

The WHO *Guidelines for Drinking-Water Quality*

Session Objectives

- To introduce the latest edition of the *Guidelines*; identifying all three volumes and the information contained within each.
- To emphasise the basic concept and the advisory nature of the *Guidelines* and to describe the difference between scientific risk assessment and risk management.
- To provide an outline of the consultation process that resulted in the revised 2nd edition of the *Guidelines*.
- To discuss the reasoning behind the prioritisation of microbiological quality of drinking water in the *Guidelines*.
- To provide a basic overview of the criteria used in the selection of contaminant substances that are contained within the *Guidelines*.
- To explain the nature of Guideline Values, highlighting substances and parameters to which they apply.
- To explain the process of the rolling revision of the *Guidelines*.

The WHO *Guidelines for Drinking-Water Quality*

Introduction

An established goal of WHO and its Member States is that:

all people, whatever their stage of development
and their social and economic conditions have
the right to have access to an adequate supply
of safe drinking-water.

In this context, 'safe' refers to a water supply which is of a quality which does not represent a significant health risk, is of sufficient quantity to meet all domestic needs, is available continuously, is available to all the population and is affordable. These conditions can be summarised as five key words: quality; quantity; continuity; coverage; and, cost.

The importance of these key words cannot be over-emphasized since the impact of contaminated drinking-water on health has been well documented and range from massive outbreaks of infectious and parasitic diseases to subtle chronic toxicological effects. It is vital that all these key issues are addressed, if clear policies and programmes on water supply and quality are to be established and maintained.

To assist governments in dealing with these and related issues regarding water quality, WHO has over the years, been involved in the review and evaluation of information on health aspects of drinking-water supply and quality and in issuing guidance material on the subject.

The first WHO publication dealing specifically with drinking-water quality was published in 1958 as *International Standards for Drinking-Water*. It was subsequently revised in 1963 and in 1971 under the same title. Because of the ever-continuing research on water quality, the 1971 standards were again reviewed, and in 1984 the *WHO Guidelines for Drinking-Water Quality* were published.

The philosophy and content of these *Guidelines* constituted a significant departure from the old *International Standards* as they were designed as advisory in nature based solely on the impacts on human health of the various substances and organisms considered. Standards have, by their nature, to take other considerations into account such as social, economic, environmental, political and financial considerations and have to balance a number of criteria.

In 1989, work was started on a second edition of the *Guidelines*. These new *Guidelines* which were published in 1993-97 rely to a great extent on the pioneering concepts of the 1984 *Guidelines*.

The purpose of this paper is to briefly describe the second edition of the *Guidelines*, the revision process and the scope and new concepts incorporated into the *Guidelines* for the 1990s.

Presentation

The *Guidelines* have been published in three volumes:

Volume 1 - Recommendations describes the criteria used in selecting the various microbiological, chemical and radiological contaminants considered, the approaches used to derive the guideline values, and brief information supporting the values recommended, or explaining why no health-based guideline value was recommended.

Volume 2 - Health Criteria and Other Supporting Information is essentially an environmental health criteria document covering the contaminants that were examined with a view to recommending guideline values. Volume 2 elaborates greatly on the health risk assessment of microbial and chemical contaminants presented in Volume 1 and should be considered as a vital companion document.

Volume 3 - Surveillance and Control of Community Supplies deals specifically with small communities, predominantly those in rural areas of developing countries.

Preparation

At the time the *Guidelines for Drinking-Water Quality* were published in 1984, it was recognized that as new information on the potential health risks of contaminants in drinking-water became available, the basis of the recommended guideline values would need to be reviewed and revised. New or changed guideline values would therefore have to be recommended.

In 1988, the decision was made within WHO to initiate the revision of the *Guidelines*. As with the 1984 *Guidelines*, responsibility for carrying out this revision was shared between WHO's Headquarters and the Regional Office for Europe (EURO). Within Headquarters, both the Urban Environmental Health Unit (UEH) and the International Programme on Chemical Safety (IPCS) were involved; IPCS providing a major input to the health risk assessment of chemicals in drinking-water.

From the onset, it was agreed that the general philosophy of the 1984 *Guidelines* remained sound and valid and should therefore not be changed.

A series of planning and co-ordination meetings took place to establish the scientific approach and mechanism for the preparation of evaluation documents, substance by substance, for the revision of the *Guidelines*. This was followed by a series of Review Group Meetings dealing with specific subject areas. A total of 19 meetings were held involving the participation of numerous institutions, and over 200 experts from some 40 different countries.

The preparation of the *Guidelines* required intensive human and financial resources. The *Guidelines* could not have been developed without the scientific and/or financial support of the following organisations and countries: DANIDA, NORAD, SIDA, ODA (UK), Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Poland, Sweden, United Kingdom, and the United States of America.

Microbial contaminants and some 128 chemicals were selected for evaluation. For each selected chemical, a lead country prepared a draft evaluation document examining its occurrence in drinking-water, exposure from food and air, effects on laboratory animals and humans. Based on the evaluation of available data, a guideline value was also proposed. The outline of such an evaluation document is given as Annex 1. These evaluations constitute Volume 2 of the *Guidelines*.

The draft evaluation document was then circulated for review by the Co-ordinator to the "support countries" and selected experts. The Co-ordinator worked with the lead countries to incorporate the comments received and prepared overviews of scientific issues to be resolved. This documentation was then submitted for evaluation to a Review Group meeting which took a decision as to the health risk assessment and recommended a guideline value. The role of the seven Co-ordinators was crucial in the revision process.

During the preparation of draft evaluation documents and at the Review Group meetings, careful consideration was always given to previous risk assessments carried out by the WHO/ILO/UNEP International Programme on Chemical Safety in its Environmental Health Criteria Monographs, by the International Agency for Research on Cancer, the Joint FAO/WHO Meeting on Pesticide Residues and the Joint FAO/WHO Expert Committee on Food Additives which also evaluates contaminants such as lead and cadmium in addition to food additives.

Basic Concept

As reflected in the title, the *Guidelines* are of an advisory nature and are intended to be used by national or regional authorities as a basis for the development of drinking-water standards and regulations appropriate to their own socio-economic and exposure situation. The *Guidelines* clearly recognize the desirability of adopting a risk-benefit approach (qualitative or quantitative) to national standards and regulations. The establishment of drinking-water quality standards by individual governments must follow a very careful process in which the health risk is considered alongside other factors, such as technical and economic feasibility. Standards achieve nothing unless they can be implemented and enforced. When establishing national standards, consideration must be given to the practical measures that will need to be taken with respect to finding new sources of water supply, instituting certain types of treatment, and providing for adequate surveillance and enforcement.

Priorities

Since water is essential to life, the first priority is that it must be made available to consumers even if the quality is not entirely satisfactory.

As with the 1984 *Guidelines*, the new 1993 *Guidelines* place the greatest emphasis on the microbiological quality of drinking-water.

The microbial contamination of drinking-water has been implicated, directly or indirectly, in the spread of major infectious and parasitic diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis and guinea-worm infection. In 1992, the United Nations Conference on Environment

and Development (UNCED) estimated that ‘.80 per cent of all diseases, and over one-third of deaths in developing countries are water-associated, and on average as much as one-tenth of each person's productive time is sacrificed to water-related diseases’ (Agenda 21, UNCED, Chapt. 18, p175). Diseases associated with water are heavily concentrated in the developing world, and within the developing world, among the poorer urban and rural households of the poorer countries.

Diseases arising from the ingestion of pathogens in contaminated water have the greatest impact worldwide. Table 1 shows the morbidity and mortality rates of the major water-related diseases. These figures provided to WHO by Member States are in many cases underestimated. For instance, no figures are available for certain diseases such as hepatitis which are often waterborne, some countries with numerous cases of typhoid do not report any to WHO, whilst others do not have the infrastructure to conduct the necessary surveys. There can be little doubt that true annual morbidity and mortality rates are well over these figures. It would be erroneous to ascribe these diseases exclusively to unsafe drinking-water. With the exception of dracunculiasis which is transmitted solely by drinking-water, a variety of non-water sources are also important.

Table 1. Morbidity and mortality rates of some important water-related diseases (after WHO, 1995)

Disease	Cases per year (thousands)	Deaths per year (thousands)
Cholera	384	11
Typhoid	500	25
Giardiasis	500	low
Amoebiasis	48,000	110
Diarrhoeal disease	1,500,000	4,000
Ascariasis	1,000	20
Trichuriasis	100	low
Ancylostoma	1,500	60
Dracunculiasis (Guinea worm)	> 5,000	-
Schistosomiasis	200,000	800
Trachoma	360,000 (active)	9,000 (blind)

The toll of human suffering from the microbial contamination of drinking-water is indeed heavy. As with the 1984 *Guidelines*, the 1993 *Guidelines*, justifiably, stress protection of water supplies from microbial contamination and call for uncompromised disinfection of drinking-water despite the potential formation during this process of compounds with potentially harmful long-term health effects.

Selection Criteria

Thousands of organisms and substances have been identified in drinking-water supplies around the world. It is neither necessary nor feasible to develop recommendations for all these.

Microorganisms selected for evaluation were selected through an international consultation process, on the basis of the presence in water and likely risk to human health. Particular emphasis was given to developing guidance on selection of indicator organisms that can give early warning of faecal contamination and likely potential risks of disease. The *Guidelines* adopted a clear policy from the outset that microbiological quality must be the key water quality priority.

Chemicals for evaluation were selected through an international consultative process, guided by three main criteria:

- The substance presents a potential hazard for human health;
- The substance was detected relatively frequently and at relatively high concentrations in drinking-water indicating that there may be significant exposure to humans;
- The substance was of major international concern (i.e. of interest to several countries).

On this basis, some 128 priority chemicals were selected for evaluation in the *Guidelines* and health-based acceptable levels of exposure from drinking-water (Guideline Values) recommended for 95 of these, taking into account all sources of exposure. *Guideline* values were not recommended for certain substances because they were found to be not hazardous to health, because of inadequate health effects information, or because the concentration of the chemical normally found in drinking-water does not represent a hazard to human health. Contaminants evaluated included chlorinated alkanes, ethylenes and benzenes, aromatic hydrocarbons, pesticides, inorganic chemicals, disinfectants and disinfectant by-products.

The Guideline Value

The recommendations made concerning water quality are expressed as Guideline values (GVs). Guideline values are not formal standards or regulatory limits and are not to be taken as strict limits such as "maximum permissible concentrations". They are intended to provide quantitative risk assessment information for regulatory authorities, risk managers, and others to make decisions concerning human health protection and to be adapted to national requirements and situations in prescribing limits and standards.

Guideline Values require adaptation because they relate to a "reference" human in a specified exposure environment. National populations and exposure situations will be different.

What is a guideline value?

- *Guidelines* are set for indicator bacteria - *E.coli* or thermotolerant (faecal) coliforms and total coliforms. These have been selected as they give a good indication of the likelihood of faecal contamination and the integrity of a water supply.
- Unlike chemical guideline values, the presence of indicator bacteria will always represent a health risk. However, when faecal contamination is indicated, water supplies should **not** be closed off unless a better source of water is available for use. The microbiological *Guidelines* should be used as a desirable end-point and improvement in microbiological water quality should be the priority for water supply.
- A guideline value represents the concentration of a chemical constituent that does not result in any significant risk to the health of the consumer over a lifetime of consumption.
- Short-term deviations above the guideline values do not necessarily mean that the water is unsuitable for consumption. The amount by which, and the period for which, any guideline value can be exceeded without affecting public health depends upon the specific substance involved.
- Although the guideline values describe a quality of water that is acceptable for life-long consumption, the establishment of these GVs should not be regarded as implying the quality of drinking water may be degraded to the recommended level. Indeed, a continuous effort should be made to maintain drinking-water quality at the highest possible level.
- When a guideline value is exceeded, the authority responsible for public health should be consulted for advice on suitable action, taking into account the intake of the substance from sources other than drinking-water (for chemical constituents), and the practicability of remedial measures.
- When developing national drinking-water standards based on these guideline values, it will be necessary to take account of a variety of geographical, socioeconomic, dietary and other conditions affecting potential exposure. This may lead to national standards that differ appreciably from the guideline values.

The recommended GVs must be both practical and feasible to implement as well as protective of public health. Guideline values are therefore not set at concentrations lower than the detection limits achievable under routine laboratory operating conditions. Moreover, guideline values are recommended only when control techniques are available to remove or reduce the concentration of the contaminant to the desired level.

Contrary to the 1984 *Guidelines*, the 1993 *Guidelines* do not propose guideline values for substances and parameters that affect the acceptability of drinking-water to consumers. The Review Groups were of the opinion that guideline values should be recommended only for those substances that are directly relevant to health.

Many of the inorganic and aesthetic constituents evaluated in the *Guidelines* are known to be essential for life. No attempt was made in the *Guidelines* to define minimum desirable concentrations of essential elements in drinking-water.

Contaminants derived from water treatment chemicals, construction materials, paints or coatings were not specifically addressed. The control of such contaminants is best accomplished by appropriate specifications for and control of the quality of the products themselves rather than the quality of the water.

The recommended guideline values are set at a level to protect human health; they may not be suitable for the protection of aquatic life.

The *Guidelines* apply to bottled water and ice intended for human consumption but do not apply to natural mineral waters, which should be regarded as beverages rather than drinking-water in the usual sense of the word. The Codex Alimentarius Commission has developed Codex standards for such mineral waters.

Future Revision

Understanding of water quality and the health risk from microbes and chemicals is constantly increasing and the knowledge base expanding. As a result, it has been agreed that there will be a continuing process of updating of the *Guidelines* with a number of substances or agents subject for evaluation each year. New editions of the *Guidelines* will be published at about ten-year intervals. For the 3rd edition of the *Guidelines*, the protection and control of water quality will be prioritised and issues such as development of monitoring and assessment methodologies in urban areas, resource and source protection and control of chemicals and materials used in water treatment fully addressed. This will lead to the preparation of a volume 4 of the *Guidelines*, either as a single volume or in the form of a series of documents in the *Guidelines* series.

Biennial addenda to the *Guidelines* are to be issued, beginning in 1997 containing evaluations of new substances or substances already evaluated for which new scientific information has become available. Substances for which provisional guideline values have been established will receive high priority for re-evaluation. Table 2 overleaf summarises the priorities for the first addendum in 1997.

Table 2: Priorities for the first addendum, 1997

MICROBES	CHEMICALS			
	Inorganics	Organics	Pesticides	Disinfectants & DBPs
Hepatitis A & E	aluminium	cyanobacterial toxins	1,2-dichloropropane diquat	chloroform
<i>Aeromonas spp.</i>	boron	EDTA	ethylene dibromide	sodium dichloroiso-cyanurate
Cyanobacteria <i>Legionella spp.</i> <i>Vibrio cholerae</i>	copper nickel nitrate & nitrite	PAHs	pentachlorophenol carbofuran 2,4-D	
<i>Cryptosporidium parvum</i>	uranium		glyphosphate cyanazine terbuthylazine	
<i>Giardia lamblia</i>				

Conclusions

The *Guidelines* are based on international consensus assessment of the risks to human health from the presence of microbial and chemical contaminants in drinking-water and provide a sound scientific basis for establishing standards with respect to health protection.

It is the hope of the Organization that the *Guidelines* will be utilized by governments at all levels to set new drinking-water quality standards where they do not yet exist, or to update and expand existing ones. Thus, legislators and policy makers now have access to more comprehensive and detailed information to match health criteria with economic and technological when establishing drinking-water quality standards.

The WHO guidelines for Drinking-Water Quality

Table 1: Priorities for the first addendum, 1997

MICROBES	CHEMICALS			
	Inorganics	Organics	Pesticides	Disinfectants & DBPs
Hepatitis A & E <i>Aeromonas</i> spp. Cyanobacteria <i>Legionella</i> spp. <i>Vibrio cholerae</i> <i>Cryptosporidium parvum</i> <i>Giardia lamblia</i>	aluminium boron copper nickel nitrate & nitrite uranium	cyanobacterial- toxins EDTA PAHs	1,2- dichloropropane- diquat ethylene dibromide pentachlorophenol carbofuran 2,4-D glyphosphate cyanazine terbuthylazine	chloroform sodium dichloroiso- cyanurate

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Presentation Plan

Section	Key points	OHP
Introduction	<ul style="list-style-type: none"> • an established goal of WHO is to ensure all population have access to an adequate water supply • WHO provides advice on health-related aspects of drinking-water 	
Guidelines presentation	<ul style="list-style-type: none"> • <i>Guidelines</i> published in 3 volumes: Volume 1 - recommendations Volume II - health criteria and other supporting information Volume III - small community water supplies 	1
Guidelines presentation	<ul style="list-style-type: none"> • when 1st edition of the <i>Guidelines</i> published in 1984, it was recognised that they would need updating • 2nd edition published in 1993-97 • preparation went through a series of planning and co-ordination meetings to establish the scientific approach & mechanism; by review meetings • microbial contaminants and 128 chemicals selected for evaluation • for each microbe and chemical a lead country prepared draft document and, where appropriate, suggesting a preliminary guideline value (GV) • documents circulated to review group (over 200 scientists from 40 countries) and GVs revised and approved 	2,3
Basic concept	<ul style="list-style-type: none"> • <i>Guidelines</i> are advisory In nature • intended that GVs are used as a basis for establishing national and regional standards based on risk assessment and prevailing socio-economic conditions • the <i>Guidelines</i> stress the use of risk-benefit approaches to standard setting • standards must be developed which are achievable and enforceable; this may mean setting interim standards 	4
Priorities for standards	<ul style="list-style-type: none"> • access is key priority even where quality is inadequate • the priority water quality concern is microbiological quality because of the link to health and acute disease • 1992 , UNCED estimated >80% of all disease and >1/3 deaths in developing countries are caused by the consumption of contaminated water • disease associated with water heavily concentrated in less-industrialised countries in the poorer households in these countries 	5

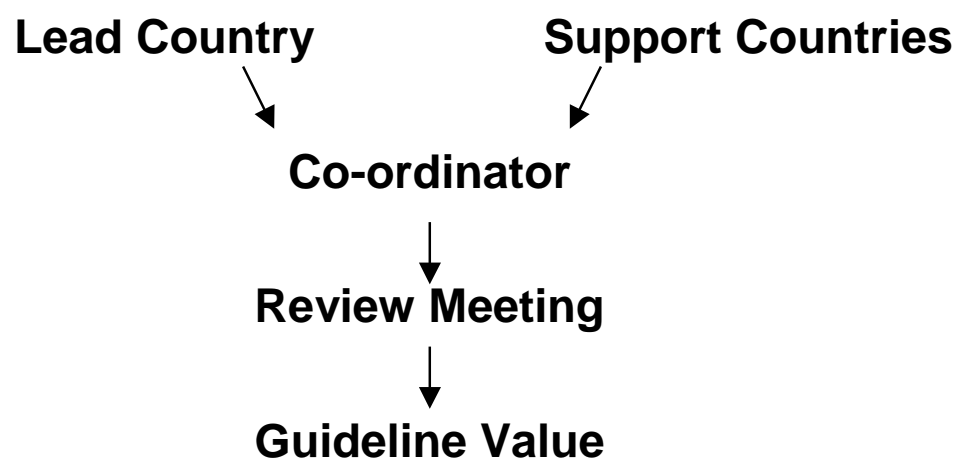
Section	Key points	OHP
Priorities for standards <i>(continued)</i>	<ul style="list-style-type: none"> • greatest impact on health is from ingestion of pathogens • available global figures on disease are likely to be underestimated • improvement in microbiological quality of water should lead to a reduction in disease incidence and severity 	
Selection criteria	<ul style="list-style-type: none"> • major pathogens reviewed but no GVs set as routine surveillance of pathogens is not practical • GVs set for indicator bacteria and operational parameters such as turbidity and chlorine residual • of 128 substances reviewed, GVs set for 95 	6,7
Guideline Values	<ul style="list-style-type: none"> • are not strict standards, but advisory guidelines • provide quantitative risk assessment for authorities, but require adaptation as refer to reference human in specified exposure environment • exceeding microbial GV indicates faecal contamination and therefore health risk • most chemical GV set for health risk from lifetime consumption • exceedance of chemical GV for short periods does not necessarily mean water unfit for consumption • no GV for aesthetic parameters • no minimum concentrations specified • do not address environmental/ecological concerns • do not specifically address treatment chemicals, construction materials etc. • do not apply to natural mineral waters 	8,9
Future developments	<ul style="list-style-type: none"> • rolling revision started, with addenda published every 2 years starting 1997 • 3rd edition will see greater emphasis on risk management • new Volume IV to be prepared on protection and control of water quality 	10,11, Tab 1
Conclusions	<ul style="list-style-type: none"> • GV based on international consensus of health risk • GV should be used to set or revise national/regional standards using a risk-benefit approach • Guidelines require continuous updating as knowledge increases 	

WHO Guidelines for Drinking-water Quality

- Volume 1 - Recommendations
- Volume 2 - Health Criteria and other supporting information
- Volume 3 - Surveillance and control of community supplies



Consultation Process for Setting Guideline Values (Part 1)



Consultation Process for Setting Guideline Values (Part 2)

<u>Co-ordinators</u>	<u>Review Meetings</u>
Microbiology	2
Inorganics	2
Organics and pesticides	4
Disinfectants and by-products	1
Radionuclides	1
Volume 3	2
Planning consultations	4
Other consultations	3
TOTAL	19



What is a Guideline Value?

- For microbes: no significant risk of pathogen presence at infectious dose.
- For most chemicals: no significant risk to health over a lifetime of consumption.
- Some chemicals (e.g. nitrate): no significant risk of acute intoxication of vulnerable group.
- National standards may be appreciably different from guideline values.



Priority Microbes considered in the GDWQ

- Orally transmitted pathogens of high priority (microbes associated with human faeces)
- Opportunistic and other water associated pathogens (moderate priority)
- Toxins from cyanobacteria
- Nuisance organisms causing rejection
- Guideline values for indicator bacteria and operational parameters



Selection Criteria

- 1 Adverse effects
- 2 Magnitude, frequency and duration of exposure
- 3 Population exposed
- 4 International concern



IARC Groups

Group 1: The agent is carcinogenic to humans

Group 2A: The agent is probably carcinogenic to humans

Group 2B: The agent is possibly carcinogenic to humans

Group 3: The agent is not classifiable as to its carcinogenicity to humans

Group 4: The agent is probably not carcinogenic to humans

IARC overall evaluation of chlorinated drinking-water:

Group 3



Guideline Values

- No GV for individual pathogens: use indicator bacteria, turbidity and chlorine residual
- No GV for aesthetic parameters
- Treatment chemicals and construction materials not addressed
- No environmental effects
- Not for mineral water
- No minimum desirable level



Provisional Guideline Values

- Limited health effects information and/or UF>1000
- Health-based GV below quantitation level
- Health-based GV cannot be achieved through practical treatment methods
- Disinfection likely to result in health-based GV being exceeded
- GV at 10^{-5} lifetime excess cancer risk not feasible



WHO *Guidelines for Drinking-Water Quality*

- 1983-4 Publication of first edition
- 1993-6 Publication of second edition
- 1997 First addendum to second edition
- 1999 Second addendum to second edition
- 2001 Third addendum to second edition
- 2004 Third edition



Protection and Control of Water Quality

Aim to include balanced, integrated guidance on monitoring and assessment of drinking-water supply and quality and on the elements of risk management in the Guidelines in 2003.

Monitoring and assessment of water supply and quality:

- » Volume 3 coverage good for rural areas
- » Guidance for urban settings will be developed, field tested and revised

Risk management:

- » resource and source protection
- » water treatment
- » chemicals and materials
- » significant expansion

