the Commission. We also need to sort out how institutions such as the WHO European Regional Office, which possesses significant resources and expertise, can be harnessed successfully to the benefit of Europe as a whole and in a way that would be both helpful and effective. If in the next few years the United Kingdom successfully develops its own public health function, achieving the right balance of harmonisation and subsidiarity in the context of Europe, devolution and the renewal of local government, it would be well placed to take the initiative and provide a lead on public health in Europe as well.

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# Drinking water and gastrointestinal disease: need of better understanding and an improvement in public health surveillance

Twenty five per cent of the population in the developing world have no access to drinking water. Infectious and parasitic diseases are still the principal cause of death and illness throughout the world, mostly because of the poor quality of water, and diarrhoea ranked globally in 1997 as the first cause of morbidity and the sixth cause of mortality.[1] The actual burden of waterborne diseases is unknown because of underreporting in both developed and developing countries.[2] A recently published work shows that infectious intestinal disease occurs in one in five people each year in England, but only a small proportion of cases are recorded by national laboratory surveillance system.[3] In communities with a high economic and public health development access to abundant and good quality water is stated as a basic right, and consumption of tap water is not seen as an important risk. Otherwise, in recent years some concern has been raised about the safety of drinking water, both in Europe and North America. On one hand, in some regions of Europe, specially those in the former Soviet Union, there is evidence of increase in disease attributable to restricted water supply.[4] Apart from that, the privatisation of water supplies in some countries (for example, UK), and its subsequent price increase, could lead to a reduction of its use for low income groups introducing potential detriment of their health.[5] In addition, chemical products in drinking water have been associated with bladder and pancreatic cancer,[6–8] and also with reproductive effects.[9–11]

In countries with good epidemiological surveillance systems, a series of waterborne outbreaks have been reported in communities with adequate established measures of water quality control. This represents a warning about the potential risks from drinking water despite the state of the art water treatment.[5 9 12] One of the best known outbreaks happened in Milwaukee (Wisconsin). In March of 1993, and because of a contaminated water supply, there was a widespread outbreak of gastrointestinal illnesses, mainly attributable to *Cryptosporidium* among the residents of Milwaukee that affected more than 400 000 people (about 30 per cent of the population).[13] Before this outbreak there were marked increases in the turbidity of treated water, reaching a maximal daily turbidity of 1.7 nephelometric turbidity units (NTU). After this episode the standards for water treatment were proposed to be strengthened in the United States (95% of all daily finished water turbidity measurements in a month should not exceed 0.5 NTU). Likewise, two randomised controlled intervention trials conducted in Quebec, found that 14% to 40% of gastroenteritis were associated with tap water[14 15] suggesting the importance of drinking water in occurrence of endemic gastrointestinal disease.

Attention paid to health problems regarding drinking water is in a considerable amount attributable to the gastrointestinal disease incidence related with pathogens that are not easy to control—that is, they are difficult to detect and to eliminate from water using conventional procedures, such as viruses (for example, Norwalk virus,[16] hepatitis A virus or rotavirus[2]), and parasites. In the 1980s *Giardia* was considered as the most frequently isolated enteric protozoan from populations worldwide and the most common pathogenic parasitic in the United States.[17] Otherwise, nowadays, the deepest concern comes from the potential health risks associated with waterborne cryptosporidiosis.[18] The major difficulties dealing with *Cryptosporidium* are that it is difficult to detect in water samples, it is very resistant to disinfection, its infective dose is low, it could affect more severely immunocompromised subpopulations, and, at present, there seems to be no effective treatment.[19 20]

In this issue of the journal, Schwartz and colleagues present a time series study examining the relation between daily fluctuations in drinking water turbidity and hospital admissions for gastrointestinal disease of elderly people in Philadelphia.[21] Regarding population aged 65 and older, they found that an interquartile range increase in tap water turbidity was associated with a 9% increase (95% confidence intervals 5.3%, 12.3%) in hospital admissions, 9 to 11 days after. The association was stronger in those over 75 than in people aged 65–74.

Up to now, most of epidemiological studies of waterborne diseases are investigations of severe outbreaks. With this approach a limited period of time in which a number of cases higher than expected occurred is examined. Subsequently confirmed cases are described regarding personal characteristics and exposure to water, and comparisons with controls are made. In the past years, however, and the article from Schwartz and colleagues presented here is a good example, another approach is being used. This relies on assessment of the relation between daily variations of health and water indicators using time series techniques.[21–24] Time series analysis measured the short-term associations between an effect indicator (that is, hospital admissions for gastrointestinal disease) and an exposure (that is, water turbidity). This approach has been successfully developed for the study of the health effects of air pollution on daily hospital admissions and mortality. The underlying hypothesis is that part of the variance of the usual (that is, non-epidemic) daily distribution of the health effect is associated with the daily fluctuations of the exposure indicator, after considering all the potential confounding factors, using Poisson regression techniques. The main advantage of this design is that the population under study serves as its own control, and covariates that vary between subjects but not over time are not potential confounders. In addition, covariates that vary across people tend to remain constant over time or their daily variations are unlikely to change with the exposure of interest.[23 25 26] Another advantage of these designs seeking at short-term effects is that the potential biases are reduced to the factors changing day to day and related to both water and health effect indicators. The main limitations of these studies in providing strong evidence derive from their ecological design.[27] Thus, the measurement of exposure is a daily average for the city, the correlation of which with the personal exposure depends on individual patterns of water drinking, such as the amount of water consumed. In a recent paper[28] Schwartz and Levin, answering some criticisms after another article on this topic,[23] argued that most of the misclassification error in exposure was non-differential, and the estimated effect resulted biased downward. Besides, they demonstrated that misclassification of disease cannot bias the estimated effect unless misdiagnosis of disease would have to vary daily in correlation with turbidity.

These two articles in Philadelphia,[21 23] contribute, in our opinion, with two principal features. Firstly, from an epidemiological point of view, they deal with endemic rather than epidemic presentation of disease. And, secondly, from the public health point of view, the association occurred in filtered water supply accomplishing the current US standards. It is important to note that the first evidences suggesting the possibility that air pollutants could have a significant impact on health at levels around or below the established standards came from time trends studies, which has been further confirmed by other type of studies. The merit of Schwartz and colleagues has been to show non-detected associations between environmental factors (that is, yesterday air pollution, today water pollution) and health indicators in the ecological domain, with a strong potential for prevention. To improve the knowledge about endemic waterborne disease, the use of other surrogate measures of microbial contamination of drinking water in addition to turbidity has been claimed,[29] as well as a search of the impact of its variations on general population rather than focusing only on people demanding hospital attention.[29 30]

In Europe, to date, no reliable data are available to estimate the burden of water related diseases and waterborne disease outbreaks. In 1997, the WHO for Europe asked 52 European countries for information on health effects related to contaminants in water for the period 1986–1996.[5] Only 26 countries returned the questionnaires. Furthermore, not all these countries provided data on waterborne diseases or outbreaks. Most countries reported less cases of gastrointestinal diseases linked to drinking water than cases of such diseases reportedly associated with outbreaks. For example, Spain did not provide data about the gastrointestinal disease incidence, however it was the country with the highest number of reported waterborne outbreaks (n=208).

The understanding of the actual impact of drinking water quality on human diseases will be difficult to reach. On the one hand, to establish solely stricter water treatment guidelines could not ensure a tap water completely free of risks. On the other hand, a passive surveillance system has serious limitations to detect endemic gastrointestinal disease, and even mild or moderate outbreaks. It could be more convenient to combine monitoring water quality and epidemiological surveillance.[31 33] A comprehensive public health surveillance strategy seems the most efficient approach to better understand and control the impact of water quality on gastrointestinal disease. The proposals for *Cryptosporidium* surveillance[18 19] could be extended to other gastrointestinal diseases, including: increase of surveillance for cases of diarrhoea and/or vomiting, especially of populations at risk; standardisation of laboratory detection; designation of specific gastrointestinal illnesses as reportable diseases; and an accurate investigation and control of waterborne outbreaks. Seroepidemiological studies have also been proposed as an alternative to improve estimates of the extent of endemic waterborne transmission for many aetiological agents.[33 34] The use of time series techniques in surveillance has been recommended.[31] However, the use of more specific indicators of water contamination are required to improve the surveillance methods of "safe" drinking water contamination in gastrointestinal infections in the developed world. Because of the fact that many pathogens could have a potential role in waterborne diseases it is important to investigate developing methods that can simultaneously measure the presence of many pathogens. In this sense, the use of DNA chip technology[35] could represent a good chance to detect the presence of multiple pathogens in drinking water. Regarding the potential benefits of surveillance, an analysis of the Milwaukee cryptosporidiosis outbreak using dynamic modelling suggested that, had surveillance systems detected the earlier outbreak, up to 85% of the cases might have been prevented.[36]

Besides surveillance, two more needs have been stated as crucial for the future microbiological safety of drinking water, integration of risk assessment methodologies, and the understanding of the pathogen's ecology.[2 17 20] Regarding the understanding of the aetiological processes, evidences from time series studies, as in the field of the study of air pollution effects, must be complemented by studies on sensitive people and on pathogenic mechanisms of microorganisms. Furthermore, a more proactive role of public health professionals has been demanded[20] encouraging the promotion of a communication programme with physicians and other sanitarian professionals, and contributing to the development of public health policies that limit contamination of source water, improve water treatment and protect public health. Lastly, but not least, drinking water industry and the public must be informed and invited to participate in the design and goals of the new disease surveillance and public health programmes.

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