STATUS OF WATER DISINFECTION IN LATIN AMERICA AND THE CARIBBEAN

Raymond Reid
PAHO/WHO
Washington, D.C., USA

ABSTRACT

The "Mid decade evaluation in the Latin American and the Caribbean Region" reported access to water supply at 73% in the Latin American and the Caribbean Region indicating that the development of water supplies has been slower than expected. Several countries reported decline in overall water coverage statistics. Some countries continue to cover less than 40% of their population with access to safe water. The cholera epidemic stimulated considerable interest and progress in disinfection of water supplies however systematic disinfection continues to be a problem. The shortage of chlorine, logistical problems, lack of funds and improper operation and maintenance of disinfection equipment were common factors for lack of disinfection in small towns. It was estimated that 59% of the population of Latin America and the Caribbean received disinfected water on a regular basis. When the information was broken down by urban and rural sectors it became clear that rural water supplies in the region were not disinfected. Several countries including Brazil reported less than 10% of their rural water supplies were disinfected. On the positive side some countries have made progress: example: Mexico and Nicaragua have substantially increased their coverage of disinfection since 1991. In general chlorine remains the disinfectant of choice in spite of concern regarding its safety. Since the cholera epidemic much more emphasis has been put on onsite generation of chlorine and on home disinfection. Disinfection remains the most important barrier for the prevention of waterborne diseases however it must be applied in the context of an integrated water quality management.
1. Introduction

The availability of water at the community and household levels makes it possible to create a hygienic environment to avoid or control the spread of infectious diseases that affect human health. Water is also an important vehicle in the transmission of many diseases and has been largely responsible for several large epidemics such as typhoid, and cholera throughout the world and in this Region. Poor water drinking quality in particular affects human health due to the presence of bacteria, viruses, protozoa or helminthes. Water can be contaminated at the source, in storage tanks, in the distribution system or in containers used at the household levels. In general, microbial contamination of drinking water due to lack of, or inadequately treated sewage remains the principal water quality problem in the Region. Water pollution increases the risks of contacting many infectious diseases, including those caused by cryptosporidium and giardia, which are yet to be evaluated.

Water disinfection has been recognized as one of the most important barriers for human health protection. However, disinfection should be constant and should not be relied upon as the sole treatment for poor water quality. It is important that disinfection be combined with source protection and appropriate treatment where necessary. Also without adequate sanitation, fecal contamination of watercourses will occur, which will make it easy to continue the propagation of waterborne diseases. Therefore, good hygienic practices and health education are a necessary complement for any sustainable program for reducing health risks associated with drinking water and sanitation.

Water may be disinfected by physical or chemical means. Physical disinfectants are treatment such as boiling or irradiation applied to the water, which make it safe to drink. Filtration could also be considered a method of disinfection. Many chemicals, in particular chlorine and iodine are used as disinfectants. After Koch demonstrated in 1881 that chlorine could kill bacteria, it was used continuously in England, for the first time in 1905 to control typhoid epidemics. Since then, chlorine in one of its forms has been found to be the disinfectant of choice throughout the world. The most common forms of disinfectants in the Region are chlorine gas and sodium or calcium hypochlorite. Some attempts to introduce the use of chlorine dioxide have met limited success. Other forms of chorine based disinfectants proposed at household or emergency bases are dichlorine triazine, trione sodic salt, and sodium dichloroisocyanurate (NaDCC). There is still some concern about the acceptability of the latter due to limited information about its potential toxicity.

The recent controversy about the safety of chlorine and its by products, has renewed interest in other forms of disinfection, such as ozone. The use of iodine as a commercial disinfectant has been proposed in several countries in particular Chile. Iodine was evaluated in the revised edition of the WHO Drinking Water Quality Guidelines. It was concluded that the available toxicological and epidemiological information was inadequate for the derivation of health base guideline value for iodine in drinking water. The use of iodine was recommended
only for short-term usage, such as emergency disinfection of drinking water, and by campers. The general policy in this Region is that disinfection of water is a primary public health intervention that greatly reduces the incidence of water borne diseases when it is effectively carried out, and that the benefits outweigh the risks caused by the by-products although more research is needed on the occurrence of these health risks.

The factors that determine the selection of disinfectants are mainly availability, cost factors, logistics, cost of equipment and safety factor. Many cultural factors enter in the decision of whether or not to disinfect water at the household level.

2. Status of water supply and sanitation in the Region

The Mid-Decade Evaluation of Drinking Water and Sanitation indicated that the development of water services in this region has been slower than expected, when compared to the 1988 evaluation figures. By 1995, the overall water service coverage was estimated at 73%, that is 84% in the urban water supply services and 41% in the rural areas.

In 1995 several countries, including Brazil, Colombia, Haiti and Venezuela reported reduced figures for total water supply. Brazil reported a drop in urban water coverage from 100% (1988) to 80% (1995), and in rural coverage from 86% to 28%. Haiti also reported a drop from 55% in urban coverage to 38% in 1995. Venezuela reduced both urban and rural coverage. The report also shows major discrepancies still exist between countries, Haiti and Paraguay are still covering less than 40% of their population with access to a safe water source. Other countries Ecuador, Guatemala, Nicaragua, Peru, and Brazil are reporting less than a 70% coverage of their population. The total unserved population was estimated at 128.3 million in 1995. Of the 21 countries that reported water supply coverage at the end of the International Drinking Water and Sanitation Decade and in the Mid-Decade Evaluation, in 1995, 12 countries reported an increase in coverage, six reported a decrease and three did not report any change. Bolivia, Dominican Republic, El Salvador, Mexico, Nicaragua and Suriname reported a significant increase in water supply coverage, while Brazil, Colombia, and Venezuela reported a notable decrease. The information reported by the latter countries may reflect a reevaluation of the quality of their services.

Coverage information on water supplies is shown in Table 1 and Figure 1.

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Figure 1. Water supply service coverage 1995 (% of population service)
The Mid-Decade Evaluation data further show that 69% of the population has access to some form of sanitary services. However, only 52% of the population in urban areas was connected to a municipal sewage collection system compared to 79% with domiciliary water house connections. One of the most critical sanitary problems remains the lack of adequate sewage treatment with only approximately 10% of the sewage collected receiving adequate treatment. Previous studies thorough GEMS have indicated a higher level of bacterial contamination in surface water in Latin America than other parts of the world. The lack of political support and financing of wastewater facilities has been identified as the most critical issue in that subsector. The development of an integrated and well coordinated water resource management program that would give consideration to health, environmental and economic aspects has been recommended as a proper strategy for the countries of this Region.

3. Status of disinfection

In the past decades most international and national agencies had subscribed to the concept that water accessibility was more desirable and quality could come later. Therefore, data on disinfection was sporadic and not covered to the same extent that water coverage was as part of the water monitoring process. It is only recently that disinfection and water quality aspects were included as elements in the periodic monitoring in this Region carried out by PAHO.

In 1984, a survey organized by PAHO determined that in 75% of the municipality water systems in Latin America and the Caribbean disinfection was grossly inadequate or non existent. Most large cities were disinfecting regularly in all cases with chlorine, but several deficiencies were observed. The most important observations were:

- Many wells connected to distribution system without disinfection;
- Disruption of chlorine supplies was frequent;
- Equipment failure or lack of replacement parts was common; and
- None or inadequate chlorine residuals were maintained in all points of the distribution system.

It was also estimated that more than 90% of smaller towns and villages with population of less than 10,000 lacked disinfection all together.

Since the cholera epidemic in 1991, there has been considerable interest in water disinfection, and also more progress in the disinfection of water supplies has been made. The precarious state of the sanitary infrastructure in the countries was largely blamed for the reappearance and rapid spread of the diseases in the Region. A 1994 survey carried out by PAHO (17 countries replying on the status of disinfection) put the average coverage of disinfection in the Region at 58.8% of the population that receives disinfected water on a regular basis. This coverage of disinfection varies largely between countries from 10% reported in Guyana to 92%
in Uruguay. This information is shown on Figure 2. It can also be seen that the median coverage is closer to 50%, since half of the countries responding provided disinfection to 50% or less of their population with access to disinfected water.

**Figure 2. Water disinfection coverage for Latin America and the Caribbean**

In the Mid-Decade Evaluation survey in 1995 countries were asked to indicate the coverage of Disinfection. When the results are broken down by urban and rural sector, a completely different picture emerges. All countries with the exception of Guatemala, Haiti and Suriname reported coverage over 50% of their urban population with disinfected drinking water. However, in the rural sector five countries including Brazil, the largest country in the Region, Colombia, Costa Rica, Haiti and Suriname reported less than 10% of their rural water supply population covered with disinfected water. Four more countries reported much less than 50%. The countries with the best disinfection coverage were Chile, Trinidad and Tobago and Uruguay. Coverage of disinfection in urban and rural sector is shown in Figures 3 and 4.
Figure 3. Level of water disinfection coverage urban water coverage

Figure 4. Level of water disinfection coverage. Rural water coverage
4. **Barriers to effective disinfection in the Region**

The following issues reflect the main barriers to disinfection.

- Lack of effective policies and regulations regarding disinfection.

  An example of disinfection requirement can be found in the Safe Drinking Water Act of the USA, which specifies:

  “All surface water systems and ground water under the influence of surface water must provide disinfection. Systems will be required to monitor the disinfectant residual leaving the plant and at various points in the distribution system. The water leaving the plant must have at least .2 mg/l of the disinfectant”.

- Absence of institutional capabilities at local level for addressing water quality issues.

- Lack of system of monitoring in particular from the regulatory and health agencies that would ensure compliance and assist community to meet disinfection requirement.

- Poor operations and maintenance management that results in series of mishaps such as interruption of the chlorine supply, breakdown of equipment, lack of spare parts, electrical failures and inadequate training of operators.

Recently the concern over the health risk caused by disinfectant by-products has caused some agencies to delay investments in disinfection systems, or to bypass the systems where they exist. The general consensus among public health officials is that disinfection is the best measure to ensure safety of water supplies. However, the concern over the health risks associated with disinfection by-products should not be ignored. It should be the responsibility of the health officials to properly convey the level of risks to the public to avoid exaggeration. The issue of health risks of chlorination by-products was debated by the International Agency for Research on Cancer in 1991, and at the Conference on Balancing the Microbial and Chemical Risks of Drinking Water in Washington, D.C. in 1992 and Argentina in 1994. The recommendations of these Conferences are, that “since the cost of disinfection especially chlorination is so low and that the health benefits are so extraordinarily high, disinfection should be practiced universally, maintaining an adequate residual in all points of the distribution network and residences, to enable everyone to enjoy the benefits of microbiologically safe water.”

Following are some examples of the status of disinfections in selected countries of Latin America.
Mexico

In April 1991 only 35 million Mexicans who resided in 372 localities of the country disposed of installed equipment for water disinfection. In the majority of the cases this equipment was obsolete or broken. Today, 70.7 million people are supplied with disinfected water. This represents 96% of the flow of water distributed to the population by regular water supply systems.

Bolivia

It is estimated that 72.4% of the water supplied by the water agencies is disinfected. When the rural sector is considered, this puts the national average at approximately 51.8%.

The level of disinfection in the urban sector varies from 63% in Trinidad to 100% in Tarija. In the rural area no water quality analysis is done, therefore, the water quality situation is not known. Among the priority and strategies of the country, are; the preparation of projects that increases the disinfection of water in small communities, taking advantage of appropriate disinfection technologies, such as the onsite chlorine generators. The strategies also include training aspects and control of water quality through the monitoring of residual chlorine.

Brazil

In Brazil, 92% in the urban populations, but only 3% in the rural areas is supplied with disinfected water. Of a total of 27,900,000 cubic meters of water supplied, 17% received disinfection as the only method of treatment.

Nicaragua

In 1990 the population that received disinfected water was estimated at 454,000, which was supplied by the systems of Managua, Leon and Ocotal. Starting in 1991, the population served has been increased and reached 976,455 people. By the end of 1995, the population that received disinfected water was estimated at 96% of the population served at the national level, that is to say from 1,660,000 served with disinfected water from a total of 1,730,000 persons served with domestic water connections. An impressive initiative from INAA, which had only 20 chlorinators installed in 1991 drastically increased the number of disinfecting equipment in the water supplies systems, because of the menace of cholera.

Chile

Chile is one country that has maintained a high level of disinfection, 12 million out of 13.7 million or 87% had access to adequate disinfection. It is reported that in 1994, 340 water supplies out of a total of 355 did not present any problems of bacteriological water quality and 95.8% of the services always maintained acceptable level of residual chorine during the whole year. The water regulatory
agency has further requested the concessionaires to include in their investment plans the necessary funds to improve the water quality and disinfection capability of their systems. Chile was able to rapidly control the spread of cholera in its territory.

**Cuba**

In Cuba, out of a total of 157 installations of gas chlorinators in the country 138 or 88% was reported to be functioning. The others were stopped due to a lack of chlorine gas or were broken down. Out of 907 installations of hypochlorinators, 868 or 96% was reported functioning. The remainder was not functioning due to lack of chemicals or equipment failures.

5. **Cholera and other diarrheal diseases situation**

The main factor responsible for shaping water and sanitation programs in the Region during this Decade, is the reappearance of cholera in 1991, and the endemic nature of the disease to date. The introduction of cholera in the Americas has resulted in renewing interest in water supply disinfection as the countries took a more aggressive approach for increase safety of drinking water. Since 1991, there have been over 1,207,000 cholera cases and 11,950 deaths due to cholera reported in 21 countries, however, the number of reported cholera cases continued to decrease in 1997. Of the 18 countries reporting data in 1997, 12 countries reported a decrease, 5 reported an increase and one with no change. Notable increases occurred in Venezuela and in Brazil while significant decline were reported in Ecuador and El Salvador. Table 2 summarizes the annual reported cases and deaths from cholera from 1991 to 1997.

Table 2

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Diarrheal diseases continued to represent the largest single cause of death in small children in 1996, representing 18% of all of children from one to four years of age. From the latest information available, the highest mortality rates in children less than five years old were found in Nicaragua, (9.83/1000), Guatemala (7.46/1000), Peru (5.50 /1000) and El Salvador (4.09/1000.) The lowest rates were observed in Chile (0.17), Cuba (0.18) and Trinidad and Tobago (0.13).
A close relationship has been observed between access and quality of drinking water in the countries with the incidence and mortality of diarrheal diseases, since the ranking of the countries by access or disinfection seem to closely reflect that of the mortality in children by diarrheal diseases.

6. On-site disinfection

The population that is most likely to be threatened by cholera and waterborne diseases is the poor and those that are not served with biologically safe water. This includes most of the rural areas and small communities in Latin America and the Caribbean. In fact, 41% of the population in this Region does not have access to regular supply of disinfected water. For example, over 90% of the rural population in Brazil does not have disinfected water. In rural areas the water may also become contaminated during transit or in storage, because many people have to travel long distances to get water. In addition, emergencies and natural disasters, such as those experienced during the El Niño season created situations in which the population is exposed to contaminated water. Therefore, there is a large unmet demand for onsite disinfectants in Latin America and the Caribbean as the population become more aware of the benefits of safe water with regard to the control of diarrheal diseases. This recognition has led to the consideration and popularization of household disinfection in the Region.

Manufacturers of disinfectant tablets have sought the approval of their products from national and international health authorities, and have expanded their channel of distribution in several countries of Latin America and the Caribbean. Today the chlorine tablets are available in most major cities of the Region. The sale or consumption figures for this product is not readily available and warrants additional research. The most common brands of disinfecting tablets are Aquatabs and Pyam.

By far the largest extension of disinfection products has been in the area of on-site generation of disinfectants by electrolysis of salt. This explosion was due in part to the recognition by the countries of an immediate need for improving water disinfection as a means of reducing the risks of cholera. The Pan American Health Organization, through several projects in Bolivia, Colombia, El Salvador, Guatemala, Honduras, Nicaragua, Panama and Peru funded by Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), the Italian Government and others, facilitated the procurement of on-site disinfection equipment. The generators produced sodium hypochlorite solution or mixed oxidant solution for distribution or sale to the population. Disinfection at the household level coupled with the use of a specially designed containers to reduce contamination in the home has been proven to reduce the incidence of diarrheal disease. In Montero, Bolivia, families using this intervention has greater than 80% reduction in diarrhea when compared to non-intervention families from the same communities. The Montero project, was implemented in collaboration with the Center for Diseases Control (CDC) and PAHO, the families also received education and instructions
about the correct use of contaminants and disinfectants. The experience in El Salvador with this type of intervention has been also positive. The statistical information for the municipality of Osicala in the Department of Mazaran in which the Project for Social Mobilization and Training for the Prevention of Cholera operated indicated a reduction of 74% in the prevalence of intestinal parasite and 30% in diarrheal disease in 1997. The solution of sodium hypochlorite from on-site generators is currently marketed in Bolivia under the trade name of CLARO and in El Salvador under PURIAGUA. In Honduras, the project includes the development of chlorine banks at the municipal level for small communities. In Nicaragua, plastic jugs and chlorine solution generated by dipcells equipment have been distributed to the population.

During the period of January 1992 to 10 September 1998 the Procurement Office of PAHO purchased on-site disinfection equipment for the countries amounting to over $1.7 million dollars. By far the largest purchaser was the government of Costa Rica with purchase amounting to over $800,000. The most common purchases were made through Equipment System Engineering (Sanilec type), Magneto-Chimie B.V. (dipcell) and Chlorids S.A. To date this type of equipment has been purchased for use in Bolivia, Colombia, Costa Rica, Ecuador, El Salvador, Haiti, Jamaica, Nicaragua and Peru. This methodology, in particular when coupled with solar energy provides a practical means of providing rural and poor communities with access to disinfected water. Equipment with solar panels is currently in operation in rural communities in Peru and is being introduced in Haiti. An evaluation of the utilization of on-site sodium hypochlorite generators in Central America has been organized by PAHO.

Recommendations for water disinfection at home and during emergencies have been provided through various PAHO publications, Inter-American Water Day booklets and in the WHO emergency kit.

7. Conclusion

There is a positive outlook regarding drinking water disinfection in this Region. This has been reinforced by the Plan of Action for Improving Access and Quality of Drinking Water, which arose as a tool for the implementation of Initiative 47 of the Santa Cruz de la Sierra Summit. Several agencies, including the OAS, UNICEF, USEPA, AID, the World Bank, Inter-American Development Bank, NSF International and AIDIS are supporting this plan. Also the recent Chile Summit recommendations of promotion of basic sanitation technologies will support improvement in disinfection. Initiative 47 requested the countries to establish programs, laws and policies to protect public health by ensuring that drinking water is free from microorganisms harmful to health. This resolution provides the basis for reinforcing and extending the disinfection of water supplies in Latin America and the Caribbean. However, water disinfection should be seen in the broader context of water quality improvement which should adopt water quality standards in line with the WHO Guidelines for Drinking Water Quality, improvement of water quality surveillance and adequate education programs for consumers.
8. References


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