The new WHO *Guidelines*: establishing comprehensive water-safety frameworks

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The third edition of the WHO's *Guidelines for Drinking-Water Quality* has just been launched. It emphasizes monitoring water supply systems from catchment to consumer to ensure that at critical points water safety is maintained, in order to meet health-based targets.

The World Health Organization (WHO) has recently launched the third edition of its *Guidelines for Drinking-Water Quality* (*GDWQ*). The *GDWQ* provides a common point of reference for all countries in terms of what can be considered 'safe' and provides the basis for most national, regional and agency-level water-quality requirements worldwide. They also fulfil an important role in relation to Target 10 of the Millennium Development Goals (MDGs) 'to halve the number of people without access to safe drinking water'.

The third edition of the *GDWQ*

The new *GDWQ* shows a significant development in how water safety is assured, particularly important in relation to microbial quality of water, which remains the most important aspect of water safety globally. This development has refocused attention on monitoring and managing processes and practices to ensure water is continuously safe, complemented by testing water to ensure it meets defined requirements and targets.

The new *GDWQ* sets out a water-safety framework that entails three key components:[1]

1. *Health-based targets*, taking into account public health burdens and priorities and normally set by health authorities.
2. *System- or technology-specific water-safety plans* normally comprising: (a) system assessment to determine whether the drinking-water supply (from source through treatment to the point of consumption) as a whole can deliver water of a quality that meets the health-based targets; (b) operational monitoring of the control measures in the drinking-water supply that are of particular importance in securing drinking-water safety; (c) management plans documenting the system assessment and monitoring plans and describing actions to be taken in normal operation and incident conditions, including upgrade and improvement, documentation and communication.
3. *Independent surveillance*: a system that verifies that the above are operating properly.

Health-based targets

The water-safety framework puts public health centre stage through the establishment of health-based targets. These provide the overarching objective by defining the level of public health protection required. These targets are a significant innovation, particularly for microbial quality. Previous approaches tended to equate a numeric value for *E.coli* in a 100ml sample as a health-based target. However, the absence of *E. coli* provides limited assurance that there is an absence of pathogens (particularly viruses or protozoa). The importance of these other pathogens in developing countries is becoming more apparent, for instance: pathogens such as Hepatitis E virus (the most recent outbreak of which was in Dafur, Sudan) and *Cryptosporidium parvum,* which is associated with persistent diarrhoea in young children with HIV/AIDS and for which the connection with contaminated drinking water has now been established in developing countries.[2] Our growing understanding of 'emerging pathogens' in developing and developed countries makes establishing targets for water safety all the more important.

The *GDWQ* advocates that a risk-benefit approach be adopted, thus approaches to setting targets should take into account other potential routes of exposure and overall investment needs. Using a more flexible approach allows a country or agency to define a water-

Box 1. Examples of approaches for health-based targets

- Epidemiological: for instance, measured disease reductions of diarrhoea or arsenicosis.
- Risk assessment: expected reductions in disease burdens from intervening against a suite of disease-causing agents singly or together.
- Disease burden: overall estimates of disease level in a population and proportion ascribed to water and sanitation and measured reductions.
- Water quality: reductions in contaminant level in relation to health-based Guideline Values (e.g. fluoride or arsenic concentrations).
- Performance targets: validated reductions in exposure from applied processes to reduce contaminants (e.g. for treatment processes).
- Specific technologies: set technologies and standard designs that have been calibrated with respect to removal of contaminants in drinking water.

quality target, taking into account the relative benefit compared to improvements in sanitation or hygiene and balancing investments in different interventions. For instance, it might be more effective to establish less strict water-quality requirements in order to be able to fund improvements in hygiene via a hygiene-education programme. At a simplistic level, such allocations can be achieved through relatively simple health-risk modelling and at a more complex level would require detailed burden of disease studies (see Box 1).

Targets can be set in terms of risk reductions or maximum levels of risk, expressed in terms of disability-adjusted life years (DALYs, see Box 2). Quantifiable estimates allow comparisons between different technologies and between different parameters. This helps decision makers choose the investments that are most effective at improving health.

The article by Shamsuddin et al. in this edition of *Waterlines* shows the value of such approaches when selecting technologies and establishing requirements for arsenic mitigation. A similar exercise has been undertaken for water supplies in Kampala, Uganda,[3] which provided quantified risk estimates and indicated that, for example, improvements in distribution management would deliver greater risk reduction than improvements in water treatment.

Water-safety plans

Water-safety plans (WSPs) are similar in philosophy and approach to the Hazard Analysis and Critical Control Point (HACCP) approach used in the food industry to secure food safety. They also draw on other risk-management approaches, notably the multiple-barrier principle of water treatment. A key aspect of the development of the WSP approach has been to organize in a systematic manner management practices used in the supply of drinking water and to ensure these are relevant to the management of drinking-water safety. For a detailed description of the development of WSPs, see the *GDWQ* or the paper by Davison.[4]

WSPs place an emphasis on ensuring that processes used to produce safe water are controlled and function in such a way that hazards are excluded or removed from water before it is delivered to the consumer. They are a catchment-to-consumer approach, with actions taken from source protection through treatment (where applied), distribution (whether piped or manual) and storage and use within the home. WSPs therefore tie in activities such as hygiene education. Understanding how hazardous events occur places an imperative on environmental protection and therefore issues such as improvements in sanitation are acknowledged as having important benefits for protecting water safety, as well as providing health benefits in their own right.

WSPs include a systematic review of whether a water supply – however small or complex – can meet health-based targets. System assessment asks 'can this water supply provide safe water?' The outcomes may include decisions on upgrading and improvement if these are needed. System assessment will always include identification of 'control measures', the principal processes or barriers that ensure water safety. For a protected dug well there may be a few control measures, for example providing a cover and ensuring the apron is in good condition; for a large piped supply there may be very many control measures, for instance the filtration rate, the dosing rate of coagulant or chlorine, or specific measures to prevent ingress of water at valve boxes in distribution systems. In both small- and large-scale systems, the control measures should be the focus of monitoring and management.

Monitoring of control measures is the second principal component of WSPs. Monitoring will normally involve periodic sanitation inspections. For analytical tests, more emphasis is placed on simple low-cost tests that can be applied frequently or online to ensure that control measures are operated properly, a good example being chlorine residual testing. Water safety should be periodically verified through a separate exercise to monitoring, as a final check on whether water safety is assured, and this may include testing of microbial indicators such as *E.coli*.

The final component of the WSP is to ensure that control measures, results from monitoring and verification, and actions taken are documented. This demonstrates that the plan is functioning properly and is providing evidence that control measures are able to deliver safe drinking water.

Developing a WSP demands a detailed knowledge of the water supply. It requires a multi-disciplinary team that can bring together different skills, including engineering, water quality and social development skills. For utility supplies, it would generally be expected that a system-specific WSP would be developed for each supply. However, experience in Uganda shows that the WSP developed for Kampala actually acted as a 'model' from which to base further WSP development for Jinja. In small systems, developing system-specific WSPs for each individual source may not be realistic; the water sources may be very large in number (for instance the 10 million shallow tubewells in Bangladesh) or remote from each other and from centres of technical expertise (commonly found in mountain areas and large parts of Africa). In these cases, a technology WSP may be defined with subsequent emphasis placed on the development of community monitoring and management tools. The article by Shamsuddin et al. in this edition of *Waterlines* provides an example of how this is being developed.

Surveillance

Surveillance of water quality has been a consistent theme in WHO guidelines. Surveillance involves independent oversight of water safety from a public health perspective (see Box 3), although implementation may be by

Box 2. Disability-adjusted life years (DALYs)

DALYs are a means of comparing the different health outcomes for a range of diseases and injuries and allow different hazards to be compared when assessing the importance of their impact on health. DALYs incorporate measures of morbidity (disease) and mortality (death) and can differentiate the impacts between vulnerable groups and the general population. They are a population measure, providing estimates across a specified population rather than the impact likely upon an individual.

Box 3. What is surveillance?

Surveillance is the continual and vigilant public health assessment and review of the safety and acceptability of drinking-water supplies.

'A set programme of investigation to assess water supply and to identify the potential risks to health derived from poor water supply(s) or water handling; whether certain groups are particularly disadvantaged from inadequacy of water supply; and to identify what actions would lead to improvement in the water supply and the likely health gain or reduction in social disadvantage.'[5]

the health, environment or local government sectors. Surveillance is crucial in ensuring water safety and for reassuring consumers. Guidance is available in Volume 3 of the *GDWQ* for small community-managed supplies[5] and in a range of documents for urban areas that are now being consolidated into a new Volume 4.[6]

Where water supplies are delivered by a utility, experience has shown that surveillance can be undertaken through either audit or through direct assessment. Audit approaches are attractive because they place an emphasis on the water supplier to demonstrate due diligence and compliance with regulations and have been used, for instance, in Ghana.[4] Direct assessment approaches rely on the surveillance agency undertaking water-quality monitoring in parallel to the supplier. Such monitoring requires sufficient resources to be available for the surveillance agency and normally represents a duplication of effort.

However, towns and cities in developing countries have complex water-supply arrangements as well as extremes in socio-economic status. Experience in several countries has shown that, for surveillance to be effective, all water supplies and water hygiene must be taken into account. Zoning an urban area, taking into account both water-supply arrangements and poverty indices, can enhance the effectiveness of surveillance.[7]

When compared to urban areas, surveillance of small community-managed water supplies is often difficult and expensive to implement. Problems may be related to relative remoteness of communities or sheer numbers of supplies. For instance, in the Andean regions of Peru and mountain areas of Nepal, communities are scattered and often inaccessible by vehicle. Likewise in many African countries, rural communities are often highly dispersed and, even if accessible by vehicle, the distances between communities limit the number that may be visited in one day. In countries like Bangladesh, in addition to access problems, the number of individual supplies is staggering.

Despite such problems, experience shows that surveillance of rural water supplies is possible in a cost-effective way provided clear objectives are set. Using programme designs that allow a sample of water supplies to be visited each year, either through a rolling programme or in clusters, lessons can be learned about performance of the water supply and what policy changes may be needed. For such approaches to be effective, community monitoring for routine management within a WSP must be emphasized.

Guidance on chemicals

One of the long-term features of the *GDWQ* has been the guidance on concentrations that are toxic to human health for individual chemicals that may be found in water to support decision-makers confronted with their occurrence or regulation. These have been updated to easily accessible fact sheets on each chemical, with more detailed text available via the WHO website. Management-oriented texts are also available via the WHO website to help regulators and water suppliers in dealing with those chemicals that occur in water. The new *GDWQ* is accompanied by guidance in the light of local or national conditions on the identification of priority chemicals that do not require extensive chemical testing.

Future directions and challenges

Work contributing to the rolling revision of the *GDWQ* and the publication of the 4th edition in 2008 has already started (see Box 4).

An important area of work in the rolling revision is the development, collation and documentation of experience of applying the *GDWQ* framework and using the lessons learnt to improve and refine the *GDWQ*. This is already being actively pursued in a number of developed and developing countries. In addition, a new initiative for small systems is being developed by WHO, in collaboration with a number of countries.

Further important areas of work are improving the evidence base for health-based targets and development of simple risk-assessment methodologies. At present relatively few countries have applied these approaches, in part due to a lack of tested methodologies. These are becoming increasingly available and should provide the tools that will permit greater health assessment in water supply.

wBox 4. Supporting documents and work in hand in the rolling revision of the GDWQ

Supporting documents to WHO Guidelines for Drinking-Water Quality

- Water treatment and pathogen control
- Water quality in piped distribution systems
- Toxic cyanobacteria in water
- The HPC test and drinking-water safety

All available on www.who.int/water sanitation health/

Work in hand in the rolling revision of the WHO GDWQ

- assessing priority chemicals in drinking water
- monitoring drinking water supply in urban areas
- protecting groundwater sources of drinking water
- protecting surface water sources of drinking water
- preparation and updating of facts sheets on microbes that may cause water-borne disease
- reviewing chemical facts sheets and guideline values as new information becomes available
- desalination for safe drinking-water supply
- the H_2S test and drinking-water safety
- Legionella and the prevention of legionellosis
- water safety plans
- managing fluoride in drinking-water.

Many of these can be reviewed in draft form on www.who.int/water_sanitation_health/

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Water-safety plans

- **WHO Guidelines on Drinking Water Quality (2004)**
  This fully revised third edition discussed elsewhere in this issue is available at:
  http://whqlibdoc.who.int/publications/2004/9241546387.pdf

- **Safe piped water: Managing microbial water quality in piped distribution systems (2004)**
  The information and conclusions contained in *Safe Piped Water* are described as being intended for policy makers and those responsible for formulating 'Water Safety Plans' for the supply of drinking water. The book is also described as being highly relevant to engineers and scientists who are responsible for water-supply planning, operations and monitoring. Full text available for downloading.
  http://www.who.int/water_sanitation_health/dwq/en/safepipedwater.pdf

- **Watermark**
  This is a worldwide website for drinking-water supply surveillance and monitoring in developing and transitional countries. The site is structured around a reference manual providing detailed description of urban surveillance, guides for implementation based on Ugandan experience, surveillance tools and reports and case studies from programmes.
  http://www.lboro.ac.uk/wedc/watermark/index.htm

- **Bangladesh Arsenic Policy Support Unit (APSU)**
  This site provides information on the development of risk management plans for arsenic-affected waters. There are links to APSU studies and reports detailing experience of applying the WHO guidelines for drinking-water quality in Bangladesh.
  http://www.apsu-bd.org

- **Drinking water standards for New Zealand 2000**
  This lists the maximum concentrations of chemical, radiological and microbiological contaminants acceptable for public health in drinking water.
  http://www.moh.govt.nz/moh.nsf/wpg_index/Publications-Drinking-Water+Standards+for+New+Zealand+2000

- **How to prepare and develop public health risk-management plans for drinking-water supplies**
  These plans are an adaptation of Water Safety Plans based on the Hazard Analysis and Critical Control Points (HACCP) principles to help create and operate a public health risk-management plan for drinking-water supply.
  http://www.moh.govt.nz/moh.nsf/238fd5fb4fd051844c256669006aed57/cca65c18b2e29251cc256a7900082b9c?OpenDocument

- **UBA – German Environment Agency**
  An international conference in Berlin in 2003 to promote the understanding of currently available approaches to risk management, particularly of approaches using elements of HACCP. A further aim was the exchange of current experience with this approach in relation to other quality-management systems applied to secure drinking-water safety.
  http://www.polarpixel.de/archiv/uba/

- **The Sphere Project**
  The Sphere Humanitarian Charter and Minimum Standards in Disaster Response has a chapter on water, sanitation and hygiene promotion. It includes qualitative minimum standards, key indicators to measure and communicate results and guidance notes to consider when applying the standards and indicators in different situations.
  http://www.sphereproject.org/handbook/html/4_ch2.htm

- **Sanitation Connection**
  The Monitoring and Evaluation topic of Sanitation Connection provides an introduction to these issues, with links to online key references, publications and websites.
  http://www.sanicon.net/titles/topicintro.php3?topicId=41

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