PUBLIC HEALTH SYSTEM CHANGE INTO THE 21ST CENTURY

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April, 2004

Acknowledgements: Sincere thanks are extended to Drs. Stan Houston, Steve Hrudey, Colin Soskolne, Duncan Saunders and Lory Laing for for their very helpul reviews and advice pertaining to various sections of this Report. It should be noted that although all advice was considered, the final responsibility for errors or omissions rests with the authors.

I. GENERAL INTRODUCTION

In the past few years, public health incidents have occurred that have caused some alarm in Canada. These include communicable disease outbreaks such as Severe Acute Respiratory Syndrome (SARS), Influenza and Influenza-Like-Illness (ILI) and water-borne diseases such as *Escherichia coli* 0157:H7 (*Ecoli*) and *gastroenteritis.* There were also environment incidents that occurred such as those caused by *Polychlorinated Biphenyls* (PCBs), dioxins, furans, and microcystine. On the global scene also, there have been these, and other, public health incidents of varying types and magnitudes, which, equally, may have arisen from gaps in the public health system.

Rationale for study

The need for this study was based on the assumption that given this broad upsurge in readily transmittable illnesses and conditions, that public health gaps may now exist in Alberta just as they exist in many other health systems Worldwide. This review identified public health gaps in Canadian and some international public health systems in regard to the incidents or outbreaks. In doing so, lessons were learned from the strategies developed by the various public health systems in which the reviewed public health incidents occurred. These in turn formed the basis for recommending ways of strengthening and repositioning the Alberta and other public health systems to cope with the public health challenges of the 21st century.

Scope of the study

Public health covers many activities and functions. In this project, public health has been defined as "an organized process, which protects and promotes physical and mental health and prevents disease, injury, disability, and premature death". Public health services are population-based services, which are focused on improving the health status of the entire population plan (Nebraska Public Health Improvement Plan, 1999).

In all, five diseases, disease categories or public health incidents were reviewed. These are SARS, Influenza or Flu, Water-borne disease outbreaks, Poliomyelitis, Yellow Fever and Cholera treated together under one chapter and global environment incidents of PCBs, Dioxins and Furans. Public health incidents from the following countries were reviewed: Canada, the United States, some countries of Asia notably China, Hong Kong, Thailand, Vietnam, Singapore and Cambodia. Incidents were equally reviewed from England, Denmark, Nigeria, Ghana, The Netherlands, Togo, Burkina Faso, Chad, Benin, Cameroon, Guinea, Sierra Leone, Comoros, Cote d'Ivoire and Malawi. Others are Mozambique, Democratic Republic of Congo, South Africa, Tanzania, Uganda, Zimbabwe, Burundi, Mali, Mozambique, South Africa and Zambia.

Approach/Procedure

Published and unpublished materials on the disease outbreaks or health incidents from several countries were reviewed. The study also relied on Internet resources and, when and where necessary, verbal discussions with experts in the areas under review. In each chapter the following four sub-headings were created: Introduction, responses or reactions (local and global), public health gaps, and lessons for the future. In addition to these four sub-headings, sources of PCBs, dioxins and furans as well as research findings on PCBs, dioxins and furans were also added as sub-heading in the fifth chapter on PCBs, Dioxins and Furans.

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II. SARS OUTBREAKS IN AND OUTSIDE CANADA

Introduction: In November 2002, a strange infectious disease diagnosed as communicable atypical pneumonia, occurred in the Guangdong Province of China. The World Health Organization, (WHO) documents that, the new disease, later to be known as Severe Acute Respiratory Syndrome (SARS) had by February 2003, spread to Hong Kong. It subsequently extended to 32 other countries (mostly in North and South America, Europe, and Asia) or regions, infecting approximately 8,459 patients and resulting in more than 800 deaths.[1] The most affected locations were China, Hong Kong, Singapore, Vietnam, Taiwan, and Canada. In Singapore, a SARS case was first recognized on March 12, 2003. As of June 12, 2003, a total of 206 cases and 31 deaths attributed to SARS had been reported in Singapore alone.[2] SARS is reputed to be the first severe and readily transmissible disease of the 21st century.

In July 2003, SARS cases were no longer being reported, and the disease outbreaks worldwide were considered contained. That was not to be as the disease bounced back on January 8, 2004 in the same Guangdong province of China, where the first outbreak was recorded in November 2002.

The cause of SARS is not yet confirmed, but a novel human corona virus (SARS-CoV) has been identified and resembles a virus found in civet cats.[3] SARS is the latest in a series of new infectious diseases (e.g., HIV/AIDS, Ebola, Nipah, and Avian H5N1 influenza) that are adding additional stress to Worldwide healthcare system already dealing with the resurgence of established conditions (e.g., dengue, malaria, and tuberculosis).

SARS is now a global public health threat with many medical, ethical, social, economic, political, and legal implications. Experts have observed that the nonspecific signs and symptoms of this disease, coupled with a relatively long incubation period and the initial absence of a reliable diagnostic test, limited the understanding of the magnitude of the outbreak. Added to these myriad complications is the fact that global air travel is now commonplace and has facilitated the international spread of SARS.

The SARS virus appears to have been contracted from an animal source (possibly civet cats used for human consumption. Close contact between humans and animal vectors in southern China

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[1] Abdullah A.S.M, Tomlinson B, Cockram, C.S and Thomas G.N (2003). Lessons from the severe acute respirator syndrome outbreak in Hong Kong. *Emerging Infectious Diseases.* Available from: URL: http://www.cdc.gov/incidod/EID/vol9no9/03-0366.htm

[2] World Health Organization (2003). *Cumulative number of reported probable cases of SARS* [June 23].
Available from: URL: http:/www.cdc.gov/ncidod/EID/vol9no9/disc09.htm

[3] Drosten C, Gunther S, Preiser W, van der Werf S, Brodt H-R and Becker S (2003). *Identification of a novel coronavirus in patients with severe acute respiratory syndrome.* [April 10]. Available from: URL: http:/www.cdc.gov/ncidod/EID/vol9no9/disc12.htm

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has been responsible for a number of epidemics, including influenza A. SARS is clinically characterized by fever, dry cough, myalgia, dyspnea, lymphopenia, and abnormal chest radiograph results. The WHO criteria to define a suspected case of SARS include fever (>38°C), respiratory symptoms, and possible exposure during 10 days before the onset of symptoms; a probable case is defined as a suspected case with chest radiographic findings of pneumonia and other positive evidence.

SARS seems to spread primarily by close person-to-person contact, such as in situations in which persons have cared for, lived with, or had direct contact with respiratory secretions and/or body fluids of a person known to be a SARS case. Its potential infection/transmission modes are close contact which includes touching the skin of other persons or objects that become contaminated with infectious droplets and then touching your eyes, nose or mouth. To date, no evidence of airborne transmission of SARS exists, although the virus can be carried on water droplets for a short period of time.[4]

Local and Global Reactions to SARS: Reactions to the SARS outbreak were many and varied. In China, as it was in many other countries where outbreaks occurred, panic, uncertainty, confusion, and in some cases, conflicting communications ran through affected and yet-to-be-affected communities. Patients with suspected SARS cases were subjected to laboratory tests, hospitalized and their close contacts traced and medically monitored. Many suspected patients were also quarantined. Other measures that were adopted to control community transmission (i.e., outside of healthcare settings) and prevent international spread included public information campaigns, mounting of hotlines to report fever, temperature screening in public places, recommendations to travelers, and entry and exit screening at borders with questionnaires and temperature checks. Within countries and at a global level, there were intensified surveillance activities to check the spread of the disease. In Toronto, as in other parts of North America and some European countries, there was mounting stigmatization and scape goating of Asian populations who were believed to have been responsible for the outbreak and spread of the disease. [5]

Public Health Gaps: Weeks after SARS broke out in China, reports indicate that local, provincial, and federal authorities in China were not forthcoming in disclosing to WHO and the world the nature and severity of the new disease in the country. These accusations appeared to have been confirmed with the apology, which the Chinese government later tendered to the world for not properly handling and disseminating SARS information. Two high-ranking China health officials lost their jobs following their alleged official negligence and ineptitude in SARS handling. Some observers also identified gaps in WHO's intervention and strategy. The world's

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[4] Lee N, Hui D, Wu A, Chan P and Cameron P, Joynt GM, et al (2003). A major outbreak of severe acute respiratory syndrome in Hong Kong. *New England Journal of Medicine*, 348, 1986-94.

[5] World Health Organization (2003). *Update 33 – Affected areas, status of SARS outbreaks in individual countries* [18 April]. Available from: http://www.cdc.gov/ncidod/EID/vol19no9/disc20.htm

apex health organization was accused of failing to timely issue travel advice on China following the outbreak. Nonetheless, WHO defended its action, saying it has the mandate to act only when an outbreak occurs in more than one country. Again, hastily issuing a travel advice on the world's most populous nation and fastest growing economy (China), WHO observed, was not in the best interest of world peace and global economy.

According to the Chairman of the Naylor Committee on SARS, great many systemic deficiencies in the response to SARS were identified in Ontario and invariably, Canada. Among these were lack of surge capacity in the clinical and public health systems; difficulties with timely access to laboratory testing and results; absence of protocols for data or information sharing among levels of government and uncertainty about data ownership. Dr. Naylor's committee identified inadequate capacity for epidemiologic investigation of the SARS outbreak; lack of coordinated business processes across institutions and jurisdictions for outbreak management and emergency response as public health problem areas. Others are inadequacies in institutional outbreak management protocols, infection control, and infectious disease surveillance; and weak links between public health and the personal health services system, including primary care, institutions, and home care.[6]

In Canada, the US, Singapore, and Vietnam (which comprise 7% to 10% of the total SARS cases worldwide) the relatively prolonged contact occurred because of the patients' close cultural ties with China. The impact of such ties on public health outbreaks and disease spread seemed to have been overlooked pre SARS. Public authorities also failed to recognize the risk factors involved in the transmission of SARS. For example, in the Amoy Gardens outbreak in Hong Kong, aerosolization of fecal waste contaminated with the SARS agent has also been proposed to contribute to transmission. The virus has been reported to be stable in feces and urine at room temperature for at least 1–2 days, and up to 4 days in stool from patients experiencing diarrhea. After drying on plastic surfaces, the virus can survive for up to 48 hours, although commonly used disinfectants and fixatives are effective against it. Super-spreading patients (patients who have relatively depressed immune systems) also played a role in the spread of the disease. Other unsafe medical procedures such as the use of ventilators and nebulized bronchodilators have been reported to lead to SARS spread by droplet transmission and aerosolization of virus-containing particles.[7]

Information gathering and dissemination about SARS also constituted a problem. The accuracy and timeliness of the reporting and dissemination of data relating to SARS were not adequate enough. Reports indicate that inadequate reporting of cases may have hindered implementation of preventative measures. Similarly, media information dissemination, in many cases also tended to have been sensationalized, leading to misconceptions over community preventative strategies, government and institutional procedures, and the magnitude of the outbreak. On the other hand,

[6] Renewal of Public Health in Canada: A Report of the National Advisory Committee on SARS and Public Health, October, 2003.

[7] Li G, Zhao Z. X, Chen L. B and Zhou Y. H (2003). Mild severe acute respiratory syndrome. *Emerging Infectious Diseases* [serial online].
Available from: URL: http://www.cdc.gov/ncidod/EID/vol9no9/03-0461.htm

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lack of information led to the development of public myths, with people in Guangdong believing that boiling white vinegar would protect them from infection and leading to carbon monoxide poisoning from charcoal burning to heat the vinegar. Similarly, difficulty in obtaining information from all relevant sources delayed appropriate analyses, reporting of the situation, and implementation of necessary actions.

There were also some public health gaps in health equipment and expert human resource supply, which led to misdiagnosis of SARS cases, particularly in super-spreaders in whom the disease symptoms differed. Response coordination of SARS treatment, prevention and control activities were also problematic. These had to do with development of contingency plans, including ensuring coordination and surge capacity at global, regional, and national levels as well as development of laboratory and information technology systems.

Similarly, gaps existed in sewage disposal systems (deficiencies that were a possible source of the Amoy Gardens outbreak) and legislation on ownership of pets and animal consumption. Wild animal consumption was seriously implicated in the causation of diseases in China.

Lessons for the Future: SARS placed unprecedented demands on the public health system, challenging regional capacity for outbreak containment, surveillance, information management, and infection control. Following are some of the lessons that could be learned from the challenges that SARS posed to countries, regions and health authorities in the past:

1. Previous SARS research has shown that the disease can be controlled and contained **through early detection, isolation of suspect cases, and tracing of their contacts**. As no prophylaxis vaccination or specific proven treatment is yet available against SARS, **prevention is the only measure that one can take**.

2. There is need to **ensure stringent hygienic practices** (e.g., washing hands before and after seeing a patient, handling food, etc., even when no epidemic is apparent).

3. **Communicating the risks and preventive measures** in an effective and acceptable manner is also very important.

4. Health authorities should more than ever before plan to **constantly have steady availability of infrastructure and qualified and well-motivated health personnel.**

5. Leadership is also essential to **coordinate activities and information dissemination** in order to minimize confused messages and public panic during outbreaks. Coordination should be maintained with all relevant sectors including the health professionals, policymakers, community leaders, media, and the public.

6. Provincial and federal efforts to **improve public health and emergency preparedness** must be coordinated and complementary.

7. There is need **to back up emergency preparedness with communication and surveillance personnel and infrastructure**.

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8. There is also need **to develop inter-province and international health linkage and network** building for guaranteed emergency support in times of public health outbreaks.

9. SARS has also pointed out to health professionals the increasing **need for appropriate history taking, to obtain important information, such as recent travel history or contacts with possibly infected persons, when a patient with a fever is seen**. This could help to quickly identify persons at risk and reduce spread.

10. Health authorities should ensure **the implementation of strict quarantine and isolation procedures** if suspected SARS patients are identified.

11. The use of **high-risk medical procedures that may inadvertently spread the disease through aerosolization of the agent should be evaluated** with potential new diseases in mind. Other high-risk procedures should also be reconsidered with regard to infection control to limit risk from the use of intubation, cardiopulmonary resuscitation, and positive airway pressure devices.

12. From a global perspective, the SARS epidemic demonstrated the importance of a **worldwide surveillance and response capacity** to address emerging microbial threats through timely reporting, rapid communication, and evidence-based action.

13. There is urgent need **for national and international collaboration** to be coordinated by WHO or other designated health agencies. Partnerships among clinical, laboratory, public health, and veterinary communities have also been demonstrated to be workable in the wake of SARS outbreak.

14. There is also need to **expand the intervention mandate of WHO to cover strange and very serious outbreaks that occur within a country**.

15. Another lesson that has been learned from outbreaks of SARS is that strong **political leadership at the highest levels is needed to mobilize the entire society**; speed of action and improved coordination between national and district levels in countries with federal systems.

16. Health authorities should ensure proper and renewed **legislation on animal rearing and pet ownership, surveillance, isolation, and quarantine measures.**

17. There should also be in place **improved infection control in healthcare and long-term-care facilities and at borders** to prevent the outbreak of SARS.

18. SARS outbreaks have reminded public health systems of the essence to always be on the alert to tackle outbreaks at any time. In this regard, **establishing an outbreak response unit with appropriate resources within the healthcare sector** should be a priority of every public health authority.

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19. SARS once more brought into focus the **increasing need to invest in public health.**

20. Health systems should **ensure accountability for future well-funded institutions**.

21. Towards ensuring accountability, a **mechanism to measure progress with respect to public health** is required. It is recommended that an independently prepared annual performance report of provincial and regional public health authorities be established and provided to both the legislature and the public.

22. An equally important key area in which health authorities must address in anticipation of future public health outbreaks is the **development of a strong and well-articulated public health model for provinces**.

23. Public health systems should also ensure **infection control readiness** that is supported with good strategy and qualified health personnel.

24. Also, issues that bordered on legal frameworks and power imbalances were also raised in the wake of SARS. Based on these concerns, it is hereby recommended that **provincial and national governments should review their laws to provide clear authorization to the Chief Medical Officer of Health**. This is to avoid confusion and unnecessary delays in times of emergency.

25. Also, the problem of short supply of public health personnel and health infrastructure during outbreaks makes the **development of provincial, national and international public health human resource revitalization strategies pertinent.** This in broad terms encompasses the development of an increased capacity for the education and training of public health professionals.

26. Towards achieving the development of provincial, national and international public health resource revitalization, **comprehensive campaigns and incentives need to be put in place to promote public health careers**.

27. In furtherance of the foregoing objectives, **sustainable employment strategies for nurses and other healthcare** workers to increase the availability of full-time employment should be established.

28. The SARS outbreaks have once again called the world's attention to the psychological trauma that health officials, victims of public health outbreaks, their relations and members of the public suffer during emergencies. Ministries of Health, in collaboration with professional associations and relevant experts, should **develop plans for the development and use of psycho-educational programs in emergency preparedness training.** These programs should address the preparation of staff to deal with the consequences of emergency situations, including anxiety and depression. The programs should also help staff and members of the public develop coping skills.

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29. Health authorities should also **deal with the problem issues of isolation and stigmatization associated with SARS** using psycho-educational and enlightenment programs.

30. There are many threats that public health workers face during disease outbreaks. Many of them suffer losses too. In the light of the above, employers should **develop compensation packages for health workers who lost income as a result of being unable to work while ill, quarantined, or restricted to one facility as a result of a health emergency.**

31. There is also an urgent need for provinces, territories and regions within a country to **dialogue with the federal government to heal any existing strained and fractured relationship between the federal, territorial and provincial governments,** which might have affected not a few provincial and national programs and issues. Overcoming these divisions, which for example permeated the response to SARS in Canada, is a necessary requirement for effectively managing future public health outbreaks.

32. More than ever before, human migration is now a key means for infectious disease transmission. Today, experts believe that the volume, speed, and reach of travel today have accelerated the spread of infectious diseases. There is also the threat of accidental or intentional release of biological agents as highlighted by the intentional release of anthrax spores in the USA in the Fall of 2001. All these, coupled with the tendency of some countries to suppress outbreaks information (as it was alleged in the case of China during the first outbreak of SARS) makes the **building of far-reaching disease surveillance intelligence networks by countries and provincial governments** pertinent.

Lastly, we agree with the submission by Dr. David Naylor's Committee on SARS that improving our capacity to handle health emergencies is not just a debt but a down payment on the future. It is an investment for those who fight the next major health emergency, so that they may have access to some of the tools, supports, and processes that Ontario lacked during the first SARS outbreak[6]

III. INFLUENZA (FLU) OUTBREAKS IN AND OUTSIDE CANADA

Introduction: Flu, used throughout this paper to mean Influenza and influenza-like illness (ILI), is an acute viral and contagious disease of the respiratory tract characterized by among other symptoms fever, headache, myalgia, prostration, runny or stuffy nose, muscle aches, sore throat and dry cough. Cough is often severe and protracted, but other manifestations are usually self-limited, with recovery in 2-7 days. Gastro-intestinal symptoms, such as nausea, vomiting, and diarrhea, are much more common among children than adults.[8] Flu in individuals may be indistinguishable from disease caused by other respiratory viruses.

[8] Chin, J. (2000). Control of Communicable Diseases Manual: An Official Report of the American Public Health Association, 17th edition, USA.

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Flu derives its importance from the rapidity with which epidemics evolve the widespread morbidity and the seriousness of complications, notably viral and bacterial pneumonias. During major epidemics, severe illness and death occur, primarily among the elderly and those debilitated by chronic cardiac, pulmonary, renal or metabolic disease, anemia or immunosuppression.

Three types of flu virus are recognized. These are types A, B and C. Type A has three sub-classifications (H1N1, H2N2 and H3N2) that have been associated with widespread epidemics and pandemics; type B has been infrequently associated with regional or widespread epidemics; type C has been associated with sporadic cases and minor localized outbreaks. Virus type is determined by the antigenic properties of the two relatively stable internal structure proteins, the nucleoprotein and the matrix protein.[8]

The geographic site of isolation, the culture number and the year of isolation describe most A and B flu viruses. Examples of prototype strains with these designations include A/Beijing/262/95 (H1N1), A/Japan/305/57 (H2N2), A/Sydney/5/97 (H3N2) and Yamanashi/166/98.

Emergence of completely new subtypes (antigenic shift) occurs at irregular intervals and only with type A viruses; the y are responsible for pandemics and result from the unpredictable recombination of human and swine or avian antigens. The relatively minor antigenic changes (antigenic drift) of A and B viruses responsible for frequent epidemics and regional outbreaks occur constantly and necessitate annual reformation of influenza vaccine. Clinical attack rates are usually higher (more than 50%) in closed populations such as boarding schools or nursing homes than in general community. In temperate zones, epidemics tend to occur in winter; in the tropics, they often occur in the rainy season, but outbreaks or sporadic cases occur in any month.

Flu infections with different antigenic subtypes also occur naturally in swine, horses, mink and seals, and in many domestic and wild avian species in many parts of the world. Interspecies transmission and reassortment of influenza A viruses have been reported to occur between swine, humans and domestic fowl. Typically, however, humans are the primary reservoir for human infections.

Airborne spread of the flu virus is the most predominant mode of transmission among crowded populations in enclosed spaces such as school buses; transmission may also occur by direct contact, since the flu virus may persist for hours, particularly in the cold and low humidity.

Flu virus infections cause disease in all age groups. The main way that flu viruses are spread is from person to person in respiratory droplets of coughs and sneezes. This is called “droplet spread” and can happen when droplets from a cough or sneeze of an infected person are propelled (generally up to three feet) through the air and deposited on the mouths or in the noses of people nearby. Though much less frequent, the viruses also can be spread when a person touches respiratory droplets on another person or an object and then touches their own mouth or

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nose (or someone else's mouth or nose) before washing their hands with soap and water or with wiper (alcohol-based).[9]

Certain people are at increased risk for serious complications from the flu. This group includes people age 65 years and older and people of any age with chronic medical conditions. Pregnant women and children between six months and 23 months of age also are at increased risk from flu complications. Some of the complications caused by flu include bacterial pneumonia, dehydration, and worsening of chronic medical conditions, such as congestive heart failure, asthma, or diabetes. Children may get sinus problems and ear infections.

In recent studies, flu infection among travelers is quite common; hence, it may rank with hepatitis A as one of the most common vaccine-preventable diseases of travelers. Seasonal epidemics of flu generally occur during the winter months on an annual or near annual basis and are responsible for several thousands of annual deaths in Canada.[10] In many other countries of the world too, hundreds of thousands of aggregate deaths occur annually from flu. In addition, many more deaths may occur in people with underlying medical conditions complicated by flu. The most common of the medical conditions as a consequence of flu is pneumonia.

The other costs of flu to individuals and nations are enormous. In Canada and also the US, where an estimated 10% to 20% of residents get the flu each year, it has been established that several millions of workdays are lost annually. Most deaths (60-90%) from flu occur in-patients 65 years and older, but at least 45% of flu-related hospitalizations occur in-patients younger than 65 years old. Young children also contribute some percentage to flu-related hospitalization cases. High complication rates from flu in the elderly have also been reported.

The risk of exposure to flu during international travel depends on the time of year and destination. In the tropics, flu can occur throughout the year, while in the temperate regions of the Southern Hemisphere most activity occurs from April through September.
While it is unusual for people to get flu infections directly from animals, such transmission has been documented several times in recent years. For example, extensive laboratory studies (such as those carried out in Hong Kong in 1997) using both molecular and epidemiological data, linked all 18 cases of human H5N1 infection to contact with live infected poultry. In February 2004, cases of flu linked with live infected poultry occurred in China, Vietnam and Thailand. In the past similar cases had also occurred in Holland. The WHO recommends more laboratory investigations to establish animal to human transmission of flu.

In mid-December 2003, outbreaks of H5N1 infection were detected in the poultry populations of Cambodia, China, Hong Kong, Indonesia, Japan, Korea, Laos, Thailand, and Vietnam. In

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[9] Department of Health and Human Services, Centers for Disease Control and Prevention (2003b). Preventing the Flu**:** Pandemic Preparedness and Flu Aid 2.0.

[10] Health Canada (2003). Weekly influenza reports. Influenza season 2003.

addition, H5N2 has been confirmed in Taiwan and H7 has been confirmed in Pakistan.[11] On February 4, 2004, more than 16 people were reported to have died of avian flu: 12 in Vietnam and three in Thailand. Among the deaths announced by WHO during the first week of February 2004 were a 58-year-old Thai woman who raised chickens and a teenage Vietnamese boy believed to have contracted the disease from eating undercooked chicken. The month of February 2004 witnessed the reporting of flu outbreak in 10 Asian countries, and the slaughtering of at least 25 million chickens in a bid to eliminate the animal reservoir. Whether all these deaths were caused by the flu A (H5N1) is not known although severe acute respiratory syndrome (SARS) has been ruled out as a cause of the illness.

At both local and international levels, there has been intensified surveillance of avian flu following increased reports of the outbreaks of the disease. Focus has been on the systematic and regular collection of information on the occurrence, distribution and trends of flu on an on going basis. The aim is to obtain accurate and complete information that will provide basis for action. Within a country, outcomes of epidemiologic studies, which lead to prompt identification of flu viruses, are typically reported to national health agencies. National health authorities within whose jurisdictions flu cases occur are expected to report the epidemics to WHO. Specifically, countries are expected to identify the causative virus in reports, and submit prototype strains to one of the four WHO Centres for Reference and Research on Flu (Atlanta, London, Tokyo and Melbourne).

Local and Global Influenza Activity: Several countries have reported outbreaks of highly pathogenic flu A(H5N1) in poultry. This is of great concern because frequent transmission of avian flu viruses to humans increases the possibility for genetic reassortment (co-mingling and evolution) with circulating human influenza strains and the possibility of a new flu pandemic caused by such resassorted viruses. Most reported 'flu infections during the 2004 season have been attributed to flu A(H3N2) viruses. The majority of A(H3N2) viruses antigenically characterized so far have been shown to be A/Fujian/411/2002-like; the others have been A/Panama/2007/99-like. [11]

Flu seasons vary in severity and generally result in more cases when flu A H3N2 virus is circulating, as is the case this year (2004). A/Fujian, a new strain of H3N2 (a type of flu A) has been documented in many countries, including Canada, so far this year. In Canada, flu activity for the 2003 season and the activity for the 2004 season (which arrived earlier than in previous years, and appears to be more severe than the last three seasons) have varied/fluctuated across and within Canadian provinces/territories. Current national and international data, however, indicate that its impact in Canada is still within the expected range.

From statistics for five selected flu weeks (Weeks 47,48,50 and 52 in the 2003 season[12] and Weeks one and two in the 2004 season[13] partly covering November 2003 and January 2004),

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[11] Department of Health and Human Services, Centers for Disease Control and Prevention (2003). *Bird Flu Fact Sheet, Basic Information About Avian Influenza, Information About Influenza A H7 Viruses.*

[10]Health Canada (2003). Weekly influenza reports. Influenza season 2003.

[13] Health Canada (2004). Weekly influenza reports. Influenza season 2004.

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widespread flu activity was reported and did continue in Ontario, Quebec, Newfoundland, Nunavut and some parts of British Columbia.

Widespread flu activity was also reported in Saskatchewan during Week 47. Flu outbreaks were also reported in Alberta, British Columbia, Manitoba, Nova Scotia, Ontario and Saskatchewan during the same week. Flu consultation rate was 21 cases per 1000 consultations, which is below the national baseline level for Week 47. Of the 87 flu viruses antigenically characterized by the National Microbiology Laboratory at the time, 61 were A/Fujian/411/2002-like viruses, 25 were A/Panama/2007/99-like viruses and one was an A/New Caledonia/20/99-like virus. Appendix one and Appendix two present selected flu cases in Canada and United States during the third and fourth quarters of 2003 and the first quarter of 2004.

Local and Global Reactions to Flu: Local and global reactions to flu have been varied and dependent on severity of the pandemic in countries, territories or regions. Resource availability and local health policies are also among other factors, which determine local and global reactions to flu.

Following are some of the measures that local and international health authorities have adopted to prevent or control the spread of flu.

Preventive measures:

1. **Vaccination:** The single best way to prevent the flu is to be vaccinated each fall or before flu season.[14] In the absence of vaccine, however, there are other ways to protect against flu virus infection. Before and during each flu season, health authorities in Canada, the US and many other countries vaccinate citizens and residents of respective countries as a way of preventing them from catching the flu. Annual flu vaccination is recommended for groups that are at risk for complications from flu. These include persons more than 65 years of age, residents of nursing homes and other chronic-care facilities that house persons of any age who have chronic medical conditions. Others are children of six or more months of age who have chronic disorders of the pulmonary or cardiovascular systems, including asthma and children of six or more months of age who have required regular medical follow-up or hospitalization during the preceding year because of a chronic metabolic disease.

   People aged between six months and 18 years who are receiving long-term aspirin therapy and might be at risk for developing Reye syndrome after flu also need annual flu vaccination. So also are women who will be in the second or third trimester of pregnancy during the flu season and health-care workers and others in close contact with persons at high risk for flu-related complications. Vaccination is also recommended for persons 50–64 years of age because a substantial proportion of these persons may have a medical condition that places them at increased risk for flu-related complications. Vaccination is encouraged for healthy children 6–23 months of age because this population is at increased risk for flu-related hospitalization.

[14] Fairbrother G, Kuttner H, Miller W, Hogan R, McPhillips H, Johnson K. A., Alexander E. R. (2000a). Findings from case studies of state and local immunization programs. *American Journal of Preventive Medicine* 19, 3S, 54–77.

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2. **Antiviral Medications:** Four antiviral drugs, namely, amantadine, rimantadine, zanamavir and oseltamivir, are approved and commercially available for use in preventing flu. Different countries and health authorities have used these medications, although the medications are said to be not so effective for Type B flu.

3. **Other Habits for Good Health:** This involves education of the public and health care personnel. Before, during and after every flu season, health authorities at various levels as well WHO promote such flu contracting preventive measures as close contact avoidance and staying at home when infected with flu. Other measures are respiratory etiquette (e.g. covering one's nose and mouth when coughing), cleaning or washing of hands as well as preventing one's eyes, nose or mouth from being contaminated with flu viruses.

Treatment methods: Flu treatment methods that are typically adopted by health authorities and personnel include the following:

1. **Antiviral Medications:** Four antiviral drugs (amantadine, rimantadine, zanamavir and oseltamivir) have been approved for treatment of the flu.

2. **Hospitalization and/or resting:** If and when a person develops flu**,** health experts advise that such a person should have plenty of rest, drink a lot of liquids, and avoid using alcohol and tobacco. The idea is for the flu virus infected person to replenish or gain more energy and further strengthen his/her immune system among other derivable health benefits. People at special risk from complications of flu are normally advised to consult their health-care provider when they notice flu symptoms beginning to manifest in them. This includes people 65 years or older, people with chronic medical conditions, pregnant women, or children.

3. **Control of patient, contacts and the immediate environment**: The control of patient, contacts and the immediate environment strategy encompasses reporting of flu outbreaks or confirmation of laboratory cases to local health authority, isolation, protection of contacts and investigation of contacts. Patient isolation strategy is readily adopted for avian flu cases due to the severity of these cases.

Surveillance: In Canada, the Health Canada's Flu Watch program monitors outbreaks of flu throughout the flu season and advises public health professionals via its Flu Watch website. Flu surveillance is a collaborative effort between provincial and territorial ministries of health, participating laboratories, the College of Family Physicians of Canada, sentinel physicians, and Health Canada. The main objectives of the flu surveillance or monitoring system are to detect outbreaks of flu as early and quickly as possible in order to facilitate early public health intervention and to specify the organisms involved.

The state of Virginia in the US has developed a multifaceted flu surveillance system. The first component of the system is passive, and utilizes flu information received from physicians, persons in charge of medical care facilities, and directors of laboratories who are required by the Regulations for Disease Reporting and Control to report flu to the health department. The second component is an active sentinel component, which consists of medical practices distributed geographically among the state's five health planning regions. The medical practices report to the state via the local health departments.

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A third component of the system is that of laboratory surveillance. The state laboratory attempts to identify the various strains of flu virus present in the state so that a comparison between the strains present in the community and vaccine may be made and recommendations on antiviral therapy formulated. The laboratory accepts all specimens throughout the year, but sentinel physicians are particularly encouraged at the initiation of the sentinel surveillance to send both nasopharyngeal washings and serum specimens for examination.

The WHO also has a Global Flu Program. The mission of the Program is to contribute to reducing death and disease from annual flu epidemics as well as to prepare for the next flu pandemic.

WHO's vision on flu surveillance and control includes:

- Effective and timely flu surveillance in all regions of the world
- Antigenic and genetic match of flu vaccine and current circulating flu viruses
- Efficient national flu control strategies and campaigns
- Sufficient flu vaccines made available before and during pandemics and epidemics

It's objective is to increase and strengthen global epidemic and pandemic preparedness through:

- Improved quality and global coverage of flu surveillance
- Improved understanding of health and economic burden of flu, including benefits from epidemic control and pandemic preparedness
- Increased national epidemic and pandemic preparedness including vaccine and pharmaceutical supplies
- Expanded use of existing vaccines particularly in developing countries and in high-risk groups and accelerated introduction of new vaccines
- More rapid communication and information exchange between WHO Flu Network Members and key partners and stakeholders

Priority activities include focusing on four major groups of activities (including research) on:

- Global flu surveillance for accurate and timely recommendations on flu vaccine composition
- Enhancement of global and national pandemic preparedness including initial outbreak investigation and coordination of rapid response
- Preparation and publication of technical and standard setting documents on flu surveillance and control
- Providing international leadership in the coordination of implementation and advocacy of the Global Agenda on Flu Surveillance, Prevention and Control

As part of their control and awareness creation programs, the Centers for Disease Control and Prevention (CDC) Atlanta, USA and WHO have heightened avian flu surveillance and are working with the international community to prevent further human cases and spread of disease in poultry. In this respect, the two health organizations have issued advice to people traveling to flu-infected countries and regions. They also have advised on the need to properly cook foods from poultry as well as avoid live poultry.

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The co-circulation of human and highly pathogenic animal flu viruses is of serious concern to WHO, the CDC and other health authorities worldwide. This is because an exchange of genes between the two viruses might occur if individuals were co-infected with both human and avian flu viruses. This gene exchange could give rise to a new flu virus to which humans would have little or no immunity and which could be transmitted from person to person.

Following the incessant cases of avian flu in Asia, a WHO team was sent to Vietnam to investigate the outbreaks. Similarly, WHO Collaborating Centers for Reference and Research on Flu and some national reference laboratories are conducting antigenic and genetic analysis of the H5N1 viruses isolated from humans and birds during the recent outbreaks in Asia. Results will guide WHO in preparing prototype viruses for pandemic vaccine production and providing diagnostic test kits for H5N1 viruses to national flu centers. CDC has recommended enhanced flu surveillance and, with WHO and other partners, is exploring other measures to prevent further human cases.

The WHO has been trying to allay fears that the outbreak of avian flu in Asian poultry could explode into a pandemic that could kill millions of people. In particular, the United Nations (UN) agency is playing down the importance of reported cases of human-to-human transmission of the virus, saying this is normal and expected and there is no evidence that the current strain could spread readily and rapidly.

The thinking of the global health organization is that the current outbreak could be controlled in the bird population, and the threat to humans would disappear. In a high-level meeting on February 3, 2004, officials from the WHO, the World Organization for Animal Health and the UN Food and Agricultural Organization gathered in Rome, Italy, to plot strategies to deal with avian flu.

Public Health Gaps: Several gaps in public health systems have been identified as being responsible for outbreaks and for the spread of flu. These include inadequate or total lack of immunization programs and facilities, which result from inadequately funded or manned public health systems.[15] Many public health systems have also failed in the area of educating the citizenry on the need to maintain proper hygiene and be free from infections and diseases. In many public health systems also, decreased public health support has hindered the funding of vector control. The absence of laws regulating the rearing, sale and consumption of animals (poultry in regards to avian flu causation) has worsened the flu situation in many countries, particularly Asian countries. Equally, many public health systems lack well-articulated flu and other infectious diseases monitoring programs. This makes them ill-prepared to handle serious outbreaks when they arise.

Public health gaps have also existed in the movement of people and animals within and outside some countries. This gap equally aggravated the flu situation in many countries. Experiences in some countries of Asia, and others where outbreaks of flu occurred, showed that there were instances where breakdown in public health interventions accelerated the spread of flu. For

[15] Bates A.S., Wolinsky F. D. (1998). Personal, financial, and structural barriers to immunization in socioeconomically disadvantaged urban children. *Pediatrics* 101, 4 (Pt 1), 591–596.

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example, flu virus infected health care workers due to lack of basic infection control precautions. These health care workers then probably carried the disease back to their families and community. In order to check the spread by health personnel, such simple preventive measures as temporary minimization of infected workers' contacts with their families and non-infected colleagues and provision of infection prevention devices such as face masks and disinfectants to health workers would have been adopted. Similarly, intensified general education of health workers and the general public on the need for good personal hygiene and observance of respiratory etiquette would make a difference.

As in the case with China during SARS, a few countries in which avian flu broke out concealed information on the out-break of the disease. Thailand notably covered up information that bird flu was in the country. WHO was critical of the country and the government of Thailand apologized to the WHO and to the World during a meeting of Asian Health Ministers.

Information suppression at a very critical stage in the life of the avian flu disease thwarted the preventive and controls efforts of international health personnel and agencies, thereby negatively impacting on the efforts of both the regional and world health authorities at tackling the flu pandemic.

Logistical problems and the inadequacy or total lack of health facilities (such as diagnostic laboratories and equipment) and expertise also worsened the flu problem. These were especially the cases with avian flu. Just as in SARS, distorted or total lack of communication about the cause, prevention and control of avian flu presented a substantial public health challenge to many countries and regions.

Lessons for the Future: Following are some of the lessons that could be learned from past and on-going flu outbreaks as a way of coping with future likely outbreaks:

1. Since flu is more or less a seasonal disease in many countries and regions of the world, the need exists for public health systems to **develop good all-year-round monitoring programs for the disease.** Monitoring programs should be intensive as well as extensive (extend beyond national frontiers where possible).
2. Anticipation of flu outbreaks makes it pertinent **for health care personnel and citizens to be immunized annually.**
3. There should **be effective health planning and education strategy**, which should sensitize the citizenry about immunization programs and immunization.
4. Health authorities also need to **maintain adequate supplies of antiviral drugs** to treat high-risk flu patients and essential personnel in the event of the emergence of a new pandemic strain for which no suitable vaccine is available in time for the first wave.
5. There is a need for **adequate funding of public health systems.** The annual vaccination of citizens, especially at-risk citizens, is expensive and will be possible only when public health systems are well funded.
6. As funding is secured, efforts should be made to **provide health facilities and ensure adequate staffing and training of health personnel**.
7. Infectious diseases, including flu, tend to spread fast. As such, there is need **to educate the citizenry on the need to ensure high standards of hygiene** as a way of preventing the contracting and spread of diseases. Observing of respiratory etiquette and regular washing of

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hands with soap and water or other disinfectants are good measures to prevent the spread of 'flu and some other infectious diseases.

8. Since flu spreads across regional, national, and international frontiers, there is great need **for research collaboration and networking among researchers, regions, countries and organizations.**

9. As countries collaborate, they should conduct **epidemiologic studies and promptly identify viruses and report to the relevant health agencies.** Collaboration will also enable them identify causative flu virus in reports, and submit prototype strains to one of the four WHO Centers for Reference and Research on Flu (Atlanta, London, Tokyo and Melbourne).

10. Public health workers are a vulnerable group to be infected in times of disease outbreaks. Public health systems should recognize this vulnerability and **devise means for protecting their workers from infections.**

11. As well, public health systems should **develop ways of compensating health workers in the event of their being affected by disease outbreaks.**

12. Health issues are not limited to core Health Ministries. As such, it is pertinent for governments to **include health departments in other Ministry activities where policies that could affect health are being considered or formulated.** Ministry activities, which affect health, include housing, education, social services, economics and agriculture.

13. More intensive research efforts are needed to improve the scientific understanding of flu and to yield better control tools most notably rapid and reliable point-of-care diagnostic tests. **Government should support research partly by ensuring that sufficient commercial and/or government facilities are available for rapid production of adequate quantities of vaccine and antiviral drugs, and maintain program for vaccine and antiviral drug administration to high risk people and essential personnel.**

14. As new strains of 'flu virus come out quite often, flu **research activities should, of necessity, formulate alternative vaccine strategies too.** This will better guarantee flu pandemic preparedness.

15. Learning from the dangers of concealing diseases that have a tendency for international spread, health authorities should **aim for the timely reporting of diseases that are unusual and appear to be out of control.**

16. Importantly too, governments should **make pandemic preparedness one of their top health priorities.**

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IV. WATERBORNE DISEASE OUTBREAKS IN AND OUTSIDE CANADA

Introduction: Waterborne disease outbreaks are a common occurrence in developing countries. Like many other public health incidents, water disease outbreaks are so recurrent in developing countries that their menace no longer seems to attract any unusual global attention. Contrary to widespread assumption that waterborne disease outbreaks occur exclusively in the developing countries, they occur in the developed countries as well. For the obvious reason that developed countries readily have available drinking water of high quality, waterborne outbreaks in these countries receive more than a passing attention. In North America and Western Europe for example, waterborne disease outbreaks have continued to occur despite wealthy economies and access to proven drinking water treatment technologies.[16]

Hrudrey, Huck, Payment, Gillham, and Hrudey's (2002)[16] documented accounts of waterborne outbreaks indicate that in the past three or four decades, the incidents have occurred in several developed countries of the world, including Canada. Altogether, up to 15 major outbreaks from 4 countries (Canada, U.S., England, and Denmark) each affecting between 47 and a potential of more than 400000 people, including a total of at least 11 deaths attributed to waterborne disease occurred between 1974 and 2001. The specific causes of the outbreaks have been found to differ from place to place, although experts have identified some common themes that ran through the outbreaks. These include administrative lapses, system and technical deficiencies and ecological or environmental problems among other issues. Indeed, reactions to the different outbreaks across countries and even within countries have also not been exactly the same.

Local and Global Waterborne Disease Outbreaks: Between January 1974 and 2001, more that 15 major waterborne disease outbreaks have occurred in some developed countries round the globe. Notable among the waterborne disease outbreaks were those that occurred in the USA, England, Denmark, and Canada. Table 1 presents Hrudey, Huck, Payment, Gillham, and Hrudey's summary of the various water disease outbreaks that occurred in the above mentioned developed countries between 1974 and 2001.

Waterborne Disease Outbreaks in Canada: In 1985, an outbreak involving at least 241 cases of gastroenteritis occurred in Orangeville, Ontario. Investigations revealed that the outbreak resulted from contamination of unchlorinated groundwater drawn from six "deep" wells, one of which was found to be clearly under the influence of surface drainage from mixed farming operations. It was further revealed that heavy snow accumulation was followed by heavy runoff and spring rainfall, which together contaminated the Orangeville water source.[17] The pathogen

[16] Hrudey, S.E., Huck P.M, Payment P, Gillham RW and Hrudey E.J (2002). Walkerton: Lessons learned in comparison with waterborne outbreaks in the developed world. *Journal of Environmental Engineering and Science*, 1, 6, November, 397-407.

[17] O' Connor D.R. (2002). Report of the Walkerton Inquiry, Part 1. The events of May 2000 and related issues. Toronto: The Walkerton Inquiry.

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identified in this outbreak was *Campylobacter jejuni***,** which is one of the deadly drinking water contamination bacteria.

In May 2000, an estimated 2300 people became seriously ill and 7 died from exposure to microbially contaminated drinking water in the town of Walkerton, Ontario. Walkerton is a community of 4,800 residents located about 175 kilometres northwest of Toronto. The outbreak of waterborne disease in the Walkerton community marked the beginning of unprecedented drinking water safety publicity in Canada.[16]

During the Walkerton outbreaks, more than 2300 members of the community experienced gastroenteritis illness attributed to exposure to another deadly bacterium, *Escherichia coli* 0157:H7 and *Campylobacter jejuni*, which contaminated the community's drinking water. 65 people were hospitalized, 27 developed hemolytic uremic syndrome (HUS), a serious and potentially fatal kidney ailment, and 7 died. The total economic cost of the Walkerton tragedy was estimated to be over $64.5 million.

The North Battleford waterborne outbreak is Canda's most recent major water disease outbreak. It occurred in April 2001. North Battleford is a city of approximately 15,000 people located in Saskatchewan. According to the Mr. Justice Robert Laing-led Commission of Inquiry, which probed the North Battleford water disease outbreak, between 5800 and 7100 residents became ill as a result of having been affected by the waterborne disease which was caused by a drinking water contamination bacterium known as *Crptosporidium parvum.* Hundreds of people from other communities and provinces who drank the *Crptosporidium parvum*-infected water also suffered the waterborne disease.[18]

Investigations by the Laing-led Commission revealed that the source water for the North Battleford water supply, the North Saskatcewan River, exhibited numbers of *Crptosporidium parvum* as high as any water supply in North America. Again, there was no watershed protection program operative in Saskatchewan even as the source water is difficult to treat for drinking water. Furthermore, effluent from the upstream North Battleford community sewage treatment plant passed over the drinking water intake from time to time. Indeed, dangers of the pending risks of contamination that were dated back to 1963 were said to have been noticed by experts and communicated to relevant authorities in the city as well as the province. However, those expert warnings reportedly fell on deaf ears.

Local and Global Reactions to Waterborne Disease Outbreaks: Most public health outbreaks, especially those with high casualty rates and hospitalization figures, call for immediate response on the part of concerned health authorities. During Canada's two major waterborne disease outbreaks, several people were hospitalized even as public health education on the epidemic was intensified along with the issuance of several boil water advisories.

[18] Laing, R.D. 2002. Report of the Commission of inquiry into matters relating to the safety of the public drinking water in the City of North Battleford, Saskatchewan. Department of Justice, Government of Saskatchewan.

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The severity of the drinking water disaster in Walkerton in May 2000 resulted in the Government of Ontario calling a public inquiry to probe the incident. Mr. Justice Dennis O'Connor headed the Commission of inquiry. The mandate of the commission was to address the cause of the outbreak, the role, if any, of government policies in contributing to the outbreak, and ultimately, the implications of this experience on the safety of drinking water across the province of Ontario. Expectedly, suffering emanating from the Walkerton waterborne outbreak was not limited to those who were ill but included the relatives of all those citizens who became severely.

Throughout Ontario, municipalities routinely carried out water sampling on a weekly basis all year round prior to the Walkerton outbreak. But after the incident, suggestions were made for daily sampling during critical time periods. The provincial authorities accepted and implemented the daily sampling suggestions. Although the risk of contamination can be reduced with chlorination, the Ontario public health authorities have, following the Walkerton and North Battleford outbreaks, accepted increased sampling because of the potential to overwhelm the chlorination system if it is not adjusted in response to environmental conditions.

In response to the outbreak of the North Battleford water disease outbreak, the Saskatchewan government also set up a public commission of inquiry to investigate the incident. Mr. Justice Laing headed the commission. Apart from attending to the people who were sick and hospitalized as a result of the disease, other remedial responses to the North Battleford outbreak came by way of chlorination of the sewage effluent in North Battleford.[19] As was the case with the Ontario province during the Walkerton outbreak, the Saskatchewan government also embraced increased water sampling because of the potential to overwhelm the chlorination system if it is not adjusted in response to environmental conditions.

Since the Walkerton outbreak, an alarming number of boil water advisories have been issued across Canada. In the province of Saskatchewan alone, over 79 boil water advisories were issued during the last seven months of 2001 following the North Battleford outbreak. These signs are an indication that many communities may be operating their water treatment facilities in a manner that is jeopardizing public health, causing the public to be skeptical of the government's ability to provide safe drinking water.

Public Health Gaps: There is no doubt that the Walkerton and North Battleford water disease outbreaks in Canada, together with similar outbreaks in other countries, exposed a number of public health gaps that existed in the affected governments, communities and water treatment and supply agencies. For example, the Walkerton tragedy involved evident or potential failures in water contamination barriers. The evidently or potentially failed elements of the contamination barriers were the water source, treatment, distribution and response system.

The pathogens causing the Walkerton outbreak (*Escherichia coli* 0157:H7, known for short as *E.coli* 0157"H7 and *Campylobacter jejuni,* known for short as *C. jejuni*), for instance, were

[19] Hrudey, S.E. and Hrudey E.J. (2002). Walkerton and North Battleford – Key lessons for Public Health professionals: A commentary. *Revue Canadienne De Sante Publique*, 93, 5, 332-333.

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attributed to contamination of the shallow (5-8 m) well #5 arising from cattle manure from a nearby farm following a period of heavy spring rainfall. One of the farms adjoining well #5 was judged to be the source of the 2000 outbreak, notwithstanding having followed model environmental management farming practices.

Justice Laing, Chairman of the North Battleford outbreak commision of inquiry found that the Saskatchewan government and its environment protection agency failed to assure drinking water safety. According to the committee, the economy rather than the need to ensure the safety of the population dictated water quality in Saskatchewan. Both City of North Battleford and the government of Saskatchewan did not seem to have learned lessons from the Walkerton tragedy in May 2000, the Commission observed.[18]

As for Canada's Disraeli waterborne disease outbreak in which 3 reported cases of *campylobacteriosis* plus at least 50 cases of *gastroenteritis* were identified in 1986, experts found poor location as being remotely responsible for the outbreak. It was discovered that the buried intake was not only subject to contamination from a park that had hosted a large public event attended by 3,000 people without adequate sanitation facilities, it was adjacent to three open abandoned wells. Moreover, the buried intake was a subject to influence from a nearby river downstream from pig farms. All these were public health issues that were not considered by the relevant authorities prior to the Disraeli outbreak.

In most of the waterborne outbreaks reviewed in this paper, it was found that complacency led to the occurrence of the incidents, although this position has been refuted by Woo and Vicente (2003)[20] who rather advocate improvement in drinking water system design. Hrudey, Huck, Payment, Gillham and Hrudey (2002)[16] observed that there was a systematic failure on the part of Canada's North Battleford City to recognize its responsibility to produce safe drinking water.

Public health gaps were also noticeable in the poor quality and numerical inadeqacy of water treatment personnel in both Ontario and Saskatchewan. Many of the water agency employees were said to have lacked knowledge of what it takes to produce safe drinking water. Worse still, there existed a number of policies that discouraged the possibility that such personnel might acquire the needed knowledge. Complacency was also evident in the way the Ontario and Saskatchewan governments as well as the Walkerton and North Battleford City authorities disregarded earlier expert warnings that were issued regarding threats to the safety of drinking water.

Poor location of water treatment plants as well as failure in ensuring rich sanitary conditions in and around water treatment and distribution spots were other characteristic epidemic-causing elements which had public health significance. Livestock feces also served as a source of environmental contamination for surface water and played a leading role in the causation of some of the reported waterborne diseases.

Lessons for the Future: Obviously, there are quite a number of lessons that could be learned from the various water borne disease outbreaks that have occurred in different countries in the

[20] Woo and Vincente (2002).

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distant and recent past. Following are some of the lessons, which can help in preparing various governments and water treatment, distribution and supply authorities to cope with similar or even more serious public health challenges in the future:

1. Drinking **water system operators must be personally dedicated** to continuously providing consumers with safe water. Develop attitudinal and behavior change programs to eliminate complacency among water operators. Complacency could be replaced with the culture of vigilance and accountability.
2. There is need to **promptly investigate and remedy concerns or complaints about water quality** from consumers and experts.
3. There is need to **re-design or update drinking water systems** to enable them cope with modern technological and scientific challenges of drinking water treatment, distribution and supply. This includes adequate staffing of water agencies. From a theoretical point of view, Woo and Vicente (2003)[20] see system design rather than personal accountability or vigilance to be the solution to organizational inefficiency and ineffectiveness. According to Woo and Vicente, people cannot be expected to be superhuman or infallible. Rather, systems can be designed to create proper conditions for safety." Rasmussen's framework on which Woo and Vicente's conclusions were based suggests that the problem with inefficiency in the water industry is not so much with the complacency of particular individuals or organizations as with common systems design failures. People appear to be complacent, not by choice, but because they are working within, and responding to, a system that was not designed to provide adequate feedback, resources, oversight, and competencies to safeguard public health. If these structural factors were changed, then perhaps people would behave differently. After all, no individual or organization deliberately set out to harm the public in any waterborne disease outbreaks. Although it might be tempting to look at Hrudey, Huck, Payment, Gillham and Hrudey (2002) and Woo and Vicente (2003)'s views of complacency and system design as opposing each, it should be realized that both views are important and need to be implemented in an eclectic manner.

4. Health authorities should **plan for present as well as short- and long-term supply of public health inspectors**.

5. **Water agency staff should be encouraged and supported to update their skills and knowledge periodically.** A mandatory certification program is a positive step to improving the quality of drinking water in a province.

6. The **record keeping system for water treatment and supply agencies should be up to date and lend itself to third party review.** Hrudey and Hrudey (2001)[21] have rightly observed that a water system needs to be robust or resilient to challenge. This means the ability of the system to withstand upsets. A robust system will continue to perform adequately despite failure of one or more of the mechanical or institutional components.

[21] Hrudey, S.E. (2001). Drinking water quality – A risk management approach, *Water*, 26: 29-32.

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7. Governments and drinking water treatment and supply agencies should **adopt the multiple barrier approach** in their effort to provide high quality drinking water to the citizenry. A multiple barrier approach is necessary for providing safe drinking water and consists of five elements, namely, source protection, multi-process to remove or inactivate contaminants, distribution system security, monitoring programs to control treatment processes and detect contamination and responses to adverse conditions that are well conceived, thorough and effective.[21]

8. Ensuring an effective regulatory process and a new commitment to total quality management from source to tap are other good approaches to ensuring high quality drinking water supply. As much as possible, **there should be quality control and quality assurance guidelines for the surface water plant operation.** Due to its importance and sensitivity, drinking water treatment, distribution and supply activities must be properly monitored and regulated by constituted authorities.

9. Ensuring high quality of drinking water presupposes that **all water-operating agencies should be accredited based on an independent audit with periodic review by certified accrediting body**.

10. Drinking water operators should be made to **submit periodic reports on their activities to designated authorities and such reports should be made available to third party evaluators.**

11. To safeguard against failure in following water treatment and supply guidelines, **appropriate sanctions should be meted out to erring operators.**

12. Since water is an important resource to everyone, it should be **moderately yet realistically priced and qualitatively supplied.** It makes more sense for citizens to pay a fortune for high quality water than for them to pay so little or nothing at all for poor quality water.

13. **Public enlightenment campaigns should be mounted to make citizens realize how less they sometimes pay for water** than they pay for less important goods and services such as movies, popcorn or soft drinks in a year.

14. In addition to modest and realistic sharing of water cost with consumers, **water treatment, distribution and supply activities should also be adequately funded by government.**

15. Each provincial government should **ensure that a provincial protocol for water-borne disease investigation is prepared, distributed, and adopted by all health districts in the province.**

16. Government and other relevant authorities should **put in place mechanisms for surveilling waterborne diseases** with the aim of timely arresting waterborne disease outbreaks when they occur. Public health authorities should periodically carry out surveillance of waterborne disease within their health regions.

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17. As well, public health authorities should mount **campaigns to educate the citizenry on the techniques and processes for ensuring high water quality supply.** A case in point that readily comes to mind regarding the need for such education is the strong resistance which the people of Erickson, a small rural community located in the south eastern corner of British Columbia, once put up against government's chlorination of drinking water in a their community.

18. Government **should educate the citizenry on such important issues as the need for safe farming practices**, which are necessary for ensuring safe and healthy environment, which are needed for quality water supply.

19. Care should also be taken to **properly locate and maintain sewage treatment plants** at locations downstream from the surface water treatment plants.

20. Finally, governments as a matter of necessity need to **be ready at all times to cope with waterborne disease outbreaks that may occur within their jurisdictions unexpectedly.**

21. Readiness to cope with waterborne outbreaks entails the **development of strategic plans for medical supplies and resources** such as diagnostic equipment, drugs, quality health personnel, vehicles for mobility, communication facilities, reference books and materials and other logistics.

22. Above all, there should be **good measures on ground to prevent citizens from contracting waterborne diseases.** Such measures unarguably yield more results and cost less.

Ultimately as observed by Justice O'Connor, therefore, the safety of drinking water is protected by effective management systems and operating practices, run by skilled and well-trained staff.

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Table 1. Summary of selected waterborne disease outbreaks

Locations and dates	Characteristics	Reference
Richmond Heights, Fla., U.S.A Jan.-Mar. 1974	1200 cases of gastroenteritis, likely shigellosis in a chlorinated shallow (6-15 m) groundwater supply	Weissman et al. (1976)
Bradford, Pa., U.S.A. Sept.-Dec. 1979	3500 cases of giardiadiasis in a chlorinated but unfiltered supply	Akin and Jakubowski (1986)
Bramham, England, July 1980	3000 cases of gastroenteritis of unidentified etiology in a chlorinated groundwater supply	Short (1988)
Eagle-Vail, Colo., U.S.A. March 1981	80 cases of gastroenteritis, likely rotavirus, in a direct filtered and chlorinated supply	Hopkins et al. (1986)
Orangeveille, Ont., Canada April 1985	241 cases caused by Campylobacter jejuni in a municipal water system of "deep" well with no chlorination required	Millson et al. (1991)
Pittsfield, Mass., U.S.A. Nov. 1985-jan. 1986	3800 cases of giardiasis in a chlorinated but unfiltered surface supply	Kent et. (1988)
Disraeli, P.Q., Canada August 1986	3 reported cases of campylobacteriosis plus at least 50 cases of gastroenteritis identified upon further investigation in an unchlorinated, unfiltered surface supply	Tessier et al. (1990)
Penticon, B.C. Canada June 1986	3000 cases of giardiasis in a chlorinated, but unfiltered, surface-groundwater supply	Moorehead et al. (1990)
Oakcreek Canyon, Ariz., U.S.A. April 1989	110 of 240 guests surveyed had gastroenteritis, likely caused by a Norwalk-like virus, in an unchlorinated private well	Lawson et al. (1990)
Cabool, Mo., U.S.A. Dec. 1989-Jan. 19990	243 cases of gastroenterities including 86 cases of bloody diarrhea, 2 cases of HUS and 4 deaths caused by E coli O157:H7 in an unchlorinated community water supply	Swerdlow et al. (1992)
Uggelose, Denmark Dec. 1991-Jan. 1992	1400 cases of gastroenterities of suspected viral etiology occurred in a filtered but unchlorinated municipal water supply	Laursen et al. (1994)
Warrington, England Nov. 1992-Feb. 1993	47 confirmed cases of cryptosporidiosis in a water supply zone serving 38000 consumers by groundwater with chlorination only	Bridgam et al. (1995)
Milwaukee, Wis., U.S.A. Mar.-April 1993	Possible 400000 cases of cryptosporidiosis in a filtered, chlorinated surface supply	MacKenzie et al. (1994)
Gideon, Mo., U.S.A. Dec. 1993	600 cases of salmonellosis, 15 hospitalizations and 7 deaths in an undisinfected groundwater supply	Clark et al. (1996)
North Battlwford , Sask., Canada April 2001	More than 5800-7100 cases of cryptosporidiosis in a chlorinated, filtered surface supply	Laing (2002)

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Reproduced with permission from: Hrudey, Huck, Payment, Gillham and Hrudey (2002). Walkerton: Lessons learned in comparison with waterborne outbreaks in the developed world. *Journal of Environmental Engineering and Science*, *1*, *#6*, November, p. 399.

V. POLIO, YELLOW FEVER AND CHOLERA OUTBREAKS IN SOME DEVELOPING COUNTRIES

Introduction: Infectious disease experts support the view that most public health outbreaks result from gaps that exist in public health systems and jurisdictions. In the past two decades, there have been outbreaks of infectious diseases in some developing countries. Among those outbreaks that have occurred in developing countries are poliomyelitis, yellow fever and cholera.

Poliomyelitis: Poliomyelitis, otherwise known as polio, is a viral infection most often recognized by the acute onset of flaccid paralysis. Symptoms include fever, malaise, headache, nausea and vomiting. If the disease progresses to major illness, severe muscle pain and stiffness of the neck and back with flaccid paralysis may occur.[8]

The infectious agent of polio is a virus known as *genus enterovirus*, which has three types (1, 2 and 3) all of which can cause paralysis. Type 1 most frequently causes epidemics. Poliomyelitis is on the verge of worldwide eradication. As a result of improved immunization programs worldwide and WHO's global initiative to eradicate poliomyelitis, circulation of polioviruses is limited to a decreasing number of countries.[8] According to WHO's world polio indices, the greatest risk of polio now occurs on the Indian subcontinent and, to a lesser extent, in the countries of west and central Africa.

In endemic areas, cases of polio occur both sporadically and in epidemics with an increase in cases during the late summer and autumn in temperate countries. In tropical countries, a seasonal peak occurs in the hot and rainy season, but is less pronounced. Polio remains primarily a disease of infants and young children. The mode of transmission for polio is person-to-person spread, principally through fecal-oral route; virus is more easily detectable and for a longer period, in feces than in throat secretions.[22]

Yellow Fever: This is an acute infectious viral disease of short duration and varying severity. The mildest cases of yellow fever may be clinically indeterminate. However, typical attacks are characterized by sudden onset, fever, chills, headache, backache, generalized muscle pain, prostration (extreme fatigue), nausea and vomiting. The pulse may be slow and weak out of proportion to the elevated temperature. Jaundice is moderate early in the disease and is intensified later.[8]

The virus of yellow fever is *flavivirus*. Yellow fever exists in nature in two transmissions cycles, a sylvatic or jungle cycle that involves mosquitoes and nonhuman primates, and an urban cycle involving mosquitoes and humans. Sylvatic transmission is restricted to tropical regions of Africa and Latin America while the urban cycle is found in some restricted parts of North America and Europe. The incubation period for yellow fever is three to six days.

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[22] Strode G. K. ed. (1951). *Yellow fever*. New York: McGraw Hill.

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Cholera: Cholera is an acute bacterial enteric (intestinal) disease characterized in its severe form by sudden onset, profuse painless watery stools, nausea and vomiting early in the course of illness. In untreated cases, the main characteristics of cholera includes rapid dehydration, acidosis (over-acid condition of blood or body tissues), circulatory collapse, hypoglycemia (abnormally low glucose or blood sugar levels) in children, and renal (kidney) failure. The cholera infectious agent is known as *Vibro cholerae.* Transmission of cholera occurs through ingestion of food or water that is contaminated directly or indirectly with feces or vomitus of infected persons. The incubation period for the cholera disease is from a few hours to 5 days, usually 2-3 days.[8]

Polio, Yellow Fever and Cholera Outbreaks: Although wild poliovirus has probably ceased in most industrialized countries, importation remains a threat. On a number of occasions in recent past, cases of poliomyelitis were recognized in industrialized countries among tourists who have never been immunized as well as nonimmunized immigrants revisiting their country of origin. On the other hand, outbreaks of polio, yellow fever and cholera among other diseases have continued to occur frequently in developing countries. Table 1 presents a summary of some recent outbreaks of polio, yellow fever and cholera, which occurred mostly in developing countries.

Local and Global Reactions to Polio, Yellow Fever and Cholera Outbreaks: Polio, yellow fever and cholera are all infectious diseases. Their outbreaks can lead to some similar local and global reactions. But due to some peculiar characteristics that each of the diseases is associated with, each can also elicit distinctive local and global reactions.

Polio: In most countries or health jurisdictions where polio outbreaks have occurred in the last one or two decades, the likely response had been the control of patients, contacts and the immediate environment. Local health officials who come across a case or cases of polio are traditionally obliged to report the incidents to designated local health authorities. The most important way of preventing polio outbreaks as stipulated by WHO is immunization. Although some health authorities have in the past resorted to isolation of patients with suspected polio cases in hospitals, experts have isolation to be unnecessary under home conditions. This is because many household contacts get infected before poliomyelitis is diagnosed.[23]

In many health authorities or jurisdictions, concurrent disinfection of throat discharges feces and articles soiled therewith have constituted the combating reaction strategy for polio disease. Immunization of familial and other close contacts, investigation of contacts and source of infection have also formed part of the polio combating strategy. As part of the international measure, the WHO, most of the times in collaboration with the countries where outbreaks have occurred, intensified surveillance activities. The world's apex health organization has also advised countries to network with its Collaborating Centers while advising international travelers to immunize. Reactions have also been noticed at the level of prevention in which members of

[23] WHO's disease outbreaks by country: http://www.who.int/csr/don/archive/country/en/

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the public have been educated on the need for early childhood immunization as well as routine immunization.

In Togo, Burkina Faso, and Ghana where outbreaks of polio occurred in 2003, the Ministries of Health of all four countries and neighboring states in the region through the assistance of WHO conducted synchronized National Immunization Days, targeting children 5 years of age and younger. During the 2003 polio outbreaks and some others before and after them, the WHO took a major steps to prevent any further spread by conducting what it calls "mop-up campaigns" to immunize all susceptible children in an area where a new case occurred. During the 2003 polio outbreaks in West Africa also, WHO launched a US$10-million effort in response to the pandemic in the sub-region. With the US$10-million, the organization aimed to vaccinate 15 million children in five surrounding countries in the West African sub-region in three days.[23]

During the 2004 outbreaks, teams from the World Health Organization, the UN Children's Fund (UNICEF) and local health agencies in West Africa had spent four days distributing oral polio vaccine to infants in 10 West and Central African countries. The effort was aimed at eradicating the polio disease by the end of 2004. However, the campaign to vaccinate Nigerian children has faced stiff Islamic religious opposition and political difficulties. Four states (Kano, Bauchi, Zamfara and Niger) in the northern part of the country boycotted the polio immunization drive, but Niger and Bauchi States later dropped their opposition and said they were re-joining the campaign.

According to radical Islamic leaders in the four Nigerian states, tests have revealed that the polio vaccines contain hormones that are cable of rendering their young girls sterile. Some local people believe vaccination is linked to HIV or birth control. As the United Nations wound up the first round of its drive to protect 63 million African children from polio in 2004, Governor Ibrahim Shekarau of Kano State said the decision of the state to boycott the immunization was a "lesser evil." According to Governor Shekarau, "It is a lesser of two evils, to sacrifice two, three, four, five even 10 children (to polio) than allow hundreds or thousands or possibly millions of girl-children likely to be rendered infertile."

In an attempt to woo the government and people of Kano and other states to join the polio immunization campaign, Nigeria's health ministry early in 2004 set up a team of all concerned parties to witness tests on the vaccine in laboratories in South Africa, India and Indonesia. The group returned to Nigeria and the Federal Government and the representatives of the Islamic group released their final report on the controversial oral polio vaccine, and affirmed its safety and potency. But an unimpressed Kano State Government maintained that it would have nothing to do with the vaccine, because, as it claimed, the verification team sent to South Africa by the Federal Government to verify the safety of the vaccine deceived its (Kano) own verification team. On the political note, a campaign mounted during the dry season early this year clashed with elections. This strained infrastructure, competing for people, communications, transport and political attention. Other West African countries, including Ghana, are currently promoting a system that features greater integration of polio disease surveillance.

Yellow fever: As it is the case with polio and some other infectious diseases, the most dependable preventive measure for yellow fever is immunization of people of 9 months and

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older.[24] As a way of preventing the outbreaks of urban yellow fevers particularly, governments and health authorities have embarked on eradication or control of mosquitoes, which spread the yellow fever disease.

Among other methods of controlling yellow fever, countries and communities where the disease occurred in the past adopted the control of patients, contacts and the immediate environment. This entailed reporting of cases to local health authorities, isolation (blood and body fluid precautions), concurrent disinfection, spraying living rooms promptly with insecticides), immunization, and investigation of contacts and source of infection.

In 2000, when yellow fever outbreaks occurred in Kano and Ekiti States of Nigeria, Nigeria's Ministry of Health in collaboration with WHO, UNICEF and Médecins sans Frontières, worked out a plan to conduct a mass vaccination campaign in the affected areas of Kano and Ekiti States. In 2001, during another cholera outbreak in Ibadan, also in Nigeria, the WHO provided cholera kits and technical assistance to Nigeria for outbreak investigation and control. In addition to provision of kit and technical assistance, massive WHO-AFRO-sponsored vaccination campaigns were mounted in the country.

Outbreaks of yellow fever involving four other West African counties also occurred in 2003. In response to the outbreaks, the Ministries of Health of all four affected countries including Burkina Faso and Sierra Leone along with WHO and other international partners, intensified surveillance and conducted mass vaccination campaigns. The Center for Disease Control (CDC) recommends yellow fever vaccination for most travelers to yellow fever-endemic countries in Africa or areas in South America in the endemic zone. Proof of vaccination is required for entry into certain countries. The International Health Regulations require revaccination at 10-year intervals if traveling to these areas. During other recent yellow fever outbreaks in Senegal, remedial actions were taken by WHO. These included the organization of a mission to the country by WHO to support the vaccination campaign and the delivery of more than 2.5 million doses of vaccine.

Cholera: Among other measures, reactions to cholera outbreaks normally involve treating victims of the disease in hospitals while improving environmental and sanitary conditions of the community for the benefit of all and sundry. An outbreak of a disease like cholera always brings about different reactions that have social as well as economic consequences. For example, in 1998 cholera outbreaks occurred in Tanzania. The European Union which imports fresh-water and marine fish from Tanzania but does not have the safeguards in place to distinguish infected from uninfected fish placed a ban on imports from Tanzania upon knowing the news of cholera in this region. Tanzania had only one avenue to appeal the ban, which was via the International Health Regulations, which are administered by WHO.

The WHO Director General can conduct a risk assessment for the countries imposing a ban. This was done in the case of cholera and found there was never any risk of cholera transmission. Based on this evidence, the ban was lifted but not before huge financial costs occurred. Tanzania

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[24] Nasidi A., Monath T. P., DeCock K., et al (1989). Urban yellow fever epidemic in western Nigeria, 1987. *Trans R Soc Trop Med Hyg*, 1989, 84, 401-6.

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lost US $36 million from the unnecessary ban. It was over 6 months before the ban was lifted causing serious economic hardship for Tanzania.

Public Health Gaps: Different as well as similar public health gaps may exist for polio, yellow fever and cholera diseases in a number of countries. In the case of polio, for example, overcrowding of no immune groups and collapse of the sanitary infrastructure pose an epidemic threat. Similarly, war torn countries in the West African region where the health infrastructure has been destroyed have been at particular risk of polio epidemics. Earlier, who set the end of 2000 as the target for worldwide eradication, but many experts believe that it is likely to take a little longer to accomplish this goal.

In many developing countries, sharp disparities that persist in the availability of medical facilities among regions, rural and urban areas, and socioeconomic classes have constituted gaps that led to public health incidents. Infrastructure problems continue to present a challenge, too. The lack of transportation often prevents parents and guardians from going out to immunize children, and efforts are hampered by a lack of communication, with some districts and regions having no radio at all.

In Kano and other states of Nigeria, the chief obstacle to polio eradication is the opposition to polio immunization by some Islamic leaders. Those opponents contend that the vaccine contains hormones those sterilize girls. Obviously, their contention has constituted serious public health problems in the state, the country and neighboring countries. A Muslim doctor, Ibraham Datti, president of the Supreme Council for Shariah, was quoted by the news agency as saying: "It's not contamination, it's adulteration. It's an attempt to control the population of the Third World." But the WHO says the vaccine contains only the Sabin poliovirus that protects the disease.

The severity of the public health gap and danger in Kano lie in the fact that UNICEF described the City as the world's biggest and fastest growing pool of polio infections and the biggest single threat to the international community's ambition to eradicate the virus by the end of 2004. Carol Beleammy, UNICEF director recently commented on the frustrating activities of the Kano anti-polio campaign initiators and perpetrators, saying: "It is unforgivable to allow still more children to be paralyzed because of further delay and baseless rumors. We call on these authorities to immediately re-join the polio eradication effort."

In many developing countries, public health gaps are created through inadequate or total lack of sewage systems and sanitary conditions. Cholera is among the old infectious diseases that have reemerged as a result of the breakdown of public health infrastructure. In the 2001 cholera outbreaks in Ibadan, Nigeria, for example, experts found that contamination of otherwise potable sources of water coupled with late presentation to the cholera treatment unit and low levels of knowledge about diseases led to the difficulty in effectively controlling this disease in the community.

Poor record keeping and inadequate or total lack of trained manpower and infrastructure (including medical infrastructure) has continued to create gaps in many public health systems of developing countries. Although overall local health officials in countries like Ghana, Nigeria and Senegal appear to be improving in such areas as reporting, and their speed in collecting stool

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samples and getting them to the laboratories, they are still far from reaching the World Health Organization's minimum standards.

Lack of articulate and well-coordinated health programs have also created gaps in the public health systems of many developing countries. For instance, yellow fever has a very good, effective vaccine available for use. However, lapses in the immunization program for yellow fever in Africa in the late 1980s resulted in a large increase in cases, with particularly large outbreaks in Burkina Faso and Ghana. Similarly, the poor operating environments in which public health professionals in developing countries find themselves have prevented them from developing to the level that could make room for the positive changes that have for long been desired by WHO and other concerned organizations.

Lessons for the Future: Following are some of the lessons, which could be learned from some of the recent polio, yellow fever and cholera outbreaks, reviewed in this paper.

1. Governments at all levels should **take immunization against infectious diseases more seriously**.
2. Government should also adequately educate their **citizens on the need to be active participants in immunization campaigns.** In communities where there are strong oppositions to immunization and other health activities, governments may do well to involve the various leaders and opinion groups in such communities for better results. The Centers for Disease Control and Prevention (CDC) recommends that all infants and children receive four doses of inactivated poliovirus vaccine (IPV) at 2, 4, and 6-18 months of age and 4-6 years of age. Adults who wish to travel to polio-endemic areas and are unvaccinated or unsure of their vaccination status should be made to get themselves vaccinated against polio. There are immunization specifications for other immunizable diseases too.

3. Apart from the epidemiologic measure of mass immunization, **shielding of citizens from the harm caused by disease transmitting agents such as insects** could help prevent disease. For example, spraying the inside of all houses, eliminating or applying larvicide to all actual and potential breeding places can make a positive and noticeable difference.

4. Governments should **ensure better funding of health and environment activities.** Such life necessities as clean drinking water, good and affordable housing, affordable food and access to functional healthcare and education should more than ever before be made priorities of governments.

5. The need for the **provision of appropriate sewage disposal facilities** is another good lesson that governments and municipal authorities need to learn.

6. Laws that aim at **ensuring safe and standard preparation, storage and sale of food and beverages** need to be in place and made to be protective of citizens.

7. As a way of promoting good hygiene among the citizenry, respective governments and health authorities should **aggressively promote such sound health practices as hand washing,**

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proper sanitation and handling of feces among citizens. Other good health practices that should be promoted include dairy products and suitable quality control in industries.

8. Another good lesson to learn from past public health outbreaks is the need to for local health authorities to always report **new disease cases to higher health authorities.**

9. For a disease like cholera, there should be concurrent disinfection of feces and vomitus.

10. There should also be **good management of patients and contacts through surveillance, investigation of source of contacts and infection,** specific treatment (aggressive dehydration therapy, administration of effective antibiotics, treatment of complications) and planning of control measures accordingly.

11. Another lesson to be learned from the levels of epidemic measures **include educating the populace on the need to timely seek treatment** of disease.

12. Health authorities should **also provide effective treatment facilities for health institutions, personnel and the citizenry.**

13. Adopting of emergency measures to **ensure a safe water supply and ensuring careful preparation and supervision of food and drinks** is another good measure to preventing waterborne outbreaks.

14. Other lessons include the need for countries **to swiftly respond to outbreaks soon after such outbreaks occur.** A measure to be taken in that regard is telegraphic or speedy reporting of outbreaks to WHO.

15. Health authorities **should educate citizens on appropriate ways of handling animals** (for example, monkeys and other wild primates, which cause yellow fever).

16. Immigration and health authorities should **insist that every travelers to and outside the affected country or countries possesses international certificate of immunization.**

17. There is also the need for health authorities to **follow international health regulations** to check ships, aircrafts and land transport arriving from cholera or some other reported infectious disease countries during outbreaks is also a good lesson that countries need to learn.

18. On a more general note, progress should also be made **towards developing suitable vaccines for the control of internationally important public health diseases** such as cholera so that the responsibility of disease control is not left entirely to individuals and communities, particularly in developing countries.

19. For other diseases, which are already immunizable, governments and health **authorities should endeavor to always have sufficient vaccines, other health facilities and qualified health personnel before and during outbreaks**.

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20. The role of zoonosis (transmission of diseases by animals) in public health is another good lesson that government and public health authorities need to learn from previous disease outbreaks. More than half of newly recognized emerging infectious diseases, according to disease experts, have their origins in animals, either via direct transfer from animals to humans (known as zoonotic diseases) or through an intermediate vector (known as vector borne diseases). The ever-increasing global movement of people, products, and animals has facilitated the emergence of a number of these diseases. A country's health and global health are inextricably linked. **Researching into animals and their roles in disease causation** is a long-standing public health gap that may countries need to fill.

21. Fulfilling a country's domestic mission – to protect the health of its population - requires **global awareness and collaboration with domestic and international partners to prevent the emergence and spread of infectious diseases**.

22. Based on the forgoing, governments and public health authorities should **develop long-term strategies that are needed to coordinate and control the importation, exportation, re-exportation, interstate trade, and intrastate sale and distribution of exotic and native wild animals.**

23. The development of knowledge about the roles of animals in disease causation calls for the **strengthening of the linkages and interactions between human and veterinary clinical and public health practitioners.**

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Table 2. Summary of Selected Polio, Yellow Fever and Cholera Outbreaks

Disease	Locations and dates	Characteristics
Polio	1992-93: The Netherlands	Poliovirus detected in members of a large religious group that refuse immunization. The virus was also found among members of a related religious group in Canada, although no cases occurred.
	1996, 1998 and 2000: Ghana	Several cases of wild poliovirus reported in the country.
	2003 – November, Togo, Burkina Faso, Ghana, and Southern Chad	Two confirmed cases of paralytic poliomyelitis due to type 1 poliovirus in Chad. Single cases of poliomyelitis due to type 1 wild poliovirus from Togo and Burkina Faso and six cases have from Ghana.
	2003: Benin and Cameroon	There were Type 1 poliovirus outbreaks in these countries. WHO placed blame on Nigeria which borders Benin and Cameroon and was home of 300 of the 2003 polio cases, nearly half the world total.
	2003: Nigeria	178 polio cases out of the world's 414 polio cases in 2003. Cases were mostly type 1 and caused Nigeria to knock off India as the number-one spot polio spot in 2003. A dozen children in Burkina Faso, Ghana, Niger, Togo and Chad were paralyzed by polio, which WHO accused Nigeria of exporting to these countries. DNA from the victims' viruses traced all of these cases back to Kano, one of Nigeria's largest cities.
		39 suspect cases, including 8 deaths, were reported to
Yellow Fever	December, 2000: Guinea	512 suspected cases, including 190 deaths were reported in 15 districts in northwestern Guinea.
	May 2000: Nigeria	Scores of yellow fever cases confirmed in Kano and Ekiti States of Nigeria.
	2001: Brazil	Yellow fever cases reported in various counties, states and regions of Brazil.
	2003: Burkina Faso and Sierra Leone	Several cases spanning several months reported in the countries.
	March 2004: Liberia	Scores of yellow fever cases in eight counties of Liberia were reported to WHO
Cholera	January –December 1996: Ibadan, Nigeria	There was an outbreak in which 1384 persons were seen, diagnosed and treated for cholera. No child less than one year was seen. Diarrhea and vomiting were the most common combination of symptoms present in 97.3% of all cases, followed by diarrhea, vomiting and dehydration (84.3%).
	November 2001: Nigeria	724 cholera cases and 52 cholera-related deaths were reported in the country with state by state breakdown as follows: Akwa Ibom State (Opkoso health district - 25 cases and 8 deaths), Kwara State (Bode Saadu - 124 cases and 16 deaths) and Kano State (Kano Metropolis - 575 cases and 28 deaths.
	2003: Comoros, Cote d'Ivoire, Ghana, Malawi, Mozambique, Nigeria, DR Congo, South Africa, Tanzania, Uganda and Zimbabwe	Cholera, which is endemic in many countries on the African continent with an upsurge in cases during the rainy season, was reported to pose a serious public health concern in the 11 listed countries.
	January –February, 2004: Burundi, Cameroon, Mali, Mozambique, South Africa, Zambia	A total of 19,986 cases of cholera and 397 cholera-related deaths were reported in the listed countries.

Source: WHO's disease outbreaks by country: http://www.who.int/csr/don/archive/country/en/

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VI. GLOBAL ENVIRONMENTAL INCIDENTS INVOLVING PCBS, DIOXINS AND FURANS

Introduction:

Polychlorinated biphenyls (PCBs) are synthetic organic chemicals comprising 209 individual compounds. They were discovered over 100 years ago; their production and commercial use began in 1929. Because of their remarkable insulating capacity and their flame retardant nature, they soon gained widespread use as coolants and lubricants in transformers and other electrical equipment where these properties are essential.[25]

In the past, discharges of PCB-laden wastes into rivers, streams, and open landfills were considered acceptable, legal, and hazard-free practices. PCBs were also sometimes intentionally released into the environment—for example, to reduce dust emissions from dirt roads, or as extenders in some agricultural pesticide formulations. In retrospect, these practices were inappropriate and potentially harmful.[26]

As awareness about their high toxicity grew, PCBs, being pollutants that were discharged as waste water by industrial plants, were banned. They were long lasting, accumulated in water and soil and in animal and human fat, and are secreted in breast milk. The Great Lakes basin is the most PCB-contaminated area of North America; Great Lakes fish are particularly contaminated. Exposure to each of the PCB compounds is associated with different levels of risk for harmful effects. Because of resistance to degradation, PCBs persist in the environment for decades. Concern about their presence in the environment began in the 1960s, when PCBs were found in soil and water. Research confirmed that some PCB congeners degrade very slowly in the environment, and can build up in the food chain.[27]

PCBs as a class of manufactured chemicals tend to last for many years. They do not break down easily on their own, and they are difficult to destroy. Not so much is known about the long-term health effects of PCBs, so scientists advise that it is important to keep our exposure to these chemicals as low as possible.

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[25] National Safety Council webpage --- Polychlorinated Biphenyls (PCB) Chemical Backgrounder http://www.nsc.org/library/chemical/polychlo.htm

[26] Beile N. (2000).”What Monsanto Knew: Outraged by PCB Contamination, an Alabama Town Unearths a Company’s Past." *The Nation.* http://www.thenation.com/doc.mhtml?i=20000529&s=beiles

[27] Fisher Associates Environmental Engineers Ltd., "FAQs about PCBs." Webpage: http://www.fisherenvironmental.com/

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Small amounts of PCBs are found in the environment all over the world. There are also traces of PCBs in our food and in our own bodies. PCBs move up the food chain by getting into the body fat of animals and staying there for a long time. Larger concentrations of PCBs are found in certain types of electrical equipment, and at storage sites in some parts of the world, which contain PCBs that have been collected for disposal. An uncontrolled fire at one of the storage sites could release large amounts of PCBs into the environment.[28]

Dioxins and furans are toxic chlorinated chemicals that are found in very small amounts in the environment, including in the air, water, and soil. They are also present in some foods. Dioxins are among the most toxic chemicals ever made by human beings, and furans are about a tenth as toxic. All three compounds (dioxins, furans and PCBs) are often referred to collectively as "dioxin." Chemically, dioxins and furans are alike in that they are all formed when certain organic compounds and chlorine are heated to high temperatures. However, the degrees of toxicity of different dioxins and furans vary greatly.

Scientists have researched the effects of dioxins and furans on laboratory animals. While the impact varies from one type of animal to the next, the serious health effects that can occur include weight loss, skin disorders, liver problems, immune effects, impaired reproduction, birth defects and cancer. In people exposed to high levels of dioxins and furans through job-related activities, or through chemical spills, the health effect seen most often is a diseased skin condition called chloracne. There are also some reports of other effects on the skin, liver, thyroid, and on reproduction and the immune system. Other findings implicate PCBs in cancer causation. While the evidence of these effects in humans is not conclusive, the findings generally support the results of animal studies. All the same, scientists agree that exposure to dioxins and furans should be kept as low as possible

Dioxins and furans have never been manufactured deliberately, except in small amounts for research purposes. They are unintentionally created in two major ways: 1) by the processes used to manufacture some products, for example, certain pesticides, preservatives, disinfectants, and paper products; 2) when materials are burned at low temperatures, for example, certain chemical products, leaded gasoline, plastic, paper, and wood.

Sources of PCBs, Dioxins and Furans: There are no known natural sources of PCBs and Dioxins. However, the two main sources of exposure to PCBs are the environment and the workplace. Dioxins can be inadvertently formed during the manufacture of a group of chemicals called chlorophenols, and the products made from them. Chlorophenols have been widely used to preserve wood, hides, textiles, paints, glues, and other materials, as disinfectants, and to keep industrial cooling waters free of nuisance organisms. Some of these uses have been phased out.[29]

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[28] Riseborough R. and Brodine V. (1971). “More letters in the wind," in Sheldon Novick and Dorothy Cottrell, editors, *Our World in Peril: An Environment Review* (Greenwich, Conn.: Fawcett, 243-255.

[29] Lincoln D. (1999). Environmental Consultant, February 19, Greenlite Home Page, History of PCB Pollution Problems: http://hometown.aol.com/davelinc/index.html

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Many of the products and wastes that are contaminated with dioxins and furans will produce larger amounts when burned. For example, when treated wood is eventually burned, the chlorophenols that burn with it could be a widespread source of dioxins and furans.
Many sources of combustion produce dioxins and furans. Incinerators, both municipal and industrial, are significant sources. They are, indeed, the largest industrial source of emissions of dioxins and furans to the environment. Other major industrial sources include metal smelters, cement kilns and coal-burning power plants. Residential wood burning, oil heating, backyard trash burning, cigarettes and emissions from diesel vehicles are some other non-industrial sources of dioxins and furans.

Some dioxins and furans in the environment occur through natural processes, such as forest fires and human waste or manure. Because of the natural sources of dioxins and the fact that unknown amounts of dioxins and furans may still exist, total elimination of dioxins and furans in the environment is not possible. Among human beings, recent studies conducted in the Great Lakes basin indicate that fish consumption remains the major route of exposure to PCBs, an indication that health consequences are associated with these exposures.

Research Findings on PCBs, Dioxins and Furans:
Harold Humphrey of the Michigan Department of Public Health and his colleagues through their work in the 1970s and 1980s demonstrated a correlation between levels of PCBs in breast milk and maternal consumption of contaminated Lake Michigan fish.[30] The investigators reported both developmental disorders and cognitive deficits in the children of mothers who had eaten contaminated fish during the six years preceding the pregnancy and who continued to do so during the pregnancy.

In the North Carolina Breast Milk and Formula Project which studied mothers with background levels of PCB exposure, it was found that children of women who had greater exposures to PCBs manifested deficiencies in psychomotor development. At subsequent examinations at ages 3, 4, and 5 years, these effects were not observed. It has been proposed that neurobehavioral effects (e.g., spatial learning/memory and motor deficits) are caused by complex interactions between neuroendocrine and neurophysiologic systems.[30]

Studies in Japan (1968) and Taiwan (1979) of PCB exposure (Harada 1976; Wong and Huang 1981; Hsu et al. 1985) from consumption of contaminated rice oil also contributed to the weight of evidence that xenobiotic agents disrupt normal endocrine function and are associated with neurobehavioral deficits. The illnesses in these two countries were referred to as Yusho disease (Japan) and Yu-Cheng disease (Taiwan). Adverse health effects also have been reported in persons exposed to PCBs who had evidence of other contaminants in body fluids. A study of

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[30] Eric F. (1994). "Conspiracy of Silence: The story of how three corporate giants— Monsanto , GE and Westinghouse—covered their toxic trail." From Sierra magazine, cover story, Sept./Oct. http://www.planetwaves.net/silence.html

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Inuit women from Hudson Bay indicated very high levels of PCBs and toxic substances in breast milk (Dewailly et al. 1989).

Researchers in the Netherlands investigated the effects of PCBs and dioxin exposure (as measured in maternal breast milk) on infants' mental and psychomotor development (Koopman-Esseboom et al. 1996). The results indicated that high in utero exposure to PCBs (also measured in maternal serum) was associated with lower psychomotor scores at age 3 months.
Korrick and Altshul's (1998) cohort study of mother-infant pairs who live adjacent to a PCB-contaminated waste site in southeastern Massachusetts found that environmental exposures such as those of fish consumption were likely, whereas residence adjacent to a PCB-contaminated site was considered an unlikely exposure source.

Several occupational or epidemiologic studies have indicated or demonstrated other adverse health effects from exposure to PCBs, including cancer and effects on the cardiovascular, hepatic, immune, musculoskeletal, endocrine, gastrointestinal, and dermal systems (Kreiss et al. 1981). A review by Hauser (1998) examined the relationship between thyroid hormone function and PCB exposure. There is increasing evidence in animal and human studies that exposure to certain environmental pollutants, including PCBs and dioxins, during the prenatal period can impair learning, memory, and attentional processes in offspring. The precise mechanisms of action of the adverse effects these toxicants exert on neurodevelopment have not yet been specified, although it is possible that they are partially or predominantly mediated by homonal changes and effects.
reported in a cross-sectional study of PCB-exposed transformer workers (Emmett et al. 1988) and electrical equipment manufacturing workers exposed to various Aroclors
In another study, gastrointestinal effect and appetite loss were (Smith et al. 1982). A characteristic health outcome common in the occupational setting is skin disease such as rashes. In yet another recent cohort study of people who were exposed to PCB (Yu et al. 1997), the incidence of chronic liver disease and cirrhosis was significantly increased for the cohort in comparison with the general population of Taiwan.

Rice (1999) also observed neurobehavioral deficits in monkeys exposed to PCBs. Studies involving animals also demonstrated that PCBs produce damaging effects on the immune system. Studies of rhesus monkeys, rats, mice, and mink also indicate PCBs' disruption of reproductive function which manifests in such ways as alterations in menstrual cycles [e.g., duration and bleeding, decreases in fertility, increased number of abortions, and reduced number of conceptions (Barsotti et al. 1976; Arnold et al. 1990)]. Four commercial PCB mixtures—*Aroclors 1016, 1242, 1254, and 1260*—have been tested in rats and found to lead to cancer (Mayes et al. 1998).

Global Incidents of PCBs, Dioxins and Furans:
Over the last 30 years, since the end of the Vietnam War, serious birth defects have been common in Vietnam. Scientists believe the dioxin elements are causing the birth defects**.** There are some other public health incidents around the world, which have been attributed to the effects of dioxin elements.

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The Yusho and Yu-Cheng Incidents: In 1968 some 1,300 people in Fukuoka, Nagasaki, and other areas of Western Japan, became ill from consuming rice bran oil contaminated with 2,000-3,000 parts per million (ppm) of a Japanese brand of a PCB heat-transfer agent (Kunita *et al.*, 1984; Kuratsune, 1989). The victims developed a very severe and persistent form of acne called chlorine-acne or chloracne. The disease symptoms soon progressed to include fatigue, nausea, and swelling of the arms and legs; some people developed liver disorders. Neurological manifestations (primarily subjective in nature) also were reported. Some newborns of exposed mothers exhibited small size, discoloration of skin and nails, and premature eruption of teeth (Kuratsune *et al.*, 1972).

Within five years of the Japan poisoning, about 1,200 cases of "Yusho" ("oil disease") had been reported and 1977 had recognized 1,665 cases. During the 11 years following exposure, 51 Yusho patients died. The cause of death was determined in 31 cases, and 11 of these (or 35 percent) were due to cancer. In a similar unexposed population only 21 percent of deaths would have been expected to result from cancer. Although the above figures may not have been statistically significant, they point to the potential dangers that the effects of dioxins pose to human beings and the environment if not checked.

A similar poisoning episode occurred in Taiwan in 1978 and was reported as "Yu-Cheng" disease. Once again, rice bran oil was contaminated by heat-degraded PCBs and subsequently ingested by over 2,000 people. Effects were observed among the Yu-Cheng victims similar to those in the Yusho victims. Offspring of Yu-Cheng mothers exhibited symptoms of acute toxicity as well (Rogan, 1989; Rogan *et al.*, 1988). Elevated mortality from liver diseases other than cancer was observed within three years after the poisoning outbreak (Hsu *et al.*, 1985; Hsieh *et al.*, 1996).

According some researchers, some of the learning disabilities seen in Great Lakes children studies may be due to the multiplied health effect (synergism) of mercury and PCBs. Mercury is a nerve poison and especially dangerous for unborn and developing babies. Evidence based on baby studies is building that mercury and PCBs together are much more toxic than either one individually or simply added together.

Other epidemiological studies have been conducted in Michigan, the Netherlands, and North Carolina. Some of these studies examined infants born to mothers who consumed fish with high levels of PCBs before and during pregnancy. Other studies examined infants born to women with no known exposure other than to background levels of PCBs. There have been reports of prenatal PCB exposure-related neurodevelopmental deficits among the most highly exposed subgroup of a North Carolina cohort of infants.[31]

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[31] DeLong R.L. and others ((1973). "Premature Births in California Sea Lions: Association With High Organochlorine Pollutant Residue Levels," Science, 181 (Sept. 21), 1168-1170.

Incidents of PCBs, Dioxins and Furans in Canada:
According to a Health Canada report, in January 1999, the Federal/Provincial Task Force on Dioxins and Furans released the first Dioxins and Furans and Hexachlorobenzene Inventory of Releases, followed by a draft Update issued by Environment Canada in October 2000 and a revised Update published in February 2001. The inventory documents the current understanding of anthropogenic (human traceable toxic disease) sources in Canada releasing dioxins and furans. The Inventory of Releases and the Updates list emissions from over 20 sectors by province and territory, and provides national summaries for each sector.

For many years young native children from Nunavik have had a high incidence of infectious diseases, in particular meningitis, bronchopulmonary, and middle ear infections. Otitis media [middle ear infections] and the damage it can cause to hearing is a major problem for Inuit children and adults. In fact, Inuit in Nunavik report hearing loss as their most common chronic health problem. The causes for this unusual pattern of infectious diseases is uncertain, but is plausibly linked to the high levels of organochlorine chemicals experienced prenatally in the womb by Inuit children.

Dioxins and furans are the by-products of specific activities. According to Environment Canada, the biggest source of dioxins and furans in Canada is the large-scale burning of municipal and medical waste. Some other major sources include the production of iron and steel, backyard burning of household waste, especially plastics and fuel burning, including diesel fuel and fuel for agricultural purposes and home heating. Other sources are wood burning, especially if the wood has been chemically treated, and electrical power generation

Due to their extraordinary environmental persistence and capacity to accumulate in biological tissues, dioxins and furans are slated for virtual elimination under the Canadian Environmental Protection Act (CEPA). The federal Toxic Substances Management Policy (TSMP) and the Canadian Council of Ministers of the Environment's (CCME) Policy for the Management of Toxic Substances (PMTS) are also collaborating with CEPA to achieve this important task.

Local and Global Reactions to Incidents of PCBs, Dioxins and Furans:
In the past one or two decades, many developed nations, including Canada, have realized the public health dangers posed by environmental pollutants such as PCBs and Dioxins and began to act to safeguard the environment. Fortunately, most Canadians, according to Environment Canada and Health Canada, are not exposed to high levels of PCBs. For most, exposure to PCBs is limited to the very low levels found in food and the environment. These levels are not likely to cause health problems. There may be health risks for specific groups of people who eat large amounts of sport fish or game contaminated by PCBs. These higher risk groups include Aboriginal peoples and the families of people who hunt and fish for food.

The Government of Canada has been working to eliminate measurable manufactured releases of these substances into the environment to help protect Canadians against harm from dioxins and furans. Actions to date include:

- A ban on the use of pesticides with high levels of toxic substances such as Dioxins and PCBs. The dioxin content in current pest control products is very low.

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- Guidelines to minimize the release of dioxins and furans from municipal solid waste and hazardous waste incinerators.
- Regulations requiring the virtual elimination of dioxin and furan releases from pulp mills.
- Active support for international agreements to reduce releases of these substances on a global basis.

Health Canada and Environment Canada have taken strong and effective steps to control every aspect of PCBs, including how they are used, stored and destroyed. The long-term solution to the problem is to destroy the remaining stores of PCBs. This process is underway using proven methods that do not threaten the environment. In the meantime, Health Canada continues to monitor the amount of PCBs in Canadians food, air and water to ensure that Canadians are not exposed to levels that pose a health risk. In addition, Health Canada continues to track and assess research about the long-term health effects of low-level exposure to PCBs.

These efforts are working. The latest inventory shows a 60 percent decrease since 1990 in the overall release of dioxins and furans from sources within Canada. Also, the levels of dioxins and furans in breast milk, which were already low, went down by roughly 50 percent between the 1980s and the 1990s.Initial efforts have focused on atmospheric releases, the most complete component of the Inventory. Six areas have been identified as priorities for early action. These are waste incineration (municipal solid waste, hazardous waste, sewage sludge and medical waste); burning salt laden wood in coastal pulp and paper boilers in British Columbia; residential wood combustion; iron sintering; electric arc furnace steel manufacturing; and conical municipal waste combustion in Newfoundland. Canada-wide standards are being established to address releases from remaining manufactured sources. These have been backed up with food monitoring and surveillance activities to identify and eliminate previously unknown sources of dioxin contamination.

In December 1998, Canada signed and ratified the United Nations Economic Commission for Europe's (UNECE) Protocol on Persistent Organic Pollutants under the Convention on Long-Range Transboundary Air Pollution. This international Protocol has as its objective, "to control, reduce or eliminate discharges, emissions and losses of persistent organic pollutants (POPs)." As well as obligations for other specified POPs, it specifically obliges Parties "to reduce their emissions of dioxins, furans, polycyclic aromatic hydrocarbons (PAHs) and hexachlorobenzene (HCB) below their levels in 1990 (or an alternative year between 1985 and 1995)."

In the US, efforts at eliminating toxic wastes have been on at all levels of government.
By 1977, concern about the impact of PCBs on the environment led to a North American ban on manufacturing and importing PCBs. However, the ban did not cover existing PCBs that were used in electrical applications. Those are being phased out now, and the federal government has set strict guidelines for the storage and disposal of PCBs.

In Winsconsin, the Division of Health issues a fish-eating advisory, which gives information on fish contamination in various lakes and rivers of the state. Attention has been especially focused on susceptible populations (e.g., certain ethnic groups, sport anglers, the elderly, pregnant

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women, children, fetuses, and nursing infants) which recent findings indicate continue to be exposed to PCBs via fish and wildlife consumption.

The US Congress in 1991 amended the Great Lakes Critical Programs Act, stipulating that the Environmental Protection Agency (EPA), in consultation with the Agency for Toxic Substances and Disease Registry (ATSDR) and the Great Lakes states, submit a research report to Congress. The report was to assess the potential health effects of water pollutants in the Great Lakes basin. This report identified significant gaps in scientific research bearing on human health effects of Great Lakes toxicants, leading to a program of research, the ATSDR Great Lakes Human Health Effects Research Program (GLHHERP). ATSDR's GLHHERP is designed to investigate and characterize the association between the consumption of contaminated Great Lakes fish and short- and long-term harmful human health effects. Through November 1998, the US Congress has appropriated approximately $19 million to support human health effects studies.

There are efforts under way to clean up PCBs in the environment. Soil excavation and disposal in EPA-approved landfills have cleaned up most sites, although soil incineration has also been used. These efforts, along with the ban on PCB manufacture, ensure that exposure to PCBs in the U.S. will continue to decline. EPA is currently overseeing several Superfund sites containing significant levels of PCBs, where complete remediation has been delayed by various factors, including lack of suitable technology (a particular problem for sediments) and local opposition to landfills or incinerators. Before actual remediation can occur, remedial investigation and feasibility studies (including cost analysis) must be performed. Such a process is underway for the Hudson River, heavily contaminated because of industrial discharges.

Public Health Gaps: Although experts are of the opinion that it is difficult to completely eliminate toxic compounds, many incidents of PCBs and furans are said to have resulted from public health gaps that existed in the places where such incidents occurred. Below are some of these gaps.

1. Total absence or ineffective monitoring plans for toxic chemical substances. This may stem from a number of factors ranging from lack of technical know-how for monitoring toxic compounds to complacency or negligence on the part of authorities and bodies charged with the responsibility of ensuring environmental protection and safety.

2. Lack of proper legislation that will promote public health in such areas as preventing indiscriminate dumping of waste, regulating industrial activities as well as food production, distribution and consumption and bush burning. Other areas where lapses exist especially in developing countries are sewage treatment and drinking water quality, the explosive pace of urbanization, and in many cases limited technical, administrative and financial capacities impact negatively on urban planning and management. Removal of these barriers, as well as alternative approaches, is urgently needed. Since the 1970s, public health problems have been noticed from the contamination of coastal waters with sewage-borne pathogens. Many developed countries have improved on their sewage handling practices, but most developing nations have not.

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3. In quite a number of developing countries, low or total lack of research activities in the area of environmental pollutants has constituted serious public health threats to citizens who are exposed to toxic compounds such as PCBs and furans.

Lessons for the Future: The following lessons need to be learned from research on and exposures to toxic chemicals such as PCBs and Dioxins:

1. Dioxins and furans endure in the environment and in human bodies for a long time. Their exposures come in so many different ways and they can travel long distances in the atmosphere, which means that countries and regions need to **work out individual as well as joint plans to be able to check the menace of these toxic substances.**

2. There is need for town and city council authorities and governments to **legislate on such environmentally unfriendly activities as burning of garbage, especially construction materials that might contain wood preservatives or plastic.**
3. In the same regard, citizens should be **educated and encouraged to use limited wood they burn in their fireplaces or stoves**. They should also be enabled through a campaign to learn about wood-burning techniques that release fewer dioxins.

4. Minimizing the effects of PCBs and Dioxins presupposes that **citizens have enough food and are encouraged to enjoy a variety of these foods. Vegetables, fruits and grains contain fewer dioxins and furans than meat, milk products and fish.**

5. **Research on toxic chemical substances should be initiated and sustained at every level of government** to enable local scientists move with current trends in toxicology and health research. If and where necessary, provincial and territorial governments should issue advisories about eating certain types of fish and encourage citizens to follow such advisories.

6. **Smoking and exposure to smoke should be avoided and individuals and families encouraged to keep away from second-hand smoke as much as possible.** By taking these steps, the risk of exposing families to dioxins and furans will be reduced, thus helping to limit the overall release of these substances into the environment.

7. At the individual or group level, **taking such precautionary measures as wearing protective clothing when exposed to PCBs and Furans and following decontamination procedures after working** in PCBs-contaminated environment could help in no small way. The same applies to replacement or servicing of old electrical equipment, transportation of PCBs to storage and destruction sites as well as handling of PCBs at these sites.

8. Because no treatment exists to remove these toxins from our bodies, we must **concentrate on effective prevention**, which means regulation of these compounds before they enter our environment.
9. There should also be in place **a national and regional policy that allows people to identify and eliminate toxic substances.**
10. The **development of innovative, cost-effective remediation techniques, particularly for sites that are difficult to remediate (e.g., river sediments)** is recommended.

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11. Also recommended are **scientifically-based improvements to risk assessment, to reduce the considerable uncertainty associated with PCB exposure and health effects in humans.**

VII. DISCUSSION AND RECOMMENDATIONS

A review of the above recommendations in the Alberta context indicates that some apply to several types of public health outbreaks and some are more or less unique. Table 3 shows the extent to which the various recommendations may have applicability across the public health problem areas under study. Other recommendations may not be so generalizable due to their peculiarity to the disease or diseases for which they were made.

There are many recommendations, and they will differ in importance across areas since some will have already been addressed in some jurisdictions and not in others, and some will differ in relevance according to local conditions. The priorities that follow, then, have been considered in the context of Alberta's needs and existing infrastructure. While trying to put recommendations to practice, health care authorities and personnel should take care not to rigidly draw dividing lines between and across recommendations. This is because public health is holistic and should be so considered. Only then will success be recorded in an effort to improve Alberta's public health system and other public health systems for that matter.

Based on the foregoing, it is recommended that health authorities should continue to periodically review their public health systems as a way of not only timely identifying problem areas but also appropriately attending to such identified problem areas. That way effectiveness, efficiency and sustainability would be guaranteed in health systems.

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Table 3: The applicability of recommendations across outbreaks

	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Ensure early detection, isolation of suspect cases, and tracing of their contacts	√ (1)				
Ensure stringent hygienic practices (e.g., washing hands before and after seeing a patient)	√ (2)	√ (7)		√ (7)	
Communicate risks and preventive measures in an effective and acceptable manner	√ (3)				
Constantly have steady availability of infrastructure and qualified and well-motivated health personnel	√ (4)	√ (6)			
Coordinate activities and information dissemination in order to minimize confused messages and public panic	√ (5)				

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Improve public health and emergency preparedness	√ (6)	√ (16)	√ (20)	√ (14)	
Back up emergency preparedness with communication and surveillance personnel and infrastructure	√ (7)				
Develop inter-province and international health linkage and network	√ (8)				
Ensure appropriate history taking, to obtain important information, such as recent travel history or contacts with possibly infected persons	√ (9)				
Ensure implementation of strict quarantine and isolation procedures	√ (10)				
Evaluated high-risk medical procedures	√ (11)				

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Develop worldwide surveillance and response capacity	√ (12)				
Initiate national and international collaboration	√ (13)	√ (8)			
Push for the expansion of the intervention mandate of WHO to cover strange and very serious outbreaks that occur within a country	√ (14)				
Ensure political leadership at the highest levels to mobilize the entire society	√ (15)				
Legislation on animal rearing and pet ownership, surveillance, isolation, and quarantine measures	√ (16)				
Ensure improved infection control in healthcare	√ (17)	√ (10)			

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Establish an outbreak response unit with appropriate resources within the healthcare sector	√ (18)				
Invest more in public health and environment	√ (19)	√ (5)		√ (4)	
Ensure accountability for future well-funded institutions	√ (20)				
Develop a mechanism to measure progress with respect to public health	√ (21)				
Develop a strong and well-articulated public health model for provinces	√ (22)				
Ensure infection control readiness	√ (23)				
Review the country's laws to provide clear mandate for Chief Medical Officer	√ (24)				

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Develop provincial, national and international public health human resource revitalization strategies	√ (25)				
Develop comprehensive campaigns and incentives to promote public health careers	√ (26)				
Develop sustainable employment strategies for nurses and other healthcare workers	√ (27)				
Develop plans for the development and use of psycho-educational programs during emergencies	√ (28)				
Deal with the problem of isolation and stigmatization which people with SARS usually suffer	√ (29)				

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Develop compensation packages for health workers who handle or suffer outbreaks	√ (30)				
Dialogue with other levels of government to heal any existing strained and fractured relationship among federal, territorial and provincial governments	√ (31)				
Build far-reaching disease surveillance intelligence networks among countries and organizations	√ (32)				
Develop good all-year-round monitoring programs for the disease		√ (1)			
Immunize health care personnel and citizens annually		√ (2)			

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Ensure effective health planning and education strategy		√ (3)			
Maintain adequate supplies of antiviral drugs		√ (4)			
Ensure epidemiologic studies and promptly identify viruses and report to the relevant health agencies		√ (9)			
Develop ways of compensating health workers in the event of their being affected by disease outbreaks		√ (11)			
Include health departments in other Ministry activities where policies that could affect health are being considered or formulated		√ (12)			

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Support research for rapid production of and continued supply of adequate quantities of vaccines and antiviral drugs		√ (13)			
Formulate alternative vaccine strategies		√ (14)			
Aim for the timely reporting of diseases that are unusual and appear to be out of control		√ (15)			
Train water system operators to be personally dedicated			√ (1)		
Promptly investigate and remedy concerns or complaints about water quality			√ (2)		
Re-design/update drinking water systems to cope with modern industry challenges			√ (3)		

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Plan for present as well as short- and long-term supply of public health inspectors			√ (4)		
Encourage and support water agency staff to update their skills and knowledge periodically			√ (5)		
Develop a record keeping system for water treatment and supply agencies that will be up to date and lend itself to third party review			√ (6)		
Adopt a multiple barrier approach for water treatment and supply			√ (7)		
Develop quality control and quality assurance guidelines for surface water plant operation			√ (8)		
Accredit all water operating agencies			√ (9)		

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Get water operators to submit third-party certified periodic reports on their activities to designated authorities			√ (10)		
Impose appropriate sanctions to erring water operators			√ (11)		
Moderately but realistically price water while ensuring high quality			√ (12)		
Mount public enlightenment campaigns to sensitize citizens on the need for realistic water pricing			√ (13)		
Government should adequately fund water treatment, distribution and supply activities			√ (14)		

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Prepare and distribute a provincial protocol for water-borne disease investigation to be adopted by all health districts in the province			√ (15)		
Put in place mechanisms for surveilling waterborne diseases			√ (16)		
Mount campaigns to educate the citizenry on the techniques and processes for ensuring high water quality supply			√ (17)		
Educate the citizenry on such important issues as the need for safe farming practices			√ (18)		
Properly locate and maintain sewage treatment plants			√ (19)		

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Develop strategic plans for medical supplies and resources			√ (21)		
Put good measures on ground to prevent citizens from contracting waterborne diseases			√ (22)		
Take immunization against infectious diseases more seriously				√ (1)	
Educate citizens on the need to be active participants in immunization campaigns				√ (2)	
Shield citizens from the harm caused by disease transmitting agents such as insects				√ (3)	
Ensure the provision of appropriate sewage disposal facilities				√ (5)	

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Ensuring safe and standard preparation, storage and sale of food and beverages				√ (6)	
Report new disease cases to higher health authorities				√ (8)	
Ensure concurrent disinfection of feces and vomitus				√ (9) for especially for cholera	
Ensure good management of patients and contacts through surveillance, investigation of source of contacts and infection				√ (10)	
Educate the populace on the need to timely seek treatment of disease				√ (11)	
Provide effective treatment facilities for health institutions, personnel and the citizenry				√ (12)	

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Ensure safe water supply and ensuring careful preparation and supervision of food and drinks				√ (13)	
Educate citizens on appropriate ways of handling animals				√ (15)	
Insist that every traveler to and outside the affected country or countries possesses international certificate of immunization				√ (16)	
Health authorities show ensure that international health regulations are adhered to				√ (17)	
Work towards developing suitable vaccines for the control of internationally important public health diseases				√ (18)	

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Provide sufficient vaccines, other health facilities and qualified health personnel before and during outbreaks				√ (19)	
Research on animals and their roles in disease causation				√ (20)	
Create/promote global awareness and collaboration with domestic and international partners to prevent the emergence and spread of infectious diseases				√ (21)	
Develop long-term strategies to coordinate and control wild and exotic animal trade and distribution within and out the country				√ (22)	

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Strengthen linkages and interactions between human and veterinary clinical and public health practitioners				√ (23)	
Work out individual and joint plans to check the menace of toxic substances					√ (1)
Legislate on environmentally unfriendly activities such as burning of garbage					√ (2)
Educate/ encourage citizens to use limited wood they burn in their fireplaces or stoves					√ (3)
Provide enough and toxic-free food for citizens					√ (4)
Initiate/sustain research on toxic substances					√ (5)
Avoid smoking and exposure to smoke					√ (6)

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	SARS	INFLUENZA	WATERBORNE DISEASES	POLIO, YELLOW FEVER, CHOLERA	PCBS, DIOXINS, FURANS
Encourage taking of precautionary measures such as wearing protective clothing and decontamination procedures before and after exposure to toxic substances					√ (7)
Develop and encourage effective prevention methods for against toxic substances					√ (8)
Formulate national and regional policy that allows people to identify and eliminate toxic substances.					√ (9)
Dev innovative and cost-effective remediation technique					√ (10)
Do a scientific risk assessment always to reduce harm to society					√ (11)

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