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# Antibiotics 2020: Human health risk due to exposure of ciprofloxacin in drinking water samples of Yamuna River, India - Minashree Kumari - Indian Institute of Technology Delhi

**Minashree Kumari**
Indian Institute of Technology Delhi, India

**Statement of the Problem:**
Consumption of pharmaceuticals particularly in developing countries is rapidly increasing due to fast economic growth and sharp increase in population. India is one of the top manufacturer and consumer of pharmaceutical compounds in the world. The release of pharmaceuticals from sewage effluents to rivers and lakes is an issue of growing concern. Due to increased consumption and the absence of systematic control guidelines, pharmaceutical compounds and their residues are frequently detected in the aquatic environment, including drinking water and wastewater (Hopkins and Blaney, 2014; Zhang et al., 2019). Existing conventional water/wastewater treatment plants are ineffective to meet the environmental standards, and absence of systematic control guidelines on wastewater discharge augment the existing issue. Over the years, occurrence of several class of pharmaceutical compounds such as ciprofloxacin, norfloxacin, amoxicillin, ampicillin, trimethoprim etc., has been detected in Indian river water (Fick et al., 2009; Larsson et al., 2007; Kurunthachalam, 2012; Mutiyar and Mittal, 2014; Ramaswamy et al., 2011). At environmentally relevant concentrations, some of these pharmaceuticals can adversely affect the aquatic ecosystem, and may aid in development of antibiotic resistance in bacteria ('superbugs').Yamuna river originates from the Great Himalayan glaciers and passes through the national capital territory. It is the largest tributary of the holy Ganges and one of the most prominent rivers of India. The river serves as the main source of drinking water to Delhi and is also the receiving water body for raw and partially treated sewage from the city. Only 2% percent of its total length of the river flows through Delhi city, however it receives 79% of its total pollutant loading, principally through sewage and discharge of industrial effluents (Mutiyar and Mittal, 2014). Due to this uncontrolled discharge, water quality of the river has severely deteriorated and now it is considered to be one of the most polluted rivers in the world. As mentioned, a wide variety of pharmaceutical compounds were detected in river Yamuna out of which ciprofloxacin (CIP) is one of the most frequently detected antibiotic with progressively high concentrations (Hughes et al., 2013; Kalpan, 2013; Mahmood et al., 2019; Paiga et al., 2016; Zhang et al., 2012). CIP is a fluoroquinolone antibiotic, and one of the most consumed drug used to treat a number of bacterial infections. In the light of current situation, it becomes essential to perform human health risk assessment of CIP in people using Yamuna river water for drinking water purposes.

**Methodology and Theoretical Orientation:**
The study assessed the potential health risk of CIP due to direct ingestion of water in the nearby population of Yamuna river, Delhi, India. Human health risk assessment of CIP from drinking water exposure was carried out for two different sub-populations i.e. children and adults Environmentally detected concentration (EC) of CIP was taken from published literature. To estimate the predicted no effect concentration (PNEC), acceptable daily intake (ADI) value was ascertained using the point of departure (POD) and uncertainty factors (UFs). UFs associated with CIP was taken from Schwab et al. (2005). PNEC converts the ADI values into an acceptable water concentration by considering possible exposure through daily consumption by humans of water (U.S. EPA, 2000a). For PNEC estimation, the value of input parameters like body weight (BW), and water ingestion rate (IR) were taken in accordance with Indian conditions (ICMR, 2009), whereas, for other parameters such as exposure frequency (EF), exposure duration (ED) and average time (AT), the value was taken as per the United States Environmental Protection Agency guidelines (USEPA) guidelines. Risk exposure of CIP for sub-population was calculated by using hazard quotient (HQ) values as a ratio of ECs and PNEC values (EC/PNEC). HQ identifies the level of risk assessment and determines the non-cancer risk of contaminants for sensitive sub-populations. If the estimated HQ value is more than 1, concern exists over possible toxicity (USEPA, 2000b). Margin of safety was also identified by means of HQ values i.e. 1/HQ.

**Findings:**
On the basis of ADI values followed by PNEC estimation, it was observed that average PNEC value was found to be 55.20 µg/L in adults and 26.28 µg/L in children. The study revealed that the 99th percentile value was found to be 51.56 µg/L for adults, and 23.65 µg/L for children, respectively. The estimated PNEC value was reported to be twice in adults compared to children, which is primarily due to increased BW and ED of adults. 90% confidence interval values were observed to be 16.05 × 10-3 µg/L in adults and 9.19 × 10-3 µg/L in children.
Statistical analysis of HQ was carried out to determine the 99th percentile value and 90% confidence interval values. Risk assessment studies revealed that 99th percentile values for both the sub-populations (adult: 2.07 × 10-4; children: 1.40 × 10-4) was found to be less than 1 × 10-4 for both adult and children (the margin of safety, 10-4), demonstrating no probable risk on human health due to drinking water exposure.

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The average and maximum HQ values in adults and children were also observed to less than the acceptable risk level. Concern exists if the values exceeds 1 however, for both the studied sub-population; the HQ value was found to be less than 1. The overall study revealed that there exist no possible concern and harmful effects on human health due to drinking water exposure.

**Conclusion and Significance:** The study revealed that HQ values for both the sub-populations was found to be less 1, indicating no potential risk on human health due to CIP from oral ingestion of water. The observed values indicate only the point estimate value; uncertainty analysis using Monte Carlo simulations must be carried out to remove overall uncertainty in risk assessment process. The study will help regulatory agencies like central pollution control board in developing the effluent discharge standard limits of antibiotics including health risk guideline values. Appropriate and strict control measures should be taken by regulatory agencies to eradicate the spread of antibiotic pollution based on the results of health risks of antibiotics exposure.

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