ORIGINAL RESEARCH PAPER

Microbiology

STUDY OF LIQUID WASTE MANAGEMENT IN A TERTIARY CARE HOSPITAL

KEY WORDS: Biomedical Waste, Liquid waste, Effluent treatment plant

Mukty Modi	Grant Govt. Medical College, Sir JJ group of Hospital, Mumbai,
Dr. Ritesh Shirpurkar*	Assistant Professor, Department of Microbiology, Grant Govt. Medical College, Sir JJ group of Hospital, Mumbai, *Corresponding Author
Dr Chhaya Chande	Associate Professor, Department of Microbiology, Grant Govt. Medical College, Sir JJ group of Hospital, Mumbai
Dr. Kavita Bhilkar	Assistant Professor, Department of Microbiology, Grant Govt. Medical College, Sir JJ group of Hospital, Mumbai
Dr. Renu Bharadwaj	Professor, Head of Department of Microbiology, B. J. Medical college, Sasson Hospital, Pune
Dr. Abhay Chowdhary	Professor, Head of Department of Microbiology, Grant Govt. Medical College, Sir JJ group of Hospital, Mumbai

ABSTRACT

Introduction – Biomedical waste generated in hospitals and health care institutions has a potential to disseminate infection in community as well as in hospital. Among the different categories of biomedical waste, liquid waste is one of the least studied aspects. The study was performed to evaluate the need for providing a separate effluent treatment plant (ETP).

Material and Method-All patient cares areas such as wards, operation theatres (OTs), ICUs and OPDs.were studied. The study had two components to it. First was the evaluation of various types of chemicals, reagents and disinfectants and second was the evaluation of the quality of effluent draining out of hospital drains.

Result & Discussion - Sodium hypochlorite was the most common chemical in use followed by benzalkonium chloride, phenyl and isopropyl alcohol. Qualitatively the hospital effluent when tested for parameters such as Ph, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), total ammonia and total chlorides was observed to be well within the permissible limits as mentionedin Biomedical Waste Guidelines, 2016.

Conclusion - In the larger interest of preventing pollution of precious and scarce water resources, treatment of hospital effluent in ETP plant is a step in the right direction.

Introduction:

Biomedical waste (BMW) management in hospitals and health care institutions is an important ethical and legal issue due to its potential to disseminate infectious agents. Biomedical waste generated in a hospital includes human anatomical waste, solid waste, soiled waste, waste sharps and liquid waste among others [1]In a hospital liquid waste is generated in all patient care areas areas such the wards, operation theatres (OT) and OPDs. Liquid waste is categorized as a yellow category waste in the BMW guidelines 2016.[1]Among the different categories of biomedical waste, liquid waste is one of the least studied aspects. A need was therefore felt to perform a liquid waste audit to evaluate the need for providing a separate effluent treatment plant (ETP).

Materials & Methods:

The study carried out over a period of 2 months under two components. First was the evaluation of various types of chemicals, reagents and disinfectants used in all patient care areas including laboratories, their consumption on a monthly basis and their treatment before discharge in drains, if any. Second was the evaluation of the quality of effluent draining out of the hospital through various hospital drains. The site visits covered all patient cares areas such as wards, operation OTs, ICUs and OPDs. Site visit was also done to places such as labs, Blood Bank, Mortuary, Laundry, Eye Bank, Nephrology Department, Radiology Department, Pre and Paraclinical departments.

Samples of effluent were collected from 6 drains (Table 1)in the morning half since the water consumption and hence its discharge is maximum during this period.

Table 1:

Drain no.	Areas drained
1.	Laundry.
2.	Paediatric wards.
3.	Main Hospital building*.
4.	Building housing Gynaecology, Psychiatry and Plastic Surgery departments
5	Separate buildings each for Anatomy & Physiology, Pathology & Microbiology, Forensic Medicine & Pharmacology departments and Mortuary. **
6.	OPD building.

(*The main hospital building includes majority of wards and O.T.s, Artificial Kidney Dialysis (AKD) unit, MRI and CT scan sections, Intensive care unit etc.)

(** all these areas drain into a common drain 5)

They were tested at the Municipal Corporation Laboratory for sewage water.Various parameters such as pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Oil and Grease content, Total suspended Solids (TSS), Chloride content and Ammonia content. In addition, the overall water consumption of the hospital was also recorded.

Result

Overall, 61 patient care areas were evaluated which included 36 wards, 12 OTs, 12 laboratories, a separate building which houses all OPDs and departmental buildings of pre and para-clinical departments. A total of 12 disinfectants, 74 different chemicals

and 20 kits based reagents were recorded as in-use. The hospital used an average of 93 litres of sodium hypochlorite per day, an average consumption of 1.52 litres/day/area, Benzalkonium Chloride per day, an average consumption of 0.93 litres/day/area and Isopropyl alcohol per day, an average consumption of 0.43 litres/day/area.

The hospital is spread over 48 acres of land with 38 buildings, both residential and hospital-based, receiving 6.47 million litres per day (MLD) of water supply. Following the dictum that 60% of the water supply gets discharged as effluent into the drains, the approximate amount of effluent generated is 3.88 MLD.

Sample of effluent collected from 6 drains were tested for various parameters as shown in table 2.

Table 2: The various parameters and their values for the 6 drains.

Sr. No	Parameters	Drain 1	Drain 2	Drain 3	Drain 4	Drain 5	Drain 6	Average values	Cut-off*
1	pH	7.81	6.97	7.20	6.57	6.40	6.50	6.9	6.5 - 9.0
2	B.O.D.	42	53	75	88	256	59	**95.5**	30
3	T.S.S.	40	87	80	67	600	340	**202**	100
4	Oil and Grease	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	B.D.L.	10
5	Free Ammonia	1.12	12.32	15.68	4.48	17.36	3.92	9.14	NA
6	D.O.	0.4	0.7	2.0	0.3	B.D.L.	B.D.L.	0.5	NA
7	C.O.D.	267	172	193	185	287	217	**220.1**	250
8	Chlorides	28	36	43	50	57	28	40.33	NA

* Permissible limits for liquid waste treated in an ETP as per BMW 2016 guidelines(All parameters except pH are expressed in mg/L) (B.D.L.: below detection limit.) (T.S.S. –Total Suspended Solids, B.O.D. – Biological Oxygen Demand, C.O.D. – Chemical Oxygen Demand, D.O. – Dissolved Oxygen, NA – Not Available)

Discussion

Sodium hypochlorite was found to be the most common chemical in use followed by Benzalkonium Chloride and isopropyl alcohol. Phenyl was preferred in cleaning but the use of a cleaning agent depended on availability. Spirit was also used as a skin disinfectant in many of the areas of the hospital each area using an average of 0.45 litres per day. The use of Cidex (2% gluteraldehyde) was restricted for sterilization of the instruments such as endoscopes and thus mostly used in the operation theatres and to some extent in the ward with an average each area used 0.2 litres per day. Liquid soap found its application for cleaning purposes and for washing hands in many areas of the hospital as an alternative to phenyl. About 0.3 litres/area/day was used.

The hospital receives 6.47 million litres per day (MLD) of water supply. Following the dictum that 60% of the water supply gets discharged as effluent into the drains, the approximate amount of effluent generated is 3.88 MLD.The total amount of chemicals and disinfectants discharged by the areas conducting hospital activities was calculated to be 336 litres per day. The subsequent admixture of these chemicals and disinfectants with the drained water resulted in their dilution. The dilution factor for the chemicals and disinfectants discharged into the drain was calculated to be 11,000. So, the chemicals and disinfectants discharged into the drain got diluted to a huge extent thus reducing their toxicity. This correlates with the findings of Chitins V. et al who in their study discovered that the dilution factor of the effluent discharged from the pathology laboratory was very high.[2]

Various parameter of effluent from 6 drains were studied (Table 2).It was observed that the average pH (6.90) for all the six sites was within the permissible limits prescribed by BMW 2016 guidelines.[1] The average TSS was observed to be 202 which was above the cut off. The permissible limit prescribed by BMW 2016 guidelines for oil and grease is 10 mg/litre. In all the six drain samples, oil and grease were found to be below detection limits indicating a very low content of it in the hospital effluent. The average chloride content was found to be 40.33. The average free ammonia of the hospital effluent was observed to be 9.14 mg/dl.The amount of dissolved oxygen (D.O) gives the index about the load of microorganisms present in the waste water. Higher levels of D.O. indicate a lower burden of microorganisms and hence point towards a lower B.O.D. and C.O.D. The average D.O. content (0.56) was found to be low, being below detection limits in drain 5 and drain 6. Consequently the average B.O.D. (95.50 mg/dl) and average C.O.D. (386.8 mg/dl) was found to be above the permissible limit.(30 mg/dl for B.O.D. and 250 mg/dl for C.O.D.).

However, the cut-off values of these parameters are for effluent treated in ETP as given in 2016 BMW guidelines. The values of in the study are of untreated effluent. In a document published by Central Pollution Control Board (CPCB) in 2005 on "Status of Sewage Treatment in India," the average sewage characteristics of the three main parameters of BOD, COD and TSS was reported to be 185.5mg/L, 481mg/L and 328mg/L respectively for untreated effluent[3] Thus, in comparison to the national average, the values of thee three important parameters in the present study were less by 49% for BOD, 20% for COD and 38% for TSS. Untreated sewage quality varies from region to region, ranging from an average 600 mg/L for BOD in Europe to 200 mg/L in USA.[4]

The parameters were observed to be deranged maximally in drain 5. It was found that apart from carrying the effluent from Anatomy, Physiology, Pathology, Microbiology departments and the Mortuary, the drain also carried the effluent from the slums located at the rear end of the hospital campus. This could account for the high levels for various parameters in the effluent. This also resulted in a high average values for parameters such as B.O.D., C.O.D. and T.S.S.

All parameters of the samples collected from the drain 1 that carried the effluent from the laundry were within permissible limits except C.O.D. which was marginally above the cut off value. A similar pattern was also observed with the samples collected from drain 2 and 4 which carried the effluent from the Paediatric, Gynaecology, Psychiatry and Plastic surgery wards. The values of various parameters for drain 6 which drains the OPD building were also within permissible limits except for T.S.S. and D.O. which were deranged.

Thus, it was observed that the chemicals used in different areas of the hospital were being diluted to a very great extent (dilution factor being 11,000). The effluent from the hospital drains into the in public sewer which is finally drained into the terminal municipal ETP where the effluent is treated before being discharged into the sea.

Conclusion

To conclude, no particular practices were carried out by the HCWs for neutralizing the chemicals and disinfectants before their discharge. However, chemicals drained got diluted to a great extent because of high amount of water consumed and subsequently drained, the dilution factor being to the tune of 11,000. On the basis of the three important waste water quality indicators of BOD, COD and TSS it was observed that the hospital effluent fared better than the national average. In the present study, however, the bioassay test which detects fish survival in effluent was not conducted (90% fish survival after 96 hours in 100% effluent), although this cut-off is applicable to treated effluent and not to raw sewage water.[4]

However, pollution caused by discharged, untreated sewage is the primary cause of degradation of water resources in the country[5]. The CPCB report has pointed out to the ever widening gap between sewage generation and treatment capacity, the generation being 29,000 MLD against the existing treatment capacity of 600 MLD.[5] Also, the quality of effluent keeps on changing, it being a dynamic process.

CPCB has categorised Health care facilities (HCFs) as a red category industry under the Water (Prevention and control of Pollution) Act 1974 in 2012 to promote cleanliness of streams and rivers by

prevention, control and abatement of water pollution.[5] This has made setting up of an ETP plant in hospital premises mandatory. The notification of Government of India, Ministry of Environment, Climate and Forest Change published on 28th March, 2016, for Biomedical Waste Management states of setting up of an ETP plant in hospital premises for liquid waste management.[1] However, this involves major engineering changes in the existing drainage system. The ETP plant would also require space in the premises, which in a city like Mumbai may be a difficult proposition. All these factors have to be taken into account for setting up an ETP plant. In the larger interest of preventing pollution of precious and scarce water resources, treatment of sewage water in ETP plant is a step in the right direction. This treated water can be utilized for other non-potable uses such as gardening. However, continuous monitoring of the quality of effluent along with sensitization and training of HCW is necessary.

References :

1. Ministry of Environment, Forests & Climate Change notification New Delhi, 28th March, 2016 - Bio-Medical Waste (Management and Handling) rules.
2. Chitnis V, Vaidya K, ChitnisDS.Effluent Treatment Plant: Why and How? Journal of Academy of Hospital Administration.2002; 14(1):33-37
3. Status of Sewage Treatment in India – Central Pollution Control Board, November2005
4. Clair N. Sawyer; Perry L. McCarty; Gene F. Parkin (2003). Chemistry for Environmental Engineering and Science (5th ed.). New York: McGraw-Hill. ISBN 0-07-248066-1
5. Standard methods for examination of water & wastewater by Lenore s. Clescerl, Arnold Greenberg, Andrew d. Eaton,20th edition pages:5-2 -5-17.