How to understand and use common data on drinking water quality and health

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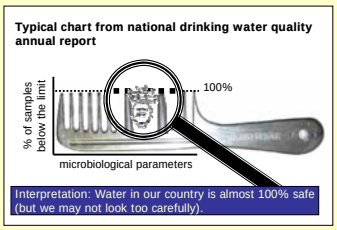


Introduction

Water utility managers and health/water authority officers are supposed to understand the meaning of common data on drinking water (DW) quality in terms of health risks to be able to accept appropriate strategy to respond monitoring results. However, it was shown by recent study [1] that even water professionals and public health and environmental specialist do not often understand the meaning of water monitoring data. This poster describes routine data on water quality and health and provides basic information and examples what experience or conclusion may be obtained from these data and when quantitative or only qualitative health impact assessment may be used.

Routine data on water quality and health

Most usual kinds of these data includes compliance of DW monitoring results in respect to national or international standards, numerical data on DW quality in given zone or territory, and numbers of water-borne outbreaks reported.

Before starting to evaluate any collection of data on water quality, several basic questions should be answered:

a) How reliable are data on water quality produced by the laboratories?
b) Is a selection of monitoring sites and sampling frequency representative for all supply network monitored?
c) Are there any significant imbalances in the amount of data from different water supplies, which may introduce bias into the survey design?
d) If there is any data selection, what is its nature and purpose – may it influence a representativeness of the survey?
e) What is population coverage of the survey assessed?

Table 1. Example of data on drinking water quality expressed as summary data on non-compliance for selected parameters: number and percentage of results exceeded the limit values (LV) and number of results under limit of quantification (LOQ) and expressed as summary data on numbers/concentrations for selected parameters. Data from all public water supplies in 2006, Czech Republic [2].

Parameter	Unit	No. of analyses	<LOQ	>LV		Average	Quantile			Max
				number	%		10 %	50 %	90 %	
Arsenic	µg/l	5709	4451	55	0,96	1,158	0,25	0,5	2,5	81
E. coli	CFU/100ml	32326	1	546	1,69	0,219	0	0	0	298
Iron	mg/l	32044	9851	2704	8,44	0,098	0,015	0,05	0,2	10,7
Nitrate	mg/l	31459	1921	1214	3,86	18,048	2,5	13,1	39,6	149,8

Data on compliance or non-compliance

If water quality in particular supply shows 95-100% compliance, we can conclude that water is safe in agreed way through accepted regulation. It would be highly improbable that such water causes any health damage, although not entirely impossible (e.g. due to pathogens which presence is not indicated through current system of faecal indicators or due to chemical substances which are not monitored).

If non compliance (i.e. exceedance of limit value) is real, repeatedly found and long lasting, we can say that water does not conform to regulatory requirements, but before to conclude about possible health risk, we have to know: Which parameter is not in compliance and how much and how often was the limit exceeded? It is because not all parameters and not all limit values are of direct health relevance. It is necessary to consider the meaning of each parameter assessed.

Different meaning and purpose of drinking water parameters

The list of parameters/indicators included in the Council Directive 98/83/EC (DWD) and in respective national regulations represents mixture of parameters of various nature, purpose and health relevance. Many of them have been traditionally used just for operational control (e.g. pH value), filtration efficiency control (e.g. colony counts), corrosion control (e.g. conductivity), or as chemical indicator for faecal pollution (e.g. ammonia or chloride). For most of such parameters any sudden change in concentration might be more important and risky than permanent exceedance of the limit caused by geological natural conditions.

Evaluation of non-compliance with chemical health-related parameter limit values

Even the breach of the limit value of chemical health-related parameter does not necessarily pose any health risk, because:

- the limits are usually set with considerable margin of safety [3];
- the limit is based on organoleptic basis: e.g. some volatile organic compounds like the xylenes have the limit value based on taste and odour about one order more strict than health-based limit;
- the limit value is set by political decision: e.g. this is the case of most pesticides for which the DWD sets uniform limit value 0,1 µg/l, which is expression of political decision that the pesticides should not be present in DW.

However, there is the group of parameters where moderate exceedance of the limit may cause harm effect (mostly for sensitive subpopulations): nitrate and nitrite; copper; sulphates; lead; fluoride; etc.

Evaluation of non compliance of microbiological parameters

Routine control of drinking water quality is not based on monitoring of pathogen(s) itself, but on monitoring of bacterial indicators of faecal pollution (*E.coli*, coliform bacteria, enterococci etc.). Any attempt to translate the findings of monitoring that describe a risk (which is an inherently probabilistic approach) into a certainty, means the principal flaw in the use of indicator bacteria. What should be the lessons learned?

a) Any figures in microbiological analysis of water are relative and defined by the method used. If we use little modified method or even another method we get totally different results from the same water sample.
b) Any result – either positive or negative finding of indicator bacteria – does not provide absolute information on the presence or absence of health risk; it just expresses the probability of the risk.
c) Key assessment action may be done only on the level of the single zone, taking account the results of other relating parameters and information from sanitary survey or local investigation of water supply.

Numerical data on water quality

Microbiological parameters

Although there have been already developed the methods for quantitative health impact assessment (quantitative microbial risk assessment) related to biological pollution of drinking water, the information available from routine monitoring is not usually sufficient for such calculation.

Chemical parameters

If numerical or concentration data on each health related parameter are available, various kinds of quantitative health risk assessments are possible.

Health risk assessment in case of non-compliance. In case of non-compliance of threshold chemicals we can calculate average daily dose consumed and through comparison with tolerable daily intake to assess whether one can expect health risk or not (and for what age-specific population, based on usual body weight of each age group). In case of non-compliance of non-threshold chemicals we can calculate lifetime average daily dose consumed, and with help of cancer slope factor (exposure - response function) we can assess whether level of individual lifetime cancer risk is still acceptable or not. These assessments should be made obligatory before any derogation is granted to ensure that such derogation does not constitute a potential danger to human health.

Assessment of importance of exposure from drinking water. In case of compliance of health related parameters we can assess, how important is drinking water as a source of exposure for some chemical pollutant: through calculation of average daily dose we can identify the share (%) how DW can contribute to tolerable daily intake of respective chemical substance. Comparing this contribution with other routes of exposure (air or food), we can identify priority for risk management measures, if needed.

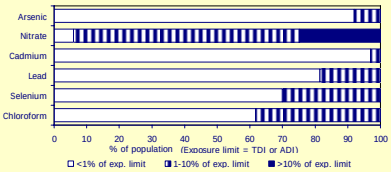
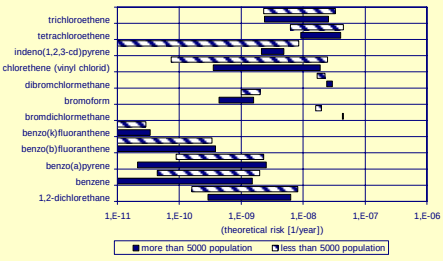


Figure 1. Distribution of population exposure to selected contaminants from drinking water expressed as % of exposure limit (tolerable daily intake, TDI or acceptable daily intake, ADI). Data from all public water supplies in 2006, Czech Republic [2]. Daily water consumption of 1 litre considered; median concentrations used for calculation.

Assessment of carcinogenic potency of drinking water. In case of compliance of non-threshold chemicals (carcinogens) we can calculate individual lifetime cancer risk (caused by the presence of these chemicals in DW) and consequently population cancer risk if data on water quality and the size of population supplied are matched together. The example is given in Figure 2 – the calculation revealed that any excess cancer risk from 12 substances considered did not reach the level in order of 10^{-7} (1,E-07), which means that DW intake might theoretically result in an annual excess cancer risk of about 2×10^{-7}, i.e. 2 excess cancer cases per 10 million population.

Figure 2. Theoretical excess of relative cancer risks from chronic exposure to selected organic contaminants (carcinogens) associated with drinking water intake (Rmin – Rmax) for big and small water supply zones. Data from all public water supplies in 2006, Czech Republic [2]. Daily water consumption of 1 litre considered; two methods of calculation used to get mean values of chemical concentration in water as most results were under limit of quantification (LOQ): minimum Rmin – values under LOQ replaced by zero; maximum Rmax – values under LOQ replaced by the LOQ value.



Assessment of safe temporary limit in case of accident or emergency. Knowledge on tolerable daily intake and the method how to calculate limit value allows to set not only safe limit value for derogation (up to 3 or 6 years), but also to set even less strict "emergency" limit value for a number of parameters, which may be applied only temporarily (e.g. for 10 days or 30 days) in emergency cases without compromising consumer's health. Some countries developed such guidelines (e.g. the Health Advisory Program of the U.S. EPA [4]) for local authorities or water suppliers to be able quickly respond in case of accidents or emergency water supply.

Number of water-borne outbreaks

Number of outbreaks of water-borne diseases is important and the only direct information on health impact of drinking water quality which is usually available. Beside data on total number of outbreaks, various additional data processing may be available, e.g. number of cases, infectious agents etc. We have to keep on mind that any differences in reported numbers among countries mostly do not reflect real situation in drinking water quality and its health effect, but rather efficiency of surveillance system.

Acknowledgement

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References

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