DRINKING WATER AND HEALTH HAZARDS: AN OVERVIEW

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ABSTRACT

Biological contamination remains the most significant public health risk associated with drinking water even in industrialized countries. High potential for organic chemical transport to drinking water continues to exist even with source protection because of the multitude of chemical types and quantities. Drinking water is usually not a unique source nor the most significant contributor to total exposure from synthetic organic chemicals but it might be one of the most controllable. The major public concern with drinking water contamination has been possible contribution to cancer risks from organic micropollutants. Even though the actual risks are probably small in most cases it is clearly within the public interest to prevent adulteration of water supplies and to protect their quality for the future so that these concerns or risks can be avoided. Water consumption patterns and the relative importance of the drinking water exposure route show that inorganic water contaminants generally contribute much more to the total daily intake than organic micropollutants. An exception is chloroform and probably the group of typical chlorination by-products. Among the carcinogenic organic pollutants in drinking water only chlorination by-products may potentially increase the health risk. Treatment should therefore be designed to reduce chemical oxidant application as much as possible. As disinfection is the central issue of the present water treatment practice the search for the ideal disinfection procedure will continue and might result in a further reduction in the use of chemical oxidants.
Keywords*:* drinking water, organic micropollutants, chemical oxidant, environment; health risk

1. INTRODUCTION

Drinking water organics have been handled in a way that may seem somewhat overdone to those dealing with air or soil contamination but it also provides the most sophisticated examples of how environmental problems can be tackled. The studies on drinking water quality is the most advanced branch of environmental research (Cotruvo *et al.* 2014).

Currently, there is a long list of environmental concerning issues such as acid deposition abatement, introduction of cleaner and less noisy vehicles, disposal of toxic chemical wastes, nuclear energy or renewable energy sources, clean-up of contaminated soil and sediment, which will expand in the future with other issues such as greenhouse effect due to CO2, changes in the ozone layer, indoor-air pollution and, nuclear winter(Zoeteman*et.al*., 2005; Trehy *et. al*., 2016). All these problems need to be politically addressed to and investments. Against this background drinking water obtains a low priority, maybe a too low priority. The ultimate environmental calamity is the use of nuclear weapons followed by a further environmental catastrophe. Estimates by Sagan (1983/1984) show temperature drop, varying from 5-50-C in the Northern Hemisphere during periods of 4-12 months, depending on the severity of the nuclear exchange. Such a calamity would of course by far outweigh all other environmental issues mentioned before and for the first time environment starts to become a significant factor of strategic defense planning (Loper, 2003; Kreijl *et. al*., 2004). Our existence on this planet would actually be at risk. We feel threatened externally by toxic vapors, acid rain and eventually a fatal darkening of the sky and internally by coronary heart disease, cancer, viruses and AIDS (Kool *et. al*., 1998*;* Zoeteman *et. al*, 2002;2006). Within this context we have to look at our problem of today as society feels all these stresses and has to decide to what extent money will be allocated on this particular problem. In comparison with other environmental issues much money has been spent on the study of drinking water organics. This is due to the recent discovery of the occurrence of these compounds in the drinking water, to our wish that drinking water must be absolutely safe and to the traditionally excellent organization of the water supply industry (Chek *et. al*., 1980; Williamson *et.al*.,2015). It could be stated that advanced analytical techniques and extremely sensitive epidemiological and toxicological methodologies have been developed and applied to study drinking water quality.

2. MATERIALS AND METHODS

A literature analysis has been made. Quality of water consumed requires assessment ofthe relative importance of the drinking water exposure route. The recently published WHO guidelines for drinking water quality (2011) supporting information which can be used to derive for most of the substances mentioned the relative contribution of drinking water to the total daily intake. Based on this WHO document and some additional publications a survey has been composed and presented.We measured the relative contribution of some drinking water contaminants in the mean daily intake (the estimated mean daily intake for the most frequent substances present in the drinking water) (WHO, 2011), such as some inorganic contaminants (Al, As, Be, Fe, Se, Ag, Ba, Cd, Cr, Mn, Hg, Ni, Na, S04, Cl, Ca, F, Pb, Mg, NO3) and some organic components (Chloroform, Trichloroethene, Benzo(a)pyrene, DDT, Vinylchloride, Benzene)

3. RESULTS AND DISCUSSIONS

Table 1 summarizes the data, and shows that practically all known organic micropollutants in drinking water contribute less than 1% to the total daily intake of these compounds. The inorganic contaminants seem to be of much greater interest for human health, particularly fluoride, lead and magnesium. The only exception among the many organics is *chloroform* (Table 2). Generally speaking, these compounds are of interest when having water quality manipulated either by chemical treatment or distribution through piping materials that release compounds. Lead is a good example of the latter, and chloroform is an indicator for the total group of halogenated by-products, such as halophenols, halo-acids, haloacetonitrites etc. which are probably mainly ingested via the drinking water route. Table 2 also shows that with the exception of the volatile halogenated organics for which air is the major exposure route, food is always the most important contributor to the daily intake. Exposure to inhalation can also be traced back for some organics to indoor tap water use (Anderson 2015; Haring *et.al.*, 2019). This shows the need to look at these problems in an integrated way. Since adequate water treatment techniques have been developed and applied the past decades industrial organic micropollutants present in raw water sources are generally sufficiently removed to make the drinking water exposure neglectable.

Table 1. Survey of the relative contribution of drinking water contaminants to their mean daily intake by man

< 0.1	**0.1 - 1.0**	**1.0 - 10**	**> 10**
	Al, As, Be, Fe, Se, Ag	Ba, Cd, Cr, Mn, Hg, Ni, Na, S04, Cl	Ca, F, Pb, Mg, NO3
Vinylchloride Aldrin/Dieldrin Chlordane, DDT, Hexachlorobenzene Heptachlor(epoxide) Lindane Benzene	Carbon tetrachloride, 1,2 Dichloroethane, Tetrachloroethene, Benzo(a)pyrene	Trichloroethene	Chloroform

Contribution range (%) of drinking water contaminants to the mean daily intake

Table 2. Main exposure routes for some drinking water contaminants

	% contribution to total intake			
Substance	**Drinking water**	**Food**	**Air**	**Smoking**
Fluoride	50	50	< 1	-
Lead	32	65	3	-
Magnesium	29	71	< 1	-
Calcium	16	83	< 1	-
Chloroform	15	77	8	-
Nitrate	14	85	< 1	-
Trichloroethene	1	5	94	-
Benzo(a)pyrene	1	87	4	8
DDT	< 1	100	< 1	-
Vinylchloride	< 1	5	95	-
Benzene	< 1	56	44	-

4. CONCLUSIONS

We suggest the new approaches in public water supply be included in environmental policies. Due to the mature status of the water supply industry most of its problems can be handled in the quiet atmosphere of solid cost-benefit optimization studies. A good example was recently presented by Cotruvo (2014) in relation to the cost of chloroform reduction and the benefit of less cancer treatment costs. Standard setting procedures and inclusion of other exposure routes were applied for drinking water quality in the early stage. Risk assessment methodologies have surprisingly developed for the relative small risks associated with drinking water. Nowadays they obtain already a wider application in the assessment of air pollutants and soil pollutants. Similar trends can be described for the handling of the exposure to radioactive materials, which subject obtains much attention but generally results in smaller risks than those caused by recent environmental problems. In both cases it is the large existing organization that more or less autonomously creates further refinements in the scientific approaches. One of the major benefits of this achievement will be the use of the water supply experience for other environmental problems that have nowadays a high priority (Bock *et. al.,* 2019). Water supply experts can therefore move to other areas of environmental research and policy making. The case of water chlorination has shown the validity of the rule that pollution should be treated as close as possible to its source (Slooff *et.al.,*2004). Waste water containing enteric bacteria and viruses should therefore be mainly treated before discharge into our water sources (Fiessenger *et. al.*,1995). Finally, micropollutants released by coatings, plastic pipes and bacterial after-growth in the distribution systems are of great interest.

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