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Influence of Hospital Wastewater Discharged from University of Benin Teaching Hospital (UBTH), Benin City on its Receiving Environment

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Abstract: The bacteriological and physiochemical qualities of hospital wastewater discharged into the environment from University of Benin Teaching Hospital (UBTH), Benin City was investigated to assess the influence of the hospital wastewater in the receiving environment. The bacteriological parameters were carried out using the standard microbiological techniques. The bacteriological parameters examined were total heterotrophic bacterial counts, which had values ranging from $1.9x10^7$ to $8.3x10^{12}$ cfu/ml. The total coliform counts ranged from $1.2x10^3$ to $1.6x10^3$MPN/100ml. The isolated and characterized isolates included eight (8) bacterial genera. The bacterial isolates were *Klebsiella, Pseudomonas, Escherichia, Serratia, Staphylococcus, Streptococcus, Proteus* and *Bacillus*. The bacterial genera, *Klebsiella, Pseudomonas* and *Serratia* were the most frequently distributed isolates in the hospital wastewater. Physiochemical parameters studied revealed that the hospital wastewaters though show some parameters whose values are higher than the WHO to percent levels. Other falls within the WHO acceptable limits. There is therefore, contamination of the receiving environment (water, soil and air) due to the discharged hospital wastewater, which could probably be hazardous to human health.

Key Words: Hospital waste · Bacterial isolates · UBTH · Benin City

INTRODUCTION

Wastewater is referred to any water, whose quality has been adversely being abused by anthropogenic influence. This includes liquid waste discharged from domestic home, industries, agricultural and commercial sectors [1]. Health care waste consists of both organic and inorganic substance including pathogenic microorganisms. Hospital waste possess serious health hazard to the health workers, public and air flora on the area.

The hospital waste is classified into seven (7), which comprises of both the liquid and the dissolved substance generated within the hospital environment [2,3] main groups namely, general waste which composed largely of non-hazardous particles such as kitchen waste, paper and plastics, parts of human, foetus, blood and body fluid, which are hazardous, infectious wastes, this include culture and stock of infective agents from laboratory waste, waste from surgery, etc, shape waste, waste material that could cause damages to the handling persons (knife, needle, broken glasses, scalps), pharmaceutical wastes, this includes pharmaceutical products (drugs and chemicals) that have been returned from wards, contaminated or expired products, chemical waste which comprises of discarded solid or liquid and gaseous chemical and radioactive waste, which include solid, liquid and gaseous waste contaminated with radionuclide generated from invitro analysis of body tissues and fluid. WHO [4] reported that, about 85% of hospital waste is non-hazardous, 10% infective and 5% not infective but hazardous in the United States of America, while about 15% of hospital waste is regarded infective. In India, it was reported that the value could increase from 15% to 35% depending on the total amount of hospital waste generated, while in Pakistan about 20% of hospital waste could be found potentially infective or hazardous [5].

Sources of pharmaceutical products in the environment are more than just consumers expelling unabsorbed medications through excretion into septic systems and wastewater treatment plants. Sewage and

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wastewater from hospitals and any clinics are huge contributors to this problem [6]. Other sources include animal farms, crop production and fish farms, where pharmaceutical products are used as growth promoters or as preventive maintenance.

Hazardous medical waste consists primarily of chemicals and discarded cytotoxic drugs, which find their ways into the environment due to improper usage and indiscriminate disposal. Their presence in the environment possesses serious environmental health risk due to their carcinogenic natural [7,8].

Connection of hospital waste to the municipal sewage network may create problems such as public health risks and imbalance of the microbial community in the sewage systems, which in turn affect the biological treatment process [9]. It is very necessary to understand the sources of waste that contribute pollutant to the individual wastestreams and the shortcomings that will be encountered in an attempt to treat the waste.

The major health risks possess by medical waste to the inhabitants of the terrestrial and aquatic ecosystem as audited by the WHO report of 1999 [4] includes the following; contamination of dirty water possibly the leachate entering the aquifers, surface water, accumulation of toxic nonbiodegradable hospital waste products, which could lead to the blockage of the sewage system, release of toxic substance into the air due to burning, accumulation of heavy metals and unprotected landfill as well as inefficient sorting of waste materials.

Wastewater generated in the companies, industries and principally from healthcare institutions may represent a serious health hazard and little or none is known about the health hazard of hospital wastes in Benin City metropolis. Children, adults and animals all have the potential to come into contact with these wastes, which may pose severe health risks to them [10]. The chemicals used for the staining and preservation of slides and for the sterilization and cleaning of equipment and surroundings are potentially harmful to the laboratory technicians and the environment.

This study was aimed at investigating the influence of hospital and pharmaceutical waste in the environment as well as to isolate and characterized the microbial isolates associated with the wastes.

MATERIALS AND METHODS

Source of Sample: The wastewater samples were collected from five wastewater outlets from different units of the University of Benin Teaching Hospital (UBTH), Benin City. The five samplings points were designated 1 to 5, sampling point 1 is the point at which the washes from the generator set enters the drainage, sampling point 2 is the point at which the washings from the laundry and catering enters the drainage, sampling point 3, the point at which the washings from the dietary building enters the drainage, sampling point 4 is the point at which the washings from the mechanic workshop enters the drainage while sampling point 5 is the point at which the wastewater is emptied into the soil.

Sample Collection: Sample for bacteriological and physiochemical analysis were collected in a clean sterile containers. Samples for dissolved oxygen (DO) and biochemical oxygen demand (BOD) were collected in 250ml bottles with stoppers, one millimeter each of Winkler's solutions A and B were added to samples on site to fix the oxygen [11]. The samples were collected at 7.00am and 9.00am and were transported to the laboratory where analysis was initiated within 2h of sample collection.

The bacteriological parameters monitored include total viable aerobic counts to isolate heterotrophic bacterial and fungal, total coliform counts, *Escherichia coli,* faecal streptococci counts and *Clostriduim perfringens* counts according to the methods of Gerhardt *et al*., [12]. The isolation and identification of bacterial isolates were carried out according to Bergey's Manual of Determinative Bacteriology [12,13]. The physiochemical parameters were studied using the standard methods of APHA [11].

RESULTS

Results in Table 1 shows the total heterotrophic bacterial population ranging from $1.9x10^7$ cfu/ml to $8.3x10^{12}$cfu/ml. The highest total heterotrophic bacterial population of $8.3x10^{12}$cfu/ml was recorded in sampling point 2 and the lowest count of $1.9x10^7$ cfu/ml was recorded with sampling 5. The total coliform counts were observed to fluctuate among the sampling points. The result showed that, the total coliform count was lowest ($1.2x10^5$ MPN/1000 ml^{-1}) in station 5 and highest (1.6x105 MPN/100ml^{-1}) was recorded in station 2. There was a variation in bacterial population, which ranges from species, as some species of bacterial isolates were found to be more predominant in sampling points 2, 4, 3 and 1 than sampling point 5. *Klebsiella pneumonia, Pseudomonas aeruginosa* and *Staphylococcus aureus* were found to be more predominant among the bacterial

Table 1: Result of Microbiological analysis of UBTH, Benin City Hospital Wastewater

Parameters	Sample Point 1	Sample Point 2	Sample Point 3	Sample Point 4	Sample Point 5
Total heterotrophic bacterial count cfu/ml	$6.7x10^7$	$8.3x10^{12}$	$2.6x10^{11}$	$8.8x10^8$	$1.9x10^7$
Total coliform count MPN/100ml	$3.3x10^3$	$1.6x10^3$	$1.7x10^3$	$1.8x10^3$	$1.2x10^3$

Table 2: Frequency of distribution of bacterial isolates in the sampling points

Bacterial isolate	Sample Point 1	Sample Point 2	Sample Point 3	Sample Point 4	Sample Point 5
Klebsiella pneumonia	+	+	+	+	+
Pseudomonas aeruginosa	+	+	+	-	+
Escherichia coli	+	+	+	+	-
Serratia marcesens	+	+	+	+	-
Staphylococcus aureus	-	+	-	+	-
Streptococcus faecalis	-	+	-	+	-
Proteus vulgaris	-	+	-	-	-
Bacillus spp	-	-	+	+	-

Table 3: Results of physiochemical analysis of UBTH, Benin City Hospital Wastewater

Parameters	Sample Point 1	Sample Point 2	Sample Point 3	Sample Point 4	Sample Point 5
pH	6.68	6.47	6.39	6.13	6.78
Salinity (mg/l)	0.10	0.10	0.10	0.00	0.10
Total dissolved solid (mg/l)	147.00	139.00	53.00	36.00	61.00
Dissolved oxygen (mg/ml)	2.40	2.40	4.60	2.50	5.40
BOD	51.27	9.50	42.12	41.68	38.50
COD	658.74	68.00	856.29	797.22	717.22
Sulphate (µg/l)	22.76	19.15	6.30	3.69	0.24
Nitrate (µg/l)	1.00	1.00	1.00	1.00	1.00
Potassium (µg/l)	9.45	2.94	3.50	4.90	6.47
Cadmium (µg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Lead (µg/l)	0.10	0.20	<0.80	<0.80	<0.80
Chromium (µg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (µg/l)	0.02	0.03	0.07	0.08	0.04
Iron (µg/l)	0.06	0.02	0.07	0.03	0.04

species. Eight bacterial isolates were identified and characterized and these include *Klebsiella pneumonia, Pseudomonas aeruginosa, Escherichia coli, Serratia marcescens, Streptrococcus faecalis, Proteus vulgaris, Bacillis* spp. and *Staphylococcus aureus*. The results of the occurrence and distribution are showed in Table 2. Sampling points 2, 5 and 1 were seen to have high bacterial counts, which is an evidence of the degree of pollution as a result of the human activities. The physiochemical parameters of the hospital wastewater studied are showed in Table 3. During the periods of study, the pH value varied from 6.13 to 6.78. The total dissolved solids (TDS) and Dissolved oxygen values varied from 36mg/l to 147mg/l with sampling points 4 and 1 and 2.4mg/l to 5.4mg/l with sampling points 1 or 2 and 5, respectively (Table 3), with sampling points 4 and 3 and 4 and 5 recording the highest values for TDS and DO. The sulphate and potassium concentrations were recorded higher with sampling points 1 and 2 and 1 and 5 respectively. The correlation coefficient tests conducted for the sampled points between the microbiological and physiochemical parameters at 95% probability level showed positive relationships in all the parameters studied.

DISCUSSION

The research studies showed the various effects of hospital wastewater on the bacteriological and physiochemical parameters on the receiving environment. There was increase in most of the bacteriological and physiochemical parameters studies with slight fluctuation. The hospital wastewater was observed to play a significant role in the influence on the qualities of the parameters studies. The introduction of wastewater in the environment brings about increased amount of organic matter and essential nutrients, which influence the changes in the microflora [14]. Aluyi *et al*. [15] noted

that high counts of bacterial load reflected the level of pollution in the environment that is an indication of the amount of organic matter present. This findings correlate with the results of the influence of hospital wastewater in the University of Benin Teaching Hospital (UBTH), Benin City environment. When evaluating the effects of hospital wastes on microbial communities, it is important to note that, target organisms vary between hospital wastes. Indigenous communities of bacterial and fungal populations are very complex and they have the important task of cycling nutrients.

The presence of high coliforms densities in the wastewater samples during sampling periods is an indication of faecal pollution of the environment due to human activities. Aluyi *et al*., [15] reported high faecal load with high concentration of *E. coli* in Udu River, Warri, Delta State, Nigeria, which was attributed to human activities.

The physiochemical parameters studied showed some degree of variation among the sampling points (Table 3). Sampling prints 1 and 2 showed the highest value and therefore decreased along the sampling points, probably due to removal of soluble salts by biological utilization. The concentration of sulphate, nitrate and potassium in all the sampling points were high. Concentration of total dissolved solids was high in sampling points 1 and 2 compared to sampling points 3, 4 and 5, this could be attributed to the influence of the degradative activity of the microflora. The concentration of dissolved oxygen was higher in sampling point 5 as compared to other sampling points, which could be due to increased waste disposal and other human activities that may enhance their growth and proliferation leading to consumption of available oxygen.

Conclusively, it was observed that hospital wastes have negative influence on the microbiological and physiochemical parameters on the environment. The microbial load as well as the high densities of the physiochemical parameters suggests 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 waste in the world, especially in the developing countries like Nigeria.

It is therefore advised that Government Health Agencies, Government Environmental Agencies and Private Enterprises should encourage symposia on current issues relating to health institution waste disposal and the environment.

Hospital waste poses a significant impact on health and environment. From this study, it can be said that there is an urgent need to raising awareness and education on medical waste issues. Proper waste management strategy is needed to ensure health and environmental safety. It is therefore advised that all stakeholders and the health sector to harness ways on proper waste management and the need to collect information and examples from developed countries, which has sound medical waste management system.

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