Impact of Hospital Waste from the University of Port Harcourt Teaching Hospital on the Environment

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Authors’ contributions
This work was carried out in collaboration between both authors. Author HOS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors HOS and VNE managed the analyses of the study. Author VNE managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The aim of this study is to determine the impact of hospital wastes indiscriminately dumped at exposed dumpsites within the University of Port Harcourt Teaching Hospital. Ten random samples (100g each) were withdrawn from a depth of 0–15 cm from each sampling site for soil analysis and settling plate technique was used for microbial air quality assessment. The Microbiological assessment of the dumpsites revealed an array of microorganisms viz; Baccilus sp., Staphylococcus sp., Pseudomonas sp., Salmonella sp., Proteus sp. Escherichia coli, Trichophyton sp., Scopulariopsis sp. Candida albicans, Fusarium sp., Mucor sp. and Cladosporium sp. and the microbial population dynamics reveals that the bacterial and fungal counts where more abundant on hospital dumpsites when compared to a pristine soil, as was the heavy metals levels. The air quality assessment of the dump site area reveals that most of the isolated pathogens from the soil analysis could also be airborne. This study has shown that improper dumping of hospital waste impacts deleteriously on the environment and measures must be put in place for proper management to avert any adverse health impact.

Keywords: Hospital waste; soil; air quality; heavy metals; microorganisms.

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1. INTRODUCTION

Hospitals and Medical facilities which include medical research and diagnostic centers produce extremely hazardous waste that puts people within the vicinity in grave danger of risks of disease which could be fatal [1]. Generally, Waste refers to substances viz; gas, liquid, metal or solid that has no immediate feasible use and is permanently discarded. When a waste is laden with any such characteristics as combustible, explosives, infectious, reactive, corrosive, radioactive, infectious, irritating, bio-accumulative or sensitizing, it is regarded as hazardous waste and should be handled and treated with caution [1,2].

Hospital wastes emerge during treatment, clinical diagnosis, pharmaceutical research, medicine production. How to effectively manage medical waste has been of utmost concern owing to its potentially high risks to the environment, and human health. In order for any medical waste to transmit infectious disease, the waste must of necessity contain large and sufficient numbers of pathogenic agents which can successfully infect susceptible hosts which must have contact with the pathogenic agents. A portal of entry must exist in the susceptible host which will efficiently serve as route of infection. This route of entry could be open wounds, nostrils, mouths and even genitals [3].

In Nigeria hospital wastes are still handled and disposed with domestic waste [4] Due to the increasing level of poverty and joblessness in Nigeria, the number of scavengers is on the increase and they are at the forefront of the danger of infectious diseases emanating from hospital wastes. Most hospital waste handlers do not have formal training in waste management and as such do not adhere to hospital waste disposal protocols, and the hospital administrators, on their part often do not pay much attention to proper management of hospital waste [5]. As a consequence, the immediate environment around the hospital becomes inundated with hazardous wastes with great potentials to disseminate infections.

This study was carried out to assess the impact of hospital waste in the vicinity of the University of Port Harcourt Teaching Hospital.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is the University of Port Harcourt Teaching Hospital (UPTH) Dumpsite beside the Mortuary (N4°54'06.3" E6°55'40.8") and a Mini Dumpsite beside the Accident and Emergency (A and E Blocks) (N4°54'02.6" E6°55'39.6") and a control site (N 4°54'03.6" E 6°55'.38.8").
2.2 Dump Site Sampling

Soil samples were obtained from two Hospital Dump site and a pristine soil served as a control. Ten random samples from each sampling site (100 g each) were withdrawn from a depth of 0–15 cm from each sampling site and sieved through a 4.5 mm-mesh sieve. The soil samples were then homogenized to make a composite sample for each sampled site and immediately transported to the laboratory for the analysis. Cetrimide agar (CA), Salmonella Shigella Agar (SSA), Nutrient agar (NA), Potatoe Dextrose agar (PDA) and Blood agar (BA) were used for microbial analysis.

2.3 Determination of the Presence of Airborne Pathogens

The settling plate technique as described by Mbakwem-Aniebo, [6] was used as sample collection method. In this technique, standard 18 mm diameter Petri dishes containing 18ml of sterile culture media (Nutrient Agar and Potato Dextrose Agar) were opened 20 meters close to the dumpsite and a non-dump site (control). Twenty minutes of exposure, 1 metre away from the floor and 1 meter away from the wall or obstruction as observed, after which the Petri dishes were closed and placed in the incubator at 37°C for possible bacterial growth while the fungal plates were incubated at room temperature for five days for the determination of airborne diseases.

The bacterial isolates were identified based on their cultural and biochemical characteristics with reference to Holt et al. [7]. Gram staining, spore staining, catalase test, oxidase test, indole test, methyl red voges prausker (MRVP), starch hydrolysis and motility test were carried out. Morphological characteristics such as shape, colour, arrangement of spores, structure of the mycelium, and structure of hyphae and arrangement of sporangiophores were used in identifying the fungal isolates as described in Ellis et al. [8]. Germ tube test was also carried out.

2.4 Physicochemical Analyses

The pH of soil was measured in situ using a pH meter JENWAY 3071, model pH 82 (degree of accuracy 0.01) equipped with a temperature probe (924001). Determination of nitrate was carried out as described in Anyanwu et al. [9]. Heavy metal content of the samples was determined using AAS.

3. RESULTS

Table 1 shows bacterial and fungal isolates from sampling site. The bacterial isolates found in the dump sites soil include Escherichia coli, Salmonella sp., Aeromonas sp., Proteus sp., Serratia sp., Micrococcus sp., Acinetobacter sp., Pseudomonas sp., Corynebacter sp., Staphylococcus sp. and Bacillus sp., while the fungal isolates include Trichophyton sp., Scopulariopsis sp., Mucor sp., Candida albicans, Cladosporium sp. and Fusarium sp. Dumpsite beside UPTH mortuary had more bacterial and fungal species than dumpsite beside UPTH A and E and the control.
Fig. 3 shows the microbial population of sample sites. Dumpsite beside UPTH mortuary had the most bacterial and the least fungal count.

Fig. 4 shows the physicochemical parameters of sampled sites. Nitrate (NO$_3^-$), lead (Pb), arsenic (As), cadmium (Cd) and chromium (Cr) levels of the dumpsites were higher than the control. The pH values of the dumpsites were slightly lower than the control.

Table 2 shows bacterial and fungal isolates from sampling site. The bacterial isolates found in the dump sites soil include Aeromonas sp., Proteus sp., Serratia sp., Micrococcus sp. Acinetobacter sp., Pseudomonas sp., Corynebacter sp., Staphylococcus sp. and Bacillus sp., while the fungal isolates include Candida albicans, Rhizopus sp., Aspergillus sp. Rhodotorulla sp., Scopulariopsis sp. and Cladosporium sp. Dumpsite beside UPTH mortuary had more bacterial and fungal species than dumpsite beside UPTH A and E and the control.

4. DISCUSSION

The Microbiological assessment of the dumpsites soil revealed an array of microorganisms which include Baccilus sp., Staphylococcus sp, Pseudomonas sp, Salmonella sp. Serratia sp., Proteus sp. Escherichia coli, Trichophyton sp., Scopulariopsis sp. Candida albicans, Fusarium sp., Mucor sp. and Cladosporium sp. Most of the organisms identified are grouped under Bio safety level two organisms [10]. Bio safety level two organisms such as Salmonella sp. are agents associated with human disease for which preventive or therapeutic interventions are often available and have the potential to pose moderate individual risk and low community risk or a pathogen that can cause human or animal disease [11]. The interaction of these microorganisms with nutrients from blood containing samples and other organic samples dumped in the environment provides a perfect living and breeding condition. The study by Altaf and Mujeeb [12] suggests the possibility of transference of disease and infection to humans from animals which often visit dumpsites.

The microbial population dynamics reveals that the bacterial and fungal counts where abundant more on hospital dumpsites when compared to a pristine soil. In developing country like Nigeria, this becomes a very great concern to public health, because unavailability of effective water supply could lead to situations where people drink water that is already contaminated with

| Table 1. Bacterial and fungal isolates from soil sampling sites |
|---|---|---|
| S/N | Sampling site | Bacterial isolate | Fungal isolate |
| 1 | Dumpsite Beside UPTH A and E | Escherichia coli, Salmonella sp., Aeromonas sp. | Trichophyton sp., Scopulariopsis sp., Mucor sp. |
| 2 | Dumpsite Beside UPTH Mortuary | Bacillus sp., Proteus sp., Serratia sp., Micrococcus sp. Acinetobacter sp., Pseudomonas sp., Corynebacter sp., Staphylococcus sp. | Cladosporium sp., Fusarium sp. |
| 3 | Control | Bacillus sp., Staphylococcus sp., Pseudomonas sp. | Penicillium sp. |

| Table 2. Bacterial and fungal isolates from dumpsites ambient air |
|---|---|---|
| S/N | Sampling site | Bacterial isolate | Fungal isolate |
| 1 | Dumpsite Beside UPTH A and E | Staphylococcus sp., Bacillus sp., Aeromonas sp. | Aspergillus sp., Penicillium sp., Candida albicans, Cladosporium sp. |
| 2 | Dumpsite Beside UPTH Mortuary | Staphylococcus sp., Bacillus sp., Proteus sp., Serratia sp., Micrococcus sp. Acinetobacter sp., Pseudomonas sp., Corynebacter sp., Staphylococcus sp. | Aspergillus sp., Rhodotorulla sp., Scopulariopsis sp., Penicillium sp., Candida albicans |
| 3 | Control | Bacillus sp., Staphylococcus sp., Pseudomonas sp. | Rhizopus sp., Aspergillus sp |
Fig. 3. Microbial population of dumpsites soil

Fig. 4. Physicochemical parameters of sampled dumpsites soil

bacteria washed from hospital waste sites. Also microbial community arising from hospital materials could be pre-exposed to antibiotics and that could lead to future antibiotic resistance. There have been reports of groundwater contaminated with drug resistant gram-negative bacteria such as Escherichia coli, Klebsiella pneumoniae, Enterobacter sp., commonly encountered in hospitals [13-15]. The heavy metals (Pb, Cr, As, Cd and Cr) load as well as nitrate level of soil from the hospital dumpsites were higher than that of the pristine soil.

Chemicals and heavy metal residues that are left in the environment can have effects on the natural ecosystem and possibly contaminate nearby water sources. Shareefdeen [1] affirmed that metal accumulation in soils is toxic to humans and other animals, and it is normally chronic (exposure over a longer period of time), due to food chain transfer. Lead can result to mental lapse, cadmium can affects kidney, liver, and gastro intestinal tract and arsenic can give rise to skin poisoning, affects kidneys and central nervous system. Hospitals facilities produce extremely hazardous waste that puts people within the vicinity in grave danger of risks of disease which could be fatal.

The air quality assessment of the dump site area reveals that most of the isolated pathogens from the soil analysis could also be airborne. The air
quality showed *Staphylococcus* sp., *Bacillus* sp., *Micrococcus* sp., *Klebsiella* sp., *Aeromonas* sp., *Aerococcus* sp., *Streptococcus* sp., *Pseudomonas* sp., *Serratia* sp., *Proteus* sp., *Aspergillus* sp., *Candida albicans*, *Rhodotorulla* sp., *Penicillium* sp., *Cladosporium* sp. and *Scopulariopsis* sp. to be air borne within the study area. The study revealed that *Staphylococcus* sp., was airborne at all sample sites. This is supported by previous studies which showed that *Staphylococcus* sp. is the most commonly found pathogen in air [4,16]. Bacillus sp. and most of the fungi are known spore formers and the production of spores enables this organism to withstand unfavourable conditions such as low temperatures or heat and may improve the chances of *Bacillus* to be present in high numbers in the air [17].

## 5. CONCLUSION

This study has shown that improper dumping of hospital waste impacts on the soil and ambient air environment. These wastes are laden with heavy metals and microorganisms some of which are pathogenic can proliferate and pose public health threat. Hospital waste management system and practice at the UPTH need improvement to meet acceptable standard, to forestall the spread of infectious diseases and probably an epidemics.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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