ISSN: 2230-9926

International Journal of Development Research

Vol.6, Issue 09, September - 2014

IMPACT FACTOR / INDEXING JOURNAL

ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of
DEVELOPMENT RESEARCH

International Journal of Development Research
Vol. 4, Issue, 9, pp. 1915-1918, September, 2014

Full Length Research Article

PHYSICO-CHEMICAL ASSESSMENT OF HOSPITAL WASTEWATER QUALITY

***[1]Pratibha Sharma, [1]Mathur, N., [1]Singh, A. and [2]Bhatnagar, P.**

[1]Department of Zoology, University of Rajasthan, Jaipur 302004, Rajasthan, India
[2]International College for Girls, Mansarovar, Jaipur 302020, Rajasthan, India

ARTICLE INFO

Article History:
Received 18th June, 2014
Received in revised form
28th July, 2014
Accepted 17th August, 2014
Published online 30th September, 2014

Key words:
Hospital Wastewater,
Environmental Threat,
Physico-Chemical Characterisation

ABSTRACT

Hospitals discharge significant amounts of wastewater loaded with microorganisms, heavy metals, toxic chemicals, and radioactive elements. Screening of wastewaters produced from hospitals is, therefore, necessary to predict the actual health hazards that may be caused due to their improper discharge. The analysis of a recognized set of physico -chemical parameters is the most commonly used method of assessing wastewater quality by pollution control boards / regulatory authorities. This paper points out the areas of concern for hospital wastewater disposal and reports the findings of a limited physico-chemical study executed with effluents of three major hospitals located in different parts of Jaipur (Rajasthan), India. Monitoring of pH, turbidity, conductivity, salinity, total dissolved solids and biological and chemical oxygen demands indicates that the activities of hospital wastes in the environment is a major health and environmental threat, which therefore call for a proper regulatory system on disposal of hospital effluents untreated, worldwide, especially in the developing countries like India.

INTRODUCTION

Hospitals consume a significant amount of water in a day, ranging from 400 to 1200L per bed (Deloffre-Bonnamour, 1995; CCLIN Paris-Nord, 1999) and generate equally significant amounts of wastewater loaded with microorganisms, heavy metals, toxic chemicals, and radioactive elements. Such waste effluents may endanger public health and welfare, and contribute to oxygen demand and nutrient loading of the water bodies and in the process promote toxic algal blooms and leading to a destabilized aquatic ecosystem, if discharged without treatments into water bodies (WHO, 1985). Chemicals used in hospitals are potential sources of water pollution, mainly through the sewerage system. These chemicals may contaminate the city's water system and bring about skin diseases or enteric illness. Besides these, the untreated wastewaters from health centres can also present a potential risk due to the content of toxic and genotoxic chemicals (Paz *et al*., 2006). In a country like India, there is a tendency of disposal of hospital wastewater directly into municipal sewer system, which is further treated along with the domestic sewage in the municipal sewage treatment plant (Gautam *et al*., 2007). Many of the chemical compounds present in hospital effluents resist normal wastewater treatment. Residues of pharmaceuticals can be found in all wastewater treatment plant (WWTP) effluents, due to their inefficient removal in the conventional systems (Kümmerer, 2001; Kolpin *et al*., 2002; Petrovic *et al*., 2003; Snyder *et al*., 2003; Carballa *et al*., 2004). They end up in surface waters where they can influence the aquatic ecosystem and interfere with the food chain. Humans are particularly exposed by the drinking water, produced from contaminated surface water (Pauwels and Verstraete, 2006). Therefore, concerning the possible threat generated due to untreated hospital wastewater, this paper points out an imperative assessment of physico-chemical quality of these effluents draining directly into the urban sewer network. A seasonal investigation of untreated effluents from three selected hospitals located in Jaipur (Rajasthan), India was carried out during the study.

Corresponding author: Pratibha Sharma
Department of Zoology, University of Rajasthan, Jaipur 302004, Rajasthan, India

MATERIALS AND METHODS

Sampling of waste waters

For this work, the samples were collected in January, 2012 and July, 2012. Sampling was repeated at two consecutive days in a month. Samples were collected from main discharge points (just before the hospitals wastewaters are discharged into the

municipal sewerage) of three hospital sites situated in different areas of Jaipur (Rajasthan), India.

Sampling sites

Sawai Man Singh Hospital (SMS)

Sawai Man Singh Hospital is the biggest government hospital in Rajasthan. There are 43 wards with a total of 1563 beds. Samples from this hospital were collected from the main sewer as the hospital doesn't have any wastewater treatment plant to treat its waste water before releasing it into municipal sewerage system.

S.K. Soni Hospital

Soni Hospital is the most frequented private hospital for Critical Care in Rajasthan, with over 300 ICU beds to handle all kinds of trauma and emergency cases. S.K. Soni hospital does not have an effluent treatment plant, but all the liquid waste is disinfected by sodium hypochlorite solution before being released into the municipal sewer. Different concentrations of hyposolution are used for disinfection of different wastes. For instance, the microbiology laboratory uses 1% sodium hypochlorite solution while for cytotoxic waste a 5% hyposolution is preferred. For cleaning of floor and wash rooms also, chlorination is done. From this hospital, samples were taken from the main sewer.

Santokba Durlabhji Memorial Hospital (SDMH) cum Medical Research Institute

SDMH is the most modern hospital of its kind in the state of Rajasthan. It has a bed capacity of 310 including 31 ICC/CCU beds and 161 beds for special care of neo-natals. This hospital has an effluent treatment plant encompassing provision for filtration and chlorination of effluent. Therefore, the samples from this hospital were collected both before and after treatment. Untreated sample was taken from the sewer of the hospital, where the entire water from the hospital is collected before being treated. Treated wastewater was collected from the outlet from where it comes out of treatment plant and is then used for irrigating the gardens of hospital.

Sample Collection

Samples from hospitals were collected in precleaned, sterilized glass bottles. Samples were taken during maximal activity periods, usually 8:00 am-6:00pm in hospitals. All samples were stored at 4°C until testing. These samples were further tested for physico-chemical parameters in their crude state without being concentrated.

Physico-chemical analysis

Following physico-chemical parameters were measured during the study:

- pH
- Temperature (°C)
- Conductivity (mS/cm)
- Turbidity (NTU)
- Salinity (ppt)
- Total Dissolved Solids (TDS (ppt))
- Biological Oxygen Demand (BOD (mg/l))
- Chemical Oxygen Demand (COD (mg/l))

A multiparameter Water Analyzer Kit (Systronics Water Analyzer 371) was used to determine the above said parameters except BOD and COD which were estimated by Membrane electrode method (APHA, 1995) and open reflux method (APHA, 1999) respectively.

RESULTS AND DISCUSSION

Water-related environmental quality has been shown to be far from adequate due to unknown characteristics of wastewater (Lin and Han, 2001). Thus, an important element in preventing and controlling water pollution by several unregulated discharges like hospital effluents is the existence of reliable information about the presence of pollutants in wastewater.
The results obtained with physico-chemical analysis of effluents from three different hospitals (or four sampling sites) are summarized and compared in Table 1 & 2 with General Indian Standards for Discharge of Environmental Pollutants IS:10500 as there are no specific standards for hospital wastewaters. During both sampling periods wastewater samples showed most of the physico-chemical properties to be similar, suggesting little or no seasonal influence on the quality of samples from hospitals.

The pH values for all the untreated samples were found to be within the limits of standards except Soni hospital samples (10.76±0.03) collected in January, 2012. The values for BOD_5 were also reported below (as in most of the cases) or near the standard value (340 ± 24.04mg/l for untreated SDMH July samples) for these pollutant discharges to be discharged into public sewers but were recorded higher than standards to be discharged into surface waters for all the samples. The COD values were also found much higher than specified by Indian standards for all the samples during both sampling periods. For treated samples from SDMH, also, similar observations were found *i.e.* except BOD and COD other parameters were observed to lie within the prescribed standard limits. However, the values for BOD, COD as well as turbidity were observed to be significantly declined for treated samples as compared to untreated samples from SDMH. Comparing the BOD and COD values with the WHO standards for wastewaters (COD: 60, BOD: 30 mg/l) (WHO, 1996) to be discharged into the environment, all the untreated and treated samples were found unacceptable for their direct discharge downwards.

As there are no specific standards mentioned in "General Indian Standards for Discharge of Environmental Pollutants IS:10500" for turbidity, conductivity, TDS and salinity, these parameters were compared with different standards available in literature. The maximum permissible levels for turbidity vary from 0-10 NTU in wastewaters (WRC, 2003). Except for the treated samples, greater levels of turbidity were observed with untreated wastewater samples from all three hospitals (Tables 1 & 2). Total Dissolved Solids were found to stroke maximum permissible value of 1000 mg/L or 1ppt as prescribed by WHO (Jayalakshmi *et al*., 2011) for SMS and SDMH wastewaters (both treated and untreated); however, Soni samples were found to have much higher values during both the sampling periods. Similarly, values for conductivity

Table 1. Observed values of physico-chemical parameters for hospital waste water samples collected during January, 2012

Sample sites → / Properties ↓	SDMH (Untreated)	SDMH (Treated)	S.K. SONI	SMS	Standards
pH	7.27±0.01	6.24±0.03	10.76±0.03	6.97±0.01	5.5 – 9.0
Color	colorless	colorless	whitish	pale	-
Temperature (°C)	31.8±0.42	31.5±0.14	31.3±0.28	31.5	Shall not exceed 5°C above the receiving water temp.
Conductivity (mS/cm)	1.52±0.06	2.23±0.04	80.6±0.42	19.9±1.41	-
Turbidity (NTU)	55.09±0.06	12.76±0.03	97.77±0.18	59.65±0.01	-
Salinity (ppt)	0.82±0.1	1.18±0.01	-	10.8±0.7	-
TDS (ppt)	0.78±0.06	1.14±0.07	41.5±0.14	10.2±0.85	-
BOD_5 (mg/l)	290±2.83	168±11.31	276±15.56	310±8.49	350[1] / 30[2]
COD (mg/l)	580±50.91	348±52.33	698±63.64	560±21.21	250[1]

To be discharged into public sewers

Table 2. Observed values of physico-chemical parameters for hospital waste water samples collected during July, 2012

Sample sites → / Properties ↓	SDMH (Untreated)	SDMH (Treated)	S.K. SONI	SMS	Standards
pH	7.79±0.06	8±0.14	8.12±0.04	8.16±0.06	5.5 – 9.0
Color	colorless	colorless	whitish	pale	-
Temperature (°C)	43.5±0.14	50.8±0.7	49±1.31	45.9±0.7	Shall not exceed 5°C above the receiving water temp.
Conductivity (mS/cm)	1.95±0.07	2.26±0.01	72.9±0.28	3.61±0.27	-
Turbidity (NTU)	68.22±0.04	10.03±0.1	84.58±0.04	52.06±0.23	-
Salinity (ppt)	0.88±0.03	0.95±0.03	-	1.56±0.03	-
TDS (ppt)	0.82±0.01	0.99±0.04	40.8±0.28	1.49±0.06	-
BOD_5 (mg/l)	340±24.04	170±7.07	288±11.31	294±2.83	350[1] / 30[2]
COD (mg/l)	559±38.18	326±8.49	654±24.04	597±12.73	250[1]

To be discharged into inland surface waters

were also observed to be little above the permissible limit as specified by mS/cm (Wyasu and Okereke, 2012) for SDMH and SMS samples; and much above for Soni samples (Tables 1 & 2). The findings of this study for hospital wastewater physico-chemical analysis are supported by some previous studies (Ekhaise and Omavwoya, 2008; Mahvi *et al*., 2009; Ibeh and Omoruyi, 2011; Alabi and Shokunbi, 2011) carried out in countries other than India, however, for different hospitals different values were observed every time. To our knowledge there is no published work studying the physico-chemical parameters of hospital wastewaters in India till now. Therefore, in present study an attempt has been made to characterise physico-chemical parameters of effluents discharged from Indian hospitals. Although this is a regional study representing only a part of India but the results of this study trigger a concern over the indiscriminate discharge of hospital waste waters nationally and globally too. As in this study, three different hospitals effluent samples were studied, it could be noted that even upon chlorination (a routine practice in Soni hospital) or an inefficient treatment (as done in SDMH), the risk associated with hospital effluents could not be negated and therefore requires urgent attention.

Conclusion

The study concludes that hospital wastewaters could not be regarded safe to be disposed off directly into the environmental water bodies. These effluents can contaminate the surface and even underground water, thereby making it unfit for irrigation and drinking. Varied and unacceptable densities of the physiochemical parameters of these effluents suggest that the activities of hospital wastes in the environment is a major health and environmental threat, which therefore call for a proper regulatory system on disposal of hospital effluents worldwide, especially in the developing countries like India. As concluded, it is extremely difficult to quantify the risk associated with the pollutants like hospital wastewaters because their hazardous components usually occur in the concentrations too low to allow analytical determination and putative mutagens, with few exceptions have never even been identified. Intensive research is further required to have an exact idea of the unfavourable effects generated due to the wastewaters from health-care sectors comprising mainly clinical laboratories and multi-speciality hospitals. Further, a properly designed effluent treatment plant is a feasible solution to avoid hazardous consequences resulting from discharge of untreated hospital wastewaters.

Acknowledgement

The authors are thankful for the financial support provided by UGC Major Project entitled "Genotoxicity evaluation of wastewaters discharged from hospitals in Jaipur city" [F. No. 40-113/2011 (SR)] and CSIR-JRF [F. No. 09/149(0581)/2010-EMR-I]. We also pay our sincere thanks to Department of

Zoology, University of Rajasthan, Jaipur to provide basic laboratory and infrastructural facilities.

REFERENCES

Alabi, O.A. and Shokunbi, O.S. 2011. Toxicological effects of hospital wastewater using animal bioassays. Ann. Biol. Res., 2(2): 265-275.

APHA 1995. Standard Methods for the Examination of Water and Wastewater. 19th Ed. American Public Health Association, American Water Works Association, Water Environment Federation.

APHA 1999. Standard Methods for the Examination of Water and Wastewater. 20th Ed. American Public Health Association, American Water Works Association, Water Environment Federation.

Carballa, M., Omil, F., Lema, J.M., Llompart, M., Garcia-Jares, C., Rodriguez, I., Gomez, M. and Ternes, T. 2004. Behavior of pharmaceuticals, cosmetics and hormones in a sewage treatment plant. Wat. Res., 38: 2918–2926.

CCLIN Paris-Nord 1999. Elimination of liquid effluents in hospital establishments—recommendations. Institute of biomedical, Cordeliers, Paris, pp. 74. Available on:/http://www.web.ccr.jussieu.fr/guide_effluents_liquides.pdf S, 20/09/2001.

Deloffre Bonnamour, N. 1995. Wastes rejects from health establishments: liquid effluents to solid wastes. Master's Thesis, Department of Environment and Ecodevelopment. University Claude Bernard-Lyon1, Institut Universitaire Professionnalise´, Lyon, pp. 75.

Ekhaise, F. and Omavwoya, B. 2008. Influence of Hospital Wastewater Discharged from University of Benin Teaching Hospital (UBTH), Benin City on its Receiving Environment. American-Eurasian J. Agric. and Environ. Sci., 4(4): 484-488.

Emmanuel, E., Keck, G., Blanchard, J.M., Vermande, P. and Perrodin, Y. 2004. Toxicological effects of disinfections using sodium hypochlorite on aquatic organisms and its contribution to AOX formation in hospital wastewater. Environ. Int., 30(7): 891-900,.

Gautam, A. K., Kumar, S. and Sabumon, P. C. 2007. Preliminary study of physico-chemical treatment options for hospital wastewater. J. Environ. Manage., 83: 298–306.

Ibeh, I. N. and Omoruyi, M. I. 2011. Seasonal Dynamics in the Physiochemical Parameters of Hospital Effluent from a University Teaching Hospital based in Southern Nigeria. JASR, 1(1): 7-17.

Jayalakshmi, V., Lakshmi, N. and Singara Charya, M. A. 2011. Assessment of Physico-Chemical Parameters of Water and Waste Waters in and Around Vijayawada. International Journal of Research in Pharmaceutical and Biomedical Sciences, 2(3): 104-1046.

Kolpin, D., Furlong, E.T., Meyer, M.T., Thurmann, E.M., Zaugg, S.D., Barber, L.B. and Buxton, H.T. 2002. Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999–2000: a national reconnaissance. Environ. Sci. Technol., 36: 1202–1211.

Kümmerer, K. 2001. Drugs in the Environment: Emission of Drugs, Diagnostic Aids and Disinfectants into Wastewater by Hospitals in Relation to Other Sources- a Review. Chemosphere, 45(6-7): 957-969.

Lin, H.Y. and Han, W.Y. 2001. Water quality assessment and analysis before and after the decade of the dry period in Ling-dingyang Estuary of the Pearl River Mouth. Journal of Marine Environmental Science, 20: 28–31.

Mahvi, A., Rajabizadeh, A., Fatehizadeh, A., Yousefi, N., Hosseini, H. and Ahmadian, M. 2009. Survey Wastewater Treatment Condition and Effluent Quality of Kerman Province Hospitals. WASJ, **7**(12): 1521-1525.

Pauwels, B. and Verstraete, W. 2006. The treatment of hospital wastewater: An appraisal. J. Water Health, 4(4): 405−416.

Paz, M., Muzio, H., Mendelson, A., Magdaleno, A., Tornello, C., Balbis, N. and Moretton, J. 2006. Evaluation of Genotoxicity and Toxicity of Buenos Aires City Hospital Wastewater Samples. J. Braz. Soc. Ecotoxicol., 1(1): 1-6.

Petrovic, M., Gonzalez, S. and Barcelo, D. 2003. Analysis and removal of emerging contaminants in wastewater and drinking water. TrAC, 22(10): 685–696.

Snyder, S.A., Westerhoff, P., Yoon, Y. and Sedlak, D.L. 2003. Pharmaceuticals, personal care products, and endocrine disruptors in water: implications for the water industry. Environ. Engng. Sci., 20(5): 449–469.

Water Resource Commission (WRC) 2003. Water Resources Management problems, Identification, Analysis and prioritization study CSIR -Water Research Institute Accra, Ghana.

WHO 1985. Management of Waste from Hospitals and other Health Care Establishments, Report on a WHO meeting, Bergen, 28 June -1 July 1983, Copenhagen, World Health Organization (WHO) Regional office for Europe, (Euro Reports and Studies, No. 97).

WHO 1996. Fact sheets on environmental sanitation, Epidemic diarrhoeal diseases control, Geneva. World Health Organization, WHO/EOS/96.4.

Wyasu, G. and Okereke, N. Z. J. 2012. The influence of hospital wastewater and food samples grown within Ahmadu Bello University teaching hospital, Zaria-Nigeria on its receiving environment. Adv. Appl. Sci. Res., 3(3): 1686-1690.

****

INTERNATIONAL JOURNAL OF

DEVELOPMENT RESEARCH