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Balancing Microbial and Chemical Risks in Disinfection of Drinking Water: The Pan American Perspective

The following is an abridged version of the keynote speech delivered by Dr. Carlyle Guerra de Macedo, Director of PAHO, at the First International Conference on the Safety of Water Disinfection: Balancing Microbial and Chemical Risks. The conference was held from 31 August to 3 September 1992 in Washington, D.C., and was cosponsored by the International Life Sciences Institute, United States Environmental Protection Agency, United States Food and Drug Administration, American Water Works Association, Pan American Health Organization, and World Health Organization.

In prescribing medication, the physician is acutely aware of the need to weigh chemical and biological risks, because virtually every medication has both benefits and potentially negative physiological side-effects. In simple terms, the physician's objective is to do the most good and to cause the least harm. The process of deciding on a course of treatment can be straightforward or quite complex, depending on the severity of

the disease, the condition of the patient, the pharmacokinetic activity of the medicine, and, most importantly, previous experience. A number of parallels can be drawn between balancing microbial and chemical risks in the treatment of infectious and parasitic diseases and the topic of this conference, particularly with regard to factors governing the decision-making process in developed and developing countries.

Public health programs have a broader scope and must be concerned not only with treatment but also with the prevention of disease and the cost-effectiveness of the prescribed interventions. Here too there must be concern for balancing biological and chemical risks. Disinfection of drinking water is a primary public health intervention that results in reduced incidence of most waterborne diseases wherever it is dependably carried out. The use of chlorine as a disinfectant continues to play a major role in the reduction and control of this category of diseases in Latin America and the Caribbean.

In the United States and Canada, the microbial quality of drinking water has generally improved to the extent that toxicologic issues have now achieved greater prominence than microbial ones. In these countries, the social and political perception of chemical hazards, coupled with the discovery of chlorination by-products—which have been identified as possible human carcinogens—has led to a growing movement toward abandoning this method of disinfection in favor of more complex and expensive methods, such as ozonation followed by chloramination. Although this strategy might be feasible for wealthy and scientifically advanced countries, it is not necessarily suitable for Latin America and much of the Caribbean, where the response to the toxicologic risk (albeit low) of chlorination by-products has all too often been to abandon disinfection altogether.

In 1989 and 1990 there were 11 outbreaks of disease associated with community water systems in the United States. Four were due to *Giardia*, one to hepatitis A, one to *Escherichia coli*, and one to cyanobacteria-like bodies; four were of unknown etiology. A total of 1 664 cases were reported, with no deaths. By contrast, in Latin America there were more than 590 000 cases of cholera causing more

than 5 000 deaths between the end of January 1991 and mid-June 1992. Epidemiologic studies have implicated drinking-water supplies (including ice) as one of the most important vehicles of transmission. In addition, several million cases of infectious diarrheal diseases were reported in Latin America, and it is estimated that in 1990 about 300 000 deaths were attributable to these diseases.

Throughout Latin America the failure to disinfect water supplies has repeatedly been implicated as a major factor contributing to the propagation of many other waterborne diseases as well as cholera. Concern about chlorination by-products, especially trihalomethanes, has been cited as a reason for abandoning disinfection.

Further confounding this issue is the fact that there is not universal agreement in the scientific community as to the degree of risk posed by disinfection and its by-products, in particular those related to chlorination. In Lyon, France, in June 1990, the International Agency for Research on Cancer convened a working group to evaluate the carcinogenic risks to humans of chlorinated drinking water and chlorination by-products. That group concluded that "there is inadequate evidence for the carcinogenicity of chlorinated drinking-water in humans."¹ However, 2 years later, the authors of an article published in the *American Journal of Public Health*² concluded that there was a significant association between the consumption of chlorination by-products in

¹World Health Organization, International Agency for Research on Cancer. *Chlorinated drinking-water; chlorination by-products; some other halogenated compounds; cobalt and cobalt compounds*. Lyon, France: IARC; 1991:127. [IARC Monographs on the Evaluation of Carcinogenic Risks to Humans; vol 52].

²Morris RD, Audet A-M, Angelillo IF, Chalmers TC, Mosteller F. Chlorination, chlorination by-products, and cancer: a meta-analysis. *Am J Public Health*. 1992;82:955-963.

drinking water and the incidence of bladder and rectal cancer. Both groups had reviewed essentially the same studies. If the best scientific minds are not in agreement on this subject, the decision makers in developing countries are receiving mixed signals. The problem is exacerbated by the public's tendency to interpret even a weak correlation with cancer as an imminent threat which overshadows the threat of enteric pathogens, even though the latter may be of considerably greater public health significance. Unfortunately, developing countries do not enjoy an economic situation in which the most conservative but more costly approaches to disinfection can be taken. Frequently, the available options are either to chlorinate or not to disinfect at all.

Accurate models comparing the risk from chlorination by-products with microbial risks from failure to chlorinate (or otherwise disinfect) have not yet been developed, nor have detailed, comprehensive studies been carried out that compare disease incidence and the corresponding mortality from microbial pathogens with those caused by chemical contaminants in the water supply in Latin America. Nevertheless, it is patently obvious from the morbidity and mortality statistics reported by the ministries of health of Latin America that the microbial risk is several orders of magnitude greater than the chemical risk. Thus, the enthusiasm found in the developed countries for replacing chlorination to reduce toxicologic risks should be tempered in Latin America and the Caribbean by the possibility of greatly increased microbial risks until a practical low-cost alternative to chlorination is a reality. The Pan American Health Organization, in collaboration with its Member Countries, is working to develop such alternatives, and some appear very promising, but wide-scale replacement of chlorination as the standard method of disinfection in Latin

America is currently not warranted. The microbial risks are simply too high, and in most cases the alternatives are not yet economically feasible.

Health statistics indicate that natural chemical contaminants, such as arsenic, currently have a much higher negative impact on public health than do disinfection by-products. Water quality data show that the contamination of water sources by industrial discharges containing heavy metals and organic solvents, as well as agricultural run-off containing pesticides and other agro-chemicals, is certainly a greater threat than disinfection by-products. Also, agro-chemicals sometimes contribute indirectly to the formation of those by-products.

In public health practice, it is usually more effective to have multiple barriers rather than a single barrier to the transmission of disease. The Pan American Health Organization recommends the sanitary protection of all sources of water supply and the disinfection of *all* public water systems in Latin America and the Caribbean regardless of the purity of the source. Both experience and studies demonstrate that the likelihood of microbiological contamination either at the source or within the water system is too great to do otherwise. Additionally, we recommend that surface-water supplies receive sufficient treatment through flocculation-sedimentation and/or filtration to remove pathogens that are resistant to the disinfection process, as well as to reduce turbidity and render the disinfectant more effective. Unfortunately, in many economically disadvantaged communities, chlorination is the only form of treatment provided to surface water. In such an unsatisfactory situation, it is doubly important that the disinfectant chosen be as effective as possible because it is the only barrier against the transmission of waterborne pathogens.

In developing countries, the principal

health concern related to water supplies should remain preventing them from becoming the vehicle of widespread transmission of enteric disease. This concern should not be overshadowed in our efforts to minimize the relatively small health risk stemming from disinfection by-products.

The high incidence of diseases related to water supply and sanitation is primarily a reflection of the social and economic inequities and marginalization that still exist in our hemisphere. Basically, the people who suffer the most from these diseases have so few economic resources

that all but the simplest and least expensive interventions to reduce their risk of exposure to the many waterborne pathogens are beyond their means. Under such circumstances, the disinfection of drinking water with chlorine or other chemical disinfectants—at the household level if necessary—is probably the most cost-effective environmental health intervention available. To cause these people to abandon chlorination is not only unwise but cruel as well, if the only alternative offered is beyond their economic and technical means.



Update: Cholera in the Americas

Cholera continues to assail the Region of the Americas, with 22 947 new cases having been notified in 1993 as of 26 March. These reports bring the total to over 768 500 cases since the epidemic began in January 1991.

The overall case fatality rate remains low. It fell from 1.0% in 1991 to 0.7% in 1992, but this regional average masks the fact that five countries had ratios of 2.0% or higher.

Cholera occurred in 20 countries of the Region in 1992, five more than had been infected during 1991. In January of this year, Paraguay became the twenty-first country to report cholera cases. Nevertheless, there is clear evidence that the rate of spread of the disease has declined, especially since the middle of 1992. The incidence of other diarrheal diseases, such as typhoid, also decreased as a result of control measures undertaken to prevent cholera. None of the island countries or territories of the Caribbean Sub-region have become infected. For now, however, cholera remains a serious threat to the Region and undoubtedly will continue to be epidemic in several countries during 1993 and subsequent years.

Source: Cholera in the Americas. *Epidemiol Bull.* 1993;14(1):14.