

CHAPTER 2

LITERATURE REVIEW

Surveillance systems must be flexible enough to adapt to ever evolving emerging infectious diseases.

2.1 INTRODUCTION

Surveillance systems must be flexible enough to adapt to ever evolving emerging infectious diseases. Since 1981, when the AIDS epidemic was first identified in the United States of America, population-based AIDS surveillance had been used to track the progression of the Human Immunodeficiency Virus (HIV) epidemic. As the disease progressed and therapy became more effective, the CDC and the Council of State and Territorial Epidemiologists (CSTE) recommended that all states and territories include HIV case surveillance and the reporting of HIV exposed infants.

There are a myriad of various types of surveillance systems throughout the world. The big question is: Are they doing their job? Are they detecting outbreaks, monitoring incidence, prevalence, incidence rates, prevalence rates and case fatality rates, monitoring progress, and predicting future trends? Are they saving lives? This researcher's response to these questions collectively is **yes**. Overall, they are saving lives, but emphasis is placed on the fact that more lives could be saved if there were an increased effort placed on enhancing the number of surveillance systems, particularly active surveillance systems and response.

An understanding of case definitions helps to define the disease, making it possible to trace incidence. Knowledge of the reservoir can be a first step in disease eradication or containment. This does not guarantee that recrudescence will not occur, as in the case of Nipah Virus outbreak in Bangladesh (WHO/CSR 2004:1). The outbreak occurred in the Faridpur District and was responsible for 34 cases, which included 26 deaths. Previous outbreaks occurred in Bangladesh in May 2001, January/February 2003 and January/February 2004 (CDC Travelers' Health 2004:1-2). Culling in response to a disease outbreak appears to be an appropriate action to reduce the burden of disease as in the case of Nipah virus and SARS. This statement is being made because there is enough evidence to support the fact that culling stops the spread of infectious disease (Meng 2003; Disease Archive 2003b:1; Lashly and Durhan 2002: 374-375; Civet Cats 2004:1).

The following additional information, from the literature review, is being provided to further enhance the very nature of its importance. The lethality of emerging infectious diseases is not to be underestimated. Newly emerging infectious diseases not covered in this research include Avian influenza and Marburg Haemorrhagic fever (MHF). Hundreds of deaths caused by these two newly emerging infectious diseases have already been reported to the World Health Organization.

2.1.1 Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome

Since 1981, when the AIDS epidemic was first identified in the United States of America, population-based AIDS surveillance had been used to track the progression of the Human Immunodeficiency Virus (HIV) epidemic. Beginning in 1988, a national seroprevalence system sponsored by CDC has gathered seroprevalence data from sexually transmitted disease clinics, drug treatment centres, women's reproductive health clinics, tuberculosis clinics, adolescent and young adult clinics, clinics serving homeless populations, clinics serving juveniles and adults in correctional facilities, sentinel hospitals, primary care practices and Indian Health Service facilities. The sentinel hospital component should be designed to monitor severe disease. Hospitals used as sentinel sites should include all of those that admit patients for severe infectious diseases in the community (World Health Organization 1999:1-4). All of these surveys use anonymous, unlinked (blinded) HIV testing in which personal identifying information is removed from the blood specimen. Only basic demographic and HIV risk behaviour information are retained. HIV seroprevalence data are also available from routine screening for military service, blood donors, and entrants into the Job Corps, a job training program for rural and urban disadvantage youth 16 to 21 years of age (Sande and Volberding 1988:11). As the disease progressed and therapy became more effective, the CDC and the Council of State and Territorial Epidemiologists (CSTE) recommended that all states and territories include HIV case surveillance and the reporting of HIV exposed infants. A survey using filter paper specimens collected for newborn metabolic screening conducted in 45 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands allows estimation of HIV seroprevalence among childbearing women (Sande and Volberding 1988:11). The combined prevalence of those living with the diagnosis of HIV and those living with AIDS provides more information on how to utilize

resources for patient care services than does AIDS prevalence alone. Second generation surveillance, begun in 1997, seeks to combine several data streams including AIDS case surveillance, HIV seroprevalence surveillance, Sexually Transmitted Infection (STI) surveillance and behavioural surveillance into a comprehensive data stream.

- A non name-based HIV surveillance system was also implemented by several states (Flemming 2001:3). In 1994, the State of Maryland implemented a program to require HIV surveillance by unique identifier (UI) patient code. This evaluation of Maryland's program found that when complete, the 12-digit UI number provided a virtually unduplicated count 99.8% unique, was 99.9% unique with only the last four digits of the U.S. government Social Security Number (SSN), date of birth (DOB), and race. A non-name based system can provide accurate, timely and valid data concerning the scope of the HIV epidemic, without the creation of a statewide name-based registry (Solomon *et al* 1999:1-2). As recommended by the CDC and CSTE, AIDS and HIV case surveillance should include surveys of incidence and prevalence of HIV infection, monitoring of HIV related mortality, behavioural surveillance and statistical estimation of incidence and prevalence of HIV and AIDS.

A typical protocol of recommended surveillance practices should include the following for all state and local surveillance programs:

- Collect a standard set of surveillance data for all cases that meet the reporting

criteria for HIV infection and AIDS. The standard data set should include the

a) patient identifier, b) earliest date of diagnosis of HIV infection, c) earliest date of diagnosis of an AIDS-defining condition, d) demographic information (e.g. date of birth, race/ethnicity, and sex) and residence (i.e., city and state) at diagnosis of HIV infection and of AIDS, e) HIV risk exposure, f) facility of diagnosis, and g) date of death and state of residence at death. Additionally, the date of HIV diagnostic testing, the results of these tests, and exposure to antiretroviral treatment for reducing perinatal HIV transmission should be collected for all infants with perinatal exposure to HIV.

- Use the same confidential name-based approach for HIV surveillance programmes as is currently used for AIDS surveillance nationwide, however, CDC recognises that some states have adopted and others may elect to adopt, coded case identifiers for public health reporting of HIV infection.
-
- Identify rare or previously unrecognised modes of HIV transmission, unusual clinical or virologic manifestations and other cases of public health importance.
-
- Collect data from all private and public sources of HIV-related testing and care services. Laboratory-initiated surveillance methods should identify all cases that meet the laboratory reporting criteria for HIV infection and/or AIDS.
- Regularly publish, in print or electronically, aggregated HIV/AIDS surveillance data

in a format that facilitates use of these data by federal, state, and local public health agencies, HIV-prevention community planning groups and care-planning councils, academic institutions, providers and institutions that have reported cases, community-based organisations and the general public.

- Conduct regular, ongoing performance assessments of the surveillance system and redirect efforts and resources to ensure timely reporting of complete, representative, and accurate data.

(CDC 1999:1-44).

Table 2.28 compares **first generation HIV surveillance** with **second generation HIV surveillance**.

Table 2.28 The Council of State and territorial Epidemiologist (CSTE) surveillance recommendations

Since 1991	CSTE recommended that all states and territories include HIV case surveillance and the reporting of HIV exposed infants (the Council of State and Territorial Epidemiologist)	First generation surveillance in 1989 emphasized early warning by measuring the prevalence of HIV infection in key groups and by monitoring trends over time.
	States also use confidential named based-HIV case surveillance on all perinatally exposed children. A non-name-based HIV surveillance system was also implemented by several states.	Second generation surveillance began in 1997, seeks to combine several data streams including AIDS case surveillance, HIV seroprevalence surveillance, STI surveillance and behavioural surveillance into a comprehensive data stream

(MMWR/CDC 1999)

As a comparison to the global effects of AIDS, Table 2.29 shows that Sub-Saharan Africa had a case fatality of 71.8%, while the global case fatality rate was 60.0%.

Table 2.29 HIV/AIDS

Year/Location	Cases	Incidence	Prevalence	Deaths	CFR%
Global					
2003	5 mil	5mil	40 mil	3 mil	60.0
2002	5 mil	5 mil	42 mil	3.1 mil	62.0
2001	2.2 mil	5.3 mil	36.1 mil	21.8 mil	60.0
Sub-Saharan Africa					
2003	3.2 mil	3.2 mil	26.6 mil	2.3 mil	71.8

(HIV and AIDS in Africa 2004:1)

In Canada HIV/AIDS cases are reportable in all provinces and territories. Reporting criteria include:

- HIV infection
- AIDS
- Deaths in persons with AIDS and HIV infection

(World Bank 2005:1).

A standard set of data should be collected using a standardised report form for all cases that meet the reporting criteria, including:

- Personal identifier
- Date of diagnosis
- Basic demographic information
- Place of residence
- Risk behaviours

- Opportunistic conditions
- Date of death

(World Bank 2005:1).

Surveillance of HIV and AIDS has been ongoing since 1979 and reportable to the Centre for Infectious Disease Prevention and Control (CIDPC) (Centre 2004:1; Health Canada 1999:1-45).

A total of 56,523 positive HIV/AIDS tests have been reported to the Centre for Infectious Disease Prevention and Control (CIDPC), a source of national information on HIV/AIDS which also publishes data on reported deaths among AIDS cases, from November 1985, when reporting began, up to 30 June 2004. The reported number of deaths of reported AIDS cases up to 30 June 2004 was 13,054 for a total case fatality rate of 23.09% (HIV and AIDS in Canada 2004:1)

The World Health Organization (WHO) has developed a public health mapping programme, which is a global information and mapping system for HIV/AIDS, in order to strengthen HIV/AIDS/STIs (sexually transmitted infections) surveillance.

The objectives of this initiative are:

- to monitor and analyse the temporal and geographical trends in HIV/AIDS/STIs to support the development of appropriate surveillance systems and prevention programmes and control activities at the national, regional, and international levels to serve as a decision support tool for improved planning and allocation of

resources

- to provide global access to essential information on HIV/AIDS/STIs to WHO and its partners

(WHO 2003e:1).

A recent paper reported findings of Simian Foamy Viral antibodies in ten (1%) of 1,099 individuals tested. Laboratory results determined three individual species of non-human primates:

- De Brazza's guenon (*Cercopithecus neglectus*)
- mandrill (*Mandrillus sphinx*)
- gorilla (*Gorilla gorilla*)

The De Brazza's guenon and mandrill are naturally infected with Simian Immunodeficiency Virus (SIV). Since eating non-human primate bushmeat is what may have caused the SIV to evolve to HIV and jump to the human population, eating non-human primate bushmeat carrying SFV may lead to another emergence of human retroviruses (Wolfe 2004: 932-937). Human Immunodeficiency Virus Type 1 (HIV-1) has caused the majority of AIDS cases in humans. The reservoir for the AIDS virus is African primates, which represent a very large reservoir. The specific primate viruses are SIVcpz from chimpanzees and SIVsm from sooty mangabeys. SIV denotes Simian Immunodeficiency Virus.

There are two genomically distinct types of human AIDS viruses:

- ✓ HIV-1
- ✓ HIV-2

These viruses are members of the genus Lentiviruses of the family *Retroviridae*. The causative agent of AIDS is HIV. HIV-1 group M viruses are responsible for the majority of all HIV infections worldwide and appear to have arisen from one cross species transmission event (Hahn and Shaw 2000:607-615).

It was reported in *The Scientist* that the organism responsible for the Black Death, *Yersinia pestis*, might have given rise to a mutation on the gene for CCR-5, a receptor on the surface of macrophages. The descendants of survivors of the Black Death would have passed this mutation on to progeny. CCR5 and CD4 (protein) are required for HIV to enter the macrophage. If the mutation is lacking (CCR5 - Delta 32), the HIV cannot enter the macrophage (Nicholson 2001:1). If what the researchers say is true, then patients lacking the mutation (CCR5-Delta 32) cannot get HIV. This information is relevant because it may have an impact on case fatality rates. Perhaps the case fatality rates would be greater if CCR5-Delta 32 did not exist.

2.1.2 MONKEYPOX VIRUS (MPXV)

Monkeypox virus (MPV) is a member of the genus *Orthopoxvirus* and family *Poxviridae*. The virus was first recognized in 1958 in monkeys. The first case of human Monkeypox

was discovered in the DRC (Democratic Republic of the Congo) in 1970 (Acha and Szyfres 2003:235-242). The current surveillance system for Monkeypox virus is inadequate in the DRC (Democratic Republic of the Congo) and elsewhere in Africa where human Monkeypox may occur (WHO/CDS/CSR/APH/99.5 1999:1-12). As of 1999 here are some key points about epidemiological surveillance in the DRC and elsewhere in Africa:

- There has been variability in investigation methodologies, and the protocols in the WHO Human Monkeypox Surveillance and Investigations Manual have not been used in the field consistently.
- Current data are incomplete on transmissibility because the suspected patient investigations have usually been delayed and control patients have not been studied concurrently.
- Due to delays in investigations, serological confirmation of suspected patients is being performed much more often than virological confirmation. The sensitivity, specificity and predictive value of serological tests are not clearly defined.
- The reservoir is yet undefined.
- Investigations have not clarified satisfactorily the clinical, epidemiological or ecological features of the current Monkeypox (1999) outbreaks.

- Major delays in receiving laboratory results and epidemiological analysis from collaborating laboratories have occurred because of administrative problems and the lack of capacity to perform such tests and analyses in the DRC.
- Skilled staff and resources for performing satisfactory surveillance investigations and research are lacking in the DRC and other affected countries.
- Laboratory diagnostic and research capabilities for Monkeypox are weak in the DRC.

(WHO/CDS/CSR/APH/99.3 1999:1-12).

Since there is inadequate Monkeypox surveillance in place, surveillance should either be established or strengthened, with the focus on forested areas of the Kasai Oriental Province of DRC and other African countries (WHO/CSR 1999:7). WHO has promised help in establishing a surveillance system in this area. As a result of a WHO meeting in Geneva, Switzerland 11-12 January 1999, the technical advisory group on Human Monkeypox, which was convened by the Department of Communicable Diseases Surveillance and Response (CSR), has made the following epidemiological surveillance recommendations:

- ✓ An updated Monkeypox surveillance and Investigations manual should be prepared. The manual should include the proper protocols to follow in event of an outbreak. Experts in human Monkeypox and diseases resembling Monkeypox should prepare

the manual. A review panel should give special attention to case definitions for routine surveillance, investigative, and research purposes. Case definitions should consider clinical and laboratory criteria.

- ✓ The heavily endemic population of Kasai Province should be designated for special emphasis surveillance (WHO/CSR 1999:7). Additionally, surveillance in other areas of the DRC and other African countries should be re-established or strengthened through WHO. These systems should be able to detect suspected cases promptly, assure rapid notification to national and WHO authorities, and elicit timely and comprehensive investigations.
- ✓
- ✓ The transmissibility of human Monkeypox needs to be determined with urgency. The sensitivity, specificity and predictive values of new *orthopoxvirus* serological assays need to be evaluated as part of prospective investigations.
- ✓ Differentiation of Monkeypox from other *orthopoxviruses* by serologic testing merits the highest priority.
- ✓ The occurrence and clinical picture of chickenpox and Monkeypox in HIV-infected and uninfected children needs to be studied.
- ✓ A population-based study is advised as the best way to understand the clinical, epidemiological and ecologic characteristics of human Monkeypox, and associated

laboratory-testing issues.

- ✓ National capability for serologic and virologic diagnosis should be evaluated, established and maintained.

- ✓ Increased resources, training, administrative and logistical support will be needed to assure that a satisfactory surveillance system and diagnostic capacity is re-established.

(WHO/CDS/CSR/APH/99.5 1999:1-12).

The only shortcoming of the epidemiological surveillance recommendations is that it does not limit the exportation of wild rodents from Africa, including Tree squirrels (*Heliosciurus sp.*), Rope squirrels (*Funisciurus sp.*), Dormice (*Graphiurus sp.*), Gambian Giant Pouch Rats (*Cricetomys sp.*), Brush-tailed porcupines (*Atherurus sp.*), and Striped mice (*Hybomys sp.*) (Monkey Emergency Order 2003:1-2). An adequate surveillance system will help in reducing the case fatality rate for Monkeypox. Immediate action in response to the recent outbreak in the western hemisphere contained any further spread of the disease. There have been no new cases since the initial western hemisphere outbreak (Wegner 2004). Gambian rats were implicated, possibly as a reservoir with cross species transmission to prairie dogs and then to humans. Active surveillance is surveillance where public health officers seek reports from participants in the surveillance system on a regular basis, rather than waiting for the reports (e.g. telephoning each participant monthly). This was not the

case in Wisconsin, where Doctor Wegner stated "there is no formal active surveillance system in place for Monkeypox" (Wegner 2004). Doctor Wegner is from the Wisconsin Department of Health (Wegner 2004). As of June 2003 there was no active surveillance system in place for Monkeypox. Only 'Heightened Awareness' of the medical community to the effects of Monkeypox was activated. Individual physicians are relied upon to report unusual rash illnesses. Here is a case of no active surveillance system in place, just 'heightened awareness' of the potential spread of disease with no deaths reported. There is nothing wrong with 'heightened awareness', except that it is a reactive response for a short duration. In Wisconsin, it worked exceptionally well. Once the disease is contained, "heightened awareness" is discontinued. It would appear to be justified to consider the issue of "heightened awareness" as a component of an active surveillance system.

On 12 June 2003 an emergency order was issued by the Wisconsin Department of Health and Family Services in order to protect the health of Wisconsin residents with regard to prairie dogs and any mammals known to have contact with one or more prairie dogs since 1 April 2003. This order prohibits:

- ❑ Importing any prairie dog into Wisconsin.
- ❑ Importing into Wisconsin any mammal known to have had contact with prairie dogs since 1 April 2003.
- ❑ Selling of any prairie dog.

- Selling of any mammal known to have had contact with prairie dogs since 1 April 2003.
- Allowing any prairie dog to have contact with any member of the public.
- Allowing any mammal known to have had contact with prairie dogs since 1 April 2003, to have contact with any member of the public.
- Releasing any prairie dog to the wild.
- Releasing any mammal known to have had contact with prairie dogs since 1 April 2003, to the wild.
- The interstate sale or offering for sale or offering for any other type of commercial or public distribution, including release into the environment (i.e. the wild) of rodents from Africa including Tree squirrels (*Heliosciurus sp.*), Rope squirrels (*Funisciurus sp.*), Dormice (*Graphiurus sp.*), Gambian Giant Pouch Rats (*Cricetomys sp.*), Brush-tailed porcupines (*Atherurus sp.*), and Striped mice (*Hybomys sp.*)

(Monkeypox Emergency Order 2003:1-2).

On 18 July 2003 the CDC had issued an updated interim infection control and exposure

management guidance in the health-care and community setting for patients with possible Monkeypox virus infection (CDC Monkeypox 2003:1-4). It proposes **symptomatic surveillance**. This is where 'heightened awareness' comes into play. An astute medical practitioner should be able to observe signs and symptoms immediately and report the findings to the appropriate health authorities. Signs and symptoms are the earliest indicators of illness and disease in the absence of medical testing. A sign is something that is physically observable by medical staff or the patient (e.g., a rash, bruising, swelling, etc.). A symptom is an experienced feeling, discomfort or pain. Psychological signs are easy to evaluate using measurements, estimations of affected area, colour, swelling and appearance. Symptoms are less easily measured but can be scored semi-quantitatively e.g., on a scale of intensity from 1 to 10. Signs and symptoms can be easily grouped into syndromes, which collectively indicate or characterise a disease, a psychological disorder or another abnormal condition .

(BWC/MSP/2004/MX/WP.53 2004:1-6).

2.1.3 SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

The Department of Health (Philippines) has reported to WHO that active surveillance has been ongoing since 17 March 2003 to detect and investigate any new SARS cases in sixteen Philippine regions (WHO/CSR 2003g:1). All 16 regions in the Philippines report daily on whether any suspect cases have been identified. A report of a suspect case initiates contact tracing and when necessary, quarantine measures (WHO/CSR 2003g:1). This type of surveillance could be used in tracking any emerging infectious disease

anywhere in the world. It would be recommended to follow-up on any probable cases also. The Department of Health in the Philippines has five strategic approaches to prevent the spread of SARS. They are:

- ❖ Minimise / prevent the importation of SARS
- ❖ Minimise / prevent the local transmission of SARS
- ❖ Raise public awareness about SARS
- ❖ Minimise / prevent SARS deaths
- ❖ Minimise / prevent the adverse effects of SARS on the economy and society (DOH [Sa]:1-3).

Global surveillance of SARS began at the end of February 2003 (SARS 2003:3). Global surveillance through GOARN provided rapid knowledge about the causative agent, mode of transmission, case definition, name and other epidemiological features (Heymann and Rodier 2004:1-5). Updated WHO revised guidelines for the global surveillance of SARS were initiated in October 2004. The guidelines include more precise guidance on laboratory testing and on the requirements for official reporting to WHO. Particular emphasis is given to the prevention of secondary transmission from common source outbreaks and sporadic

cases (WHO/CDS/CSR/ARO/2004.1 2004:1-2).

Reports indicate that Chinese authorities recently started, possibly as early as April 2003, a nation wide surveillance system to detect and report cases of SARS. Questions remain about the capability of some provinces to cope with the SARS challenge (WHO/CSR 2003j:1). Some provinces have neither the skilled medical staff nor sufficient finances to deal effectively with the challenges to be faced in dealing with a SARS outbreak.

WHO issued the Global SARS Alert on either 12 or 15 March 2003, and since then national authorities have implemented heightened surveillance for SARS cases (WHO/CSR 2003K:1). Global surveillance through GOARN provided rapid knowledge about the causative agent, mode of transmission, case definition, name and other epidemiological features (Heymann and Rodier 2003:1-5). Heightened surveillance was effective. Within four months transmission of SARS had been interrupted at all sites and on 5 July 2003 SARS was officially contained (Heymann and Rodier 2003:1-5).

The question of whether there will be a recrudescence of SARS can only be answered after twelve (12) months of post-outbreak surveillance (Heymann and Rodier 2004:173). Since the outbreak was officially contained as of 5 July 2003, a year later would be 5 July 2004. According to Dr. Heymann, from the World Health Organization, "... there is no evidence at present that SARS has become an endemic disease in humans at this point in time. There were, however, three outbreaks related to laboratory accidents." (Heymann 2004).

The European Union (EU) is a family of democratic European countries, committed to

working together for peace and prosperity. The European Union Communicable Disease Network Committee was established in response to the SARS epidemic. The Committee met on 9 -10 April 2003 and agreed to the following surveillance actions for Member States and the commission for the surveillance and control of SARS:

- To activate a surveillance system with case definitions
- To report procedures following WHO's recommendations
- To include daily reporting of probable cases to the European Commission, which is the driving force and executive body of the European Union and is one of five EU institutions (EUROPA 2005:1-2), and WHO (WHO-WER 2003f:1)
- To alert physicians in primary care and hospitals to report all suspect cases.

Additionally, the European Union Communicable Disease Network Committee issued a document on immediate actions for surveillance and control of SARS in Europe. The document contained the following immediate actions to be taken by the Committee:

- Reduce the risk of infections in travellers to affected areas
- Limit importation of infection

- Detect imported cases early
- Inform the public on how to prevent the spread of disease (Eurosurveillance Weekly 2003:1-4).

The actions of the European Union are very relevant to this study because they are another primary example of positive action taken against an emerging infectious disease in order to save lives.

The SARS experience made one lesson clear early in its course: "... inadequate surveillance and response capacity in a single country can endanger national populations and the health security of the entire world." (Heymann and Rodier 2004:173). When one nation's surveillance system fails, the rest of the nations need a strong global safety net, an international mechanism for global outbreak alert that protects all the other nations. With international air travel readily available, infectious diseases can travel the globe within hours, infecting masses of people and spreading disease through the world. The above reference is meant for China's handling of the SARS outbreak, which was inadequate. In China, the health infrastructure was weak, particularly the surveillance system as indicative of the SARS outbreak. WHO and the Chinese Ministry of Health took this opportunity to strengthen systems for responding to and detecting all emerging infectious diseases throughout the mainland, resulting in their surveillance and response systems being sufficiently robust that SARS is being controlled, but many of the processes are not

sustainable (WHO/CSR 2003j:1).

At the end of February 2003, when the Global Surveillance of SARS began, there is evidence that suspected and probable cases of SARS have left infected countries on flight to other countries (Outbreak News 2003:189). The disease has spread to 13 countries on three continents. As of 12 May 2003 WHO reported 552 deaths in > 30 countries (Galvani *et al* 2003:1-8).

Sensitive "alert" case definition, i.e. one that will identify nearly all cases of the disease being investigated (true positive) but at the same time may include other similar illnesses resulting from different causes (false positives), is needed for use in areas with the greatest risk for SARS recrudescence. There should also be SARS laboratory diagnostic capacity for early diagnosis and case classification: clinical, laboratory, and epidemiological data need to be integrated for real time analysis. A central data processing unit needs to be established to integrate the data in a timely manner; it can then be processed to a central command centre, which can make the data available to those in the medical community on a need to know basis. High quality laboratory performance is essential for diagnosis and epidemiological surveillance. The laboratory should be able to diagnose infections, support epidemiological surveillance and epidemic investigations and participate in and coordinate laboratory surveillance.

In June 2003, WHO sponsored a Global conference on 'Severe Acute Respiratory

Syndrome (SARS) – Where do we go from here?’ Doctor Ray Anthony chaired the section responsible for answering the question “Are current alert and response systems appropriately robust?” One key priority as a result of the conference was the revision of International Health Regulations, which should further strengthen capacity to contain emerging infectious diseases (Arthur 2003:1). Application of classic epidemiological measures, including patient isolation, infection control measures, contact tracing, proper management of contacts, and restriction on travel, proved effective in affected countries despite diversity of health systems and differences in severity of outbreaks.

Two researchers recently developed the ‘new’ illness SARS. A postgraduate student researcher, the index case, having been exposed to SARS, passed it on to the nurse caring for her and to her mother, a medical doctor. The researcher's mother subsequently died. Contact tracing yielded 171 contacts.

WHO and Chinese investigators are trying to determine if the exposure to SARS was caused by the researcher's experiments or other sources, since they were not using the live virus (WHO/CSR 2004:1). As part of an active surveillance system, knowledge of the causative agent of the disease is primary if one is to eventually break the chain of transmission.

Since April 22, 2004, a total of 9 SARS cases, including the two researchers, have been reported with one death (WHO CSR 2004d:1). In the Guangdong Province of China, where the first few cases appeared in November 2002, there may have been close proximity to

"wet" markets where certain wild animal species are sold for consumption. These include:

- the masked palm civet cat

- the Chinese ferret badger

- the raccoon dog.

All of these animals elicited antibodies against the SARS coronavirus (SARS-CoV). The terms SARS and SARS-COV should be considered synonymous. It is possible that this information may have been picked up earlier if active surveillance systems were in place that included both epizootic and enzootic surveillance.

The coronavirus is the cause of SARS. The coronaviruses are part of a family of RNA viruses having a pleomorphic virion 120-160nm in diameter consisting of a lipid-containing membrane, with large peplomers, surrounding a helical nucleocapsid (Dorland's Medical Dictionary 2003:420). The prime suspect as reservoir for the SARS virus is the masked palm civet cat. Laboratory research was conducted and found that these cats harbour the SARS coronavirus. They also seroconverted. Their sera inhibited the growth of SARS virus isolated from humans. Additionally, the serum from SARS patients inhibited the growth of SARS isolates from masked palm civet cats (WHO/CSR 2003i:1). Through laboratory testing, the civet cat virus proved not to be 100 percent identical to the SARS virus (Walgate 2003:1) but with the exception of a small additional sequence, the virus isolated

from the civet cats is identical to the SARS virus isolated from humans. In order to stop the spread of the virus, 10,000 civet cats were culled: drowned in disinfectant, steamed for six hours in autoclaves and then buried (Civet Cats 2004:1). It has been reported that domestic cats and ferrets are susceptible to infection by SARS-CoV. It is uncertain whether domestic animal transmission to humans has occurred (Lun & Qu 2004:959). This should certainly be part of an active surveillance system and not to be underestimated, since it could have serious implications in the spread of the disease and possible increase in case fatality rates. In the case of SARS, once there was an outbreak, China and the rest of the world responded rather quickly to contain the newly emerging infectious disease. Many deaths were directly caused by SARS, but many more were prevented because of the active response of the global medical community. Newly emerging infectious diseases can only be contained at outbreak and not at the pre-emergent stage. WHO's global alert is a primary example of how an effective surveillance system and response can contain a disease early in its emergence.

2.1.4 EBOLA (Ebola Haemorrhagic Fever [EHF])

A reinforced active surveillance system was established in Uganda during the third week in October 2000 with three case notification categories: alert, suspect, and probable (Outbreak 2001:1-13). The alert category was restricted to community use for notification to mobile teams, peripheral health units, and private clinics and pharmacies, of individuals with sudden onset of high fever, sudden death, or any haemorrhagic signs. Mobile teams and peripheral units used the suspect case definition to categorise potential cases and to

determine if any patient required transportation to an isolation ward. The probable case definition was identical to the suspect definition but with the requirement that it was described by a physician (Outbreak 2001:1-13). Ebola haemorrhagic fever was confirmed on 15 October 2000 in the Gulu district, Uganda at St. Mary's hospital in Lacor as well as in the Gulu Hospital, the regional referral hospital for the northeastern region. The virus associated with this outbreak was Ebola-Sudan. The Ministry of Health of Kampala requested the World Health Organization (WHO) to coordinate the international response of health organisation worldwide. An active surveillance system was initiated to determine the extent and magnitude of the outbreak, identify foci of disease activity and detect cases early. The system was designed to be very sensitive and detect all persons whose illness might be Ebola Haemorrhagic Fever (Outbreak 2001:1-13). The African Development Bank (ADB) approved \$500,000 to finance an emergency humanitarian assistance programme for Ebola Haemorrhagic Fever surveillance in Gabon (IRIN NEWS 2002:1). The ABD's intervention is intended to supplement the action of the Government and its development partners with a view to enhancing the surveillance and epidemiological control of Ebola Haemorrhagic Fever, care of patients and prevention of disease by way of social mobilisation (Reliefweb 2002:1). The Ministry of Health, the Congolese Red Cross, and the international team—including WHO, IFRC (International Federation of Red Cross and Red Crescent Societies)—continue to assist in mobilisation, surveillance and case management activities (WHO/CSR 2003d:1).

Outbreaks of Ebola Haemorrhagic Fever have occurred in scattered and inaccessible areas with local opposition to intrusion from the outside. Since the reservoir has not been

identified, it is still difficult to know what type of surveillance to implement because "Surveillance is reactive in response to sporadic outbreaks" (Pringle 2004). The implication of this is that knowledge of the reservoir is a primary first step toward breaking the chain of transmission.

On 16 July 2003, The European Space Administration (ESA) announced that it is donating satellites to help study Ebola. Detailed vegetation maps of Congo and Gabon will be created with satellite images. This is all part of a new European Space Administration Data User Element (due) project called Epidemio, developing Earth Observation (EO) services for epidemiologists (ScienceDaily 2003:1-2; due 2003:1-2). *The Centre International de Recherches Medicales de Franceville (CIRMF)* has teamed up with ESA to study Ebola. Environmental features can be marked where outbreaks occur. The CIRMF will combine EO data with their field results within a geographical information system (GIS). There may be particular environmental characteristics associated with sites where dead animals are found and local people have acquired Ebola antibodies (ScienceDaily 2003:1-2; due 2003:1-2). The researchers hope to study and identify temporal and spatial changes in vegetation, water levels and weather to link Ebola outbreaks with climatic changes. The researchers will focus on the Northeast Gabon/Congo region which has had eight (8) outbreaks since 1994 (Wolfe *et al* 2004:932-937).). In Gabon and Congo, the European Space Administration has observed annual periodicity of Ebola outbreaks which suggests that particular ecological conditions characterise the reservoir host habitat (ScienceDaily 2003:1; due 2003:1-2). According to Doctor Simon Pinnock of the European Space Administration (ESRIN), the Epidemio project is supplying some satellite-based landcover

maps to CIRMF in Gabon to help them optimise their fieldwork studies on the Ebola reservoir (Pinnock 2005). The project officially started on 16 July 2003.

There are several strains of Ebola:

- Ebola-DRC (Democratic Republic of the Congo)

- Ebola-Ivory Coast

- Ebola-Gabon

- Ebola-Sudan

- Ebola-Reston.

Members of a given strain are generally regarded as being the same genetically. All but Ebola-Reston have been implicated in human disease.

Ebola is a member of the family *Filoviridae*. The reservoir for the Ebola virus is still unidentified. According to WHO, EHF is transmitted through direct contact with body fluids of infected humans and other primates. Ebola virus has also occurred as a result of handling ill or dead infected chimpanzees and eating dead wild animals (bushmeat).

In 1989 and 1990 a filovirus named Ebola-Reston was isolated in monkeys quarantined in

the United States and located in labs in Reston, Virginia and Alice, Texas and Pennsylvania. Ebola related filoviruses were isolated from *cynomolgus* monkeys (*Macaca fascicularis*) imported into the USA from the Philippines.

It is suspected that non-human primates are not the reservoir but have just been a source of infection. The natural reservoir is within the rain forest of Africa and Asia. Bats have been implicated and may play a role perhaps as a host in the tropical forest, since they do not die when experimentally infected with Ebola virus (WHO 2004:1-2). Plants have also been considered as a reservoir. Additionally, birds and insects have also been suspected of carrying the virus (Lovgren 2003:1-4). In scientific experiments bats have been injected with Ebola virus and survived. "You find bats in almost every outbreak," said Bob Swanepoel, head of the Special Pathogens Division at South Africa's National Institute for Communicable Diseases. The current Ebola epidemic is "multi-centric" or spread over a vast area, which suggests that the natural host for Ebola could also be active over a large area. Purdue University scientists presented new research that links Ebola with birds, since the outer protein shell of filoviruses, such as Ebola, have a biochemical structure similar to retroviruses carried by birds, making a common evolutionary origin more likely (Lovgren 2003:1-4). Scientific research including Epidemio can add a great deal of information about the Ebola virus to help enhance any type of surveillance system. The Ebola epidemic is particularly difficult to contain because the reservoir has not yet been found and the affected villages are tucked into impenetrable forests that are too massive to cordon off. Additionally, cultural practices complicate containment efforts. Religious rites, for example, dictate that family members wash the body of a dead person before burial. Since Ebola

virus is one of the most contagious viruses known to man, it can be transmitted by a handshake, and person-to-person transmission by direct contact with blood, secretions, organs, or semen is possible, in addition to eating infected bushmeat (Acha and Szyfres 2003:117-120; Logren 2003:1-2).

Two researchers from the University of Liverpool theorise that the Black Death (the Bubonic Plague) may have been caused by an Ebola-like virus, perhaps a descendant of the current day Ebola virus that causes Ebola Haemorrhagic Fever (Derr 2001:F4). The spread rate for Black Plague was too slow, a pace of about 100 yards per year, while the Ebola virus travels at the rate of around 30 miles in two to three days. Viral diseases are passed from person to person, while the bubonic plague was spread by fleas carried on the backs of black rats (Sterling 2001:1-3). Knowing the evolutionary origin of the Ebola virus can enhance efforts for vaccine research and development, which eventually, when fully developed, can be incorporated into an active surveillance system to reduce case fatality rates

Ebola is the most horrific of the emerging infectious diseases, with severe bleeding of the visceral organs. Since the reservoir for Ebola has yet to be found, active surveillance only occurs once an outbreak emerges and then it is a reactive response. It is impossible to contain an emerging infectious disease during the pre-emergent state. It can only be contained once it emerges. In most cases scientists are not exactly sure what to look for to contain. Only after an outbreak can action be taken to break the chain of transmission. It is not feasible to monitor all animal populations, nor is it financially viable, although epizootic

surveillance has its advantages, as in the case of the culling of over a million pigs to contain the Nipah virus and break the chain of transmission.

2.1.5 NIPAH VIRUS

During the month of March 1999 Dr. Peter Daniels, a veterinarian and project leader of the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Animal Health Laboratory's (AAL) diagnosis and epidemiology section, was part of the Australian task force which travelled to Malaysia to help control and eradicate the Nipah Virus (CSIRO 2004:1-4). Dr. Daniels helped the Malaysian Veterinary Service Department to design a national surveillance and eradication program for the disease in livestock, based on the detection and culling of infected pigs. From 28 February 1999 to 26 April 1999, over one million pigs were culled in Malaysia. The result was that the epidemic and spread of the disease stopped (Meng 2003). Since 1998-99, no new cases have been reported in Malaysia. Nipah virus outbreaks have occurred in Bangladesh in 2001, 2002 and 2004 (Tetreault-Campbell 2004; ClickItNews.com 2005:1-2). As of April 20, 2004, one cluster of 30 cases was reported, including 18 cases attributed to Nipah Virus in the Faridpur District. The CDC laboratory has confirmed 16 cases (Nipah 2004b:1). The case of Nipah virus supports the hypothesis in that immediate action was taken in Malaysia to break the chain of transmission thereby reducing case fatality rates.

The source of Nipah Virus infection among most humans is exposure to pigs. Patients

reported touching or handling pigs before onset of illness. One million pigs have been culled in Malaysia. The reservoir suspected was the *Megachiropters* (fruit bats or flying foxes). There are many fruit trees on pig farms. So the possibility of crossing species exists, bats to pigs and then pigs to humans. The chain of infection was broken with the culling of one million pigs (Disease Archive 2003:1; Meng 2003; Lashley & Durham 2002:374-378).

The outbreaks in Bangladesh appear to be different from the outbreaks in Malaysia because no immediate animal host has yet been identified. Giant fruit bats are suspected to be the reservoir for Nipah virus in Bangladesh. It is hypothesised that infection could have occurred from eating the same fruits that fruit bats fed on during the night. Additionally, many of the cases in Bangladesh have occurred within households in which the victims had no direct contact with animals or bats. Human-to-human transmission, which did not play a significant role in Malaysia outbreak, could therefore be possible in Bangladesh, which could lead to a greater number of cases (Disease/Infection News 2004:1).

A new mysterious disease is now plaguing Bangladesh at Bashall Upazila in Tangail. So far 11 people have died and >20 people have been afflicted. The data suggest that Japanese encephalitis virus is the cause. Samples have been sent to the Centers for Disease Control and Prevention for analysis (ClickItNews 2005:1-2).

This information is critical to this research because it is an excellent example of an active response to contain an emerging infectious disease, specifically Nipah virus in Malaysia, to

save lives and to reduce case fatality rates. Culling is part of an active surveillance system in that it broke the chain of transmission.

This researcher believes that an active surveillance system or an increased number of surveillance systems can save lives. One researcher said that second generation surveillance for HIV/AIDS was not designed to save lives. It was probably designed to gather data. This is a futile endeavour. This researcher believes that if a surveillance system cannot help save lives it is weak and useless.

2.1.6 DENGUE VIRUS (Dengue Fever [DF] / Dengue Haemorrhagic Fever [DHF])

It is recommended that an active laboratory-based surveillance program be implemented in the state of Florida. The current passive system is inadequate. Reliance on a passive surveillance system has resulted in erroneously under-reporting Dengue cases in Florida. A research study concluded that active laboratory-based surveillance resulted in an increased number of confirmed cases of Dengue in Florida (Gill 1998:1-84). The study demonstrated the value of cooperation between the state public health laboratory system and commercial laboratories. It is recommended that a formal action plan be implemented by the Florida Department of Health in the case of a Dengue outbreak (Gill 1998:1-84).

Fundamentally, the reporting of Dengue Fever/Dengue Haemorrhagic Fever (DHF) is not standardised. Epidemiological and laboratory data are often collected by different institutions and reported in different formats, and are therefore difficult to collate. This

results in delayed collection and analysis at the regional/global levels, vital for epidemic prediction and preparedness (WHO I DengueNet 2003:1-2). The DengueNet system was established in response to WHO resolution adopted at the 55th World Health Assembly in May 2002 asking Member States to enhance their surveillance systems and to strengthen laboratory diagnosis in countries affected with the Dengue virus (WHO DengueNet 2003:1-2). Any type of system that can enhance a current surveillance system is of key importance because it can help reduce case fatality rates.

DengueNet is WHO's Internet based system for global surveillance of Dengue Fever and Dengue Haemorrhagic Fever (DH/DHF). It is a central data management system to:

- collect and analyse standardised epidemiological and virological data in a timely manner
- show in real time significant indicators such as case fatality rates (CFRs) and incidence data
- provide real time and historical data. DengueNet currently houses data from 1995 to 2001 and lastly present epidemiological trends.

(WHO I DengueNet 2003:1-2).

The overall aim of this research is to prove that an active surveillance system or an increase in the number of surveillance systems can reduce case fatality rates and thus save lives. The DengueNet system will help enhance and strengthen current surveillance

systems which in turn will help reduce case fatality rates through strengthening laboratory diagnosis, providing real-time data and presenting epidemiological trends.

Within the CDC is the Division of Vector-Borne Infectious Diseases (DVBID). The DVBID serves as a national and international reference centre for vector-borne viral and bacterial diseases. The mission of DVBID is to:

- develop and maintain effective surveillance for vector-borne viral and bacterial agents and their arthropod vectors;
- conduct field and laboratory research and epidemic aid investigations;
- define disease etiology, ecology and pathogenesis in order to develop improved methods and strategies for disease diagnosis, surveillance, prevention and control;
- provide diagnostic reference and epidemiological consultation on request to state and local health departments, other components of CDC, other federal agencies, and national and international health organisations;
- provide intramural and extramural technical expertise and assistance in professional training activities.

(CDC /DVBID 2003:1-3).

Within the Division of Vector-Borne Infectious Diseases is the Dengue Branch (CDC/DVBID 2001:1) whose mission is to:

- ✓ develop and maintain national and international surveillance for Dengue Fever and Dengue Haemorrhagic Fever;
- ✓ provide laboratory reference and diagnostic services to local, state, national, and international health agencies;
- ✓ provide epidemic aid and investigate Dengue epidemics;
- ✓ conduct field and laboratory research on the biology, behaviour and control of *Aedes aegypti* and other mosquito vectors;
- ✓ conduct research on and provide consultation and assistance to local, state, national, and international health agencies on improved methods for surveillance, prevention and control of epidemic dengue;
- ✓ provide training in laboratory and clinical diagnosis and on surveillance, prevention, and control of Dengue;
- ✓ develop, implement, and evaluate new community-based intervention strategies for

prevention of epidemic Dengue;

- ✓ function as a WHO Collaborating Centre for Reference and Research on Dengue Haemorrhagic Fever.

(CDC Dengue Branch 2001:1-3).

The CDC's DVVID and its Dengue Branch are mission focused and directed, as are the objectives of this thesis, which are focused on testing the hypothesis which states that:

Active surveillance will have an effect on zoonoses and/or anthroponosis in that it will prevent or at least limit emergence of infectious diseases.

The viruses of DF/DHF are of the genus Flaviviruses, family Flaviviridae. There are four Serotypes, DEN-1, DEN-2, DEN-3, and DEN-4. The vector in the human cycle is the *Aedes aegypti*, a mosquito that breeds in domestic water containers and bites during the daytime. *A. albopictus* may be the only vector in some parts of southeast Asia. *A. niveus*, which feeds on humans and monkeys, is believed to be the vector of the wild cycle in Malaysia. The monkey mosquito cycle serves as the reservoir in Southeast Asia and West Africa.

Dengue is basically a human disease transmitted by mosquitoes of the genus *Aedes*. In

addition to the human cycle there is a non-human primate wild cycle involving *A. niveus* mosquitoes, inhabitants of the forest's canopy. Classical Dengue Fever is an acute and febrile disease, while DHF is a more serious form (Acha & Szyfres 2003:94-97).

Control of Dengue virus is less effective with passive surveillance and more effective with active surveillance. Since the focus of this research is on active surveillance and its effect on zoonosis and anthroponosis, this researcher is in total support of any enhancements to current surveillance systems that will make them more effective in combating disease and in reducing case fatality rates. The DengueNet is a very impressive surveillance system and should serve as a model Internet-based system for other emerging infectious diseases (EIDs). DengueNet is centralised and comprehensive, provides historic data and is real-time oriented. All of these attributes can enhance current surveillance systems to active status, which in turn can have an effect on case fatality rates by reducing the spread of disease. The lethality of EIDs cannot be underestimated. Historic evidence has proven this point.

Resurgence of tuberculosis (TB) in the form of multi-drug resistant tuberculosis (MDR-TB) is a case in point. Prior to this, many TB clinics were closed on the assumption that TB was eradicated. That was not the case. MDR-TB is resistant to isoniazid® and rifampicin®, two of the most formidable drugs used to treat TB (WHO I Tuberculosis 2004:1-7). In order to get a handle on the battle against emerging infectious diseases it is necessary to evaluate all systems and get rid of weaker systems or further enhance weaker systems and actively

respond to all outbreaks expeditiously, effectively and efficiently.

2.1.7 WEST NILE VIRUS (WNV)

Experimental screening tests have been implemented to identify viremic donations and prevent NAT (nucleic acid amplification tests) reactive blood components from entering the blood supply. During the 2002 epidemic of West Nile Virus (WNV) in the United States of America, 23 persons were reported to have acquired WNV infection after receiving blood components from 16 WNV-viremic blood donors (CDC/MMWR 2003:769-772). Viremic donations are those blood donations that contain West Nile Virus. The West Nile Virus nucleic acid amplification test (NAT) is a test used to screen all blood donations and quarantine and retrieve potentially infectious blood components (Update 2003:1; CDC/MMWR 2003: 769-772). Because of the possibility of WNV epidemics recurring in the United States of America, blood collections agencies (BCAs) implemented the WNV nucleic acid amplification test (CDC/MMWR 2003:769-772). Since this is clearly a preventative measure, it can be considered part of West Nile Virus active surveillance, which can have the effect of reducing case fatality rates, which means saving lives.

The Division of Vector-Borne Infectious Diseases (DVBID) branch conducts surveillance, field investigations, and laboratory studies of vector-borne viral agents and their vectors. Additionally, this division defines disease etiology, ecology, and pathogenesis in order to develop methods and strategies for disease diagnosis, surveillance, prevention, and control (CDC/DVBID 2003a:1). The DVBID is one of the branches of the National Centre for

Infectious Diseases (NCID), which is one of 12 centres, institutes, and offices within the Centers for Disease Control and Prevention (CDC) (CDC/NCID 2003:1-2; CDC/DVBID 2003c:1-2). West Nile Virus is considered a hyperendemic disease; that is a disease that is constantly present at a high incidence and/or prevalence rate and affects all age groups equally (Last 2001:89). The development of the NAT by BACs and the mission of the DVBID are just two examples of steps taken to combat WNV. This information is included in this research because these are prime examples of both a preventative measure taken to combat the spread of disease and the implementation of an active surveillance system taken by the DVBID branch of the NCID. Both strategies can reduce case fatality rates and save lives.

West Nile Virus (WNV) is of the family *Flaviviridae*. Birds are a source of mosquito infection for WNV. The vectors are *Cules univillatus* in South Africa, *C. Modesticas* in France, and *C. pipiens molestus* in Israel. Avian morbidity and mortality surveillance in the eastern US has identified over 3600 WNV infected birds in the year 2000.

No uniform surveillance and response strategy can be relied upon to control and prevent WNV risk at all times because WNV is hyperendemic. The only truly universal line of defence is individual adherence to personal protection measures against mosquitoes (DOD/WNV 2003: 1-5). There are certain things that people can do to protect themselves from the West Nile Virus:

- spray yourself and your clothing with an effective insect repellent containing DEET® (diethyltoluamide) or permethrin®, a pyrethroid insecticide applied topically in the treatment of infestations by *Pediculus humanus capitis*, *Sarcoptes scabiei* and various species of ticks (Dorland's Medical Dictionary 2003:1408). Do not use it on children less than two years old.
- Change water in outdoor pet dishes and birdbaths often.
- Keep children's wading pools empty and on their sides when not in use.
- Stay inside during times when there are a lot of mosquitoes (evening or dusk until dawn).
- minimize the number of mosquitoes around the home by eliminating any standing water where mosquitoes can lay their eggs (flowerpots, buckets, barrels, and tire swings).
- Don't wear perfume or cologne when you go outside for a long time.
- wear long-sleeved shirts and long pants and light coloured clothing.
- Put screens on your windows and doors.
- If you use bug spray, wash your clothes before you wear them again.

(FDA/Office of Women's Health 2003: 1-2).

The above referenced measures of prevention can be part of an organised surveillance system; a public awareness campaign to initiate preventive action to decrease the likelihood of human infection.

The general surveillance and reporting framework for WNV was developed after review of the 2002 Department of Defence activities and results. Between September 1999 and December 2002, WNV has become the leading cause of arboviral encephalitis in the United States of America (USA). This demonstrated that the USA was vulnerable to new and exotic infectious diseases. In 2002 the Department of Defence West Nile Virus surveillance and response efforts to protect the Department of Defence Force health and readiness were resource intensive. In 2002, the Department of Defence strengthened its capacity and preparedness to face future outbreaks of mosquito-borne diseases.

(DOD/WNV 2003:1-5).

Four elements of a WNV surveillance system are:

- ❖ Mosquito surveillance and reporting

- ❖ Avian surveillance and reporting

- ❖ Non-human mammal surveillance and reporting

❖ Human surveillance and reporting.

(General Framework 2003:1).

The combination of all the above four elements would comprise an active surveillance system that would help reduce case fatality rate, thereby saving lives.

CDC developed an electronic based surveillance and report system, ArboNet, to track WNV activities in humans, horses, other mammals, birds, and mosquitoes. In 2003 the ArboNet surveillance system was updated to streamline reporting to CDC of WNV activity by the state public health departments. According to the DVBID, “A universally applicable arbovirus surveillance system does not exist” (CDC/DVBID 2003:7).

For each of the four elements of a WNV surveillance system comprising ArboNet, two general categories of data are measured and confidentially reported to CDC for evaluation. The CDC then combines, evaluates, and reports the data so health departments can use it for detecting and monitoring the infections. The data that are reported using ArboNet (a computer based tracking system) are:

- Weekly totals of new individuals or groups of individuals reported to, sampled by, or tested by a state’s WNV surveillance system (denominator data).
- Detailed information on individual mosquito pools, sentinel flocks, dead birds, and

ill people, horses or other species with confirmed or suspected WNV infections (numerator data).

(West Nile Virus: Monitoring [Sa]: 1-3).

In 1999, when the first cases of WNV in the USA were reported, Ontario, Canada established a surveillance protocol to monitor the possible spread of disease. This encompassed evaluation of dead birds, sentinel chickens, mosquito pools and human disease. Ontario has a laboratory-based enhanced passive surveillance system as well as an active surveillance system (Ford-Jones 2002:29-35). Between 1 July 2000 and 31 October 2000, active human surveillance for WNV infection was undertaken at 59 sentinel hospitals. In this case a sentinel hospital is a hospital that is able to detect and monitor for WNV infections. Each hospital was contacted and a local site coordinator was identified. A weekly fax summarising local and North American surveillance data was sent to each site coordinator. Designated medical, nursing, and laboratory staff identified patients who met the case definition for WNV. The site coordinator then sent weekly faxes to the surveillance coordinator indicating suspect cases, providing demographic and clinical information. Those sentinel hospitals that failed to send weekly faxes were contacted by telephone (Ford-Jones *et al* 2002:29-35).

For the enhanced passive surveillance, the chief medical officer of health contacted all hospitals and appropriate specialists in the hospital and advised them of the importance of recognising, testing and reporting cases of encephalitis, meningoencephalitis and adult viral

meningitis that may be caused by WNV (Ford-Jones *et al* 2002:29-35). Surveillance coordinators liaised weekly with the provincial laboratory to determine the status of specimen collection (Ford-Jones *et al* 2002:29-35).

The goal of the active surveillance system was the early detection of WNV infection in patients admitted to hospital with encephalopathy. The outcome of human surveillance for WNV infection in Ontario in 2000 was that the identification of acute encephalitis on the basis of symptoms at the time of admissions is often impossible (Ford-Jones, *et al*, 2002:29-35).

2.1.8 GROUP B STREPTOCOCCUS (GBS)

Active Bacterial Core Surveillance (ABCs) of the Emerging Infectious Program Network is a collaboration between the Centers for Disease Control and Prevention and several health departments and universities within the Network. ABCs conducts laboratory and population-based active surveillance and collects specimens and studies diseases caused by Streptococcus Group A and B, *N. meningitidis*, *S. pneumoniae* and *Haemophilus influenza* (Schuchat *et al* 2001:1-8). Active Bacterial Core Surveillance is within the Division of Bacterial and Mycotic Diseases within the CDC. This division monitors several diseases, including GBS. ABCs operates in nine states of the Emerging Infectious Program (EIP) network, representing a population of more than 30 million (Schuchat *et al*/2001:1-8). One of the future priorities for ABCs is to determine the effectiveness of screening versus risk-based prevention strategies for perinatal group B streptococcal disease. Population-based

risk factors associated with increased risk by multivariate analysis for GBS include black race, low birth weight, maternal age <20 years and age group <7 days old (Schuchat *et al*:1-8). ABCs continues to track the characteristics of newborn GBS cases that still occur regardless of prevention guidelines to determine whether these represent failures of intrapartum antibiotic prophylaxis or failure to offer such prophylaxis to mothers at risk (Schuchat *et al* 2001:1-8). More work needs to be done to control this pathogen. It should be mandated that all pregnant women be given intrapartum antibiotic prophylaxis, a preventative measure, until a new form of prophylaxis or vaccine is developed. All states within the United States of America and all other countries should have some form of surveillance for GBS. Active surveillance would be recommended which could reduce the case fatality rate for GBS.

Lancefield's serological classification of Streptococci distinguishes 20 serogroups, which are identified with the letters A to V, excluding I and J. This classification is based on different polysaccharide antigens on the bacterium cell wall. Several serogroups produce additional antigens that serve to identify serotypes. Streptococci are distributed worldwide. Since there are many species of Streptococci, Lancefield's serological classification helps distinguish GBS from its anaerobic variant *Streptococcus constellatus*, which is also implicated in miscarriages or adverse pregnancy outcomes and heavy cervical and endometrial contamination (Association [Sa]:1-7). It is important to know if GBS genital tract infections are further complicated by *S. constellatus*.

A study was done to determine the burden of GBS, determined by incidence, in the United

Kingdom (UK). Paediatric surveillance was done through the British Paediatric Surveillance Unit of the Royal College of Paediatric and Child Health. Paediatricians who reported cases were required to provide demographic details of pregnancy, birth, clinical presentation and outcome of disease. Microbiologists from England, Wales and the Channel Islands reported cases to the Public Health Laboratory Service (PHLS), Communicable Disease Surveillance Centre through an established routine laboratory reporting system (CoSuro), now the Health Protection Agency. Microbiologists from Scotland reported cases to the Scottish Centre for Infection and Environmental Health. Laboratories across the UK were encouraged to send GBS isolates to the PHLS Streptococcus and Diphtheria Reference Unit (Heath *et al*/2004:292-294). This information will assist in the formulation of guidelines for prevention of this disease.

GBS is anthroponotic and causes septicaemia, pneumonia, and meningitis in human newborns. The human subtype *S. agalactiae* causes two distinct forms: early onset (1-7 days of age) and late or delayed onset (7 days – several months of age). GBS is also a cause of mastitis in cows.

In humans early onset is characterised by sepsis and respiratory difficulties. Late onset is characterised by meningitis, with or without sepsis. Lethargy, convulsions and anorexia are also signs of the disease. Although both forms can cause death, mortality is higher for early onset (Acha and Szyfres 2003:259).

In adults and older children GBS can cause urinary tract infections, gangrene, postpartum

infection, endocarditis, pneumonia, meningitis, empyema and other pathologic conditions (Acha and Szyfres 2003). One of the leading causes of bacteraemia infections in newborns is group B streptococcus (Kilian [Sa] 2004:1-15). Since this disease causes, on average, over 10,000 deaths per year in the United States of America alone, an aggressive proactive response must be taken to prevent this disease from further killing children. Active surveillance or an increase in surveillance systems must be undertaken to control and reduce case fatality rates. Preventative measures such as intrapartum antibiotic prophylaxis can also be part of the surveillance system.

2.2 PURPOSE OF THE LITERATURE REVIEW

The main purpose of the literature review was to gather enough credible information on the selected emerging infectious diseases, their case fatality rates, disease incidence, and incidence rates, disease prevalence and disease prevalence rates and types of surveillance systems in place to either support or negate the stated hypothesis.

In order to test the hypothesis, an in-depth search of the literature was accomplished to gather secondary data on case fatality rates, incidence, incidence rates, prevalence, prevalence rates, case definitions and types of surveillance systems. Data was gathered in the following ways:

- ✓ Internet searches of scientific databases

- ✓ medical library search of the literature for scientific articles
- ✓ college and university searches of the literature for scientific and medical articles
- ✓ e-mail correspondence with scientists in the field.

The following emerging infectious diseases, including any appropriate surveillance system, were researched:

- HIV/AIDS
- Monkeypox
- Severe Acute Respiratory Syndrome (SARS)
- Ebola
- Nipah Virus
- Dengue Virus
- West Nile Virus (WNV)

- Group B Streptococcus (GBS).

2.3 SCOPE OF THE LITERATURE REVIEW

This research will encompass zoonoses and anthroponosis pertaining to World Health Organization (WHO) member states only (Basic 2001:470-477). Scientific articles, both primary and secondary, are referenced. Scientific books and journals have also been cited. E-mail correspondence from scientists is also referenced. The correspondence from the scientists, which has been cited extensively in this research, gave greater insight into the reality of having to deal with emerging infectious diseases on a daily basis. The literature review was extremely comprehensive and this researcher believes that the literature review was very successful.

Only information dated between 1990 and 2004 is used in this research. College and university libraries accessed for this research included:

- ✓ Saint John's University
- ✓ Princeton University
- ✓ Daytona Beach Community College
- ✓ Florida Hospital-Orlando's Medical library was also used during the literature search

- ✓ Internet-based research was done extensively
- ✓ Scientific videos (VHS format) DVD's, and audio cassettes have also been researched and referenced as appropriate

- ✓ E-mail correspondence with scientists in the field was very informative.

Since this research relies heavily on secondary data, most of the information comes from appropriate Internet sites, since the publication of data is usually a year behind schedule. Current web based scientific journal articles with data have also been referenced.

2.3.1 CASE DEFINITIONS

A case is defined as “a set of diagnostic criteria that must be fulfilled in order to identify a person as a case of a particular disease” (Last 2001:24). Case definitions change over time as the disease progresses within a particular population and clinical, epidemiological, and/or laboratory criteria confirm or deny specific findings related to a particular emerging infectious disease. In the United States of America (USA), case definitions are established by the Center for Disease Control and Prevention (McGovern, T. and Smith R. 1998:1). Each state has its own rules governing reportable/notifiable diseases. Case definitions outside the United States of America that are recognized by the CDC include the World Health Organization (WHO) and the Ministries of Health of WHO member states.

The following criteria are used to identify an Emerging Infectious Disease (EID), which is defined as a collective name for infectious diseases that have been identified and taxonomically classified recently. Many of them are capable of causing dangerous epidemics (Last 2001:58-59). Some examples of EIDs are:

- ❖ HIV/AIDS

- ❖ Ebola

- ❖ Dengue.

2.3.2 SURVEILLANCE SYSTEMS

Surveillance is defined as systematic ongoing collection, collation, and analysis of data and the timely dissemination of information to those who need to know so that action can be taken (Last 2001:174-175). There are many types of surveillance systems, each with its specific purpose. In general, they can be classified into three types: active, passive, and sentinel.

Active surveillance relies on regular periodic collection of information from health care workers or facilities. The data are more complete and accurate than other types of surveillance systems and more costly because, in general, an active surveillance system requires more effort by the data collection centre than do other surveillance systems and is

therefore more expensive to operate (Lilienfeld and Stolley 1994:104-105). Examples of active surveillance systems include:

- PROMED – Global web-based Internet surveillance early warning system
- IDPA – Assists with outbreak investigations, disease diagnosis, surveillance studies
- DENGUNET – Internet-based system for global surveillance DF and DHF
- DVVID – Surveillance of vector-borne viral agents
- ArboNet – A national electronic surveillance system to track WNV
- HIV/AIDS SGS – Combines case surveillance, HIV seroprevalence, STIs
- NON NAME-BASED HIV SURVEILLANCE – Requires UI patient code
- ABCs – Conducts laboratory and population-based surveillance for GBS.

The reader is referred to Table 2.30 for a critical comparison of key surveillance systems for more details. A key example of an active surveillance is when the CDC developed an electronic based surveillance and report system, ArboNet, to track WNV activities in

humans, horses, other mammals, birds, and mosquitoes. In 2003, the ArboNet surveillance system was updated to streamline reporting to CDC of WNV activity by the state public health departments. According to the DVBID, “A universally applicable arbovirus surveillance system does not exist” (CDC/DVBID 2003:7).

For each of the four elements of a WNV surveillance System comprising ArboNet, two general categories of data are measured and confidentially reported to CDC for evaluation. The CDC then combines, evaluates, and reports the data so health departments can use it for detecting and monitoring the infections. The data that are reported using ArboNet (a computer based tracking system) are:

- Weekly totals of new individuals or groups of individuals reported to, sampled by, or tested by a state’s WNV surveillance system (denominator data)
- Detailed information on individual mosquito pools, sentinel flocks, dead birds, and ill people, horses or other species with confirmed or suspected WNV infections (numerator data).

(West Nile Virus: Monitoring [Sa]:1-3).

Passive surveillance relies on collecting information as discretionarily reported by health care providers or facilities. It is inexpensive to operate because it requires less effort by the data collection centre. The data is likely to underestimate the presence of disease in the population (Lilienfeld and Stolley 1994:104-105). An example of an enhanced passive

surveillance system is Canada's established enhanced passive surveillance for WNV. The chief medical officer of health contacted all hospitals and appropriate specialists in the hospital and advised them of the importance of recognising, testing and reporting cases of encephalitis, meningoencephalitis and adult viral meningitis that may be caused by WNV (Ford-Jones *et al* 2002: 29-35). Surveillance coordinators liaised weekly with the provincial laboratory to determine the status of specimen collection (Ford-Jones *et al* 2002:29-35).

Sentinel surveillance collects information on "sentinel health events," i.e., cases of disease that need medical intervention or preventive therapy. Case reports indicate a failure of the health care system or indicate that special problems are emerging. It is very inexpensive to operate because it relies on case reports of disease and is less data intensive than either active or passive surveillance. It is applicable only for a select group of diseases. Cases reported under a sentinel surveillance system are termed "sentinel health events" which serve as a warning to health officials (Lilienfeld and Stolley 1994:104-105). Sentinel surveillance is based on selected samples chosen to represent the relevant experience of particular groups. Case definitions and protocols must be used to ensure validity of comparisons across time and sites despite the lack of statistically valid sampling. Sentinel surveillance may include animal sentinels to detect circulation of arboviruses (Last 2001:167).

Disease surveillance serves as an early warning system to detect as early as possible any departure from normally observed phenomena (Last 2001:56). This could include the number of birds having died from WNV or an increase in the number of HIV cases in a

specific population. In the United States of American (USA), the Centers for Disease Control and Prevention (CDC) is the lead agency when it comes to disease surveillance. The CDC is an operating division of the Department of Health and Human Services (DHHS), the federal agency responsible for protecting the health of the civilian population. The new Secretary is Mr. Mike Leavitt, replacing Mr. Tommy G. Thompson, the 19th Secretary of DHHS.

The CDC's National Centre for Infectious Disease (NCID) has developed a plan for preventing emerging infectious diseases. Sustained effort will require cooperation from state and local health departments. The first phase of this plan began in 1994 and will be implemented incrementally over the next five years as funds become available, beginning with the highest priorities for 2001-2002, which include

- ❖ International outbreak assistance

- ❖ A global approach to disease surveillance

- ❖ Applied research on diseases of global importance

- ❖ Application of proven public health tools

- ❖ Global initiatives for disease control

❖ Public health training and capacity building.

(CDC 2002:1-72).

The primary goal of this plan calls for strengthening infectious disease surveillance and response in the United States of America and internationally and improving methods for gathering and evaluating surveillance data. Several CDC programmes and centres, including international institutions, helped to initially develop the plan (CDC 2000:1-75). One of the key priorities is a global approach to disease surveillance. CDC hopes to expand regional surveillance networks into a global network of networks which would provide early warnings of emerging health threats and increase capacity to monitor public health control measures (CDC 2002: 1-72).

Many international organisations exist to improve public health. On the international front the World Health Organization (WHO) is the lead agency for health attainment by all peoples of the world. WHO is a specialised agency within the United Nations System. It was established on 7 April 1948. The Secretariat is located in Geneva, Switzerland. One key function of WHO is stated within its Constitution: to stimulate and advance work to eradicate epidemics and other diseases. WHO's position on surveillance is one of circumstances depending on the infectious disease in question. As an example WHO, through its Expanded Programme on Immunisation, has encouraged countries to use sentinel surveillance for disease reporting (Lilienfeld and Stolley 1994:105). On the other hand, WHO has the 3 by 5 initiative which is the global target to provide 3 million people

living with HIV/AIDS in developing and middle income countries with life-prolonging antiretroviral treatment (ART) by the end of 2005 (WHO | the 3 by 5 Initiative 2005: 1-2). It is a step towards the goal of making universal access of HIV/AIDS prevention and treatment accessible for all who need them as a human right (WHO | the 3 by 5 Initiative 2005: 1-2). Since prevention programmes can be considered part of active surveillance systems, then WHO is also a proponent of active surveillance.

The Pan American Health Organisation (PAHO), an agency of WHO, is an international public health organisation devoted to the people of the Americas. PAHO's Veterinary Public Health unit operates two specialised regional centres: the Pan American Foot and Mouth Disease Centre (PANAFTOSA) and the Pan American Institute for Food Protection and Zoonoses (PANIFPZ). Since 1902 PAHO has collaborated with various countries relating to surveillance and the prevention and zoonotic control of communicable diseases of man and animals (Acha and Szyfres 2003:vii-viii). PAHO's, like WHO's, position when it comes to surveillance is circumstantial and is a function of the infectious disease. Here are some examples of PAHO's surveillance positions. In 1999 PAHO was doing Second Generation Surveillance (SGS) for HIV among tuberculosis patients (PAHO 1999:1). Additionally, in 1999 PAHO was planning to establish laboratory surveillance to form a network of laboratories within the greater Southern Cone Region: Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay. It is hoped that the laboratories would be capable of obtaining accurate high quality laboratory results on new emerging and re-emerging infections found in the region (PAHO 1999:1). PAHO also favours syndromic surveillance, which applies to surveillance using health-related data that precede diagnosis and signal a sufficient

probability of a case or an outbreak to warrant further public health response (CDC/DPHSI 2004:1-2).

In collaboration with WHO, the Integrated Disease Surveillance and Response (IDSR) has been implemented in Africa, India, The Western Pacific Region, some European Region (EUR) countries, South East Asia, and Eastern Mediterranean Regions. WHO is promoting an integrated approach to disease surveillance through nationally owned systems that are sustainable (WHO/CSR 2003a:1-20). An integrated surveillance approach uses coordination and synergy among surveillance activities (CDC | IDSR 2005:1-5).

The Animal Health/Emerging Animal Diseases project was developed as part of International Lookouts for Infectious Animal Diseases. AHEAD-Iliad is a pilot test surveillance system in Tanzania that uses proactive, response-oriented surveillance (Infectious 2003:1). There is no real difference between active and proactive surveillance. Active surveillance in itself is proactive rather than reactive or passive.

The international programme for monitoring emerging infectious diseases (PROMED) is a global web based Internet surveillance early warning system. The members of the PROMED steering committee include WHO, CDC, the US National Institutes of Health (NIH), the International Office of Epizootics and other organisations and academic institutions (Glick 1996). Internet based surveillance uses either or both international and national networks, web reporting, and the web as sources of data and information.

The new wave of surveillance systems include:

- ❖ syndromic surveillance
- ❖ tandem sequential surveillance
- ❖ integrated surveillance
- ❖ Internet-based surveillance.

Syndromic surveillance is an early warning system that uses health related data which precedes diagnosis and may indicate probability of an outbreak sufficient to elicit a public health response, which is a response from those agencies that can effectively and expediently respond to emerging infectious disease outbreaks. Tandem sequential surveillance is a surveillance system that uses sentinels as indicators of a possible outbreak, thereby initiating further surveillance. As an example, in arboreal encephalitis, which is vector-borne, chickens are used as sentinels and when positive for encephalitis antibodies, initiation of mosquito surveillance begins (Gilchrist 2003:79-112). An integrated surveillance approach uses coordination and synergy among surveillance activities. Internet based surveillance uses either or both international and national networks, web reporting, and the web as sources of data and information.

Another surveillance system is the National Animal Health Emergency Management System (NAHEMS). The Animal and Plant Health Inspection Service (APHIS) maintains NAHEMS, which works with state, federal, and industry organisations to help the United States of America better prepare for and deal quickly with animal disease emergencies (NAHEMS 2004:1-2). Only the key active surveillance systems have been compared in table form. All the other surveillance systems were provided as an informational tool to be applied by the reader as appropriate.

In Japan the local Institutes of Public Health have taken on the responsibility of managing regional health crises and practicing preventive medicine as a scientific and technological support centre. They are responsible for treating emerging and re-emerging diseases and zoonoses. The National Institute of Infectious Diseases is responsible for surveillance of infectious Diseases (Tanno 2003:181-182).

Canada has an extensive system of surveillance. Firstly, they have a network for health surveillance which includes people interested in health surveillance from local, provincial, territorial, and federal governments, non-governmental organisations (NGO's) and universities. Canadian Integrated Public Health Surveillance (CIPHS) is a program that encompasses use of computers and database tools to support the collection and collation of health surveillance data. The Division of Disease Surveillance's goal is to reduce incidence of infectious diseases by monitoring and reporting notifiable and other specified infectious diseases (Centre 2004:1-2; Welcome 2003:1).

The Global Public Health Information Network (GPHIN) is one of the Global Outbreak Alert and Response Network partners (Heymann and Rodier 2004:173; HSTAT 2005:1-5). In response to outbreaks of international concern, WHO initiated the Global Outbreak Alert and Response Network (GOARN) in 1997. The Department of Communicable Disease Surveillance and Response organised GOARN (WHO/CSR/2000:1). It was formalised in 2000. GOARN has over 120 global partners and responded to over 50 outbreaks in foreign countries. SARS is the outbreak that GOARN has responded to that had pandemic potential. GOARN is a collaboration of human and technical resources to rapidly identify and respond to and confirm disease outbreaks internationally. Additionally, GOARN provides technical assistance to affected states and plans for epidemic and capacity building (WHO 2003d:1).

The European Union set up an Early Warning and Response System linking designated authorities in member states and the European Commission (EC). This allows immediate information on events that could indicate a European Union health threat (Communication 2000:1-49). This is important information because it is a key indicator of a positive response to the potentiality of threats from emerging infectious diseases. It is a warning system.

The Pacific Public Health Surveillance Network (PPHSN) is a voluntary network of countries/territories and organisations, dedicated to the promotion of public health surveillance and response. It was created in 1996. Its goal is to improve public health surveillance and response in the Pacific Islands. The Pacific Public Health Surveillance

Network links core members of the 22 Pacific Island Departments and Ministries of Public Health and allied members such as partner agencies. The Pacific Network (PACNET) is the main PPHSN media for wider communication and coordination. The Pacific Network aims to harmonize surveillance data and to develop surveillance systems in its region. The primary purpose of PACNET is to implement an early warning system by sharing timely information on outbreaks of disease so that others in the Pacific might take appropriate action when a threat is identified. The Pacific Network provides:

- ❖ timely information on outbreaks

- ❖ access to diagnostic facilities

- ❖ access to appropriate resources for outbreak control.

(PPHSN 2004:1-5).

Another surveillance system is the Department of Defense's Global Emerging Infectious Surveillance System (GEIS). The United States of America's Global Emerging Infectious Surveillance and Response System's mission is to support the Department of Defense's Global Emerging Infectious Surveillance system (GEIS) by enhancing the infectious disease surveillance and response components of the international public health infrastructure in Asia. GEIS is another GOARN partner (Heymann and Rodier 2004:173). The emerging disease programme focuses on the Department of Defense's Global Surveillance Program and participates in regional surveillance for the detection of infectious disease outbreaks and tropical diseases (GEIS 2004:1).

Within the CDC is the Division of Public Health Surveillance and Informatics. Within the Division is the National Notifiable Disease Surveillance System (NNDSS). Emerging pathogens and diseases, as recommended by the Council of State and Territorial Epidemiologists (CSTE), are reportable to CDC. Reporting is mandated by regulation or state legislation at the state level. Notifiable diseases vary from state to state (CDC/NNDSS 2004:1).

Another surveillance tool is the Infectious Disease Pathology Activity (IDPA), which helps CDC with surveillance, investigations of outbreaks, diagnosis of diseases, and infectious disease pathogenesis. IDPA is a national / international web-based information site (Shieh *et al* 2001:1020; Stone 1992:540). IDPA is important to this research because it is an example of an established surveillance system to help protect the public against emerging infectious diseases.

The above impressive list of surveillance agencies with their surveillance systems are key indicators that the human population is fighting back and taking very seriously the impact of emerging infectious diseases and their potential lethality. All the information presented in this research is critical to the ultimate recommendations at the end of this study.

Following is table 2.30, which is a critical comparison of key surveillance systems that have been cited in this research. The information provided in this table includes system name, purpose, sponsoring agency and geographic location.

Table 2.30 A critical comparison of key active surveillance systems

System Name	Purpose	Sponsoring Agency	Geographic Location
PROMED	The international programme for monitoring emerging infectious diseases. Global web-based internet surveillance early warning system.	Steering Committee: WHO. CDC, National Institutes of Health, The International Office of Epizootics and Other Organisations and Academic Institutions.	Global.
INDPA (Infectious Disease Pathology Activity)	Assists with outbreak investigations, disease diagnosis, surveillance studies and the pathogenesis of infectious diseases.	CDC	State and Local Health Departments as well as Foreign Coverage.
DENGUNET	Internet-based system for Global Surveillance of Dengue Fever and Dengue Haemorrhagic Fever.	WHO	Global.
GOARN (Global Outbreak Alert and Response Network)	To enable WHO to keep close watch over evolving infectious diseases electronically.	WHO	Global
DVBID (Division of Vector-Borne Infectious Diseases)	Conducts surveillance, field investigations, and laboratory studies of vector-borne viral agents and additionally defines disease etiology, ecology and pathogenesis in order to develop methods and strategies for disease diagnosis, surveillance, prevention and control.	CDC http://www.cdc.gov/ncidod/dvbid/misc/mission.htm	USA
ARBONET	A national electronic surveillance system to assist states in tracking West Nile Virus and other mosquito-borne viruses.	CDC	USA
HIV/AIDS Second Generation Surveillance SGS	Combines HIV/AIDS case surveillance, HIV seroprevalence surveillance, sexually transmitted infection surveillance and behavioural surveillance into a comprehensive data stream.	CDC & CSTE (Council of State and Territorial Epidemiologists recommended that all states and territories adopt SGS).	States and Territories of the US
Non Name-based HIV Surveillance	Requires HIV surveillance by unique identifier (UI) patient code.	State-based recommended by CDC & CSTE	USA
ABCs (Active Bacterial Core Surveillance)	Conducts laboratory and population-based active surveillance and collects specimens and studies diseases caused by <i>Streptococcus</i> groups A & B, <i>Neisseria meningitidis</i> , <i>Streptococcus pneumoniae</i> and <i>Haemophilus influenzae</i> .	Collaboration between CDC and several departments within the emerging infectious program network and universities.	USA
GPHIN* (Global Public Health Information Network)	To monitor reports on communicable diseases and communicable disease syndromes on the internet, GPHIN's powerful search engines actively crawl the world wide web. Searches are in English and French and will eventually expand to all official languages of the WHO.	Health Canada WHO http://www.cdc.gov/ncidod/eid/vol4no3/heyman/htm	Global
NaSH* (National Surveillance System for Healthcare Workers)	To allow the CDC to monitor trends, detect emerging occupational hazards, and evaluate prevention policies for infectious disease exposure of health care workers. Includes	CDC http://www.cdc.gov/ncidod/hip/SURVEILL/nash.htm	USA

	health care worker demographics, baseline vaccinations, bloodborne pathogen exposure, and post-exposure prophylaxis. Health care facilities voluntarily provide data. No other data available.		
MNDSS** (Nationally Notifiable Infectious Diseases)	Is a mechanism for the regular collection, compilation, and publication of reports of disease considered notifiable at the national level.	Maintained by the Epidemiology Program Office (EPO) of the CDC. http://www.cdc.gov/epo/dphsi/phs.htm http://www.cste.org/NNDSHome2004.htm http://www.cste.org/NNDSSEngine.htm	48 States and the Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Guam.
NEDSS*** (National Electronic Disease Surveillance System)	It is a major component of the public health information network to promote use of data and information system standards to advance the development of efficient, integrated, and interoperable surveillance systems at the federal, state and local levels. The NEDSS system can be used by health departments for the surveillance and analysis of notifiable diseases.	CDC http://www.cdc.gov/nedss/about/overview.html	USA

*(HSTAT 2005:1-5)

** (NNDSS Assessment 2004:1; NNDSS Assessment 2001:1-2; CDC I NCID 2004:5)

*** (Nelson 2005)

2.3.3 ZONOSIS AND ANTHROPONOSIS

There are two types of zoonosis, **epizootic** and **enzootic**. When an outbreak occurs within an animal population with the possibility of a jump to the human population, it is **epizootic**. It is **enzootic** when an outbreak of low morbidity is confined, for whatever reason, to an animal population.

All diseases discussed in this thesis are of the **epizootic** type unless specifically stated otherwise. Anthroponosis is a disease that is spread from humans to humans without a vector.

2.4 RESEARCH QUESTIONS

The following questions were used as benchmarks during this research. These questions were developed as a direct result of scientific curiosity that sparked interest in the field of emerging infectious diseases and led directly to this research.

- Are zoonosis and anthroponosis more prevalent in the human population because active surveillance is lacking?
- Is thwarting a disease at pre-emergence or at outbreak a possibility?
- Is there a statistical significance between the types of surveillance and the EID's?
- Does the type of surveillance have any effect on disease incidence, disease prevalence, and/or case fatality rates?

2.5 THE NEED FOR FURTHER RESEARCH

There still remain many unanswered questions in regard to emerging infectious diseases. Answers to the following questions will possibly save lives. The following four (4) questions arose out of this study:

- What was the *causation* of **recrudescence** of Nipah virus in Bangladesh?
- What is the status of *Simian Foamy Virus* in relationship to a possible outbreak

in the human population?

- How effective were the **space satellites** donated by ESA in helping to find the reservoir for Ebola?
- Did the **culling** of 10,000 civet cats in China *stop the recrudescence of SARS?*

2.6 SUMMARY

With the myriad number of surveillance systems, the coordinated and synergistic approach of integrated surveillance seems most promising. Collaboration among state, local and federal governments, the private sector, and international governments is necessary. Surveillance systems need to be adaptable to the Emerging Infectious Diseases (EIDs) in question and should be amenable to the various stages of an evolving EID.

Most recently, recrudescence of Nipah virus in Bangladesh needs to be resolved including the Ebola mystique. Simian Foamy Virus needs to be monitored. Research methodology, which encompasses the research process, research tools, and research procedures, will be discussed in Chapter 3.