

Surveillance Study on Hospital Wastewater from Hospitals in Bangalore City to Evaluate Environmental Toxicity

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Abstract

Due to its high susceptibility to the spread of a number of diseases, hospital wastewater poses a serious threat to human health security. In addition, the COVID-19 pandemic demanded that the entire world pay attention to the detection and removal of infectious pathogens and viruses in hospital wastewater. In this study, we have done surveillance on the hospital wastewater in and around Bangalore city to evaluate environmental toxicity. Eight hospitals were chosen from the locality and each sample was tested with pH, Colour test, Odor test, Turbidity test, Coliform test, Chloride test, Residual Chlorine test, Fluoride test, Reinsch test, Total Dissolved Salts (TDS) and Ammonium molybdate test and the results were analyzed. The results of the study showed that each sample had most of the test to be positive and the Biological oxygen demand calculated showed that each wastewater sample collected was above the range of good water quality.

Keywords: Surveillance; Hospital wastewater, pH, Biochemical oxygen demand, Wastewater treatment.

INTRODUCTION

Using techniques from the natural and physical sciences to solve legal problems in both the criminal and civil realms is known as forensic science. Toxicology is the field of scientific study that helps to understand the detrimental effects that occur in living organisms which are caused by chemical substances found in the environment or made manually. Environmental toxicology is a subfield of toxicology which studies the effect of different chemical substances or toxins on the

living organism or the environment. This domain is studied both quantitatively and qualitatively. (*The Field of Toxicology, 2017*)

Wastewater control is a crucial technique to guard the water assets within the globe and it can be done by collecting and treating the collected water and also reusing the wastewater. It is a process that relies on different issues which can be both physical and chemical. As a result, this water treatment plant is essential to be implemented all over the world. The treated wastewater in urban areas can be helpful in places where agriculture and industry are of great importance. Wastewater can be referred to as any water which is having a catastrophic effect on the activities that are persuaded by humans. The wastewater can emerge from an amalgamation of industrial, commercial or even agricultural activities. (Smith, n.d.) The treatment for wastewater is the process that converts the wastewater to effluent which is either reused or can be returned to the water cycle. One significant purpose of wastewater management is mainly to dispose of the effluents in such a way that there is no hazard to human health or to the environment and other living organisms. (*Mouni Roy, 2021, 127-160*)

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BACKGROUND

In 2002, Gomez et al., performed a monitory study pointing out the persistence of a group of 14 compounds to those conventional water treatment processes usually applied in urban sewage treatment plants. This also evaluates the efficiency of sewage treatment plants (STPs) in predicting the environmental loads and concentration of effluents in the Mediterranean Sea specifically Almeria, Spain.

In 2010, Galin et al., performed a research investigating the prevalence and characteristics of antibiotic-resistant E. Coli bacteria in wastewater discharged from municipal, hospital, and secondary treatment facilities. By quantifying the number of these resistant bacteria and analyzing their genetic makeup, we aim to assess the potential environmental and public health risks associated with wastewater contamination.

In 2023, Bian et al., performed a study investigating the prevalence of Antibiotic Resistant genes (ARGs) and bacterial pathogens from the feces of patients found across Hospital wastewater treatment plant (hWWTP) and found that 103 ARGs and 26 Mobile genetic elements (MGEs) from the feces of inpatients persisted throughout the hWWTP system; 88 of which these were significantly enriched after process treatment, especially the extended-spectrum, AmpC-type beta- lactamases, Microbiome.

In 2020, Goncalves et al., performed a study on the detection of SARS-CoV-2 RNA in hospital wastewater from low prevalence area and found out that the untreated wastewater in Slovenia showed in higher concentration factor and higher recovery efficiency. 66.7 % (10/15) of untreated hospital wastewater samples tested positive for at least one SARS-CoV-2 RT-qPCR target and SARS-CoV-2 RNA was detected in untreated hospital wastewater when only one COVID-19 patient was hospitalized.

In 2018, Ibrahim et al., performed a study on the molecular detection and genotypic characterization of enteric adenoviruses in Tunis City, Tunisia. The genotype of human adenoviruses (HAdVs) positive samples was achieved by the sequencing of the PCR products. HAdVs were detected in 64% (65/102) of positive wastewater samples. A substantial increase in the frequencies of HAdVs was observed at the exit of the two wastewater treatment techniques studied.

METHOD SELECTION OF HOSPITALS

The hospitals in Bangalore were considered. All the zones were taken into consideration, i.e., north, south, east and west. The zones were considered to have variation in the outcome to be obtained. The list of hospitals included:

- Bangalore Baptist Hospital
- Cratis Hospital
- Rainbow children's Hospital
- Narayana Health City Hospital
- K C General Hospital
- Bowring and Lady Curzon Hospital
- Sparsh Hospital
- Prakriya Hospital

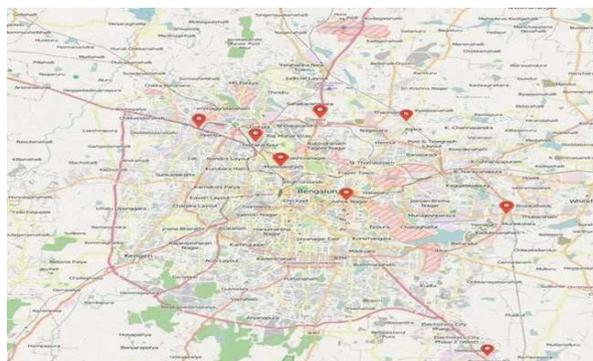


Fig. 1: Map of Bangalore City with the 8 hospital locations
(source: google map)

SAMPLE COLLECTION

The container for collection of wastewater was prepared.⁸ glass bottles with airtight lid were purchased. A gauze cloth cap was made to cover the lid and avoid further contamination of the collected samples. Following this, the bottles were sterilized by autoclaving to eliminate or destroy all forms of microbial life. The bottles were stuck with labels and taken to the site of collection at the different hospitals.



(source: google map)



(source: google map)



(source: google map)



WATER ANALYSIS

Several tests were done to analyse the collected wastewater samples. They are:

- **pH** identifies the water sample's acidity or alkalinity. This identifies the acid and bases present in water after the treatment.
- **Reinsch test** identifies the heavy metals present in the water. This can be useful to find out the presence of arsenic, mercury in the post treated water samples.
- **Ammonium molybdate test** identifies the heavy metals present in the post treated water.
- **Residual chlorine test** identifies the free chlorine residues present in the post treated water. Through the residual chlorine test the remaining chlorine amount is determined in water that has finished the treatment and is ready to be released into the water bodies.
- **Fluoride test** identifies the amount of fluorine present in the water. This promotes quality water for consumption and helps prevent damage to the environment. This was done with the help of a kit.
- **Coliform test** identifies the bacterial contamination present in the water. This is used as an indicator of the cleanliness of a water source. This was done with the help of a kit.
- **Chloride test** identifies the amount of chloride ions present in the water. This is used to know the salinity of different water sources. This was done with the help of a kit.
- **Color test** identifies the organic substances present in water by their color. This is used to find out the organic and chemical pollutants in the treatment plants.
- **Odor test** identifies the specific odor of the water sample. This is used to find out any specific smell produced by the process of treating the waste-water or by the waste itself.

- **Turbidity test** identifies the fogginess of the water sample. This is used to determine the effectiveness of the treatment produced with different chemicals and dosages.
- **Total dissolved solids (TDS)** identify the hardness and presence of salts in the water. The presence of salts can be indicative of water adulteration with pollutants like sodium, calcium, magnesium etc.
- **Biological oxygen demand** identifies the oxygen consumed by the bacteria from the decomposition of organic matter.

RESULTS

This study carefully chose 8 hospitals from the different areas of Bengaluru, ensuring to keep the list diverse and also representative of the entire city. The list includes children's hospital, multi-specialty and specialty hospitals, government run hospitals, private owned hospitals, old as well as relatively new hospitals.

Out of the 8 hospitals, color was not observed in any of the water samples. This shows the presence of an efficient waste water management system to ensure the quality of water possesses no color.

Odor was present in 2 out of 8 hospitals. The odor was found to be foul, showing the possible presence of biological / microbiological material in the water.

Turbidity was not seen in all 8 hospital waste water samples. This could be a sign that microorganisms are mostly not seen in treated

wastewater.

Fluoride was also absent in all 8 hospital wastewater samples.

Free chlorine and residual chlorine were present in 7 out of 8 samples, whereas residual chlorine was found in 1 out of 8 samples. This indicates that chlorine was being added to the waste water from hospitals which is a regular practice in India, whereas residual chloride was not seen in most of the water samples, which is a good sign that excess chlorine was not being added.

Coliform was present in 1 out of 8 samples. This is a good indication that waste water mostly does not contain coliform bacteria which are mostly infectious bacteria and commonly cause outbreaks.

Heavy metals were found in 7 out of 8 hospital wastewater, out of which 6 showed presence of arsenic and one showed presence of heavy metals other than arsenic.

The pH of the 8 samples were also tested as part of the study. 6 out of 8 hospitals had close to neutral pH whereas the other 2 had considerable acid content in the waste water.

The TDS of wastewater was all across the spectrum. The total dissolved salts were not being taken proper care of in the tested hospitals, making the water not potable / reusable.

In terms of BOD, 5 out of 8 hospitals were falling in the 'poor or fair' category. The other 3 hospitals were concerned and must work for better treatment of wastewater.

Table 1: Observations on each sample

Name of Hospitals	Color	Odor	Turbidity	Coliform	Heavy metals Reinsch	Heavy metals - Molybdic acid test	Residual chlorine	Fluoride	Chloride	TDS	Ph	BOD
Baptist, Hebbal	Colorless	Odorless	No turbidity	Negative	Positive	Positive	Negative	Negative	Negative	1980 PPM	1.99	208
Cratis, Geddalahalli	Colorless	Odorless	No turbidity	Negative	Positive	Positive	Positive	Negative	Positive	650 PPM	7.14	100
Rainbow, Marathahalli	Colorless	Odorless	No turbidity	Negative	Positive	Positive	Negative	Negative	Positive	610 PPM	7.69	71
Narayana Health City, Electronic city	Colorless	Foul odor	No turbidity	Positive	Negative	Negative	Negative	Negative	Positive	1120 PPM	7.02	222
KC General Hospital, Malleswaram	Colorless	Odorless	No turbidity	Negative	Positive	Positive	Negative	Negative	Positive	570 PPM	7.41	67
Bowring and Lady Curzon, Malleswaram	Colorless	Odorless	No turbidity	Negative	Positive	Positive	Negative	Negative	Positive	780 PPM	7.33	88
Sparsh hospital, Yeshwantpur	Colorless	Foul odor	No turbidity	Negative	Positive	Negative	Negative	Negative	Positive	560 PPM	7.64	76
Prakriya hospital, Tumkur Road	Colorless	Odorless	No turbidity	Negative	Positive	Negative	Negative	Negative	Positive	70 PPM	5.8	17



Fig. 2: pH tests of all hospitals



Fig. 3: Chloride tests of all hospitals



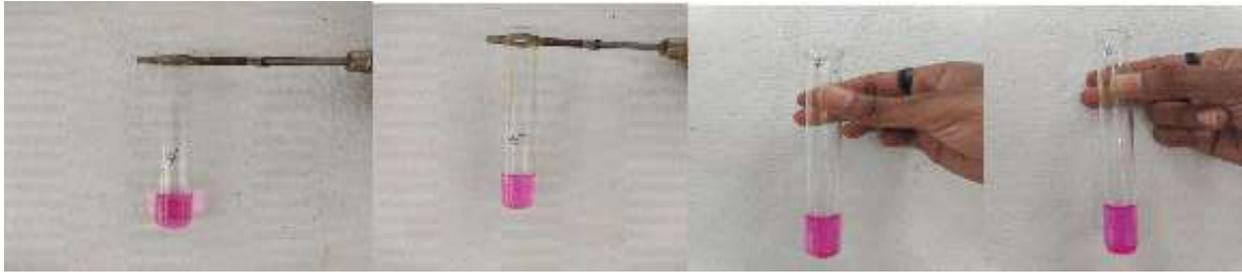


Fig. 4: Fluoride tests of all hospitals



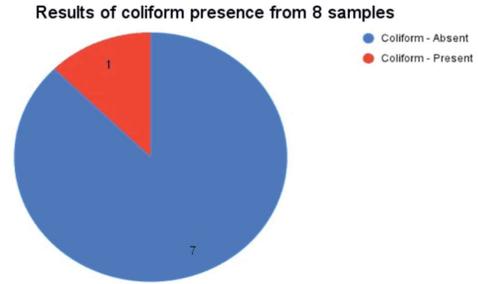
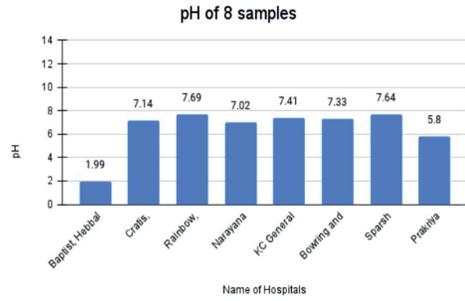
Fig. 5: Residual chlorine tests of all hospitals



Fig. 6: Reinsch tests of all hospitals

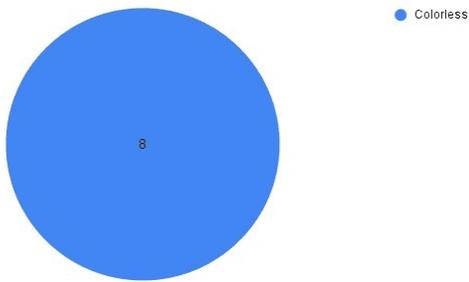


Fig. 7: Ammonium Molybdate tests of all hospitals



Results of color estimation from 8 samples

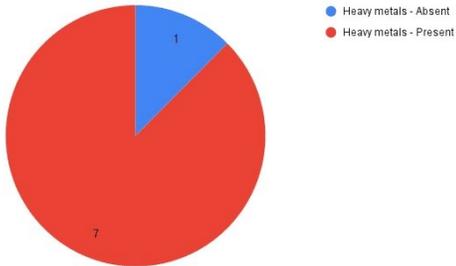
All samples showed colourless water



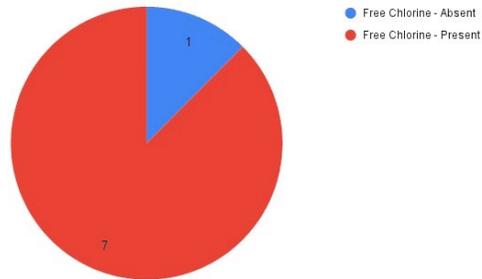
Results of fluoride presence from 8 samples



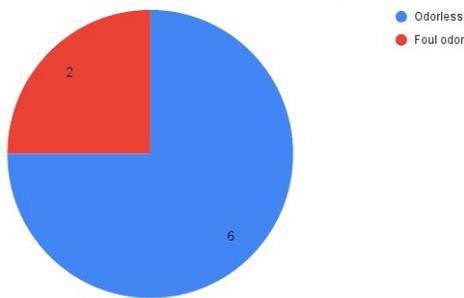
Results of heavy metal presence from 8 samples



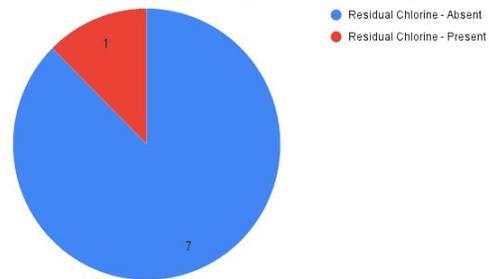
Results of free chlorine presence from 8 samples



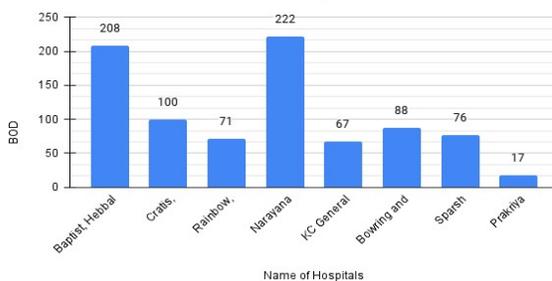
Results of odor estimation from 8 samples



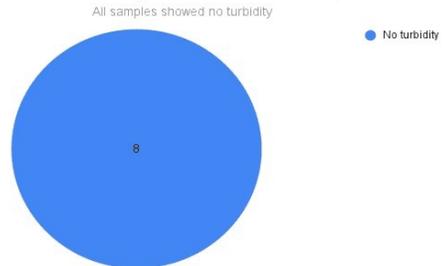
Results of Residual chlorine presence from 8 samples

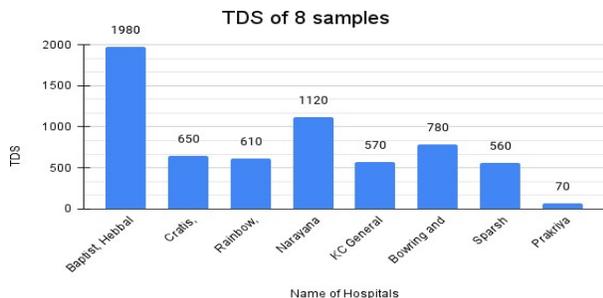


BOD of 8 samples



Results of turbidity estimation from 8 samples





DISCUSSION

Overall, the study tested 8 hospitals in an urban landscape of about 700 km². Even though the data may not be fully representative, the study seems to suggest similar results to other similar studies in other regions of India.

The purification and disposal of hospital wastewater is considered a vital action based on environmental standards. The results of multiple studies showed that the treatment methods of this type of hospital wastewater can play a significant role in reducing the spread of diseases caused by hospital wastewater treatment, including infectious diseases.

Heavy metals are a major risk when it comes to the chance of chronic poisoning. Heavy metals are toxic and can cause chronic toxicity. Heavy metal toxicity is a condition where heavy metals like lead, mercury, arsenic, cadmium, and chromium accumulate in the body and affect its normal function. Coliform presence amplifies the chance of spread of water-borne and food-borne microbial diseases. This can be a cause of major concern in all developing nations fighting against risks of epidemics.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen required by microorganisms to decompose organic matter in water. BOD is an indicator of the degree of organic pollution in wastewater and the impact of wastewater effluents on the oxygen levels of receiving water. High levels of BOD in the 8 tested samples is a cause of concern to an urban community like Bangalore.

CONCLUSION

Overall, the study underlines the need for active monitoring by government agencies and the need for better scientific and robust techniques of hospital waste water management. The study, even though

preliminary, can also be emulated in similar nature in other cities / precincts to understand the quality of hospital waste water. The study also possesses a future outlook to be carried out in more detail in Bangalore consisting of more hospitals and clinics to understand the ground situation better.

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