMW management practices(19).	Constant motivation, induction and training coupled with reinforcement in terms of feedback is vital for implementation of BMW practices. Their training should include mock drills and real-life scenarios to make thing possible in a better way(19).

2	Effectiveness of a training program about bio-medical waste management on the knowledge and practices of the health care professionals at the tertiary care teaching institute	Sukhbir Singh et. al	2020	Haryana, North India	Interventional study	In the year 2018 training regarding biomedical waste management rules was conducted. It evaluated the impact of the training program. Mean score of Pre-test and post-test was compared by Paired-t Test(35).	Structured questionnaire : assessing the knowledge regarding Biomedical waste management (M and H) rules.	Included 250 participants in the training program, majority were female's 84 percent. Improvement in the knowledge scores was observed after training program(35).	Effective structured training increased the knowledge of the participants in Biomedical Waste Management (Management and Handling) rules(35).
3	Knowledge, attitude, and practice of biomedical waste management rules, 2016; Biomedical waste management (amendment) rules, 2018;	Annapurna Parida et.al	2019	Safdarjung, New Delhi, India	Interventional study	A in-house survey was planned to assess the existing knowledge and practices of the health care workers(17).	predesigned pretested questionnaire	Focus was on reduction of the infectious waste volume by properly separation infectious waste from non-infectious. Health care workers involved in	Repetitive and comprehensive training on Biomedical waste management is the only way forward(17).

	and solid waste rules, 2016, among health care workers in tertiary care setup							study had good knowledge on colour coding, segregation, and health hazard of biomedical waste(17).	
4	Assessment of the knowledge, attitude and Practices regarding Biomedical Waste Management amongst the Medical and Paramedical Staff in Tertiary Health Care Centre	Rekha Sachan et. al	2012	Lucknow	Cross-Sectional study	The study was carried out in the obstetrics and gynecology department of CSM medical university. Conducted in surgery wards and OT(31)	Structured questionnaire : assessing the knowledge regarding Biomedical waste management (M and H) rules.	Both doctors and Nurses had good amount of knowledge regarding the Biomedical waste management. Both the groups had positive attitude and followed correct practicing habits(31)	All the employees of various designations are required to be aware of proper collection, segregation, and transport to the final disposal point. Intensive regular training need to be employed for long run and there is need for orientation programs before going to the hospitals(31).

5	Knowledge, Attitude, and Practice of Biomedical Waste management among Healthcare personnel in teaching institution	Puneet Anand et. al	2016	Haryana, India	Cross-Sectional study	Study was conducted from May 2016 to June 2016. A total of 305 participants were given questionnaire after taking consent(37).	Pre-designed, Questionnaire	Knowledge, attitude and practice of all except class four employees was very low(37)	Guidelines for continuous training program with special focus on class four employees(37).
6	Biomedical Waste Management and Nosocomial Infections, Knowledge, Attitudes and practices in the Tertiary care Hospital	Jyotsna S. Deshmukh et. al	2013	Nagpur, India	Cross-Sectional study	A study involved 168 final years passed out students who have just started the internship. Different aspects of the waste disposal and attitude towards it with prevention of the hospital acquired infection.	Pre-designed, pre-tested and self-administered questionnaire	Following the guidelines of the waste management with monitoring the compliance alone cannot give the best outcome for our goal, there should be integration of the social science approach(32).	Lack of the proper and complete knowledge about the biomedical waste management and hospital acquired infections amongst the interns. Rigorous training programs are required(32).

7	Biomedical Waste Management : a study of Knowledge, Attitudes and practices among health care personnel at the Tertiary care Hospital	Rajesh K Chudasama et. al	2014	Rajkot, Gujarat	Observational Study (Cross sectional)	The study was conducted from January 2013 to June 2013. The Participants includes intern doctors, nurses, laboratory technicians, ward boys and sweepers(34)	Pretested, semi structured proforma	A total of 282 health participants were included in the study and only 40 percent had correct knowledge of the Biomedical waste management(34)	Lack of the proper knowledge of the biomedical waste management does impact the practices in the same(34)
8	Knowledge attitude and practices of the biomedical waste management among medical and nursing students in a teaching hospital	Dipender Kaur Najotra et. al	2020	Jammu and Kashmir, India	A Cross sectional Study	A self-administered, pre-designed, pre-tested questionnaire was given to 140 participants(21)	Pre-designed, pre-tested and self-administered questionnaire	Knowledge regarding waste management was well in the medical and nursing students but there was a gap in practicing as it was not up to the mark. Compliance in segregation of the waste was low.(21).	Appropriate and evidence based training should be designed for the students in the institutions focusing on the practices of biomedical waste management rules(21).

9	Knowledge attitude and practices of the biomedical waste management among personnel of tertiary health care institute	Imaad Mohammed Ismail et. al	2013	Dakshina Kannada, Karnataka, India	A cross sectional Study	A total of 120 health care professionals working in the Medical college were selected and it had 30 each of doctors, nurses, lab technicians and class four waste handlers(33).	Pre-designed, pre-tested and self-administered questionnaire	There was a lack of the training and laxity in implementation of the biomedical waste management rules. Proper disposal of the waste in the color coded bins was practiced by less than one third of the study participants(33).	Knowledge regarding the waste disposal in color coded bins was very poor especially among class four waste handlers. Continuous training programs should be conducted(33).
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10	Study about awareness and practices about health care wastes management among hospital staff in medical college hospital	Suwarna Madhukumar et. al	2012	Bangalore, India	A Cross sectional Study	A total of 383 participants including 55 doctors, 65 interns, 83 nurses, 44 laboratory technicians, 78 attenders and 57 housekeeping staff were included(36).	Pre-designed, pre-tested questionnaire	The Activities included are reduction in the waste generated, proper containment of waste, secured transportation, occupational health and safety measure. The knowledge of technical personals like doctors, nurses were good but much less in housekeeping staff. Low level of the knowledge attributes to poor training facilities(36).	Regular training and monitoring of the health care workers in essential. The practice of the interns were low and hence they must be trained via practical knowledge(36).
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Hand Hygiene

11	A multimodal intervention to improve hand hygiene compliance in a tertiary care centre	Abdul Mannan Laskar et. al	2018	Pondicherry, India	Interventional study	The study was conducted in two intensive care units from august 2016 to October 2016. It had three phases, pre-intervention, and intervention, and post-intervention. A total of 53 health care workers including the physicians, nurses and housekeeping staff were included in the Hand hygiene audit(10)	Questionnaires	This study recorded 6350 hand Hygiene opportunities and the results were 34.7 percent, 35 percent, and 69.7 percent for hand hygiene complete adherence rate, hand hygiene partial adherence rate, and hand hygiene adherence rate respectively(10)	A good and significant results can be achieved through systemic, multidimensional interventional approach including all types the health care workers in the hospital setting, which may ultimately result in decrease in Hospital acquired infection rate(10)
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12	Hand hygiene in reducing transient flora on the hands of the health care workers: An educational intervention	R Kapil, HK Bhavsar et. al	2015	Uttar Pradesh	Interventional study	A study was conducted in the tertiary care hospital and the sample size was 60 subjects including medical students, nurses, resident doctors, hospital and sanitary workers(23).	Questionnaires	The presence of the bacterial flora in the hands of the health care workers in the hospital is significant. Hand hygiene has shown to be the effective method to control the transmission of the infection by reducing the transient flora(23).	More and more induction training opportunities should be conducted(23).
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13	Hand hygiene : an educational intervention targeting grass root level	Kalpana Chauhan et. al	2018	Meerut, Uttar Pradesh	Interventional study	In this study 152 participants were evaluated based on the questionnaire to assess knowledge, attitude and practice regarding the hand hygiene. Same group of the student were given post-test questionnaire(12)	Pre-test and post-test, self-structured questionnaire	Knowledge of the WHO five moments of the hand hygiene was not adequate in 22.36 percent on pre training but it significantly increased after that training to 98.68 percent. Continuous educational programs are the key to overcome barriers and grow knowledge. (12).	For good infection control measures like hand hygiene, education and training are most important. This study highlights the importance of the educational and training of the medical students as soon as they enter 3rd semester (12).
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14	Knowledge, Attitude, and practice on hand hygiene compliance among Health care professionals in tertiary care teaching hospitals during the 2020 pandemic	Vahithamala Kunasekaran et. al	2020	Chennai	A descriptive cross-sectional study	A total of 194 health care professionals working in the hospital at Chennai were included via random sampling technique(25)	Semi-structured questionnaire	Overall knowledge on hand hygiene was good, also higher compliance to hand washing was there in the nurses followed by doctors. Frequent training program can help change the hand hygiene practice. 11.3 percent had poor practice of hand hygiene(25).	Hand hygiene is important measure in the COVID 19 pandemic as the contaminated hand touching the mouth, nose and eyes is prevalent. Performance feedback should be there to motivate the health care workers in COVID 19(25).
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15	Impact of the educational and training programs on knowledge of the health care students regarding nosocomial infections, standard precautions and hand hygiene: A study at tertiary care hospital	Mohit Goyal et. al	2019	Rohtak, Haryana, India	Cross-sectional cum interventional	A total of 728 MBBS, BDS, and BSC nursing students were included into the workshop on nosocomial infection, standard precautions, and hand hygiene(26).	Infection Control Standardized Questionnaire	The sessions gave practical demonstration on how to do hand hygiene procedures. The impact of training sessions in knowledge status was highest on BDS students 15.46 percent, followed by nursing students 15.12 percent and MBBS students 10.31 percent increase(26).	This study highlighted the importance of the nosocomial infection, standard precautions and hand hygiene in the clinical training and hospital infection control program. For retention of the knowledge of the hand hygiene, it is important to conduct regular training and educational programs(26).
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16	Impact of the Nursing Education on Central Line Associated Bloodstreams Infection Rates: An experience from a Tertiary Care hospital.	Ranjita Acharya et. al	2019	Eastern India	Quasi-experimental Study	The study was conducted in the ICU of the tertiary care hospital in terms to education of nursing staff to reduce the incidence of the central line associated bloodstream infections. The assessment was done to assess the knowledge and percentage of non-compliance with hand hygiene practice. Central line Bloodstreams infection rate after 6 months of intervention was assessed(27).		the post test scores improved by the educational program on hand hygiene compliance and the number of missed opportunities reduced with reduction in the central line associated bloodstream infection rates(27).	Training and education of the health care workers is easy but maintaining it over the long period of time requires continuous training, reminders and motivation(27)
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17	Hand hygiene compliance among healthcare workers in an accredited tertiary care hospital	Siddharth Chavali et. al	2014	Pune, Maharashtra	Cross-sectional observational study using direct observation technique	1500 hand hygiene opportunities observed and hand hygiene compliance was tested as per WHO 5 moments guidelines(7)	Pretested Close ended validated questionnaire	By using the multimodal techniques to improve hand hygiene compliance they came to know that there were differences in the adherence between those 5 moments(7).	In India where not all can afford the technology to monitor the adherence direct observations are gold standard(7).
18	Baseline assessment of hand hygiene knowledge perception: An observational study at newly set up teaching hospital	Aroop Mohanty et. al	2020	Rishikesh, Uttarakhand	Cross-sectional observational study	Study includes medical students, nursing faculties, staff nurses, senior residents, ward sisters making a total of 171 health care workers. Assessed knowledge and awareness of hand hygiene practice.	Pretested, structured questionnaire	Knowledge and compliance of good hand hygiene practice should be mandatory in order to reduce health care associated infections and provide better safety to the patients. 67 percent health care workers in the study believed that	A well-developed hospital acquired infection control committee with proper number of staff who can do proper hand hygiene practice and it should be mandatory to have alcohol-based hand rubs at every point of care.

								hand washing is more effective than hand rub.	
19	Hand hygiene practices among health care workers in tertiary care facility	Lt V. Anargh et. al	2012	AFMC, Pune	A cross sectional, questionnaire and observation-based study	Study involved 100 health care workers with patient care except in the operation theatres. A questionnaire with respect to WHO and CDC guidelines were given. Assessed knowledge, Attitude and practice of the health care workers(16)	Questionnaire with respect to WHO and CDC guidelines	Healthcare workers preferred hand washing with soap. Compliance to hand hygiene as per WHO remained high(16).	The requirement of the indept appraisal for understanding important issues of compliance and patient safety(16).

20	A study to assess Knowledge and attitude regarding hand hygiene amongst residents and nursing staff in a tertiary health care setting	Veena Maheshwari et. al	2014	Bhopal	A Cross sectional Study	A study carried out in 3-month period to assess knowledge, attitude and practice of hand hygiene amongst residents and staff nurses Principle investigator visited both the groups and verbal consent were taken. A total of 160 respondents (80 residents and 80 nurses) (38)	Questionnaire	Residents and nurses had good knowledge on hand hygiene. However only some of the residents and nurses had known about the minimum time needed for effective hand hygiene as mentioned in the WHO guidelines(38)	Highlighting the importance of the training of the health care workers regarding the hand hygiene among residents and nurses and update current news on the health care associated infections. This would actually get implemented in a behavioral change attitudes and practices that would help reduce incidence of the nosocomial infections(38)
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21	Knowledge, attitude, and practice of hand hygiene among medical and nursing students at tertiary health care centre	Sreejith Sasidharan et. al	2014	Raichur, India	A Cross sectional Study	The study was conducted in the Navodaya Medical College Raichur, A self-made questionnaire to assess the knowledge, attitude and practice of 98 medical students and 46 nursing students were involved(28)	Questionnaire	Moderate knowledge was observed amongst all the health care workers but compliance with hand hygiene differed among professional categories. Compliance amongst the physicians was low compared to the nurses(28)	Training sessions need to be conducted continuously in a periodic time to follow correct hand hygiene practices(28)
22	Knowledge of hand hygiene in undergraduate medical, dental, and nursing students	Vaishnavi S. Thakker et. al	2015	Navi Mumbai, Maharashtra	A Cross sectional Study	Survey conducted among 84 medical, 74 dental and 40 nursing undergraduates. Knowledge was assessed using WHO hand hygiene questionnaire(39)	WHO hand hygiene questionnaire	In order to prevent cross infection hand hygiene is of utmost importance and hand hygiene is an educational priority. Formal training of the hand hygiene needs to be	The low score and unsatisfactory knowledge of hand hygiene indicates undergraduate requires training at primary level; as curricula(39)

								included at the under graduate level(39).	
23	Evaluation of existing knowledge, attitude, perception, and compliance of hand hygiene among health care workers in tertiary care centre	Ankit Goyal et. al	2020	Rishikesh, Uttarakhand	Descriptive cross-sectional study	WHO hand hygiene and compliance were used to study knowledge, attitude and compliance. The sample size was 220 participants. (40)	Majority of them received prior training on hand hygiene so the knowledge was appropriate. Overall good attitude towards hand hygiene	Promotional activities and posters does improve hand hygiene(40).	The overall compliance rates shows that encouragement and reinforcement of hand hygiene practices proper availability of hand hygiene material, posters and continuing education activities is still the demand(40).

