

Water, sanitation, hygiene and biomedical waste disposal in the healthcare system: A review

Sharad Chand¹, C. S. Shastry^{1*}, Shivakumar Hiremath², Juno J. Joel¹, C. H. Krishna Bhat¹, Uday Venkat Mateti¹

¹Department of Pharmacy Practice, ^{1*}Principal and Professor, NGSMS Institute of Pharmaceutical Sciences, ²Justice K.S. Hegde Charitable Hospital, Nitte (Deemed to be University), Paneer, Deralakatte, Mangaluru, Karnataka, India- 575018

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Corresponding author: C. S. Shastry. Email: drcshastry@gmail.com

ABSTRACT

Health is the foremost need and concern of any population. Healthcare settings are places to restore health. Healthcare settings should be designed and maintained in such a way that it should ensure the safety of patients and healthcare staff. Facilities for safe drinking water, proper sanitation, good hygiene, and proper disposal of hospital generated waste are some of the basic needs to deliver adequate and acceptable health service to the community. Maintenance of these essential facilities may differ depending upon the geography, resources, and existing beliefs and norms. The non-availability of supply and workforce may hinder the proper functioning of healthcare systems in the hospitals. Even though there are various policies and procedures to maintain the above in hospital, lacunas in its development and implementation in a hospital setting create the gaps in the desired outcome of the healthcare setting. Various healthcare settings formulate or follow different procedures to maintain water, sanitation, hygiene, and bio-medical waste management facilities. The variation in the selection, and adoption of several other policies and procedures may compromise the functioning of the healthcare system. Hence, The standard guidelines should be followed by healthcare institutions wherever applicable.

Keywords: Patient safety; hygiene; sanitation; biomedical waste disposal; healthcare standard.

INTRODUCTION

Healthcare settings are a place of healing. Assurance of robust systems in healthcare premises is critical to minimize the ill effect of disease and to prevent adverse impact due to the hospital environment (1). Healthcare-associated infections and hospital-acquired morbidity are public health issues of high-level concern. Healthcare-acquired morbidities are a persistent problem in all health systems and apparently, no country has been able to come with an effective remedial solution (2). Adequate drinking water, proper sanitation and good hygiene are fundamental to optimum health. Controlling the microbiological load in the hospital environment is an essential component of hospital sanitation. Improvement in these can substantially reduce the rate of morbidity and severity of various diseases; ultimately improve the quality of life. That is why Mahatma Gandhi in the year 1923, famously said, "sanitation is more important than independence" (3). The environment of the healthcare facility may expose patients and healthcare workers inadvertently to environmental pathogens and results in healthcare-acquired illnesses (4). The provision of proper hygiene and sanitation measures in health care facilities help to prevent infections and disease transmission. It also serves in protecting staff and patients (5).

Healthcare generated waste management is an integral part of hospital hygiene and infection control. Health-

care waste is a reservoir for various pathogenic microorganisms. If waste management is inadequate, these microorganisms can transmit and increase the risk of nosocomial infections among healthcare personnel and patients (6). An unsafe environment leads to occupational risk which may impose a higher risk of mental health illness (7). Improper handling may lead to a severe public health issue as well as a significant adverse impact on the environment. Hence, biomedical waste management rules 2016 are enforced to minimize this hazard (8).

Definitions

According to the World Health Organization (WHO), "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases" (9).

"Sanitation is defined as access to and use of facilities and services for the safe disposal of human urine and feces." (10).

"Bio-Medical Waste rules, 2016- Bio-Medical Waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps, including the categories mentioned in Schedule I appended to these rules."(8).

Key facts on water, hygiene, and sanitation

More than 100 million people are affected every year due to improper hygiene and sanitation. Around 15% of the total patients are estimated to develop one or more infections during their hospital stay (11). On average, out of every 100 hospitalized patients, seven in developed and ten in developing countries acquire at least one type of healthcare-acquired infection (HAI) (12). Globally, around 2.4 million deaths can be prevented every year with the practice of proper hygiene and sanitation (13). There is only a restricted availability of data from low resource countries. on water (54%), sanitation (36%) and hygiene (35%) (14). Out of 86 countries that responded to the WHO survey, only 25 % have fully implemented the plans and policy for water and sanitation in health care facilities. As per the vital statistics for health care facilities, out of 54 countries and 66,101 health facilities, 38% were found without improved water supplies, 19% without upgraded toilets and 35% without water & soap for handwashing (15).

Facts on biomedical waste disposal

15% of the total waste generated in the hospital is hazardous and the remaining 85% resembles domestic waste. Worldwide around 16 billion injections are administered, but they lack a proper disposal (16). Approximately 82%, 60% and 54% of primary, secondary, and tertiary care health facilities were not having proper biomedical waste management, respectively (17).

Maintenance of basic components in healthcare facilities

Water

Water-borne disease constitutes a significant burden on health. Improving the quality of water provides significant benefits to health. Keeping water safe from a source to its use is challenging. Sufficient water for handwashing, toilet facilities, cleaning, laundry, and maintaining hygiene in healthcare setup is needed first along with the provision of safe drinking water. Hence, there should be a suitable safety plan for assessing and managing water systems and ensuring the effective prevention of microbial contamination in drinking water (18).

A survey conducted by WHO/UNICEF in 2015 in 50 different hospitals across four districts of Uganda showed 94% of water sources were improved. In contradiction, the provision of water was lowest in another African region with around 42% of healthcare facilities lacking the improved source of water. High disproportionalities were noted in small healthcare setups of the rural area compared to the larger hospitals in an urban area within the same country (5). Almost 50% of the people in the developing, or

underdeveloped countries have one or more associated diseases or infections occurring due to inadequate water supply and sanitation (5, 6).

WHO/UNICEF recommends a global standard for adequate and safe access to water in the healthcare system with a minimum of the following criteria.

Quality of water

- There should be no thermotolerant bacteria (e.g., *Escherichia coli*) detectable in a 100 ml sample of drinking water.
- Water should be disinfected to ensure microbial safety until consumption or use.
- Water should be odorless or colorless for easy acceptance during consumption or use.
- Water used for cleaning, laundry and sanitation should be labeled at every outlet.
- Drinking water in healthcare settings should meet and follow national standards for drinking water quality (18).
- Water should not get contaminated during storage, distribution and handling in healthcare settings.
- Specialized care is required in the supply of drinking water to immuno-compromised patients.
- Water used for laundry and cleaning purposes need not be of drinking water quality.
- Water for medical purposes may need to be of higher quality (e.g., water used for hemodialysis) (19).

The quantity of water

The minimum requirement of water in the health-care setting, including water used for all purposes like hand hygiene, cleaning, laundry, drinking and cooking is given below:

- Out-patients - 5 litres/consultation
- In-patients – 40-60 litres/patient/day
- Operation theatre/maternity unit - 100 litres/procedure
- Supplementary feeding center 0.5–5 liters/consultation.

The quantity of water required may vary depending upon its availability, usage and climatic conditions. The required facilities should be made available in the health-care setting to allow convenient access and use of water for drinking, medical activities, personal hygiene, food preparation, laundry and cleaning.

Hygiene

As per the results of a survey conducted, the rate of hospital-acquired infection was reported to be 4.7% in a hospital of the United Arab Emirates (UAE), and 8% in one of the Saudi Arabian hospitals. The infection rate reported in Iran hospital was between 1.3 to 10% (18). The percentage of hospital-acquired infections

can be minimized by following the standard operating procedures for cleanliness and adopting the optimal measures for sweeping, mopping, disinfection and sterilization.

- Hygiene maintenance and its promotion are essential for hospital staff, patients, and caregivers as it is very important in controlling disease transmission (20).
- Routine cleaning of surfaces and fittings should be carried out to ensure that the health-care setting environment is visibly clean, aesthetic, and free from dust and soil.
- Frequency and intensity of cleanliness should be appropriate to the degree of asepsis required.
- Areas contaminated with blood or other body fluids should be cleaned and disinfected immediately.
- Soiled and clean linen should be transported and stored separately (19).
- Ninety percent of microorganisms in health-care facilities are present within visible dirt; routine cleaning can eliminate them to a good extent. Wet mopping with detergent is recommended rather than sweeping (21).
- Sweeping is sufficient in offices and other non-patient areas.
- Wet mopping has to be done daily in waiting areas, consulting rooms, disease wards and pharmacy.
- Cleaning with the disinfectant solution is required for each inpatient room daily or whenever soiled, and after each intervention.
- All surfaces and appliances should be free of dust and should have an aesthetic appearance.
- Cleaning practices should be monitored periodically and audited with feedback.
- The proper methodology has to be employed for stain removal (22).

Sanitation

Federal level policies are essential to creating a healthy environment for the maintenance of water, sanitation, and hygiene (WASH) in a health-care setting. Health workers are appropriate for practicing proper hygiene and sanitation in health-care facilities, and they can also work as stimulators for sustainable changes. Further, developing a long-term plan for the healthcare system is vital to ensure the sustainability of WASH facility (23). The use of necessary sanitation facilities may enable patients, staff and care-givers to prevent contamination of resources such as water supplies in healthcare settings (24).

- Sufficient toilets should be available (one per 20 users for inpatient settings and at least four latrines for the outpatient setting).

- Toilets design should be according to local cultural and social conditions and suitable for all age and user groups.
- Toilets should be safe (minimizing the risk of sexual violence and privacy) to use, easily accessible, clean and having handwashing facilities.
- Toilets should be cleaned at least twice per day, with a disinfectant and a brush to remove visible soiling (22).
- Suitable products such as hand sanitizer with atleast 62% of alcohol and antimicrobial soaps for routine handwash shall be selected appropriately (24).

Biomedical waste management

Biomedical waste management should be done according to the World health organization (WHO) waste management: Fundamentals of healthcare waste management and compliance to the BMW management rules, 2016 and amendment rules, 2018 of India in Indian Territory (15, 16). These rules recommend the provision of separate disposal of liquid and solid BMW. It describes stringent rules and regulations for proper segregation at the site of generation, collection, storage, transportation, and disposal of biomedical waste. BMW amendment rules emphasize the timely segregation of BMW at the site of generation in different color-coded bins (17, 22). The collected BMW should be carried to the storage site and weighed with the proper bar-coding system to record the data on the quantity of BMW generated in the hospital. The storage site must be spacious enough to accommodate the quantity generated during 24 hours. The stored BMW should be transported to the site of disposal every 24 hours (not more than 48 hours for untreated BMW). Optimally the BMW shall be carried to disposal facility by common biomedical waste disposal facilities vehicle (Approved by state or central pollution control board) equipped with a proper GPS facilitating the real-time tracking. The waste should be bar-coded in the bags while loading for transportation, and the weight of BMW should be verified for its validity after arrival in the disposal facility to avoid the loss of BMW. The BMW should be disposed of in the recommended procedures to reduce the possible health hazards (8). The healthcare establishments, which are not in the periphery of a 75 kms radius from common biomedical waste disposal facility, may have their disposal plant. The yellow category of waste comprising of all infected tissues shall be incinerated and the ash should be filled in closed tank or cement filling for safe landfill. The white category of waste comprising of metallic sharps and needle should be disposed of by deep burial after

packing in cement blocks. Similarly, the red category of waste containing the recyclable plastics and blue category of waste containing the glass and lead shall be treated, disinfected, shredded, and recycled (8, 16, 17, 22).

Source reduction, recycling products, good governance, reusing the goods if possible and waste segregation helps to minimize the quantities of hazardous waste (25). Health-care waste should be segregated, collected, transported, treated, and disposed of safely. Color-coded waste managing containers bearing clear, understandable signs and symbols should be placed at convenient locations. Bio-medical waste should be treated and disposed according to the safest and feasible method available.

The major categories of health-care waste recommended are:

- Sharps, including needle and scalpels, should be placed in yellow puncture-proof and closed containers, transported and disposed of in a sharps pit (26).
- Non-sharps infectious waste (anatomical waste, pathological waste, etc.) should be placed in yellow or red waste bags or containers with lids. Sterilized (if the facility is available), and subjected to incineration (27).
- Non-sharps non-infectious waste (paper, packaging, etc.) shall be kept in black plastic bag or black waste containers with a lid. Preferably recycled or buried in the landfills or it is incinerated, and ashes should be buried appropriately in the pit (28).
- Hazardous waste (expired drugs, laboratory, radioactive waste, etc.) should be collected and stored in appropriate and labeled containers placed in a secure location. Radioactive waste should be stored in tanks that have effective lead shielding to prevent of dispersion of radiation. Disposal may require specific treatment and disposal methods like sterilization, burial, incineration, etc. (8).

Civil legislation should be followed in the biomedical waste management wherever applicable according to biomedical waste management rules. An infection control team should monitor the segregation, collection, transportation and disposal of biomedical waste. Suitable personal protective measures should be used during the handling of biomedical waste (29).

Indian scenario

Currently, India is of no exception among other countries in terms of the high mortality rate in the world. Water, sanitation, and hygiene (WASH) facilities often lack quality and quantity in healthcare institutions. Several institutions have the availability of

WASH facilities, but their functionality, quality, accessibility, and adequacy are still questionable. Improper storage of water and poorly equipped hand washing stations without soap and proper disinfectant is another challenge in the context of India. Necessary awareness among healthcare staff on WASH facilities is also a critical point for the practice of hygiene in daily routine. Lacking awareness and promotion programs is another reason in the healthcare system of India, contributing to the poor control of hospital-acquired morbidities. In some healthcare facilities, adequate staff and supplies are available with a sufficient number of toilets and water tanks but are not cleaned regularly. Overwhelming numbers of the healthcare facilities have no policies or guidelines on regular maintenance and cleaning procedures. Most healthcare facilities have a shortage of cleaning staff. Wherever available, they are not trained and not equipped with protective measures (30). Several studies reported unsafe toilets and bathroom, non-availability of soaps and towels in the bathroom, scarcity of water, pads, and dustbins in both baths and showers (31). In India, WASH facilities are primarily focused on the quantity of infrastructure, neglecting the focus on quality. About 76000 neonates die every year in India and lack of WASH facility remains as the primary cause for such an alarming mortality rate. In response, the Government of India initiated various programs like *Swachhta* (Cleanliness) Guidelines for Health Care Facilities (*Kayakalp*) and *Swachh Swasth Sarvatra* (22, 32).

A study conducted on hygiene and sanitation in small health facilities in rural Pune (India), reported that few public health facilities had no toilets or hand washing outlets. In contradiction, all private health facilities offered toilet and hand washing stations. Most latrines were found well maintained in private setup, but often lacked the availability of dustbins. Dedicated latrines for females were rare. WASH facilities of private areas were generally acceptable, while suggestions for improvement were recommended in some government facilities (33). As per the results of a study conducted in Tamilnadu, around 41.6% of the health facilities (57 out of 137) were found to be having non-functional WASH installations, while only 5.8% (8 out of 137) were fully functional during the first supervisory visit. Several recommendations were made as per the observation, and on the second supervisory visit conducted three months later, 71.5% were found as partially functional, 21.2% were fully functional, and only 7.3% of facilities were non-functional (34).

Hospital waste management is a critical aspect that is still not given proper attention to many of the hospitals in India. The MOEF in 2011 stated that 13,037

healthcare facilities (primary, secondary, and tertiary) are violating the waste management rules. Ministry later issued 3,585 show-cause notices, where Maharashtra topped the list with 640 HCFs, followed by Rajasthan (556 HCFs), Uttar Pradesh (382 HCFs), Delhi (380 HCFs) and Karnataka (374 HCFs). MOEF figures of 2011 stated that Karnataka has the highest (62,241 kg/day) BMW generation, followed by Uttar Pradesh (44,392 kg/day), Maharashtra (40,197 kg/day) and Kerala (32,884 kg/day). The MOEF also indicated that a total of 4,05,702 kg/day of BMW is generated in the entire country, of which only 2,91,983 kg is disposed of properly and 1,13,719 kg/day of the waste generated is left untreated. There is an ultimate need for policies and protocols by health care institutions to manage recyclables. Besides the systematization of solid waste in hospitals, the establishment and installation of a treatment plant should be made compulsory to treat and disinfect the hospital generated liquid waste before discharging into the sewage (35).

A study conducted on hospital waste management during the year 2005–2006 among 53 smaller healthcare institutions in Delhi showed improvement in the segregation, collection, management and disposal of biomedical waste in the majority of the institutions. The handling of sharps and methods adopted for transportation of biomedical waste varied significantly from hospital to hospital (36). Similarly, another study conducted on BMW in Lucknow city stated that all categories of wastes were collected without segregation in common bins provided with no color code placed outside the general wards. Lucknow municipal corporation employees used to visit the hospital to collect the wastes every 2-3 days for disposal. The laboratory wastes were disposed of directly into the sewer without proper treatment. Disposable plastic items were segregated by the rag pickers. Lack of proper responsibility for the hospital in waste management was shown in the study result. It may be due to the lack of awareness and trained personnel to manage the hospital waste properly or due to the lack of allocated funds to create a proper waste management system (37). The study conducted for three months in Uttar Pradesh has found that workers were not using protective equipment like spectacles, shoes, mask or hand gloves. Workers were not provided with sufficient gloves while they did the handling of the waste materials, which might affect their health adversely. They were thus found more prone to diseases. The nursing staff, sweepers, cleaners and other personnel involved in the management of hospital wastes were found not aware of taking any precautionary measures while handling the biomedical wastes (38). Hence, there is a need for adopting a system for achieving better medical waste treatment

facilities which in turn will reduce the amount of waste generated. Lack of quality drinking water, hygiene, sanitation, and waste disposal leads to various diseases in the community. Hence, proper steps in improving the above aspects have to be adopted and implemented. In contrast, there is only a little exploration of the same in the healthcare setup where it plays a critical role in health outcomes. Indeed, improvement in the above provisions in the healthcare system is monitored as a part of the sustainable development goals. Healthcare-associated infections (HCAI) constitute a significant challenge in developing countries; the estimated risk is 2–20 times higher compared to developed countries.

Recommendations

The following strategies can be adopted to improve the water, sanitation, hygiene, and biomedical waste handling and management in health care facilities.

- Framing of national standards, adequate financing and human resourcing.
- Strengthening, implementing national policies and standards.
- Developing a system to assess and verify compliance with national standards.
- Recognition of facilities by various accreditation agencies.
- Commitment from health partners at the local, national, and global levels.
- Financial assurance and training for the staff.
- Providing appropriate tools for prioritization and improvement of hygiene and sanitation.
- Identifying the hazards and associated risks due to improper sanitation, lack of hygiene and inappropriate health care waste disposal.
- Harmonized monitoring.
- Strengthening reporting systems at the domestic and national levels.

Even though various national and international policies are available, it is a very complicated and tedious process to implement the standards effectively. Compliance with policies and guidelines help in maximizing patient safety in any healthcare setup.

CONCLUSION

Water, sanitation, hygiene, and waste minimization are frequently discussed topics in national and international scientific sessions. Still, a lot of healthcare centers in developing countries including India, lack these essential facilities. Healthcare systems are primarily meant for providing healthcare services and to promote health. Adoption as well as compliance with the relevant statutory provisions, can make these services more effective and safe.

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