frontiers FOR YOUNG MINDS

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HOW CAN WE HELP TO PREVENT MEDICINES FROM POLLUTING THE ENVIRONMENT?

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Medicines are useful for humans but can be harmful for many different kinds of wildlife. If disposed of improperly, the medicines we use can reach the environment, especially our water resources. This medicine pollution can be problematic for the organisms living in the environment, but these problems can also come back to us, since we use this same water for drinking or for growing crops. It is important for us to understand how to have all the benefits from medicines while avoiding the problems associated with improper use of these substances. You have an important role to play in helping to reduce this problem, by taking some easy precautions when dealing with medicines. It is very important to learn about this issue, and to talk with your friends and relatives about what you learn in this article. Do you want to know some simple ways to become a more aware citizen regarding medicine pollution? Then keep reading!

CURING HUMANS MAY CAUSE ANIMALS OR PLANTS DISEASES?

Achoo! Cough, cough... a little pain here, a little pain there... at some point, all of us come across some kind of disturbance to our health. Who never had a headache, a cold, or even some pain? Nowadays, there are medicines to treat almost every pain or disease, even in severe cases. Then, it is all good, right? Everyone wins this game? Well, maybe not everyone. There are a few important things about medicines that every kid should know: first, medicines are very specific for certain health issues, and should be used with caution. Never use any kind of medicine without approval from your parents, because they will know what to do when you have a problem with your health. If you need medication, your parents will know if is better to see a doctor first or they will choose the correct medicine out of the ones that you have at home. Another important thing to know is never to dispose of any kind of medicine without knowing the proper way to do it. Ask your parents and follow their advice. Medicines are powerful substances that are made to control various body processes, such as digestion and circulation, or to control an infection. Some medicines can also have an effect on other animals or on plants. So, if medicines are improperly disposed of, they can reach the environment and possibly cause harm for other living creatures. You might be wondering how medicines can go from your home into the environment. Let us have a look at this!

MEDICINES IN THE ENVIRONMENT? HOW DO THEY GET THERE?

When we take a medicine, a part of it is eliminated from our bodies through pee or poop, which then makes a long journey to reach the sewage system. Here the story begins. In the sewage system, human excretions pass through a treatment plant, where many pollutants are removed. This less polluted water is then returned to the rivers, which will then reach the sea. Unfortunately, however, in many places in the world, there are no sewage systems and human excretions end up directly in the environment, which creates a lot more pollution.

Generally, the water of rivers is also used for irrigation of crops and is used by humans for drinking and other purposes. Have you ever seen water blowers in crop fields? This is irrigation at work. What happens if there is something in the water that is not supposed to be there, like a pollutant? You are right. It will be spread all over the plants! Almost every city has some kind of water treatment that happens in specific places, called water **treatment plants**, or WTPs. In this case, the water goes through another stronger process of purification, so that we can safely drink it. However, we are discovering that our WTPs do not have enough technology to remove all the pollutants, such as medicines, that ended up in the water. These unremoved medicines in rivers, lakes,

TREATMENT PLANTS

Places where effluents are treated to return to rivers or where water is treated to become potable.

and oceans can also be harmful to organisms that are living in the water. If medicines are not removed by WTPs, they can even reach you and me—since they could be present in drinking water and in any fish that we might eat. In some parts of the world, sophisticated WTPs can remove a large part of the medicine pollution from the water, but this is far from being a reality all over the world [1].

THERE ARE OTHER WAYS THAT MEDICINES REACH THE ENVIRONMENT

Human excretion is one of the possible ways for medicines to reach the environment. In addition, pharmaceutical companies, which make medicines, may release pollution containing medicines into the environment. Medicines used by veterinarians to treat animals might end up in the environment too. These topics are too much to discuss in this article, so we will focus on the aspects of medicine pollution that we can all control. Sadly, many people still throw away medicines that they are no longer using, putting them in the trash or flushing them down the toilet. In places where trash is collected, the discarded medicine often ends up in a **landfill**. Landfills are places designed to receive solid waste—trash that we throw away. Everything that is not recycled goes to the landfill. When the trash at these sites starts to fill up, it is covered with earth and buried, but landfills are not perfect and require constant monitoring. If there is a breakdown in the protective structure surrounding the landfill, substances from the buried trash, including discarded medicines, may leak out into the soil, leading to contamination of soil and groundwater. Groundwater is also used for crop irrigation and to produce drinking water. Again, these discarded medicines can harm the environment and human health [2]. In Figure 1 you can see a summary of the routes by which medicines get into the environment.

LANDFILL

Places where our solid waste is dumped and buried.

WHAT CAN THESE MEDICINES DO IN THE ENVIRONMENT?

Pollution of aquatic systems by medicines can damage the organisms living in those systems, by disturbing their growth, behavior, and even reproduction [4]. One experimental study has shown that some concentrations of an antidepressant added to water was able to make male fish more aggressive, leading to more deaths of the females, and therefore less eggs were laid [5].

Medicines in the environment may also be contributing to the rise in bacteria that are resistant to antibiotics. Antibiotics were developed to combat bacterial infections, such as pneumonia. However, these substances need to be strictly controlled, because bacteria that are immune to the effects of antibiotics can be very harmful to humans—we can no longer fight them with our more common antibiotics [6].

Figure 1

Routes by which medicines get into the environment. Source: Adapted from Quadra et al. [3].

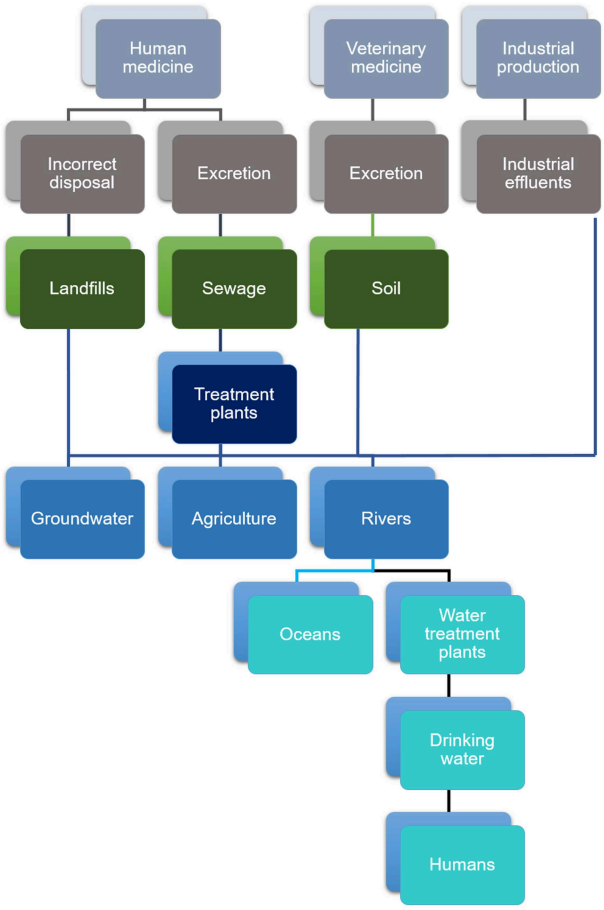

Figure 1

So, as you can see, it is very important that we help to keep all medicines from reaching the environment where they can harm other animals and also potentially harm us.

HOW CAN WE HELP AVOID ENVIRONMENTAL POLLUTION CAUSED BY MEDICINES?

Figure 2 summarizes some essential tips describing what we all should or should not do, regarding the disposal of medicines. First of all, kids should not use any kind of medicine without the proper permission from the parents, older relatives, or, of course, the doctor! Medicines are often strong compounds that are designed to produce specific effects in our bodies. To avoid any trouble with medicines, everyone must follow the directions regarding their use. Medicines are not things to play with. This rule is for our own safety, as well as the safety of other people and animals.

No medicines should be disposed of in the trash, in the toilet or down the sink. As we described earlier, these are pathways through which medicines can reach the environment and harm other organisms. How

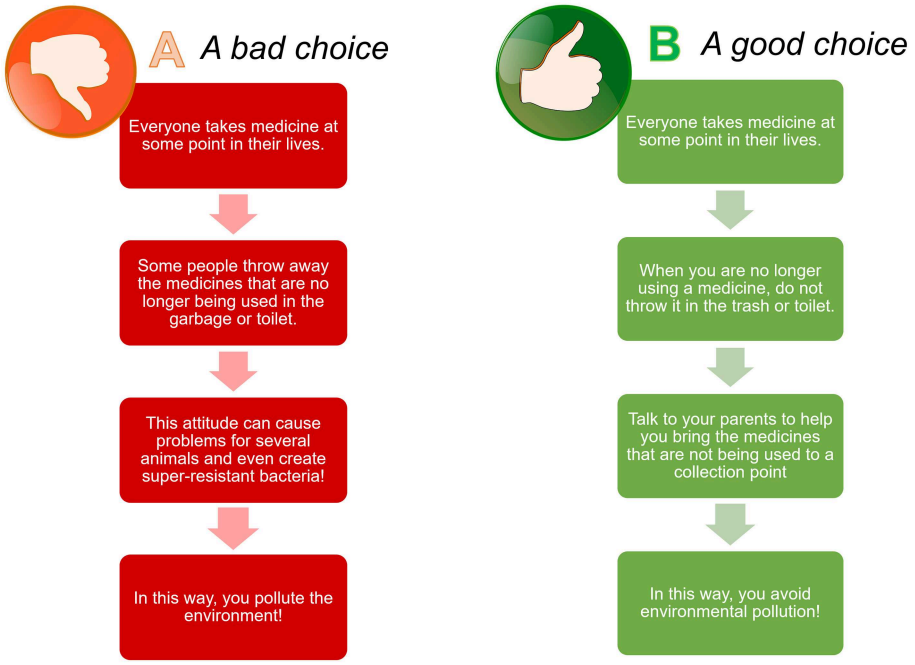

Figure 2

How can we help to prevent medicine pollution? **(A)** A bad choice–disposing of medicines improperly can pollute the environment. **(B)** A good choice–proper disposal of medicines can prevent environmental pollution. Source: Images provided by pixabay.com.

do we safely discard medicines, then? A very simple method is to separate out the medicines that you and your family are no longer using, or those that have passed the expiration date. Then, find a location that will accept these medicines and safely dispose of them for you. Some countries already have these kinds of programs and locations that will accept medicines for disposal, such as drugstores and certain government agencies. Maybe your family and friends can help you to find these drop-off spots in your city! Another possible way to safely dispose of medicines is to bring them back to the place where they were purchased. In many countries, these places can collect and dispose of the medicines correctly. Ask your family or friends what they know about the medicine-collecting policy in your area!

So, even though medicines that are improperly disposed of can be harmful, you do not have to stop taking medicines! Medicines have made it possible for humans to live longer and healthier lives. However, it is worth remembering that the responsible use of medicines is very important. This means that you should always consult a doctor before taking any medicine and carefully follow the directions for taking that medicine [7]. We must be very careful to use and discard medicines properly. You can become a more responsible citizen using the information we have provided, and you can even be the person who explains this information to the other people in your family and community.

CONCLUSION

Medicine pollution is being found in the environment all over the world. It can reach far-away places, because it can travel long distances through the water. This is a serious and complicated issue. However, the most important thing we need to know is how to use and dispose of medicines correctly. In addition, spread the word! Environmental pollution can be avoided with the help of conscious citizens. Let us all do our part!

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YOUNG REVIEWERS

LICEO COCCHETTI, AGE: 14

We are from a Scientific High School located in Milano, Italy, and we are 14 years old. We are said to be attentive and brilliant young minds, and reviewing an article gave us the opportunity to discover another aspect of science. When reviewing the article, we were excited to contribute to the publication process of a scientific article.

AUTHORS

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Ever since I was a kid, I loved science classes. Then, I studied to be a Biologist at the Federal University of Rio de Janeiro, and I graduated in 2013. In 2015, I received a Master's degree in Environmental Sciences and Conservation from the same university. Currently, I am a Ph.D. student in Environmental Sciences at the State University of Rio de Janeiro. I am studying the effects of environmental pollution in mussels that we consume. I love nature and like to go out with my friends. I like to see new places, mainly those that have natural parks. Nature brings me happiness and this is one of my motivations for studying and helping to take care of the environment. *helenabiolog@gmail.com

RAFAELA DOS SANTOS COSTA

I am a biologist and currently a Ph.D. student in Development and Environment at the Federal University of Rio Grande do Norte. I have always been interested in understanding the effects of chemicals on different organisms. I have worked with environmental pollution and ecotoxicology. In recent years, I have devoted myself to studying the effects of medicines on the environment and the impacts of medicine pollution on human health.

GABRIELLE RABELO QUADRA

I am a biologist and current Ph.D. student of Ecology at the Federal University of Juiz de Fora, in Brazil. I have a great interest in aquatic contamination by heavy metals and organic pollutants, such as medicines. I have also been involved in scientific communication. I believe we need to spread scientific findings outside of the academic network, especially to kids.

MARCOS ANTONIO FERNANDEZ

I am 60 years old, and used to dive since 15. My curiosity and admiration for the marine creatures took me to an undergraduate course of Oceanography, and to the fields of marine chemistry, biogeochemistry and ecotoxicology always connected to biological responses of marine organisms to pollution. During my academic career, I devoted my research to development of easy, simple and non-destructive techniques for bio-assays and biomonitoring studies. Now, I am getting back to where I began, looking to connect marine ecotoxicology with marine ecology, and the effects of mixtures of pollutants in real world scenarios and models. And, of course, I still love to dive.

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