

PHARMACEUTICAL POLLUTION: A SHORT COMMUNICATION

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ACCEPTED ON 29-05-2011

RECEIVED ON 11-05-2011

Do we ever wonder what happens to the medicines that we take for headaches, ulcers, infections, depressions, and epilepsy? Does the body use all of the medicine that we take and, if not, where does the unused portion of the medicine go? Well, the portion used by the body is metabolized to something else. Both unused medicines and their metabolites are excreted to eventually appear together in our water systems. The unused (surplus or expired) medicines that we dump also appear in our ecosystem. The water thus becomes a medi-soup. Would we want to drink water that contains all these medications together?

No information exists that can tell us the cumulative effects of a cocktail of medicine taken together, each even existing below its lethal dose. Also, the wastewater generated during the manufacturing process (containing substantial quantities of various medicines) may be dumped in our water systems. The bottom line is that the water is not only infested with traditional pollutants but also contains a host of pharmaceuticals. The awareness does not exist that such medi-soup exists, and the import and the potential consequences of the pharmaceuticals in water are not very well known.

The pharmaceutical industry is one of the worst polluting industries when compared on the basis of the unit quantity (such as kilogram) of the product it produces. According to some estimates, up to 2000 kg of dangerous solvents could be generated per kilogram of the product produced. There are various reports that this industry failed to take adequate precautions to curb its products from getting into the public water systems. The extent of pharmaceutical pollution on India is horrifying. We should not forget that India is the so called medicine-basket of the world for especially the bulk medicines. The mass production of medicines creates a huge steam

of effluents. The effluents, if improperly treated, contaminate water bodies and leave a cocktail of medicines. Nobody in the right mind and sense would like to consume 10-20 different kinds of medicines together but that is what the pharmaceutical contaminants offer us in drinking water.

Granted that the levels of individual pharmaceuticals may be low but one is simply ignorant as to the contraindications or the interactive toxicity of various medicines when taken together. A bunch of medicines taken together may cause a disaster that far exceeds the harm caused by any individual medicine. 'Nocebo' and 'nocebo effect' are terms that became popular in the 1990s and can be thought of as opposite to 'placebo effect'. According to Root Bernstein, "research has...shown that the nocebo effect can reverse the body's response to true medical treatment from positive to negative". Could this cocktail of medicines cause nocebo effect and induce or promote a disease where none existed before? What harm this medi-soup will do to our generations, and the youngsters who are the future of our nation?

The other source of drug-laced water is through unmetabolised drugs being excreted by humans (and also animals). Since humans

and animals are pretty evenly distributed throughout the land, the pharmaceutical pollution is likely to be distributed through the land. Thus the problem assumes far greater proportions. The current water treatment facilities, even in the developed countries, are still in the advancing stage. Researchers, lawmakers, and the community at large are neither well aware of the enormity of these problems nor are they prepared to handle these yet. An integral step for most of the current water treatment facilities is disinfection using chlorination or ozonation. All of these processes use very reactive chemicals and a major concern is the formation of disinfection by-products (DBPs). For the case of chlorination, the DBPs in water are carbon tetrachloride (CCl_4), chloroform (CHCl_3) and other similar compounds. Though they are present in small quantities their toxicity is much greater, making the problem very serious and difficult.

Now, if pharmaceuticals are also present in the water, they themselves are likely to result in the formation of their own series of products, making an even worse cocktail of chemical compounds. The effect of such cocktail on human and animal well being is impossible to predict. A fourth source of pharmaceuticals in water is dumping of surplus

and expired medicines in municipal waste. This problem can be easily rectified by increasing awareness of the serious consequences of discarded medicines on the environment and people and animals, and plants that inhabit this planet. Finally, a total unexpected but a truly scary result of pharmaceutical pollution is the rise in drug-resistant bacteria. It is easy to see that the bacteria that survive the effect of the medi-soup, will likely to be much more drug resistant. Globally, the drastic rise of bacterial resistance to the well established antibiotics poses a serious concern. Many studies have begun to appear in scientific literature, that seem to support this view.

For a country like India that is so densely populated, the spread of infection through drug-resistance could cause massive damage to the society and the country. According to the *Wall street Journal*, "India has 41 cities with more than 1 million people. The rapid growth of these megacities is overwhelming but with poor municipal services, leaving many with mounds of rotting trash, sewage flowing directly into polluted rivers." In such a situation any additional burden of infectious disease is likely to have monumental consequences. Also, there are several systems offering treatment for any disease. To name a few: Unani, Ayurved,

Homeopathy, Herbopathy, and Naturopathy all use medications in their own ways. Aquatherapy, directly uses water as a therapeutic agent. Imagine the results if the very water is contaminated. Improper water treatment can let the drugs easily get into the treated water, which in turn may be recycled as potable water to sicken the masses afresh. Most water treatment methods are not efficient enough to remove the micro levels of drugs that seep into water systems through direct, indirect and unexpected routes.

What to do?

Strict controls and checks can be placed at the production stage. The industry and health provides should be required to administer proper disposal of the surplus and expired materials. Perhaps much more sophistication in the analytical instruments will help in detecting and handling, but this is a cost intensive exercise. So, what should a common (layman) do?

- Stop drinking water (really???)
- Buy expensive water filters/ purifiers
- By an RO (reverse osmosis) unit
- Take regularly detox pills
- Compromise with what is available

- Improvise a set-up to one's own satisfaction

The last option seems to be more realistic in our Indian context. A number of cost effective and low tech (CELOT-coined by the authors) options are being studied, experimented, and evaluated in laboratories both in India and the US. The problem is monumental and the solution cannot be tailor made. We can never totally eliminate the risks but we can always reduce their intensity by meticulous planning. Of course, consumers are the end users but they could also be a part of the problem and also a part of the solution. If they realize the severity and consequences of the medi-soup in water they can also mitigate the severity of the problem by maintaining a strong civic sense.

The public could play an active watchdog role by:

- Avoiding purchase of medicines in excess of their need
- Avoiding overdose of medicines

- Avoiding throwing excess or expired medicines in trash bins or flushing them down in the sewer system

The best way to discard the excess medicines is to put them in the transparent (for safety reasons) medi-drop containers installed at strategic points by municipal corporations or through periodic door-to-door collection by genuine volunteers from registered social works groups or NGOs. An attempt is being made through organizations just to do this work in major metros of India. Much of the present day malady is the result of human intervention in nature's functions in a disproportionate ratio. Man alone can find appropriate solutions for solving this solution. (Courtesy: Bhanumati, S., Department of Chemistry, Gargi College, University of Delhi; Shukla, S. S., Department of Chemistry and Centre for Green Science Technology, Lamar University, Beaumont, Tx 77710, USA; Shukla, A., Department of Chemistry, Southeast College, Houston, Texas, USA).



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