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Marine Pollution Bulletin 53 (2006) 569–578
MARINE POLLUTION BULLETIN
www.elsevier.com/locate/marpolbul

Challenges to global surveillance of disease patterns

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Abstract

Surveillance systems for foodborne disease vary in capacity by country, especially for marine-related illnesses. Generally, the more developed the country is, the more funding that is put into its surveillance programs, but no country has an outstanding system that could serve as a model for all others. An additional problem is lack of consistency. Approaches to surveillance and available resources change over time, so that apparent trends may reflect more of an administrative function. Most countries have some passive system that allows data on foodborne illnesses to be sent to centralized authorities where summaries are generated. However, these depend on the uneven quality of the source data that vary according to the resources allocated at the local level. Active surveillance systems collect data targeted to answer specific epidemiological questions more efficiently, but at such a high cost that most countries do not have the resources, except on a occasional basis. There is also the issue of what to do with the collected data. There has to be a conscious effort to translate the problems identified from the surveillance programs to consider strategies for prevention and control of foodborne disease. Otherwise, there is little value in having these kinds of monitoring programs. Another problem is lack of coordination in surveillance systems between most countries, so that information can be rapidly and efficiently shared. That being said, surveillance over the years had generated much interesting information on how disease agents are transmitted through the food supply, and where contamination and growth by pathogens in the food production and preparation chain typically occur. In addition, attempts are being made to create regional networks in different parts of the world usually initiated by organizations like WHO and PAHO. The kinds of information collected and programs being introduced are discussed in examples taken from both the developed and less developed world, followed by a series of recommendations for improving surveillance on a global basis. A recent burden in the surveillance system is the potential for a deliberate attack on the food supply with agents not usually involved with foodborne illness. At least in the US, a major concern is for the rapid detection and containment of a massive contamination of the food supply.

Keywords: Global; Surveillance systems; Foodborne disease; Seafood; Bioterrorism

1. Introduction

The broad objective of foodborne and enteric disease surveillance systems has been defined to identify causes of disease so that prevention and control programs can be introduced and strengthened (Todd, 2001). These programs can include:

- early alert of illnesses;
- notification of diseases through physicians reporting to a central epidemiological agency and reports of laboratory isolations of enteric pathogens to a reference laboratory;
- investigation of incidents of foodborne illness and reporting of results on a regular basis;
- use of special epidemiological studies to determine a more realistic level of morbidity of a foodborne disease; and
- estimation of health and economic impacts, and setting directions for control programs.

There are, however, great discrepancies in the ways countries develop and support foodborne and enteric disease surveillance systems. This is partly a result of the priorities that governments assign to this and partly due to the

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doi:10.1016/j.marpolbul.2006.08.004

resources and expertise available. Thus, there is a tendency for developing countries to have much less information on the burden of foodborne disease than industrialized countries even though contaminated food and water is suspected to be at higher levels in these developing nations. However, estimates of these types of diseases are still crude in all countries, and many nations are not able to effectively track trends in disease and identify what agents are involved.

Passive surveillance systems collect a relatively small amount of information on outbreaks because this depends on the public's willingness to report illnesses as well as the public health authorities to investigate and submit reports. More active surveillance systems are being proposed but these are expensive and time-consuming, and there is no standard approach to these. For many countries there seems to be less information on fish and shellfish related illnesses than those from meat and poultry. So, it is a great challenge to assess the worldwide burden of acute diseases from marine and freshwater products. These are caused by a variety of agents such as bacterial, viral and parasitic pathogens as well as natural toxins, but rarely receive notoriety except where there are occasional outbreaks (e.g., Norovirus in molluscan shellfish from polluted waters) and in situations specific to a given locale (e.g., ciguatera in tropical islands, *Vibrio vulnificus* in Gulf of Mexico oysters).

There is perhaps more concern for the presence of heavy metals and pesticides accumulated in fish for trade purposes or long-term effects on vulnerable populations, but traditional forms of surveillance cannot identify easily the relationship between eating such products and a reduced quality of life. Another issue that is hard to measure is the use of private laboratories, such as those connected with hospitals, to analyze clinical specimens for pathogens, and not necessarily report their findings to a public health agency tasked with laboratory surveillance of foodborne or enteric diseases. One reason for this challenge is that national or state/provincial laboratories have been allotted limited resources to perform analyses at no cost to the clients. Thus, it may appear that diseases are less frequent when in fact their burden is just less known at a regional or national level. The food industry also tests for food internally or with contracts with consultant laboratories, but rarely is this information made available to food control agencies. For trade purposes exporters are increasingly sending samples to third party certifiers so that their products are acceptable to the importers, but virtually none of this information is captured in surveillance studies.

It is apparent that a core challenge to determining the burden of seafoodborne illness resides, in part, in the inherent weakness of surveillance to assess the level, source and severity of foodborne illness. Here, a very limited selection of surveillance systems are reviewed to consider strengths and weaknesses to determine the burden of foodborne disease, with some reference to fish and shellfish. With this broader focus on all food it is hoped that a refined understanding of opportunities seafood assessment could more easily emerge.

2. Examples of countries and regions that have consolidated and improved their activities for surveillance and control of foodborne disease

While several supranational organizations hold the role of compiling and reporting disease data, virtually all surveillance data emerges from national governments (with some measure of regional coordination). This paper provides a general survey of both national programs and regional coordinating bodies.

2.1. The European Union

The European Union EU has set up an Early Warning and Response System, linking the designated authorities in member states and the European Commission and providing early information on events that could be an EU health threat (WHO, 2000). A major foodborne outbreak with the potential to spread could and should be included. More specifically for foodborne disease, there has been increasing coordination over the last several decades through the establishment of the EU and the WHO Surveillance Programme for Control of Foodborne Infections and Intoxications in Europe. The seventh Report on Surveillance of Foodborne Diseases in Europe held information for the years 1993–1998 and covered 50 countries (including some non-EU members states) (WHO, 2003a). Some nations supply considerable detail on both laboratory enteric isolates and foodborne disease outbreaks relying on a long history of surveillance activities; others had more limited or no data at all in several categories.

Another recent non-governmental report evaluated data in northern Europe (Hataka and Pakkala, 2003). According to the authors, *Campylobacter* infections (as defined cases per 100,000 population) increased significantly in Denmark, Finland, Iceland, Norway, and Sweden from 1985 through 1999 (approximately, Norway from 10 to 45, Iceland from 20 to 160, Sweden from 40 to 80, and Denmark from 25 to 60). There was less change with salmonellosis, with a decrease in Sweden and an increase in Denmark (approximately, Norway 20–30, Iceland 35–30, Sweden from 90 to 50, Denmark from 25 to 60). *Salmonella* Enteritidis and *Salmonella* Typhimurium were the main serovars in all countries. Many of the cases were claimed to be from foreign travel; this is supported by the drop in the salmonellosis rate in Finland from 1990 through 1993 associated with a recession that reduced the number of Finns taking holidays abroad. *Yersinia enterocolitica* was the third most common enteric pathogen with the highest rate in Finland of 3–9 cases/100,000. There were sporadic cases of *Escherichia coli* O157:H7 and *Listeria monocytogenes* in all countries but few outbreaks (cases reference single discreet illnesses while outbreaks denote two or more cases derived from the same source). Most outbreaks between 1993 and 1998 were caused by *Salmonella*, *Bacillus cereus*, *Staphylococcus aureus*, *Clostridium perfringens* and noroviruses. While only 1.1% of outbreaks were related to shellfish poisonings it is recognized that many outbreaks are not reported and annual reports provide a poor reflection of the reality.

Studies estimate that about 500,000 foodborne disease cases occur each year in Sweden, with 32 to 134 food sourced outbreaks reported annually. Denmark associated three waves of salmonellosis with chicken in the late 1980s, pork in the mid 1990s, and eggs again in the mid-late 1990s. In the other Nordic countries most *Salmonella* infections were acquired abroad. Although all countries have a *Salmonella* control program to reduce contaminated sources, cases increased in both Finland and Sweden in 1999 with outbreaks from sandwiches, sauces, lettuce, alfalfa sprouts and cheese made with unpasteurized milk. There were also a number of outbreaks on ferries from a variety of foods served aboard. The large increase in *Campylobacter* cases was attributed to consumption of raw milk, poultry and pork products. On Iceland, an increase in cases in 1998 was associated with the availability of fresh broilers but has decreased since 2000 as result of a national control program. Concern with the rising number of *Campylobacter* cases led the Nordic countries to establish a major program to assess the risk and look for control strategies. An interesting observation by Helms et al. (2003) was that 2.2% of people infected with the *Salmonella*, *Campylobacter*, *Y. enterocolitica* or *Shigella* died within one year after infection compared with 0.7% of controls identified in Denmark. The risk of short-term death, even after preexisting illnesses were taken into account, was three times higher among patients infected with one of the four bacteria. Although this was a Danish study, there is a strong probability that this is a universal situation. Thus, acute foodborne illness may have significant consequences at least to some of those affected, and control strategies related to prevention may have to be strengthened.

For outbreaks associated with marine foods, the following were documented: *Clostridium botulinum* in homemade rakefisk, a partially fermented dish (Norway), *L. monocytogenes* in vacuum-packed trout (Finland and Sweden), *Vibrio parahaemolyticus* in crayfish imported from China (Sweden), *Vibrio cholerae* in mussels smuggled in from Thailand (Finland), Norwalk-like viruses (now called noroviruses) in oysters and mussels, and histamine in canned tuna fish.

In 2002, the European Food Safety Authority (EFSA, 2005) was approved. The primary responsibility of the Authority is to provide independent scientific advice on all food safety matters with a direct or indirect impact on food production and supply. A key task of the Authority is to communicate directly with the public on its areas of responsibility. Thus, the mandate is not for surveillance directly but to use data obtained from surveillance. It will work with EU Network for the Surveillance and Control of Communicable Diseases to allow close cooperation and effective coordination between EU states in the field of surveillance and control to improve the prevention and control of serious communicable diseases (EU, 2005). The Network works to develop general agreement on terms and case definitions; the nature and type of data and information needed to be collected by the national structures; epidemiological and microbiological surveillance methods used; control measures especially for emergency situations; and guidance on good practices to reduce illnesses.

2.2. Australia

Australia represents a country where progress in surveillance and meaningful reporting of foodborne disease outbreaks, as well as a focus on risk-based control programs, has progressed substantially in the last 10 years. The Communicable Disease Network Australia (CDNA) was established in 1989 as a joint initiative of the National Health and Medical Research Council and Australian Health Ministers' Advisory Council (CDNA, 2005). Its brief was to oversee:

- the coordination of national communicable disease surveillance,
- the response to communicable disease outbreaks of national importance; and
- field training of communicable disease epidemiologists.

CDNA cooperates with health authorities in New Zealand and other countries. Since 1995, the Network has overseen the implementation and development of the National Communicable Diseases Surveillance Strategy. The strategy aims to develop the infrastructure and systems for effective national surveillance, preparedness and responses to communicable disease risks. The National Enteric Pathogens Surveillance System Steering Committee within CDNA is the committee most relevant to foodborne and enteric disease surveillance. CDNAs Public Health Laboratory Network (PHLN) ensures that key laboratories around the country are aware of the most appropriate analytical methods and facilitating specialist training. In Australia, some trends in notifications of foodborne diseases were apparent for 1991–1995. Laboratory isolates for *Campylobacter* and *Salmonella* increased, those for *Shigella* and *Yersinia* decreased, and those for *L. monocytogenes* varied slightly from year to year.

The federal government established OzFoodNet (2003) in 2000 as a collaborative project with State and Territory health authorities to provide better understanding of the causes and incidence of foodborne disease in the community and to provide an evidence base for policy formulation. It is overseen by the Communicable Disease Network of Australia, and is supported by technical assistance from the National Center for Epidemiology and Population Health at the Australian National University, Food Standards Australia New Zealand and the Public Health Laboratory Network. OzFoodNet aims to minimize foodborne illness in Australia by:

1. estimating the incidence and cost of foodborne illness in Australia;
2. improving the understanding of the epidemiology of foodborne disease, by enhancing surveillance and conducting special studies on foodborne pathogens;
3. identifying inappropriate practices in domestic and commercial settings which lead to food contamination and foodborne illness;
4. assessing the efficacy of current and proposed food hygiene standards and their enforcement by jurisdictions;
5. providing data essential for future risk assessments and policy interventions; and
6. training people to investigate foodborne illness.

In support of disease surveillance, OzFoodNet epidemiologists review and interpret data collected by State and Territory health departments, so that there can be rapid reporting of outbreaks with a particular focus on emerging problems, and notifications of foodborne infections to health agencies. In addition, regular summary reports of outbreaks will indicate the most frequent risk factors associated with food and show trends over a period of time. These data also have the ability to identify industry sectors responsible for outbreaks of foodborne illness. In areas where there are repeated problems, information is passed to State and Territory authorities for action and to appropriate national policy committees. Each state and territory health department (8 in total) receives funding to hire epidemiologists, conduct special research studies and enhance surveillance. OzFoodNet Sites within state and territory health departments are required to provide fortnightly, quarterly and annual reports. Informal communication about surveillance and outbreak occurrence occurs on monthly teleconferences, six monthly face-to-face meetings and on an electronic listserve. The results of outbreak investigations are stored for future analysis and policy development. OzFoodNet has carried out a number of surveillance related activities (personal communication, Martyn Kirk Coordinating Epidemiologist, OzFoodNet Food Safety and Surveillance, Department of Health and Ageing, Canberra City, Australian Capital Territory). These include:

1. A national survey of 6000 people concerning gastroenteritis in the "community" was used to estimate the burden of foodborne illness in Australia, between 4 and 6.4 million cases of foodborne gastroenteritis each year, of which about 1 million are of known etiology (mainly enteric viruses, *Campylobacter* and *Salmonella*), and about 100 deaths. Estimates are similar to those derived from FoodNet population surveys for the US (controlled for differences in population).
2. A national case control study of 1000 cases and 1000 controls about risks for acquiring *Campylobacter* infection showed that it was most frequently associated with poultry consumption.
3. Several national case control studies for *L. monocytogenes*, *S.* Enteritidis and Shiga-toxin producing *E. coli* infections have been initiated.
4. *Campylobacter* typing methods, using eight different phenotypic and genotypic methods, are being compared to determine the best means of typing for outbreaks, routine surveillance and special studies.
5. Training programs for Environmental Health Officers to investigate foodborne disease and outbreaks of human illness.

In a report from the Disease Working Party for the Communicable Diseases Network Australia and New Zealand (Commonwealth Department of Health and Family Services, 1997), marine foods were specifically discussed. Although finfish can become contaminated by vibrios and sporeformers, the main risk is cross-contamination during later handling in commercial processing and both commercial and in-home preparation. Rock oysters have been implicated in several incidents of foodborne illness contaminated with norovirus and hepatitis A virus from contaminated water with hundreds of individuals affected. Ciguatera poisoning is an ongoing issue in Queensland where amateur fishermen catch and eat large fish from affected reefs. There have also been recent outbreaks of oily diarrhea associated with consumption of "escolar" and other fish species containing indigestible wax esters (Shadbolt et al., 2002).

2.3. Canada

The surveillance situation in Canada may appear confusing since the recording of protocols for enteric disease, including those that are foodborne, vary broadly across agencies and jurisdictions. Participants at the 1995 National Consensus Conference on Foodborne, Waterborne and Enteric Disease Surveillance recommended the development of a report showing trends in enteric disease in Canada using data consolidated from multiple sources. (Health Canada, 2003). The databases used to prepare this more integrated report were developed for different reasons and contain different data elements. In general, notification of a case of enteric disease is initiated with laboratory confirmation of a notifiable agent (i.e., an agent holding the status of required notification to a central authority). The local public health unit is informed of the case by the laboratory or physician and through subsequent follow-up acquiring more detailed information about the patient and the potential risk factors. Local and regional laboratories forward some enteric pathogens to provincial/territorial laboratories for confirmation and identification. Provincial/territorial laboratories send summary information from cases associated with these isolates to the

National Enteric Surveillance Program (NESP). As well, they send some isolates to the National Laboratory for Enteric Pathogens (NLEP) for identification and additional subtyping. Isolates from non-human sources (food, animals and the environment) are sent to the Laboratory for Foodborne Zoonoses (LFZ) for subtyping and confirmation. An additional source of data is the Discharge Abstract Database (DAD) from the Canadian Institute for Health Informatics (CIHI), which contains data about hospital admissions across the nation. The Bureau of Microbial Hazards of the Food Directorate also published detailed reports on foodborne and waterborne disease outbreaks up to 1995 that were used as background for educational and regulatory strategies. Thus, each database provides a unique perspective on enteric diseases in Canada, with the quality varying with the sources, especially if local and provincial data are key components. The systems described above were essentially passive (personal communication, Paul Sockett, Director, Foodborne, Waterborne and Zoonotic Infections Division, Centre for Infectious Disease Prevention and Control, Public Health Agency of Canada). Over the last 10 years, the Canadian surveillance programs for foodborne and waterborne diseases have evolved significantly. Currently, the systems are active, through provision of weekly reports of laboratory isolations (NESP) from Public Health Laboratories; rapid sharing of PFGE data on specific strains via PulseNet; and real-time reporting of case clusters (outbreaks) via CIOSC (Canadian Integrated Outbreak Surveillance Centre).

2.4. United States

The United States has both passive and active surveillance systems. The passive Foodborne-Disease Outbreak Surveillance System, managed by the Centers for Disease Control and Prevention, is designed to investigate foodborne outbreaks and establish both short-term control measures and long-term improvements to prevent similar outbreaks in the future (CDC, 2005). Olsen et al. (2000) reported on outbreaks from 1993 to 1997. During this period, a total of 2751 outbreaks of foodborne disease were reported (489 in 1993, 653 in 1994, 628 in 1995, 477 in 1996, and 504 in 1997).

Seafood contributed to these figures. During this period there were 60 outbreaks and 205 cases of ciguatera poisoning, 69 outbreaks and 297 cases of scombroid poisoning, and one outbreak (three cases) of an unspecified shellfish poisoning. Relatively few episodes are captured by this passive approach compared with what is thought to occur. With the availability of more accurate FoodNet foodborne disease information, Mead et al. (1999) estimated that 76 million cases, 325,000 hospitalizations and 5000 deaths occur each year in the US. Of these, only 14 million are attributed to known agents; the other 62 million are of unknown origin. Thus, even though this study is accepted as the best estimate to date, there is a high degree of uncertainty as to what is causing many foodborne illnesses.

These estimates indicate that three pathogens, *Salmonella*, *Listeria*, and *Toxoplasma*, are responsible for 1500 deaths each year, noroviruses account for over 67% of all cases, 33% of hospitalizations, and 7% of deaths. However, researchers stressed that the assumptions underlying the norovirus figures are among the most difficult to verify (Mead et al., 1999). Other important causes of severe illness are *Salmonella* and *Campylobacter*, accounting for 26% and 17% of hospitalizations, respectively. All the etiological agents discussed by Mead et al. (1999) are infectious in nature and many could be seafood sources. However, the authors did not attempt systematic estimates of disease from particular foods or food products. Further, illnesses from seafood related toxins and other chemicals are not included in these estimates.

FoodNet is a collaboration by CDC, the US Food and Drug Administration, and the US Department of Agriculture, and created in 1996 to conduct population-based, active surveillance for foodborne infections. The primary objectives of FoodNet are to (1) determine the epidemiology of bacterial, parasitic, and viral foodborne diseases; (2) determine the prevalence of foodborne diseases in the United States; and (3) investigate the link between certain foods and the proportion of foodborne disease caused by their ingestion. FoodNet conducts surveillance for *E. coli* O157:H7, *Campylobacter*, *Listeria*, *Salmonella*, *Shigella*, *Yersinia*, *Vibrio*, *Cryptosporidium*, and *Cyclospora*. This has been successful in monitoring, tracking trends, and defining risk factors for causes of foodborne illnesses, and in estimating the burden of foodborne illnesses in the United States (CDC, 2002). PulseNet is a national network of local public health laboratories that performs DNA characterization ("fingerprinting") of pathogens that may be foodborne to identify outbreaks in a timely manner. The network permits rapid comparison of these "fingerprint" pasterns through an electronic database at the CDC.

The US is one of the few countries to attempt to set goals for a quantitative reduction of foodborne disease. Such goals are to be found in all agencies in the US working to reduce foodborne disease to achieve public health goals as outlined in the Healthy People 2010 initiative (USDHHS, 2005). More than a dozen federal agencies share the lead in articulating and implementing a wide variety of health related goals. The primary foodborne goal is to reduce by 50% the incidence of disease from the main foodborne diseases over the period 1997–2010. Goals are on target for *Campylobacter*, *E. coli* O157:H7, and *L. monocytogenes*, but behind schedule for *Salmonella* which has a rate of 15.1 in 2001 and an objective in 2010 of 6.8 (CDC, 2004).

3. Examples of regions/countries with limited surveillance on foodborne disease

Developing countries tend to have weaknesses in their government public health systems that fail to ensure adequate consumer protection and also weaken their trading abilities for exported food (FAO, 2002). Such weaknesses include:

- outdated food laws, standards and regulations, and sometimes overregulation;
- no centralized approach, or even coordination among departments and agencies, to food control with jurisdictional confusion and overlap;
- lack of adequately trained personnel to carry out compliance activities, including food inspection;
- where food control laboratories exist, they have limited capacity in terms of physical structure, equipment, supplies and technical personnel;
- while food industries (preharvest, processing, retail, foodservice) are familiar with terms like good hygienic practices, good manufacturing practices and the hazard analysis critical control point (HACCP) systems, they do not have the technical ability, or will, to consistently follow through with these;
- neither the government nor the industries of developing nations are able to compete effectively in the export market to be in compliance with the dominant food quality and safety agreements (most notably the Agreement on the Application of Sanitary and Phytosanitary Measures SPS) of the Codex Alimentarius (WHO, 2005a);
- conflict between public health objectives and facilitation of trade and industry development; and
- finally, but not least importantly, limited opportunities for appropriate scientific inputs in decision-making processes.

3.1. Africa

Africa is confronted with great burdens of epidemic diseases: meningitis, cholera, dysentery, malaria, measles, viral haemorrhagic fevers and plague, and not, surprisingly, there is little in the way of foodborne surveillance, although some aspects of surveillance are improving (see, "International" below). As a result, outbreak data are extremely scarce (Todd, 2001). None of the countries of the southern African region (Botswana, Lesotho, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe) have access to adequate information (Frean et al., 2003). Many factors contribute but most commonly: limited resources to investigate outbreaks and complaints of illness and, the assumption that most disease outbreaks can be attributed to contaminated water (with the associated priority assigned these investigations), and the perception held by many regulators that reporting foodborne outbreaks will reduce food exports. In addition, civil wars, conflicts between nations, and refugees and misplaced populations overwhelm any surveillance and control system. Most foodborne disease data in southern Africa comes from South Africa (Frean et al., 2003). with documented cases of "food poisoning" annually ranging from 6 to 334 between 1993 and 1997, and only one death in this period. This is in contrast to hundreds of cases of hepatitis A and typhoid fever reported each year. It is safe to assume that precise disease etiology is quite difficult to establish – including those associated with seafood consumption.

3.2. Asia

Cholera is one of the more rampant enteric diseases in southeast Asia, although cases have generally declined since 1994 (Pitisuttithum, 2003). Typhoid fever, dysentery and enteric fever are recorded but not often laboratory confirmed. However, studies in several countries have shown a high seroprevalence of hepatitis A. Food poisoning is documented in Thailand, but not always thoroughly investigated; reported cases ranged from 126 in 1990 to 99 per 100,000 in 1995. There were an estimated 7 million persons with liver flukes, *Chlonorchis* and *Opisthorchis*, contracted mainly through ingestion of raw or improperly cooked freshwater fish, crabs and vegetables (IARC, 1997). *Salmonella* is a primary foodborne agent of concern and has frequently been isolated from fresh and processed food, e.g., local vegetables and ocean and pond shrimp. *Salmonella* Paratyphi, *V. cholerae* and *V. parahaemolyticus* were isolated from shrimp samples in Java (with the caveats of limited sampling as many as one third of shrimp in some lots have shown microbial contamination), with several shipments destined for the export market rejected because of elevated microbial burdens. Indeed, levels of *E. coli* on headless shrimp have been found up to 10^5 cfu/g. The Thai surveillance system is primarily focused at the district level (Nababan, 2001).

Singapore reports relatively small numbers of foodborne cases <200/year for cholera, typhoid, paratyphoid, and hepatitis A. These low numbers are attributed to high standards of environmental and food hygiene, but outbreaks have been documented including a large institutional one due to *S.* Enteritidis in 1995. Parasitic infections are much lower than in endemic neighboring countries, but consumption of uncooked imported Chinese carp has led to chlonorchiasis and opisthorchiasis. To link reports of illness to control, the National Agency of Drug and Food Control has drafted formal guidelines based on international standards, in part, to ensure continued and open access to international markets. In Viet Nam the Ministry of Health, responsible for food inspection of domestic and imported food, reported that from 1997 to 2000 over 4 million cases of severe enteric disease, e.g., typhoid, cholera and shigellosis. There were 1391 outbreaks involving over 25,000 cases and 217 deaths (Kim and Phuong, 2001).

The Chinese government reports periodically on foodborne illnesses but with little background information. According to the 2002 government statistics, there was a 54.6% decrease in illness and a 5.5% drop in mortality over that in 2001 (7127 ill and 138 deaths in 2002) (Anon., 2003a). Mishandling at retail was articulated as an area of particular concern with the primary source of this concern in dining halls. One specific example occurred in March 2002 when nearly 400 people fell ill, with 60 hospitalized, after they ate contaminated ham at a restaurant in Hunan province, central China; the specific pathogen was not mentioned, only that the ham contained several hundred times the amount of bacteria allowed by national food safety standards (Anon., 2003b). A press release indicated that in early 2003 some 3643 individuals suffered from food poisoning, with 89 reported deaths (Anon., 2003c). The release focused mainly on chemical poisonings, such as an accidental contamination by pesticides and/or rat poison to foods or utensils. Improper procedures in the kitchen were blamed in nine deaths and 1213 illnesses. Unusual for most countries was the high number of deliberate poisonings with 52 dead and 977 injured. No information was given on microbial illnesses although these must predominate as in other countries. There is also an indication that SARS (Sudden Acute Respiratory Syndrome) may have arisen in China through consumption of exotic animals such as palm civet cat (Suzuki, 2003), suggesting a food-related origin.

Afghanistan represents a country where the public health structure has been very limited in recent years because of tribal conflict, war, displaced persons, government fragmentation, poor economy, drought, and earthquakes; epidemics of cholera, measles, malaria, and typhoid have occurred. With international assistance, coupled with national and regional coordination, cholera task forces for surveillance, preparedness and control were established, and case-fatality rates for the disease have dropped sharply (Kakar, 2003). However, remote regions are difficult to access with few roads and potential conflict situations. It required coordination with WHO in Geneva and the Eastern Mediterranean Regional Office for flights, local pack-animal transport and supplies, investigation teams and reference laboratory to identify and treat patients. Only through joint action in the field, collaboration from Regional and Headquarters Offices, and coordinated efforts of other UN agencies and NGOs can an effective and timely response be achieved in situations as complex as Afghanistan.

3.3. Latin America

A systematic approach (SIRVE-ETA) towards investigation and reporting of foodborne disease has been developed in Latin America and the Caribbean by the Pan American Health Organization (PAHO) at INPPAZ (Instituto Panamericano de Proteccion de Alimentos y Zoonosis) in Buenos Aires (Franco et al., 2003). The main object of SIRVE-ETA (Sistema Regional de Informacion para la Vigilancia de las Enfermendades Transmiti das por los Alimentos) is the collection and dissemination of data on foodborne disease outbreaks. Quarterly reports are supposed to be sent by each nation to INPPAZ on the number of outbreaks, etiological agents, foods involved, locations, and age of infection persons. Between 1995 and 2001, 5283 outbreaks with 174,976 cases and 123 deaths, were recorded in 19 countries. The total number of outbreaks ranged from 1203 (39,444 cases) in 1996 to 14 (733 cases) in 2001. The remarkable decrease in 2001 from 856 episodes and over 28,000 cases the year before is not explained but presumably is an artifact of reporting. It may be that countries did have data but did not share these with INPPAZ. For instance, although no outbreaks were reported to INPPAZ in 1995, 1997 or 2000 for Brazil, the Brazilian State of Parana documented over 100 outbreaks a year, a total of 15,203 cases from 1995 to 1997. A truer figure for all Latin America and the Caribbean based on US estimates may be at least 10 million cases annually.

3.4. International

The international organization with primary responsibility for foodborne disease assessment is the UNs World Health Organization (WHO). WHO coordinates with partners – national (ministries of health, scientific institutes) and international (networks, other organizations, NGOs) to develop new approaches in international surveillance and early warning, some of which apply to enteric pathogens and foodborne disease. WHO has a role in global outbreak response to assist Member States on request by mobilizing international response teams, coordinating response, facilitating access to countries, providing technical guidelines, facilitating research activities and supporting national epidemic preparedness.

Networks with relevance to foodborne disease include:

(1) Global Salm-Surv, a global network of laboratories and individuals involved in isolation, identification, serotyping and antimicrobial resistance testing of *Salmonella* and *Campylobacter* to strengthen the capacities in surveillance and control of major foodborne diseases, and to reduce antimicrobial resistance in foodborne pathogens (Anon., 2003d). Started in 2000, it fosters collaboration among human health, veterinary and food-related disciplines in national institutions working with foodborne diseases and pathogens. It promotes an electronic exchange of information, provides training courses and develops reference testing services. There are 516 members of Global Salm-Surv, including 134 institutions from 113 countries.

(2) The Global Public Health Intelligence Network (Public Health Agency, 2004), developed by Health Canada with assistance from WHO, is an Internet-based, time-sensitive warning system for global, public health events (from outbreaks over environmental disasters to bioterrorism), continuously scanning electronic sources for information. This early warning global surveillance system disseminates information on global public health events through a secure website, on a real-time 24/7 basis.

(3) The present International Health Regulations were endorsed in 1969 by the World Health Assembly to ensure maximum security against international spread of diseases with a minimum interference with worldwide traffic (WHO, 2005b). They are currently under revision in order to

respond to the challenge of increasing travel and trade in a globalizing world, and the still existing threat of outbreaks of emerging and re-emerging diseases.

(4) WHO has a network for epidemiological training on sustainable outbreak alert, response and preparedness within the public health system to enhance national health programs by using epidemiology as a tool to enhance delivery of public health services (TEPHINET, 2004). Trainees from health departments are put through a flexible two-year competency based curriculum with the guidance of an external consultant, to form a core of motivated individuals that can transform the department from within.

WHO has adopted a regional effort in developing an integrated disease surveillance and response approach (WHO, 2003a,b). Pilot efforts were conducted in several WHO Regions, with a five-year progress evaluation in Uganda recently being completed as an initial test of this integrated approach. A list of 23 priority diseases was defined for surveillance purposes, and an early warning component defined by diseases with epidemic potential or those with the potential for elimination/eradication. Surveillance reporting forms were revised accordingly.

Results suggest that immediate and weekly reporting are well established, with more than 90% of the districts now reporting, as opposed to 60% in 2002. These reports are analyzed for disease occurrence and trends by district. The Uganda federal government has developed an initiative to award prizes to districts with indicators of success. District laboratory coordinators have been appointed in 80% of the districts. The national level and all districts have rapid response teams, which include laboratory personnel that investigate rumors and suspected outbreaks. All districts now have operational rapid response teams as opposed to 57% in 2000. All these efforts have resulted in timely confirmation of 80% of outbreaks in 2002, A doubling since 2000. For example the antimicrobial resistance of 6 enteric bacterial pathogens with epidemic potential in Uganda in 2001–2002 was determined. On the whole, significant progress was identified in the evaluation.

However, evaluators also identified the need to (1) improve feedback from district to lower levels and to motivate health workers and community based organizations; (2) involve private practitioners in surveillance, (3) train in statistical and mapping software programs, and (4) standardize surveillance tools and software with various institutions, partners and organizations promoting different tools. Crucial elements are (1) the support of the WHO country office, (2) strong political commitment, advocacy and networking, and (3) strong donor support. There remains a need to sustain gains made and to continue investing in building national capacities for surveillance and response for national, regional and global health security.

4. Bioterrorism/biosecurity

In recent years, there has been heightened interest in and concern for security of foods, their ingredients, and distribution for deliberate contamination. Detection of agents or means of delivery used by terrorists or disgruntled employees do not fit well with traditional approaches to surveillance. These individuals will try and cause events that have a severe impact either directly on the health of individuals or on the economics of an industry, but they would be expected to occur only on rare occasions and are quite difficult to predict. Yet, preparedness is recognized as critical to reduce the impact of any event and is also a deterrent to potential attacks. A web-based syndromic surveillance system might be effective in having early input into an outbreak with the potential for widespread infection or intoxication and could mitigate impact, by linking with national or state emergency preparedness and response teams. Increasingly, industries in the food production, processing and retail business, and the agencies responsible for control, need to partner to minimize risks through early detection and containment of events. Nearly 20% of all imports into the US are food and food products (by volume).

The events of September 11, 2001, reinforced the need to enhance the security of the US, and Congress responded by passing the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (the Bioterrorism Act). This requires domestic and foreign facilities that manufacture/process, pack, or hold food for human or animal consumption in the United States to register with the FDA (USFDA, 2002). If a foreign facility is required to register but fails to do so, its food is subject to being held within the port of entry. The Act requires that FDA receive prior notice before food is imported or offered for import into the United States. Advance notice of import shipments allows FDA, with the support of the Bureau of Customs and Border Protection, to target import inspections more effectively and help protect the nation's food supply against terrorist acts and other public health emergencies. Under the "prior notice regulation", prior notice of imported foods must be received and confirmed electronically by FDA no more than five days before its arrival and no fewer than:

> two hours before arrival by land via road; four hours before arrival by air, or by land via rail; or eight hours before arrival by water.

The FDA expects to receive about 25,000 notifications about incoming shipments each day. Thus, importers of food to the US are subject to demanding measures before they can export products. However, it does improve surveillance of shipments arriving at ports so that they can be effectively inspected and released.

5. Conclusions and recommendations

Surveillance systems around the world range from good to almost non-existent. None is completely effective in the detection of clusters of illnesses or rapidly implementing control measures. There is little coordination in surveillance systems between most countries, but recently regional networks are being developed so that information can be shared. The 2004 tsunami disaster is an example of an early warning system that should have been in place and could have saved tens of thousands of lives, and moves are being put in place to reduce the impact of a future tsunami (Morrissey, 2005). Such events, however, bring new focus on surveillance systems and the value of vital information in the mitigation of risk – whether natural or human-induced. Added emphasis for better surveillance, international trade and travel. Globalization is no longer a philosophy but a description of commerce; integrated surveillance can and should evolve from global views. Contaminated food products can be prevented from reaching consumers and borders closed to travelers to contain foodborne risks and those held in infectious diseases like SARS and avian flu. Without more active and shared surveillance data, global epidemics will become more and more real parts of our shared future.

A more complicating factor are increasing opportunities for emerging diseases, most of which have been zoonotic in origin. Such driving forces as globalization, new technologies, restructuring of agricultural systems, and consumerism are creating new conditions for emerging and reemerging zoonoses. We are today expanding into every conceivable ecological niche, displacing animal habitats, feeding meat products to herbivores, dining on exotic predators, and raising food animals in habitats that allow transfer of bacteria and viruses from the wild to humans (Suzuki, 2003). Consequently, we are exposed to "new" diseases that have never before infected humans. The aquatic environment is badly over exploited and the seafood industry is continually seeking new sources of fish and shellfish that inevitably will lead to new hazards being encountered, such as seafood toxins from harmful algal blooms (Glibert and Pitcher, 2001). All these scenarios indicate the need for a much more robust global surveillance system to detect not only current issues but be able to anticipate new problems.

The following are recommendations for improving surveillance of foodborne diseases – including those associated with fish and shellfish.

- At the national level enhance the global capacity to respond to disease threats, with coordination through WHO, focusing in particular on threats in the developing world.
- Encourage and, where necessary, reward physicians and local jurisdictions for contributing to national and regional databases.
- Consolidate existing databases to generate one set of national data for each agent (e.g., notifiable diseases vs. lab isolations) that can be compared with those in other countries.
- Have technical resources to interpret the data to look for meaningful trends that can point to appropriate control measures.
- Encourage more focus on active surveillance with population-based sentinel studies, and use special case-control studies to identify risk factors for each type of foodborne illness. This would better allow regulators to incorporate data into risk assessments, to consider intervention strategies for prevention and control, and to assist in meaningful educational programs.
- Set public health goals to reduce foodborne disease for each country and monitor progress with surveillance data; it is obviously difficult to determine appropriate budget allocations without achievable goals.
- Support research on innovative systems of surveillance for rapid detection, (e.g., syndromic surveillance), GIS, and for specific pieces of information that are needed for targeted mitigation and control strategies.
- Ensure coordination and/or harmonization of different surveillance data bases and computer software.
- Have adequate and committed long-term funding both from nations and donor organizations for the poorest developing countries. Investments should take the form of financial and technical assistance (medical, veterinary, and entomological surveillance, as well as laboratory capacity, i.e. epidemiological, statistical, and communication skills); and the development harmonized systems to ensure the rapid sharing of information across national boundaries.
- Develop and improve regional networks in different parts of the world to obtain quality population-based data on disease burden and trends in the developing world through global surveillance. The eventual aim is a global surveillance system into which member states contribute to and draw upon information needed to mitigate the risk in a system that not only integrates economically but shares risks globally as well.

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