Water Quality and Human Health

The quality of drinking-water is a universal health concern. Water is essential for life, but it can and does transmit disease in countries in all continents – from the poorest to the wealthiest.

Ensuring good quality water for the poor is an effective, health protective measure. Reductions of around a third of cases of diarrheal disease in children have been reported by projects that assisted poor households in treating water in the home and protecting against recontamination.

Although safe drinking-water is available daily to millions, especially in the industrialized countries, improvements are needed to prevent incidents such as the outbreak of cryptosporidiosis in Milwaukee (USA) which affected 400,000 people, and an E. coli O157 and Campylobacter outbreak in Walkerton (Canada) which infected more than 2,000 people and killed seven.

Chemicals in drinking-water also continue to feature in the headlines:
- Arsenic continues to be a major public health issue in Bangladesh and has become increasingly recognized in countries as diverse as the USA and Viet Nam.
- The presence of naturally-occurring fluoride in the groundwater in some of the least developed countries, which has largely been ignored, severely affects tens of millions of people with crippling effects.
- Toxic cyanobacteria in water have been headline news in California, USA, and are of increasing concern elsewhere.
- Disaster relief workers, while trying to restore supplies of safe drinking-water, sometimes struggle with unclear guidance on the safety of emergency disinfectants.

Guidelines, not Standards?

In 1982, WHO shifted its focus from ‘International Standards’ to ‘Guidelines’. The main reason for not promoting international standards for drinking-water quality is the advantage provided by the use of a risk-benefit approach (quantitative or qualitative) to the establishment of national standards and regulations. The idea is that application of the Guidelines to different countries should take account of the sociocultural, environmental and economic circumstances particular to those countries.

When WHO changed its terminology from ‘International Standards’ to ‘Guidelines’, it did so in order to recognize the different roles of risk assessment and risk management. ‘Risk assessment’ reports on what is known about specific health risks, while ‘risk management’ describes the actions to control the risks.

Work on risk assessment is best informed by pooling information, for instance from many countries. In contrast, risk management involves applying this information to control local risks under local circumstances, although it may benefit from sharing experience in effective approaches.

The water quality priorities that promise most benefit to health vary from place to place. For instance, arsenic and fluoride are not a problem everywhere, but can be a major health issue where they occur.

Who uses the Guidelines?

The Guidelines are addressed to water and health regulators, policy-makers, and their advisors, mainly to assist them in the development of national standards. The Guidelines are also used by many others as a source of information on water quality and health and on effective management approaches.

The Guidelines for Drinking-Water Quality are recognized as the UN system’s position on drinking-water quality. The European Commission and Japan use the Guidelines as the ‘scientific point of departure’ for their drinking-water directive and drinking-water quality standards, respectively; the Australian Drinking Water Guidelines are based on the WHO Guidelines, while the United States Environmental Protection Agency (USEPA) and Canada actively observe and participate in the process of development of the WHO Guidelines.

Many developing countries use the Guidelines directly or indirectly in setting national standards.

The Guidelines are often used where guidelines or standards are unavailable and are also referred to in the food standards
The Guidelines today

The third edition of the Guidelines deals with infectious diseases (microbes), hazardous chemicals, radiological hazards, and acceptability aspects.

The approach to microbial hazards advocates protection of water sources and treatment according to source quality and disinfection, with monitoring, of control measures plus verification testing for faecal indicators to ensure that targets are met.

For hazardous chemicals, exhaustive chemical-by-chemical reviews are prepared and lead to ‘Guideline Values’ representing concentrations that should be safe even with lifelong consumption.

Significant improvements are included in the third edition in response to new information and developments in risk assessment and management for chemicals and microbes.

Managing water-borne disease properly — How can water safety be ensured?

Analytical monitoring has increasingly become the focus of assuring water quality. However, by the time results are available the water has generally been supplied and may have been consumed. For microbial hazards in particular, adverse health effects may be unavoidable by the time a problem has been detected. The cost of analyses and, in some circumstances, lack of laboratory facilities may be additional constraints.

The third edition of the Guidelines is placing more emphasis on preventive management of water safety.

Comprehensive management of water quality, from catchment to consumer, is the most valuable preventive approach in the provision of safe drinking water. This approach can be applied to any type of water supply — from a complex piped supply in a major city through to a village well. The guidelines recommend that this is through application of ‘water safety plans’.

Updating the Guidelines

The pace of development — in water management and the sharing of water and health — has accelerated in the past 30 years, and so has the need to keep the Guidelines up to date when information and knowledge are moving so quickly is a major challenge.

As a result, since 1994 WHO has been carrying out a process of ongoing ‘rolling revision’ to update the Guidelines.

Most of the work concerns either developing and substantiating the recommendations in the Guidelines, or of supporting ‘guidance’ on good practice to assist in implementing programmes and projects on drinking-water quality.

Since 2001, information on the process and on individual areas of work and their progress has been put on the Internet.

There are around 100 lines of work in the rolling revision. For further information, see http://www.who.int/water_sanitation_health/GMU/index.html for the workplan and documents available for review. Some of the lines of work are close to completion and others have a development programme that will extend over several years.

Making sure that the Guidelines are of the highest quality is a priority. Phases of peer review and public domain review have been built into the rolling revision process as key elements of the approach to ensure quality and relevance.

Ensuring that the right subjects are included in the rolling revision is also an important part of the future strategy. New proposals are considered at intervals and access to the process is promoted through the Internet.

Dates of publication of the Guidelines for Drinking-Water Quality

- 1984: Volume 1 (Summary: first edition)
- 1985: Volume 2 (Supporting information, first edition)
- 1987: Volume 3 (Community supplies, first edition)
- 1993: Volume 1 (Summary: second edition)
- 1996: Volume 2 (Supporting information, second edition)
- 1997: Volume 3 (Community supplies, second edition)
- 1998: Addendum to Vol. 1 (Selected chemicals)
- 1999: Addendum to Vol. 2 (Selected chemicals)
- 2000: Toxic Cyanobacteria in Water (Supporting document)
- 2002: Addendum on microbial aspects
- 2004: Third edition
- Thereafter: Continuous ‘rolling revision', with expanded use of electronic publication

The developed by the Codex Alimentarius Commission (for instance, for mineral water and bottled water).
What about those who don’t have piped drinking-water?

Most of the world’s population does not have access to piped water (see Table).

<table>
<thead>
<tr>
<th>Year</th>
<th>Number with no access (millions)</th>
<th>Access to improved sources (millions)</th>
<th>Access through household connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1126 (21%)</td>
<td>1981 (38%)</td>
<td>2159 (41%)</td>
</tr>
<tr>
<td>2000</td>
<td>1099 (18%)</td>
<td>2110 (35%)</td>
<td>2846 (47%)</td>
</tr>
</tbody>
</table>


To contribute effectively to health protection the Guidelines have to be relevant to the way people get their water, including:

- vendor-provided water, protected wells and springs, rainwater catchment, tubewells fitted with hand pumps;
- complex piped supplies, small community piped supplies;
- emerging types of supply such as desalinated water and bottled/packaged water, as well as
- special situations such as water supply in emergencies and in health care facilities.

From the first edition, the Guidelines have given special consideration to small community supplies through Volume 3. In the third edition, the Guidelines contain guidance on their application to a wider range of different circumstances (see box overleaf).

A framework for safe drinking-water

The key activities required in actively controlling water safety:

- Health-based targets, set by national authorities.
- Checking whether systems are capable of delivering safe drinking-water through a ‘system assessment’ from catchment to consumer. This requires developing an understanding of occurrence, control and treatment of the different microbes (and other contaminants) in a particular water supply. To support these assessments, detailed characterization of microbial hazards and critical reviews of control measures are prepared.
- Systematic monitoring for safe management achieved through monitoring of control measures by simple, frequently applied methods, building on ‘sanitary inspection’ and the multiple barrier principle in water supply practice.
- Ensuring water safety plans are in place documenting the assessment and monitoring plans, management and communication procedures for both ‘normal’ and ‘incident’ circumstances.
- Ensuring independent oversight ‘surveillance’, often through auditing-type approaches.

Managing chemical quality better: learning from mistakes

As for microbial quality, emphasis on preventative approaches has been proposed for the third edition of the Guidelines. Again, system-based risk assessments will be required. In the past this has not been done effectively, as demonstrated by the disastrous series of events in Bangladesh.

In trying to tackle infectious disease transmission through changing drinking-water sources from surface water to ground-water, millions ended up drinking water that contained high levels of arsenic — with severe health effects of a magnitude that is still not fully understood.

Many lessons are still being learned about arsenic — which occurs in drinking-water in countries worldwide — and hopefully the same mistake will not be repeated elsewhere.

But looking towards the future, we have to ask what will be ‘tomorrow’s arsenic’? Monitoring for all of the chemicals that might be a health risk is simply not possible in many countries, but there are some fairly simple ways to ‘rule out’ some chemicals and to prioritize others using readily available information. Guidance on identifying chemicals that should be included in making assessments and in monitoring is being developed to accompany the Guidelines.

More guidance on managing the biggest chemical problems

There are a limited number of chemical hazards in drinking-water that cause widespread health effects. The ‘big issues’ are probably arsenic and fluoride. But guidance on managing them is not readily available in the countries and regions where the problems are greatest.

Work is progressing towards publication of guidance on arsenic and fluoride. Some chemicals such as lead, are of concern because of multiple routes of exposure and guidance is also in preparation.

Drinking-water safety in emergencies

Emergencies — accidental and deliberately induced — may lead to contamination of drinking-water supplies. Public concern about drinking-water safety may be a major issue even where the actual risk is low. If a sufficient quantity of toxic or infectious material contaminates a drinking-water supply, it may lead to actual health effects.

The preventive management approach of the third edition of the Guidelines can support planning for prevention and early detection of, and response to contamination events. Work is in hand to provide more guidance on drinking-water quality in emergencies and to include this in the Guidelines.
Guidelines for Drinking-Water Quality

The Guidelines: contents
(Third edition)

Microbial Aspects
Pathogens of concern; system risk assessment; safe management practices; safety management plans; surveillance; and guideline requirements.

Application of the Guidelines to:
- Emergencies
- Bottled water
- Desalinated water
- Travellers
- Health care facilities, schools
- Food production and processing

Chemical Safety
More than 100 chemical-by-chemical reviews covering health effects, occurrence, technical and analytical achievability and derived Guideline Values; where appropriate. Overall management approach for chemicals, by source type.

Acceptability Aspects

Radiological Aspects

Key chemicals
- Arsenic
- Fluoride
- Nitrate/nitrite

Monitoring
- Identifying priority chemicals
- Community supplies
- Monitoring in urban areas

Management
- Materials and chemicals (‘additives’)
- Groundwater
- Spills and exceedences
- Managing surface water quality
- Managing groundwater quality

Managing microbial safely
- Treatment efficiency
- Water quality in piped distribution systems
- Household treatment and management
- Role of H₂S, HPC testing
- Water Safety Plans
- Hazard characterization in food and water

Others
- Toxic cyanobacteria in water
- Desalination
- Legionella management