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Genotoxicity evaluation of hospital wastewaters

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ABSTRACT

In hospitals a large variety of substances are in use for medical purposes such as diagnostics and research. After application, diagnostic agents, disinfectants and excreted non-metabolized pharmaceuticals by patients reach the wastewater. Indeed, some of the substances found in wastewaters are genotoxic and are suspected to be a possible cause of the cancers observed in the last decades. Genotoxicity tests are an excellent means to study the toxicity and the risk associated with these releases. This paper points out the areas of concern for hospital wastewater disposal and reports the findings of genotoxicity tests for hospital effluents from 3 major hospitals in Delhi, namely All India Institute of Medical Sciences, Apollo and Escorts. Mutagenicity of hospital wastewaters from effluent treatment plants (before and after treatment) was studied. The results of this study show that the genotoxicity of hospital wastewaters is highly reduced after the treatment process. This study calls for establishment of advanced and effective effluent treatment plants in the hospitals, which are merely dumping the wastewaters in the municipal sewerage system. The results of this study call for further detailed study in this area.

1. Introduction

Health-care waste includes a large component of general waste and a smaller proportion of hazardous waste. The major sources of health-care waste are hospitals. Hospitals represent an incontestable release source of many chemical compounds in the aquatic environment due to laboratory activity or medicine excretion into wastewater (Kummerer, 2002). All individuals exposed to hazardous health-care waste are potentially at risk, including those within health-care establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management. Despite the growing concern over hospital waste management, scant attention has been paid to wastewater generated from hospitals, medical research laboratories and health-care institutions. Hospitals consume a significant amount of water in a day, ranging from 400 to 1200 L day^{-1} bed^{-1} (Deloffre-Bonnamour, 1995; CCLIN Paris-Nord, 1999) and generate equally significant amounts of wastewater loaded with microorganisms, heavy metals, toxic chemicals and radioactive elements.

Wastewater from hospitals contains pollutants that are hazardous and require on-site treatment to prevent contaminating the city's sewerage system and rivers (Gautam et al., 2006). Chemical residues discharged into the sewerage system may have adverse effects on the operation of biological sewage treatment plants or toxic effects on the natural ecosystems of receiving waters (Pruess et al., 1999). Similar problems may be caused by pharmaceutical residues, which may include antibiotics and other drugs, heavy metals such as mercury, phenols, and derivatives, and disinfectants and antiseptics. For instance, uncontrolled discharges of sewage from field hospitals treating cholera patients have been strongly implicated in cholera epidemics in some Latin American countries (Pruess et al., 1999). One of the main environmental problems caused by hospital effluents is due to their discharge in urban sewerage systems without preliminary treatment. Pharmaceuticals, chemicals, disinfectants, active substances, pigments, dyes, reagents and drug components are widely used in hospitals. Many drugs are excreted non-metabolized by patients and enter the wastewater. The different substances, which are not biodegradable, may finally enter surface water from wastewater treatment plant (WWTP) effluents, and enter groundwater when sewage sludge is used as fertilizers (Kumar et al., 2006).

Antibiotics and disinfectants are supposed to disturb the wastewater treatment process and the microbial ecology in surface waters (Kummerer, 2002). Hospitals thus represent an

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incontestable release source of many chemical compounds in their wastewaters, and which may have an impact on the environment and human health. Indeed, some of the substances found in wastewaters are genotoxic and are suspected to be a possible cause of the cancers observed in the last decades (Jolibois and Guerbet, 2005a–c).

In a country like India, there is a tendency of disposal of wastewater directly into the municipal sewer system, which is further treated along with the domestic sewage in the municipal sewage treatment plant. This is due to lack of resources and absence of proper wastewater treatment plants.

Testing of chemicals for mutagenicity in Ames assay is based on the knowledge that a substance that is mutagenic in the bacterium in the presence of animal liver enzymes metabolizing chemicals is likely to be a carcinogen in laboratory animals, and thus, by extension, present a risk of cancer to humans (Mathur et al., 2005).

The present study is thus aimed at studying the mutagenic potential of the final discharges from hospitals. Three hospitals in Delhi were studied, namely All India Institute of Medical Sciences (AIIMS), Apollo and Escorts. These sites were chosen because all these hospitals are located in prime locations of Delhi and are amongst the major hospitals of India. The genotoxicity of wastewater at different stages of treatment like after filtration, aeration and chlorination was also monitored to evaluate the efficiency of those treatment plants that are meant for hospital waste treatment. Amongst the sites chosen, Escorts hospital has a fully functional effluent treatment plant (ETP) whereas AIIMS and Apollo hospital do not have any treatment plant for their wastewaters.

Thus, this study reports the findings of genotoxicity tests for hospital effluents from the hospitals that are treating the waste and then releasing it and also from the hospitals that are releasing the untreated hospital wastewaters in the environment.

2. Materials and methods

2.1. Sampling of hospital wastewater

The samples from all the hospital sites (Fig. 1) were taken twice in 6 months. The first sampling was done on 25th July 2007. The second sampling was done on 3rd January 2008.

Site 1: *All India Institute of Medical Sciences (AIIMS)*—AIIMS Main Hospital is located at Ansari Nagar, in front of Safdarjung Hospital at the crossing of Ring Road and Aurobindo Marg. The hospital has a total of 1766 beds (including newly constructed Emergency & Private wards). AIIMS hospital does not have an effluent treatment plant for wastewater generated in hospital due to patient and other treatment activities. Wastewaters are released into the main sewer of the hospital from where it joins the city's sewerage system. Thus, the samples from this hospital were collected from the main sewer of the hospital.

Site 2: *Indraprastha Apollo Hospital*—Apollo hospital is located in Sarita Vihar at Delhi–Mathura Road. It is spread over 12 acres of land and has a built-up area of 600,000 square feet. It has a bed capacity of 560 (including 140 ICU beds and 44 HDU beds) and 14 Operation Theaters, expert medical professionals and the latest technology. The hospital handles close to 200,000 patients a year, of which 12,000 are international patients. Apollo hospital also does not have any treatment system for the wastewaters generated due to hospital activities. Samples were therefore collected from the main sewer of the hospital, which receives the entire wastewater from the hospital. Wastewater from the hospital reaches the city's sewerage system.

Site 3: Escorts *Heart Institute and Research Centre Ltd.*—It is situated at Okhla Road, New Delhi. The hospital has more than 329 beds, 9 Operation Theaters,

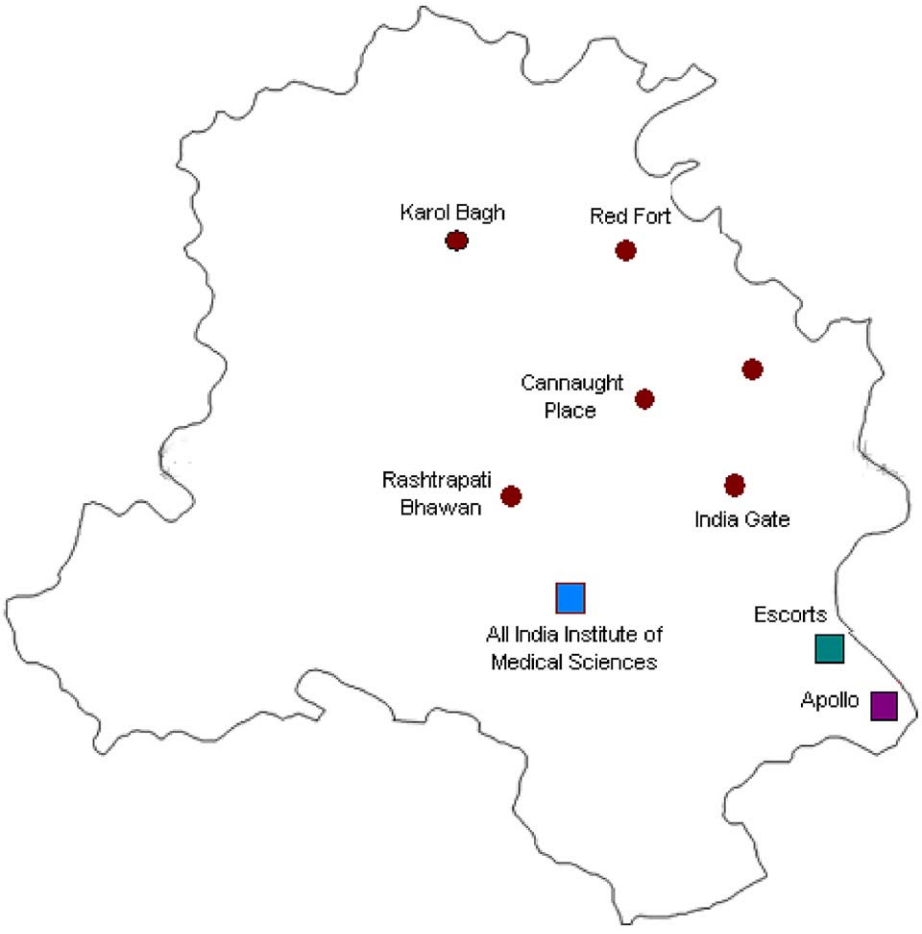

Fig. 1. Site map of Delhi. Hospitals under study are highlighted.