WaMRi-Newsletter

Number 3 April 2003

WHO Collaborating Centre for Health Promoting Water Management and Risk Communication

Institute for Hygiene and Public Health
University of Bonn

Director:Prof. M. Exner

Topic: Review about the ”Occurrence of Pathogens in Surface Water”

Taking into account the reduction capacity of drinking water treatment plants, knowledge about the concentrations of pathogens in surface water resources which serve for drinking water supply constitute a basis to estimate the risk of infection according to the ”Microbial Risk Assessment” (MRA).

The WHO Collaborating Centre for Water Management and Risk Communication at the Institute for Hygiene and Public Health of the University of Bonn was approached by the WHO headquarters in Geneva against the background of the revision of the ”Drinking Water Guidelines” to compile a review on the occurrence of pathogens in surface waters.

The intention of this report was to identify and review research results an the analyses of available information about measured concentrations of pathogens in different types of surface water and the relationship to the concentration of indicator parameters. The chosen articles were discussed with respect to the investigated catchment areas and their role in microbial contamination of surface water.

Results in brief

To date we have reviewed approx. 230 studies out of which, however, only some have carried out correlation calculations between pathogens and indicators. The evaluation of the studies was hampered by the indication of different units of measurement. In some studies there was even missing the information on the source of contamination or the catchment area.

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Head of the WHO CC: PD Dr. med Th. Kistemann **Coordinator of the WHO CC**: Friederike Dangendorf

Additionally, the appraisal of a relationship between the occurrence of pathogens and of indicator parameters may depend on the statistical method used.

Most of the **bacteriological studies** as regards the review were found for *Aeromonas, Campylobacter* and *Salmonella*. The studies investigating the occurrence of *Aeromonas* spp. showed that there are good correlations with standard indicator bacteria and turbidity (Araujo et al., 1989, Araujo et al. 1991, Ashbolt et al., 1995, Ferguson et al., 1996). The results of the *Campylobacter* studies are not that clear. It could not be ascertained if the faecal indicators and turbidity supply useful indication for the occurrence of *Campylobacter*. However, the highest *Campylobacter* concentration was found in catchment areas with agricultural use (Ashbolt et al., 2002). The detection rate of *Yersinia* seems to be similar in all the chosen studies (Arvanitidou et al., 1995, Feuerpfeil et al., 1997, Lund, 1996). These three studies did not show a connection between the occurrence of *Yersinia* and the indicator parameters at all.

Some authors detected that the degree of pollution has an influence on the quality of the indicator bacteria (Alonso et al. 1991, Araujo et al., 1989, Araujo et al., 1991, Marino et al., 1995).

There were only two studies available on human pathogenic *E. coli* (EHEC) and *Pseudomonas*. From these no general conclusions can be drawn.

The majority of **studies dealing with parasites** investigated river water and dams which are influenced by the excrements of animals (cattle, pig, fish, beavers, etc.), human beings and agricultural activities. There was no concurrent opinion between the studies reviewed whether standard indicators correlate with the concentrations of parasites or not. Only moderate correlations between parasites and other parameters, such as faecal micro-organisms, *C. perfringens* and turbidity had been reported.

High concentrations of *Cryptosporidium* spp. occur in close connection to dairy farming and the density of fallow deer in the catchment area. *Giardia* cysts were mainly connected with the existence of sewage and beavers (Atherholt et al., 1998, Hansen & Ongerth, 1991, Hsu et al., 1999, Kistemann et al., 2002, Kistemann et al., 1998, LeChevallier et al., 1991, Ong et al., 1996, Payment et al., 2000, Robertson & Gjerde 2001).

Seasonal connections with *Cryptosporidium* and *Giardia* were ascertained in numerous studies (Atherholt et al., 1998, Robertson & Gjerde, 2001).

Resuspension of stream bottom sediment or suspensions of soil and aged faecal material was assumed to be the major contributor to rainfall-induced increases in parasite concentrations (Atherholt et al., 1998, Kistemann et al., 2002, Thurman et al., 1998).

Viruses can mainly be found in river or sea water which is polluted by the discharge of densely populated and industrial areas (Johl et al., 1991, Payment & Franco, 1993, Queiroz et al., 2001, Van Olphen et al., 1991). Several studies showed that an increased turbidity and low temperatures prolong the survival of viruses in surface waters (Dumke & Burger, 1995, Schernewski & Jülich, 2001).

A study by Havelaar (1993) indicated a general tendency of enterovirus and enteric virus concentration to correlate with concentrations of FRNA phages, in particular in river water samples. Also Pallin et al. (1997) found out that especially high concentrations of total coliforms and F-specific phages indicate the presence of enteroviruses. Payment & Franco (1993) revealed significant correlation coefficients between *C. perfringens* and enteric virus concentrations. In contrast, Queiroz et al. (unpublished paper) and Lodder et al. (1999) draw the conclusion that there is no relation between standard indicator bacteria and virus concentrations. Griffin et al. (1999) showed that coliform bacteria are unsuitable indicators, particularly in tropical waters (Griffin et al., 1999).

The major problems in assessing health risks from waterborne viral diseases are caused by the lack of quantitative data on virus concentration in water. The limited availability of quantitative data is mainly due to the difficulties of current methods for virus detection in water.

There is a great diversity in the behaviour of **pathogenic fungi** in the aquatic environment. Variations may appear in relation to solar radiation, the type of waters, the water temperature, salinity, tidal influences and many other biotic or environmental parameters.

There is no clear evidence that the faecal indicators are good predictors for the presence of fungi (Ghinsberg et al., 1994, Papapetropoulou & Rodopoulou, 1994). However, total fungi and *C. albicans* were shown to be useful parameters to predict anthropogenic pollution of recreational water (Efstratiou, 1998, Papapetropoulou & Rodopoulou, 1994, Velegraki-Abel et al., 1987).

From the study results **it can be concluded** that there are indicator parameters which tend to correlate with pathogens and that, however, these relations are very site-specific.

The microbial load of the surface water varies due to the different use of the catchment area, the type of water, the climate as well as the origin of the pollution.

It seems either to be possible and to be necessary to develop specific monitoring concepts and regimes for each surface water body and for the specific catchment areas.

Future perspective of the review and the database

Future perspectives of the project are to complete the review data base, in particular with literature from developing countries. However, studies about surface water pathogens are quite rare with regard to the different types of catchment areas.

In addition to the review paper, we wish to enable WHO the use of our electronic database. This database contains extensive information on the studies reviewed allowing direct retrievals where detailed information is sought.

We are also considering restricted Internet-access to a continuously updated database. The latter is in process. Such a system will allow direct access for authorized persons.

To improve the assessment of risks from waterborne diseases, future research projects should include more detailed description of the sampling sites, catchment areas and contamination sources beside the presentation of water quality monitoring.

Friederike Dangendorf, Angela Queste, Ina Stalleicken, Thomas Kistemann and Martin Exner

Contact: friederike.dangendorf@ukb.uni-bonn.de

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Tuberculosis in poorer countries exemplified by Afghanistan

Two million death cases as a result of tuberculosis makes this disease the second most prevalent cause of death among adults.

In the poorer countries tuberculosis mainly occurs in the wake of AIDS. In some countries 70 % of all tuberculosis patients are HIV positive. The health care systems which are weakened anyway break down as a result of the burden of two epidemics at the same time.

The fact that tuberculosis often occurs in a resistant form, i. e. the pathogen is resistant against the current tuberculosis drugs: multi-drug resistant TB (MDR TB) further complicates the situation.

There are presently world-wide efforts to stem this epidemic. These efforts, however, face enormous difficulties: the DOS strategy (Directly Observed Treatment Short Course) recommended by WHO is difficult to realise. DOTS does not take effect with the increasing number of patients with multi-drug resistant tuberculosis.

Tuberculosis in connection with HIV / Aids

Mainly AIDS patients are susceptible to tuberculosis which means death for many patients as a result of this infection.

Nearly one-third of all tuberculosis cases can be explained by the AIDS immunodeficiency. This is mainly valid for Africa, but also other states are increasingly affected by this.

This disease has, for example, probably always been native to Afghanistan. Before the period of wars there were surely many efforts to stem this disease. Particularly from Pakistan and India some reasonable and sustainable strategies are known which have also been applied in Afghanistan.

As a result of the turmoils and incidences of the last 20 years tuberculosis is again widespread in large parts of Afghanistan. A high rate of infection must be assumed. Recently many multi-drug resistant tuberculosis cases have occurred through the influence of the Russian Republics in the north (see WHO publication 1997) and the uncontrolled treatment of bazar doctors where all the drugs must be purchased at high prices on the bazar.

In the year 1997, 50 000 patients infected with tuberculosis were examined by the WHO in about 35 different countries. In one-third of the countries examined the quota of resistance was between 2% and 14%. In many countries there were at least 1000 cases of multi-drug resistant Tbc. The countries which are at the highest risk are India, Russia (resistance of up to 10 %), Latvia, Estonia, the Dominican Republic, Argentina and Ivory Coast.

DOTS (Directly Observed Therapy Short-course)

WHO recommends a therapy procedure which should be effective and cost-saving. With this DOTS programme most of the non-resistant tuberculosis patients world-wide should be treated and then also be cured.

The following 5 points must really be ensured in the therapy.

- Provision of resources for the safe diagnosis of TB cases before the start of the treatment
- Direct surveillance of the taking of drugs. This surveillance is done on a daily basis at the beginning in the acute phase of the disease. In the further course of the therapy it is done intermittently (twice to thrice a week). This task can be carried out by the nursing staff, social workers or other persons trained for this task.
- Ensurance of the whole therapy and surveillance, in order to guarantee an effective treatment
- Use of effective combinations and dosage of tuberculostats
- Support of the national governments for the DOTS strategy and to attach high priority to TB control.

DOTS can be carried out in hospital as well as in the outpatient department, **if it is ensured that the outpatients come to the adequate centres regularly** to receive their drugs.

If this is done consequently and long enough the number of new cases will be reduced considerably and a large part of “normal” tuberculosis cases will be cured forever. If there is additionally an according vaccination programme and if it can be achieved that all the children are vaccinated with the BCG vaccine (also possibly the animals) this strategy will surely show great success.

Note: The BCG vaccine (Bacille Calmette and Guerin) only provides limited protection and predominantly prevents more severe forms of the tuberculosis in children. Its effectiveness in adults is judged very differently: estimates range from 0 % to 80 %!

Disadvantages of DOTS Strategy

It is often very difficult to convince patients of the fact that they have to permanently take drugs for 6 months. As soon as they feel better objectively already after a short period they are often not prepared to accept the exertions or being admitted to hospital. The compliance or co-operation and the understanding of the therapy are preconditions for treatment.

Resistance against antibiotics in the case of tuberculosis

If the pathogen does neither respond to Rifampicin nor to Isoniazid, the two most effective substances in the tuberculosis treatment, the tuberculosis is seen to be resistant against antibiotics. This situation arises if a patient does not continue the treatment until the end, due to a lack of drugs or money or compliance difficulties (i.e. problems to take the drug regularly). The chances of recovery of patients with multi-drug resistant tuberculosis are worse and they infect others with this form of the disease. Particularly in the poorer countries it is becoming a problem and makes a simple treatment impossible. In these countries the therapy with special antibiotics which can be used against resistant tuberculosis is often 100 to 300 times more expensive than the treatment with the classical tuberculosis drugs, besides the chances of recovery are despite this considerably lower.

Therapy of antibiotic resistant tuberculosis

Standard-Tuberculosis-Treatment (Therapy of first choice)

Presently there are five tuberculostats available for the first treatment:

Isoniazid, Rifampicin, Streptomycin, Ethambutol and Pyrazinamid, Thiacetazon (not to be used in case of HIV infections)

The treatment of an uncomplicated TB (only with drugs) costs approx.

15 to 40 US dollars

The treatment of a multi-drug resistant tuberculosis (therapy with reserve antibiotics for more than 21 months) costs an estimated 5,000 US dollars.

The best drugs available which have, however, a lower effectiveness than those used for the normal tuberculosis treatment are:

- Aminoglycosides: Kapreomycin, Kanamycin
- Fluorchinolone: Ofloxacin and Ciprofloxacin and Levofloxazin
- Thionamides: Ethionanid, Prothionamid
- PAS (Paraaminosalicylic acid), Cycloserin

Side effects:

Strong side effects and as a result an even lower compliance are particularly known for these drugs.

Edith Fischnaller

Edith Fischnaller is with the Institute for Hygiene and Public Health, Bonn University, and medical coordinator of NGO Cap Anamur.

Contact: edith.fischnaller@ukb.uni-bonn.de

Special events related to water and health

2003

Ozwater 2003
6-10 April 2003, Perth, Australia

The Australian Water Association has a ten-year tradition of staging successful Ozwater exhibitions in conjunction with its biennial conventions. These conventions have been conducted since 1964, and for many years have been firmly established as the premier event on the Australian water industry calendar.

Web: http://www.awaozwater.net/

Wasser Berlin. Trade Show Berlin
7 -11 April, Berlin, Germany

WASSER BERLIN is the International Trade Show and Conference for the Water and Waste Water Industry. The conference features discussion forums with international experts on a variety of water-related topics, ranging from water supply, treatment and distribution through waste water disposal. It is a capital investment exhibition for international water supply and is an ideal interface for theory and practice.
Web: http://www.wasser-berlin.com/

HACCP - based principles in drinking water
The water safety plans of the WHO
28-30 April 2003, Berlin, Germany

The current revision of the WHO Guidelines for Drinking-water Quality aims to supplement drinking-water ”product control” with risk assessment and quality management strategies focussing on ”process control”. This international workshop aims to promote understanding of currently available approaches, particularly of those using elements of HACCP (**H**azard **A**nalysis and **C**ritical **C**ontrol **P**oints), widely and successfully used in food industry, as well as to exchange current experience with quality management in drinking water.

The event will include the following themes:

- Drinking-water targets for public health
- *Water Safety Plans*: the WHO approach
- Water suppliers’ experience with HACCP principles in catchments, in treatment and distribution
- Application of *Water Safety Plans* to small and medium-sized supplies
- Integrating HACCP-principles into current quality management systems in drinking-water
- Applicability of *Water Safety Plans* for managing chemical risks
- Perspectives of regulation and surveillance authorities

The conference is organized by the WHO Collaborating Centre for Drinking-water Hygiene at the Federal Environmental Agency in collaboration with the WHO, the International Water Association (IWA), the German Technical and Scientific Association on Gas and Water (DVGW), and UNICEF.

Web: http://www.umweltbundesamt.de/water-safety/

Water Resources Management 2003 - Second International Conference on Water Resources Managment
30 April - 2 May 2003, Las Palmas, Gran Canaria

This conference will present the most recent technological and scientific developments associated with the management of surface and sub-surface water resources. The meeting aims to bring together engineers, scientists and other professionals from many different countries, involved in research and development activities in a wide range of water resources and management topics.
Water Resources Management 2003 is one of the most successful of the conferences in the series of conferences organised by the Wessex Institute of Technology.

Web: http://www.wessex.ac.uk/conferences/2003/waterresources03/index.html

Risk assessment and capital maintenance planning in the water industry
14 May 2003, The Brewery, London

Large infrastructure maintenance requirements and a changing regulatory and investment climate pose particular burdens on water industry planners and managers. Attendance at this one-day conference will show you how to successfully import and use techniques developed and tested in a range of other industries to improve your performance within the CMP guidelines.

Web: http://www.era.co.uk/conf/riskassess.htm

SEFS3 - Europe's largest conference on freshwater science in the International Year of Freshwater
13-18 July 2003, Edinburgh, UK

The Third Symposium for European Freshwater Sciences will focus on:
Physiological ecology, ecotoxicology and pollution
- Molecular ecology and population processes
- Biodiversity and community ecology
- Ecosystems, catchments and environmental change
- Conservation and management of fresh waters in Europe
- Methods and modelling in freshwater science.

Web: http://www.sefs.info/

Hydro 2003 International Conference & Exhibition
3 -6 November 2003, Croatia, Dubrovnik

The Hydro 2003 Conference & Exhibition will provide an opportunity to gain first-hand experience of development opportunities in the Central and Eastern European region, and also to discuss plans, progress and challenges for hydropower worldwide, during the Technical sessions. Over 500 participant:private developers, utilities, planners, financiers, consultants, researchers, environmental specialists, powerplant operators and manufacturers from more than 50 countries are expected to attend.

Web: http://www.hydropower-dams.com/

Events related to other environmental health aspects

Urban Transport 2003

10-12 March 2003,Crete,Greece

The 9th International Conference on Urban Transport and the Environment in the 21st Century is organized by the Wessex Institute of Technology, UK.

Urban Transport 2003 is a major annual event in the urban transport calendar with papers on both transport and the inter-related environmental issues which are of so much concern in our cities. Broad topic areas include urban transport systems, traffic control, accessibility and mobility, control and simulation, finance, air quality and noise, social issues and safety. The conference series has always attracted a wide international spread of delegates and is well established as a premier annual event. It first started in Southampton, UK (1995), continuing in Barcelona Spain (1996), Acquasparta, Italy (1997), Lisbon, Portugal (1998), Rhodes, Greece (1999), Cambridge, UK (2000), Lemnos, Greece (2001) and Seville, Spain (2002).

Web: http://www.wessex.ac.uk/conferences/2003/urban03/index.html

EnviroExpo 2003
6 -8 May, Boston, Massachusetts, USA

EnviroExpo 2003 will bring together thousands of decision makers - EH&S professionals from business and industry, utility representatives, state & federal regulatory officials, local government officials, academia and the environmental industry – to meet with manufacturers and service providers.

Web: http://www.enviroexpo.com/

10th International Symposium
in Medical Geography
14 – 18 July 2003, Manchester,UK

The Conference is organised on behalf of the Health or Medical Speciality Research Groups of the Association of American Geographers, the Canadian Association of Geographers and the Royal Society – Institute of British Geographers. Co-sponsored by the International Geographical Union Commission on Health and Development, the International Geographical Union Commission on Modelling Geographical Systems, and the International Union of Geological Sciences Working Group on Medical Geology.
We welcome papers and poster presentations addressing any topics in Health Geography and Geomedicine.
The deadline for abstract submission and payment of the registration fee is 30th April 2003.

Web: http://www.art.man.ac.uk/Geog/imgs/

Environmental Health Risk 2003
2nd International Conference on the Impact of Environmental Factors on Health
17-19 September 2003, Catania, Italy

Environmental Health Risk 2003 is the second international conference on the impact of environmental factors on health, the first of which was held at the University of Cardiff, UK in 2001.

Health problems related to the environment are becoming a source of major concern all over the world. The health of the population depends upon good environmental quality including air, water, soil, food and other factors.

The aim of a healthy society is to establish effective measures, which can eliminate or considerably reduce hazardous factors from the human environment and minimize the associated health risks.

The ability to achieve these objectives is in great part dependent on the ability to apply suitable experimental, modelling and interpretive techniques, which will allow a balanced assessment of the risks involved. The interrelation between environmental risk and health is often complex and can involve a variety of social, occupational and lifestyle factors that emphasizes the importance of considering an interdisciplinary approach. The conference will provide a forum for the dissemination and exchange of information on the impacts of

environmental factors on health, their interpretation and risk assessment.

The conference will be held at La Perla Ionica Hotel in Acireale, just outside of Catania. The hotel is situated on the sea front and is surrounded by beautiful gardens. La Perla Ionica is fully equipped with both leisure and conference facilities.

Web: http://www.wessex.ac.uk/conferences/2003/healthrisk03/index.html

EnvironmexAsia2003 & WatermexAsia2003
2- 5 Dezember 2003 Suntec City, Singapore

This event has been identified as an important sourcing tool for water and environmental technology and in 2003, it is slated to be an industry gathering that will bring participants massive business opportunities.

Web: http://www.environmental-expert.com/events/watermexasia/watermexasia.htm

New books and articles

- Hunter, P.R.; Waite, M.; Ronchi, E.(2003): Drinking water and infectious disease - Establishing the links. IWA Publishing. CRC Press.

- UNESCO (2003): Water for people - Water for life. The United Nations World Water Development Report.UNESCO Publishing.

- Farley, M.; Trow, S.(2003):Losses in Water Distribution Networks- A Practitioner's Guide to assessment, Monitoring and Control. IWA Publishing.

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- Jaspers, F. G.(2003): Institutional arrangements for integrated river basin management. Water Policy 5:77-90.

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Links

Dialog on water and climate

http://www.wac.ihe.nl/home.asp

Environment and Sustainable Development Programme of UNU : Water Crisis

http://www.unu.edu/env/water/water.html

The UN World Water Development Report

http://www.unesco.org/water/ wwap/wwdr/index.shtml

For comments & contributions please contact:

Alexandra Wieland
WHOCC for Health Promoting Water Management
and Risk Communication
Institute for Hygiene and Public Health,
University of Bonn, Germany
Sigmund-Freud-Str. 25
53105 Bonn

Tel.:(0049) (0)228-287 9516
Fax:(0049) (0)228-287 9516
mail:alexandra.wieland@ukb.uni-bonn.de