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Disaster Reports Number 2: Jamaica, St. Vincent, and Dominica

Introduction

Report on Disasters and Emergency Preparedness Number 2 : Jamaica, St. Vincent, and Dominica

Pan American Health Organization

Disaster Reports is a publication of the Emergency Preparedness and Disaster Relief Coordination Program of the Pan American Health Organization, Regional Office of the World Health Organization of the Americas. The reported events, activities and programs do not imply endorsement by PAHO/WHO, nor do the statements made necessarily represent the policy of the Organization. The publication of this Report has been made possible through financial support of the Canadian International Development Agency (CIDA).

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This publication attempts to summarize some recent thinking about a little explored field of infectious diseases epidemiology, to describe practical experiences related to this field and to put forward some general ideas about how to control infectious diseases following natural disasters, based on both the theoretical framework and the practical experiences. It is based on a thesis presented by the author at the Catholic University of Louvain School of Public Health, in January 1983 (Promotor, Prof. Dr. H. van de Voorde).

This work would not have been possible without the collaboration in the field under, sometimes, very difficult conditions of some of the most dedicated persons in the field of public health I have seen in the Caribbean—the public health nurses. In particular I am grateful to V. Bowman (St. Vincent), E. Brown (Jamaica), and J. Jacobs (Dominica) who actually operated the surveillance systems, and to the medical officers who provided the data. In the Ministries of Health cooperation was very close with Dr. C. Mulraine (St. Vincent), Dr. A. Dyer (Jamaica), Dr. L. Charles and Mr. R. Fortune (Dominica). My first initiation to disaster epidemiology came from Prof. M. F. Lechat (U. C. Louvain—Belgium) and was continued by Dr. C. de Ville (PAHO/WHO—Washington). While at CAREC, I received stimulating intellectual challenge and exchanges from Drs. Peter Diggory and Patrick Hamilton, and from Drs. M. West and N. Arnt with whom I shared several of these experiences. Most of the writing was finally done in Suriname where I received both moral and administrative support from the PAHO Office (Dr. G. A. Mora and Mrs. D. L. Wong). I gratefully acknowledge the permission to analyze the data and prepare this publication I received from the Pan American Health Organization in whose service I was when these data were collected and in whose service I still am at the date of their publication.

Xavier Leus, M.D.

In 1979 the Caribbean was struck by three consecutive disasters. In April the Soufriere Volcano in St. Vincent erupted, forcing the authorities to temporarily resettle 20% of the population of the island to the already densely populated south. In July, floods caused extensive damage to the western parishes in Jamaica. In September, Dominica was left in a state of shock and complete destruction by Hurricane David, one of the most powerful hurricanes of this century.

In all these disasters the immediate aftermath was characterized by uncertainty and fear of communicable disease outbreaks. In recent years the relationship between disasters and communicable disease outbreaks has been investigated several times. Little association was found to exist. In order to monitor closely what occurs following major disasters, specific post-disaster epidemiologic surveillance systems have been proposed.
This report describes the experiences with setting up such surveillance systems in the Caribbean following the disasters in St. Vincent, Jamaica and Dominica. A similar system was used, with variable degrees of success, in all three countries. The system was essentially based on the use of simple and sensitive infectious disease indicators through symptom−monitoring and the rapid investigation of reported outbreaks.

Several variations were introduced to accommodate the different circumstances that existed after each disaster and the surveillance systems were continued for 30 to 60 days after the disaster.

No massive outbreaks were detected during the period these surveillance systems were in operation. Several small focal outbreaks were recognized, however, and a potential for larger outbreaks was noted if these were not properly controlled. These included two food−borne outbreaks in St. Vincent and amebiasis cases among expatriate disaster relief personnel in Dominica. Most of these outbreaks or potential risk situations were associated with the disaster relief effort.

The report ends with a number of conclusions and practical recommendations for future work in setting up epidemiologic surveillance systems following natural disasters. A summary of these follows.

1. Epidemiologic surveillance systems following disasters should be organized quickly and be creative and very dynamic. The simple fact of having a system, even when it does not collect all the data one would like, makes an easy flow of information possible for whomever has something to report.

2. The surveillance system as described in this report will detect outbreaks if they occur. The drawback of the system is that it can easily detect outbreaks where there are none.

3. All of the outbreaks detected could have been prevented by adequate disease control measures following the disaster. In fact, most of the outbreaks detected were associated with the disaster relief effort.

Regarding the overall usefulness of epidemiologic surveillance systems following natural disasters, the author states that to have the system is not enough. If outbreaks are to be prevented, the authorities who requested that the system be established must be willing to act on the information it provides.

Natural disaster and communicable diseases

1. Definition

Many definitions of disasters have been proposed. The most practical one to my knowledge was proposed by Michel F. Lechat as: A disaster is any unforeseen and sudden situation with which the affected community cannot cope.

An etiologic classification can be made into natural and man−made disasters.

Natural disasters include: earthquakes, tsunamis (seismic sea waves), volcanic eruptions, landslides, avalanches, wind storms (cyclones, typhoons and hurricanes), tornadoes, hailstorms and snow storms, sea surges, floods, and droughts. Among man−made disasters are armed conflicts of all types and accidents such as: vehicular accidents (including airplanes, trains, ships and automobiles), drowning, collapse of buildings and other structures, explosions, fires, biological, and chemical (including poisonings by pesticides and environmental pollution).

As noted in the introduction man−made disasters will not be dealt with.

2. Experiences with communicable disease following natural disasters in developing countries

In developing areas of the world the paucity of baseline surveillance data makes interpretation of disease reports very difficult. Indeed, since epidemic means by definition the occurrence of cases in numbers greater than expected, some idea must be had as to the numbers that are expected. These numbers are lacking in a great deal of the developing countries of the world. Another major problem is the lack of adequate medical
and laboratory diagnostic facilities which are essential to the exact diagnosis of some if not many infectious
diseases.

Outbreaks following natural disasters have been an exception rather than the rule. Among the few
documented incidents, the following examples are given:

2.1. A malaria epidemic occurred in Haiti, 1964, following Hurricane Flora in October 1963. The increase in
mosquito breeding sites, population migration, the destruction of housing units and the washing away of
residual insecticide by continuous rain coincided with the reallocation of scarce resources from vector control
to disaster relief measures. This resulted in an explosive epidemic of P. falciparum malaria (more than 75,000
eases) starting about two months after the hurricane a buck and continuing through 1964.(13)

2.2. Several leptospirosis outbreaks were reported following floods (Portugal 1967; Brazil 1966, 1970, 1975;
Jamaica 1978, 1979). The mechanism through which this occurred is not clear. One mechanism might be
direct contact with contaminated water, or, more likely, an increase in contact possibilities with contaminated
water (Portugal 1967; Brazil 1966). Another suggested mechanism is the expulsion of infected rodents from
their normal habitat, bringing them closer to man and 0a food and water sources (Jamaica 1978, 1979). The
number varies from fewer than ten (Portugal 1967; Jamaica 1978), to thirty Jamaica 1978) to more than one
hundred (Brazil). The diagnostic criteria used to confirm leptospirosis in these outbreaks were not uniform and
mostly relied on single serology.(14−19)

2.3. In Puerto Rico, in 1956 a typhoid outbreak with 23 cases occurred following hurricane Santa Clara
(Betsy). The hurricane passed on 12 August; the first ease occurred on 24 August and the last on 17
September. Cases thought to be endemic were excluded from this outbreak and phage−typing was used to
determine the epidemiology more exactly.

There were two disaster−related factors involved in causing this outbreak:

a. After the hurricane the water supply was interrupted for almost two days and afterwards
found to have been contaminated. One particular sector of the city was exposed to low water
pressure and to maximum stagnation, as well as to risks of contamination resulting from
major sanitation defects.

b. The hurricane caused numerous people of suburban areas to seek refuge elsewhere; they
concentrated exactly in the same sector of the city mentioned in a. It was demonstrated
afterwards that many people came from one suburban area where the S. typhi strain
responsible for the outbreak was common.(20)

2.4. In a study on acute water shortage and health problems in Haiti (a situation that often occurs in disaster
situations) no significant statistical differences were found in diarrhea−rates, scabies−rates and
conjunctivitis−rates, dependent on the amount of water used per person per day.

2.5. Epidemics of conjunctivitis have been reported in various counties following hurricanes and/or floods.(22)

There are also reports of disasters that were not followed by outbreaks, or where outbreaks were expected
but did not occur:

2.6. K. Western found specific statements that no epidemics were recognized during the following mayor
disasters:(2) the Bihar famine 1966−1967; the earthquake in Peru in 1970 (65,000 deaths); the Bay of Bengal
Cyclone 1970 (5,000 deaths).

2.7. C. de Ville adds in 1977 the following disasters that were not followed by outbreaks: the earthquake in
Nicaragua in 1972 (6,000 deaths); the earthquake in Guatemala in 1976 (23,000 deaths); the earthquake in
Italy in 1976 (4,000 deaths); the earthquake in Turkey in 1970 and 1976; Hurricane Fifi in Honduras in 1974;

In a number of these the occurrence of outbreaks had been specifically investigated by national and/or
international epidemiologists with negative results.(23)

2.8. The Centers for Disease Control, Atlanta, Georgia, USA have been frequently involved over the past 20
years or more, in sending field epidemiologists to other, mostly Third World, counties struck by disasters, and
a rich variety of trip reports exist describing the absence of unusual disease occurrences.(24)
Epidemics being more interesting and easy to describe than the absence of them, it is fascinating to note that hardly any of these negative was ever published, except as a aside remark in another paper.

2.9. In the Philippines when areas endemic for cholera were flooded following a hurricane, fears of an epidemic of **cholera** did not come true.\(^{(25)}\)

2.10. When in Guatemala following the earthquake (1976) a striking increase was noted in dog bites it was supposed that this could present public health problems since canine **rabies** is endemic in Guatemala. This did not lead to public health action. No increased rabies activity was reported, however.\(^{(26)}\)

2.11. The 1970 cyclone in Bangladesh left the survivors in an apparently **better state of health**. This was explained by a change in the normal patterns of water use for the better.\(^{(27)}\)

2.12. After the cyclone In Andhara Pradesh (1977), fewer cases of **cholera** were found than might have been expected at that time if there had been no disaster.\(^{(28)}\)

Sometimes outbreaks are found during disasters that bear no causal relation to the disaster but occur at the same time. Epidemiologists unfamiliar with local conditions tend to ascribe these to the disaster, while epidemiologists accustomed to work in the same area under normal conditions will be more cautious.

2.13. In Jamaica, in 1970 an outbreak of **diarrheal illness** was investigated in the aftermath of Hurricane Allen. This hurricane also caused serious flooding in some parts of the country and caused a disruption of the water supply. Only careful investigation could reveal that this outbreak was not water−related.\(^{(29)}\)

Finally a particular situation of communicable diseases associated with or caused by the **disaster relief efforts** needs to be mentioned.

2.14. At the WHO Course on Health Aspects and Relief Management, Natural Disasters, Brussels, 1980 several examples were given of **communicable disease problems** associated with disaster relief efforts. They include: meningococcal meningitis associated with crowding; diarrhea associated with infant formulas, tinned or powdered milk; the emergence of resistant bacteria, as a result of excessive use of antibiotics; malaria, associated with injectable iron, promoting micro−organism growth; hepatitis and the use of unsterile needles; transmission from imported organisms by migrating population or relief workers.

None of these was further described, but all were stated to have occurred during disaster relief efforts.\(^{(30)}\) At the end of this section we need to caution for two things:

a. No examples were cited of disease outbreaks associated with refugee situations. These are plentiful and span the entire range of infectious disease problems. Rather than giving specific examples they will be dealt with in a general manner within the theoretical framework of how natural disasters can affect communicable disease incidence.

b. In the identification of outbreaks almost exclusive attention was focused on the immediate aftermath of the disaster. As public attention fades, epidemiologic interest in the effects of the disaster also seems to fade and very little work has been done on long−term effects of disaster on health.\(^{(31)}\) For most disasters there has been insufficient follow−up to identify outbreaks of diseases with long incubation periods such as Hepatitis A or B. or some of the parasitic diseases. Another aspect that has not been documented is how the patterns of transmission, even of diseases with a short incubation period, are affected in the longer term.

### 3. Theoretical framework

Most authors who have described the relationship between disasters and communicable disease do not believe that epidemics follow disasters as a rule.\(^{(11−13)}\) Nonetheless, none of them la willing to rule out the possibility of unusual occurrences. In fact, every single one proposes some mechanism through which a disaster could increase the probability of epidemics.

However, there la one aspect that has not been stressed before. Each one of the mechanisms involved might also result in a decrease of the probability of epidemics. No studies have been done on how disasters might affect communicable disease patterns in a beneficial manner. Whenever possible, I will therefore add to the
theoretical framework presented herein specific examples of how the same mechanism might increase or decrease the likelihood of communicable disease outbreaks.

In terms of usual thinking regard lag infectious disease epidemiology, three mechanisms could induce change in the host–agent–environment triad during natural disasters (Figure 1).

![Figure 1: The Host–Agent–Environment Triad of Disease Transmission](image)

3.1. Introduction of a new pathogenic agent

INTRODUCTION OF A NEW PATHOGENIC AGENT by or because of the disaster. Western(33) sees three possible ways of introducing new infectious diseases into a disaster area.

a. Through people. Disaster relief workers who are traveling during incubation or even with acute illness might introduce a new disease or different serotypes of diseases that are locally endemic. Influenza would be an example.

b. Through transport. This holds mostly for vectors. Because of rapid air transport vectors of disease infected or not, can be introduced into previously virgin country (Aedes aegypti might be introduced in this way and lay the grounds for a dengue epidemic later).

c. Through Roods. Two important relief goods in this respect are food and clothing. Both may have been contaminated before donation and be responsible for explosive outbreaks.

In fact such an example exists in the Caribbean and will be described later.

Western also sees possibilities that the infectious agents introduced may affect animals rather than humans (hoof and mouth disease, for example) and cause disruptive political and economic effects.

3.2. A change in susceptibility of the population by or because of the disaster

A situation where a disaster influences the susceptibility of the population la when the disaster is followed by poor nutrition or starvation, as they predispose for certain epidemics such as measles. It la uncertain if the incidence changes under these conditions. More likely the disease becomes more serious in terms of morbidity and mortality. One incident la reported in which a feeding program was associated with an increased occurrence of cerebral malaria in children.(35 )

The effect of climatic conditions such as cold or continuing rain is uncertain.

Sometimes the susceptibility of the population in feet remains alike, but subgroups within the population are moving. Three ways(33) are identified:
3.2.1. Migration of rural populations to congested areas:

People often congregate for food, safety and medical attention after disasters. The possibilities here include increased occurrence of aerosol or person-to-person transmitted diseases. Where the vector is mostly an urban vector, vector-transmitted diseases could also increase in this group. A disease that could decrease under these circumstances is malaria.

3.2.2. Migration of urban populations to rural areas:

Destruction of cities might force people to move to a rural environment, though this is not frequent. This environment might be healthier or not. A negative influence could be the transmission of malaria in many rural areas of Latin America.

3.2.3. Immigration of susceptibles to disaster-affected areas:

The obvious example here is the ease of international relief workers moving into a disaster-affected area. Most often coming from developed countries with high standards of hygiene, they are frequently susceptible to a variety of diseases that are endemic in the countries they have come to assist. A practical example in the Caribbean will be described later.

3.2.4. Accelerated transmission of local pathogens:

This seems to be the most widely accepted mechanism. It is also the most realistic in the sense that most epidemics described following disasters have come about through this mechanism. Local pathogens can be transmitted more easily following one of three ways described in the following page.

a. Through the direct effect of the physical event. Typical examples are a previously safe water supply that becomes contaminated after earthquakes, floods and typhoons, or the increase of breeding places for vectors that transmit disease.

To the opposite effect, we could cite the dilution of previously unsafe water supplies by massive rain or flooding (cholera incidence decreases during the relay season in Thailand and Calcutta), or the flushing out of existing vector-breeding sites. (Anopheles aquasalis needs brackish water to breed. These sites are often affected in the Caribbean following heavy rains. Malaria incidence decreases in some countries during the relay season.)

b. Through overcrowding and poor sanitation in refugee camps. Crowding, in general, is associated with an increased incidence of diseases that are transmitted from person to person (shigellosis, scabies, measles). In refugee camps, this is often compounded by water supplies that are both quantitatively and qualitatively inadequate, and sewerage disposal problems that promote food, water, and vector-borne diseases.

On the other hand, several investigators have found the health situation—including nutritional status—to be better in refugee camps than in surrounding villages. Also, disease control programs can be more aggressive and better organized than in the places from which the refugees originated.

Examples of the opposite are the strengthening of ongoing control programs by the disaster relief effort, the institution of water quality surveillance in areas of countries where this was non existent or insufficient, the donation of vaccine or cold chain materials for routine childhood immunization programs, or the introduction of oral rehydration on a mesa scale for supposedly disaster-related gastroenteritis.
In practice a combination of any of these mechanisms is possible. The following three examples show the complexity of the subject due to the fact that a number of risk factors often need to be operative jointly.

a. A frequent event is that disruption of the electricity supply causes spoilage of foods that need refrigeration. Often, merchants will sell these spoilt foods at rebate prices (disaster sales). Because of the disruption of food quality control programs (reassignment of staff to other duties, etc.) no action can be taken to stop this.

b. Depending on the type of disaster injuries, lacerations and fractures are sometimes common. A serious problem is the infection rate in these patients because of poor or delayed treatment. An extremely negative consequence of a disaster would be the slackening of existing hospital infection control programs resulting in increased rates of osteomyelitis in adults who received surgical care for open fractures.

c. When a population that was previously poorly immunized was working to repair hurricane−stricken houses, puncture wounds have a very high incidence. Under these circumstances, the risk for tetanus cases in this population is high.

This is summarized in Figure 2, which shows how changes in six areas influence the potential risk of communicable disease in disaster situations.

This is summarized in Figure 2, which shows how changes in six areas influence the potential risk of communicable disease in disaster situations.

In general it can be stated that the more organized and protected a population is in terms of health, the more vulnerable it is in times of disaster.

A population for whom water quality and sewerage disposal facilities are ephemeral concepts in normal times can hardly be affected by any disaster as far as these are concerned. For example, when the majority of a population has antibodies to Hepatitis A by age 15, little impact can be expected on the Hepatitis A incidence by any disaster. The occurrence of disease is most important in populations where major infectious diseases are normally absent. Natural disasters are most likely to strike where disease is already frequent—that is, in the developing world.

It can be concluded that epidemics caused by disaster in poorer areas of the world are likely to be confined to two groups, one defined by age (people who have not yet been exposed to a particular infectious disease endemic to their country, but are likely to be exposed at some later age); and one defined by socio-economic groups (people who are in normal times unlikely to be exposed to this particular infectious disease). Both groups are limited in numbers.

Paraphrasing previous authors, I would state that there is no doubt that natural disasters can influence the occurrence of certain communicable diseases. However, this influence might be positive or negative, and good disaster management can make use of the existing theoretical frameworks to counteract negative influences and boost positive ones. A natural disaster must be seen as an opportunity to influence normal patterns of transmission of infectious disease in a beneficial way.

Three disaster experiences in the Caribbean St. Vincent: volcanic eruptions, April 1979 (37)
1. Background information

St. Vincent, in the Windward islands of the Caribbean, (Figure 3) comprises the island of St. Vincent and five smaller islands in the Grenadines. The island of St. Vincent itself lies some 13 north of the equator between St. Lucia and Grenada. It is 25 kilometers long and 15 kilometers wide, for a total surface of less than 300 km². The island is of volcanic origin with one active volcano, the Soufriere, located in the northern part of the island.

At the time of the volcanic eruption, St. Vincent was an Associated State with the United Kingdom; since then it has become independent. The total population in 1979 was estimated to be 110,000 with more than 50% younger than 15. Over 80% of the population is of African or mixed African descent with white, East−Indian and Amerindian minorities accounting for the remainder.

The major population concentrations are in Kingstown, the capital, on the south west coast; Georgetown on the east coast; and Chateau Belair on the west coast. The Gross National Product is around $500 per capita, and the economy is agricultural, based on bananas, arrowroot, ginger and citrus fruit as cash crops.

The general standard of health in St. Vincent was thought to be good, despite a relatively high infant mortality rate (38 per thousand live births) due to malnutrition and gastroenteritis.

The principal hospital is Kingstown General Hospital (210 beds) where gastroenteritis accounted for 5% of all admissions each year. The country was divided into six medical districts each with a resident doctor, providing health care in thirty−three medical clinics.

Malaria was eradicated from the islands during the sixties. The last yellow fever epidemic occurred in 1852 and a cholera epidemic in 1854. Recent experience with communicable diseases included outbreaks of poststreptococcal glomerulonephritis (1976), poliomyelitis (1977), suspected pertussis (1978) and leptospirosis (1978). Sexually transmitted diseases are considered to cause of problem. Immunisation coverage was estimated at approximately 30%.
Vital statistics are as follows:

<table>
<thead>
<tr>
<th>Vital Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Birth Rate</td>
<td>35/1000</td>
</tr>
<tr>
<td>Crude Death Rate</td>
<td>7/1000</td>
</tr>
<tr>
<td>Rate of natural increase</td>
<td>2.8/100</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>67 years</td>
</tr>
</tbody>
</table>

1.1. The volcano

The country has a long history of disasters, especially with hurricanes and volcanic eruptions.

The Soufriere Volcano occupies most of the northern third of the island. The base at sea level is almost 7 miles in diameter. The cone is 4,000 feet high topped by a crater 1 mile wide. Prior to the present activity, the inside wall" of the crater fell apart nearly vertically a distance of 900 feet to the surface of a lake which was 600 ft. deep. There has been intermittent activity from the volcano throughout St. Vincent's recorded history. In 1971–72 a lava [eland was quietly extruded up into the center of the crater lake.

Following this eruption, Aspinall and co–workers at the Seismic Research Unit, University of the West Indies, St. Augustine, Trinidad, reviewed the history of the volcano and described the scientific aspects of the 1971–72 eruption.(40) A large part of this background information was obtained from their report.

The volcano appears to be capable of 2 distinctly different types of activity: non–explosive extrusions of lava, such as occurred in 1971–72, and "traditional" violent eruptions with massive destructive capacity. These have occurred in an alternating pattern with a variable number of years of activity in between.

The last violent eruption of the volcano prior to the present activity occurred in 1902–03, during which 1,565 persons were killed. The major dangers were lava flows and glowing avalanches which swept over the rim of the crater and down the valleys leading to the windward and leeward coasts. "Glowing" avalanche is a term applied to clouds of super heated expanding gases and particles of rock and ash created during volcanic explosions. They move swiftly down the outer walls of a crater suspended on a cushion of air. The loss of life in the 1902–03 Soufriere eruption was partially due to the fact that the Rabacca River bed north of Georgetown and the Wallibou river north of Chateaubelair were rapidly filled with boiling water and mud, thereby making them impassable and trapping many of the casualties on the northern end of the island.

2. The disaster: Volcanic eruption followed by massive evacuation(41)

At dawn on the 13th of April 1979 the Soufriere Volcano in northern St. Vincent (Figure 4) erupted a column of steam and ash. Six hours earlier the Government of St. Vincent had been warned that a highly abnormal situation existed and that an eruption was likely in the coming hours. Evacuation of the areas north of the Rabacca and Wallibou rivers started almost at the same time as the first eruption and was completed within 12 hours. Later, the cities of Chateaubelair and Georgetown also had to be evacuated. A total of around 15,000–20,000 people (more than 15% of the total population) were relocated to the already densely populated south.

Between 13 and 26 April a series of strong vertical explosions (seven in all) generated ash falls, pyroclastic flows and mud flows. The first eruptions were so powerful that transport of the ashplume caused ash to fall on Barbados, 180 km to the east, on the afternoons of 13 and 14 April. The volcano remained active into early June. Until this time the entire zone was closed off and no one was allowed to enter within a certain limit of the volcano crater (at first five, later ten km. ) At each eruption the mushrooming clouds reached up to 8,000 ft. and were readily visible from Kingstown, 20 kilometers away. Each explosion was followed by the deposition of a thin layer of ash over the entire island, heavier in the northern part. Ash would fall for several hours, resembling light snow. It was irritating to the eyes and mucous membranes of the upper respiratory tract.

No direct mortality was attributed to these eruptions, but a rumor about deaths due to traffic accidents associated with the evacuation could never be substantiated or dismissed on firm grounds. Several patients with fractures suffered during these accidents were hospitalized. One case of toxic pneumonitis without lower respiratory tract infection was reported in a 21 year old man who had been in the midst of the evacuation zone.
during one of the explosions. His illness resolved within one week under aggressive therapy with corticosteroids.\textsuperscript{(42)} A temporal association between these eruptions and an increased number of admissions to the pediatric ward because of asthmatic bronchitis was also described.\textsuperscript{(43)}
The number of evacuation centers reached fifty-seven during the first few days and increased later to sixty-three. Their distribution on the island is shown in Figure 4. The total population in the centers was estimated to be 15,000 with 3,000 more displaced persons living in private homes. Evaluation centers were started in schools, churches and government buildings (e.g. community development centers). These were not built to serve as evacuation centers and did not have adequate facilities. At the beginning of the disaster relief effort two epidemiologists from the Caribbean Epidemiology Centre (CAREC) made a quick survey of some of these centers to identify major problems that needed to be solved. Table 1 gives a summary of this survey.

Sanitation problems were noted in most of the centers. Some very large centers existed in which close to a thousand refugees were living in one or two school buildings.

Water was available but through a limited number of outlets, and facilities to boil water, if necessary, scarcely existed. Insufficient or unusable toilets and/or pit latrines resulted in uncontrolled defecation in the immediate vicinity of the center. Personal hygiene and garbage disposal also caused problems mainly because of lack of facilities. For food preparation widespread use was made of volunteer personnel unaccustomed and unprepared for mass catering. This resulted in dangerous food handling practices.

For most evacuees these conditions seemed to be a marked shift for the worse in their hygienic habits. Everyone was therefore very much afraid of outbreaks in these evacuation centers.

Demographic data were later collected on a representative sample of evacuation centers. Fifty–three percent of the population in the centers was younger than fifteen and one fifth of these was under two. Close to 5% was 60 or older. The sex distribution was balanced. A nutritional survey conducted one week after the first explosion on a sample of evacuation centers found the highest prevalence of malnutrition in the 12 to 23 months age group where 21.8% of the children examined would be classified as second and/or third degree malnutrition (Gomez classification). Also 12% of pregnant and lactating women, as well as 54% of persons 60 years and older had very low energy reserves (as measured by triceps fat fold thickness) to cope with a nutritional emergency for a longer period. In all, the survey gave similar results for this population as previous data (before the disaster) had indicated. It showed various nutritional problems that might predispose a population to infectious disease outbreaks.

Table 1: Summary and Assessment of Environmental Health Problems Evacuation Centers, St. Vincent, 13–20 April 1979

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number of centers visited</td>
<td>25</td>
</tr>
<tr>
<td>2. a) Population in these centers.</td>
<td>8,221</td>
</tr>
<tr>
<td>b) Average population per center.</td>
<td>328</td>
</tr>
<tr>
<td>c) Population range.</td>
<td>45–815</td>
</tr>
<tr>
<td>d) Percentage of population younger than 15.</td>
<td>50%</td>
</tr>
<tr>
<td>3. Water:</td>
<td></td>
</tr>
<tr>
<td>a) Quantity: number of water outlets per 100 persons</td>
<td>ONE</td>
</tr>
<tr>
<td>b) Quality 17/25 centers (68%) had no facilities for boiling water</td>
<td></td>
</tr>
<tr>
<td>c) Alternatives: 9/25 had water from a nearby river 3/25 had a spring nearby</td>
<td></td>
</tr>
<tr>
<td>d) Only 5/25 (20%) of centers had adequate facilities to sterilize baby bottles.</td>
<td></td>
</tr>
<tr>
<td>4. Sewerage:</td>
<td></td>
</tr>
<tr>
<td>The theoretical availability was 2.7 toilet seats (pit latrine or flush toilet) per 100 persons. In practice 40% of these had been damaged by the massive influx of refugees, leaving an effective disponibility of 1.7 per 100 persona.</td>
<td></td>
</tr>
<tr>
<td>5. Personal hygiene:</td>
<td></td>
</tr>
<tr>
<td>Only in 30% of centers were any facilities available for personal hygiene.</td>
<td></td>
</tr>
<tr>
<td>6. Food preparation:</td>
<td></td>
</tr>
<tr>
<td>(0/25) 0% had adequate facilities to cater on the scale they were required to.</td>
<td></td>
</tr>
<tr>
<td>7. Garbage disposal:</td>
<td></td>
</tr>
</tbody>
</table>
0/25 (0%) had garbage drums or other means of garbage disposal.  
0/25 had any means to clean the compound (brooms etc.).  
20/25 (80%) had formed a committee to urgently deal with this problem.

3. The surveillance system

3.1. Background information

A system of epidemiologic surveillance was rapidly established during the first days following the disaster.

The surveillance system consisted of several components:

a. Surveillance for disease in the evacuation centers.

b. Surveillance of admissions to the medical and pediatric ward at Kingstown General Hospital.

c. Surveillance of visits to the Casualty Department (Kingstown General Hospital.)

Epidemiologic surveillance has been defined as the continuous scrutiny of the factors that determine the occurrence and distribution of disease and other conditions of 111 health. Surveillance is essential for effective control and prevention and includes the collection, analysis, interpretation and distribution of relevant data for action. The following activities hence were also included in the emergency surveillance system:

d. surveillance of environmental health at evacuation centers.

e. surveillance of public health activities taking place in and around evacuation centers, e.g. immunization.

These aspects of surveillance were qualitative. A last aspect of surveillance was passive and consisted of:

f. The routine surveillance system for infectious disease that was in existence before the eruption.

3.2. Emergency surveillance for infectious diseases in evacuation centers

Five health teams had been created to visit the evacuation centers on a regular basis. Each center became the responsibility of one of the health teams. The teams consisted of one physician, one nurse, one dispenser and one public health inspector. Besides these teams one person—in−charge was assigned to each center for “first cadre,” consisting mainly of treatment of injuries and minor aches. This person was most often a student nurse.

A special form was prepared on which the health teams could report the number of cases with fever, diarrhea, and/or cough that they saw in the centers. A sample of the reporting form is shown on the following page. At a later stage skin lesions was added to the form. Space was left for other reportable conditions.

This form of reporting—in which non−specific but sensitive symptoms are reported rather than a specific diagnosis—was chosen based on recommendations in a section “Epidemiologic Surveillance and Control of Communicable Diseases” of the PAHO/WHO “Emergency Health Management after Natural Disasters Manual, at that time in draft form.

A daily report was expected from each center. In principle, the physician in charge of the particular center was considered to be responsible for this. He/she could, of course, delegate the task of collecting this information to the full−time attendant at the center. This was done in the majority of cases.
On the 16th of April, the fourth day following the first eruption, a meeting of all members of the health teams was convened. Here, the importance of maintaining surveillance was explained and the surveillance system was proposed. No special difficulties arose in this meeting. All team leaders agreed to participate in the surveillance system.

The system was started with the cooperation of two CAREC staff members. A public health nurse from St. Vincent was placed in charge of the system and stayed in charge until the surveillance system was phased out in early June. She reported the surveillance results directly to the Chief Medical Officer. The Statistical Officer of the Kingstown General Hospital provided her with assistance during this exercise.

A special log book was designed to register all reported cases by evacuation center, including symptoms, date of reporting and population.

Arrangements were made to investigate immediately all unusual reports, that is, any number of cases above the expected, and/or any rumor about infectious disease outbreaks in an evacuation center.

<table>
<thead>
<tr>
<th>Evacuation Centers Surveillance Form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EVACUATION CENTER VISITED</strong></td>
</tr>
<tr>
<td><strong>DATE 1979</strong></td>
</tr>
<tr>
<td><strong>LEADERS OF HEALTH TEAM VISITING CENTER</strong></td>
</tr>
<tr>
<td><strong>TOTAL NUMBER OF PEOPLE LIVING IN CENTER ON DAY OF VISIT</strong></td>
</tr>
<tr>
<td>INSTRUCTIONS: RECORD NUMBER OF NEW CASES WITH MARKS (ONE MARK PER CASE)</td>
</tr>
<tr>
<td>1. NUMBER OF PERSONS WITH FEVER (THERMOMETER 100 F PLUS) NUMBER</td>
</tr>
<tr>
<td>2. NUMBER OF PERSONS WITH DIARRHEA (WITH OR WITHOUT FEVER) OR &quot;GASTRO&quot; NUMBER</td>
</tr>
<tr>
<td>3. NUMBER OF PERSONS WITH COUGH (WITH OR WITHOUT FEVER) NUMBER</td>
</tr>
<tr>
<td>4. NUMBER OF PERSONS WITH SKIN INFECTIONS (SCABIES, IMPETIGO, ETC.) NUMBER</td>
</tr>
<tr>
<td>5. OTHER NEW MEDICAL PROBLEMS ENCOUNTERED ON VISIT:</td>
</tr>
<tr>
<td><strong>TYPE OF PROBLEM</strong></td>
</tr>
</tbody>
</table>

Two feedback mechanisms were used to maintain the motivation and understanding of the reporting teams:

a. a regular report on the number of cases reported by each center;

b. participation of the surveillance staff in the weekly Friday evening meeting of the five health teams with the Ministry staff.

The first feedback report was published 20 April, one week after the eruptions started.

3.3. Surveillance for admissions to the medical and pediatric wards of the Kingstown General Hospital (KGH)

One of the reasons epidemiologic assistance was requested was a report that 24 cases of gastroenteritis had been admitted to the pediatric ward of KGH on the first day of the eruptions. This would be a number highly in excess of the usual as will be shown in Section 4.

After analysis of all admissions to KGH during the first days it was considered wise to include surveillance of admissions to medical and pediatric wards in the surveillance system. KGH was the only hospital to which diseases needing hospitalization could be referred and it was within relatively easy reach (max. 15–20 km. by road) of all evacuation centers. Any serious outbreak occurring in an evacuation center was likely to show either quantitatively in the number of patients admitted to one of these wards or qualitatively in a patient with an unusual disease befog admitted to the hospital.

Surveillance of admissions to the hospital was therefore started as soon as we arrived on the island. It included data from the first day on. The surveillance consisted of two aspects:

a. A daily recording of the number of admissions to each ward and charting of these data for easy visual analysis;
b. A daily visit to each ward to review the records of newly admitted patients. Special attention was given to infectious diseases.

For comparison with baseline data the graphing was charted starting on 1st March (six weeks before the disaster.) Also hospital administrative data over 1978 were analyzed and pediatric ward data covering the same time period (April) in two previous years were retrieved.

The same public health nurse in charge of Evacuation Center Surveillance was put in charge of these tasks. The first two weeks the CAREC epidemiologists assumed most of this task however.

### 3.4. Surveillance of casualty department visits

In the hospital (KGH) a casualty department was operative. In principle it exists for emergency care but in practice it serves more as a sieving instrument for admissions to the hospital. In the existing health system it is not unusual that first care is sought at this level rather than at existing health centers. This is even more so for more urgent conditions. An example is gastroenteritis with moderate or severe dehydration where children might be treated first at the casualty department. Then, depending on their condition, they will be sent home or admitted. In order to cover this range of health services, surveillance of the number of persons seeking care at the casualty department was instituted. The data were charted for easy visual inspection.

### 3.5. Surveillance of environmental health at evacuation centers

After the first analysis of sanitary conditions in the evacuation centers this task was resumed by the public health inspectors. They had been provided with standard inspecting and recording forms. Each day their reports were discussed with the Chief Public Health Inspector and the activities his department undertook to correct deficiencies found were reviewed.

### 3.6. Surveillance of public health activities in or for evacuation centers

All activities in evacuation centers were followed as closely as possible through the weekly meeting of the health teams. Attention focused on one activity in particular: immunization. Other interests were nutrition and water quality.

### 3.7. Routine surveillance

Throughout the disaster the routine surveillance system continued to operate as it had before the disaster. The data gathered will be discussed in Section 4.

### 4. Results and analysis

#### 4.1. Emergency surveillance in evacuation centers

#### 4.1.1. Functioning of system

The system continued to operate until the let of June when all camps started to close down. Before this day the number of evacuees had already decreased. The completeness of reporting varied each day (Table 2). Out of a total number of 2352 center–days (*) reports were received for 1683 of them, a percentage of 71.6%. On 669 center–days for which no reports were received 205 fell on weekend–days (Saturday or Sunday). The percentage of center–days coinciding with weekends on which no reports were received was 39.1% as...
compared to 25.4% for other days of the week. This difference is statistically highly significant (p = 0.001 for Z = value of 6.23).

Table 2: Distribution of Reports Received as Compared to Reports Expected According to Time in Week (Weekend or Not Weekend), St. Vincent Evacuation Centers, 1979

<table>
<thead>
<tr>
<th>Report a received center–days* on weekend or not</th>
<th>Days report was received</th>
<th>Days no report was received</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of center–days coinciding with weekend</td>
<td>319</td>
<td>205 (39.1%)</td>
<td>524</td>
</tr>
<tr>
<td>Number of center–days on other days of week</td>
<td>1364</td>
<td>464 (25.4%)</td>
<td>1828</td>
</tr>
<tr>
<td>Total</td>
<td>1683</td>
<td>669 (26.4%)</td>
<td>2352</td>
</tr>
</tbody>
</table>

*By center–day is meant each day that a center was in existence. The total number of center–days was calculated by adding the numbers of days that each center was in existence.

There was also variation in completeness of reporting between the different evacuation centers. All except one had a reporting percentage of higher than 50%. This means that a report was received at least once in every two days. The median reporting percentage was 76% with a range of 24% to 93%. Only for 5 out of 54 reporting units* did a week go by without any reports. Most often this was the first week in which the system was started. All reporting units had periods in which no reports were collected. The largest span for each center ranged from one day to thirteen days. The median of the largest span a center experienced was between three and four days. One center consistently reported badly but a report was received at least once a week even from this center.

Looking at the size of the reporting unit, the greater the size of the centers, the more consistently they reported (Table 3).

Table 3: Reporting Percentage According to Size of Evacuation Center, April 1979

<table>
<thead>
<tr>
<th>Population covered by reporting unit</th>
<th>Number of reporting units in more of the this category</th>
<th>Number of units reporting on 72% on 72% or center–days</th>
<th>% of units reporting more of the center–days</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>18</td>
<td>8</td>
<td>44</td>
</tr>
<tr>
<td>150 – 299</td>
<td>23</td>
<td>15</td>
<td>65</td>
</tr>
<tr>
<td>300</td>
<td>13</td>
<td>10</td>
<td>77</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>33</td>
<td>61</td>
</tr>
</tbody>
</table>

* Although 63 evacuation centers were in existence, several of these were grouped geographically and/or were administratively managed by one team. Hence 54 reporting units existed.

Therefore the situation was better monitored in the centers where outbreaks were most likely, i.e. in centers with a large population. In all it can be said the reporting system worked well with a very regular contact between the majority of the centers and the surveillance unit. Even the worst center had contact at least once a week during the entire period and any outbreaks most probably would have been reported at that time.

On the collecting aide the only serious problem occurred when several persons involved with reporting and collecting information got absorbed in the immunization campaign. This caused a minor breakdown about halfway into the reporting period. It was rapidly solved after discussions in the weekly meeting.

4.1.2. Report a and analysis

No single indicator–symptom affected in total more than one third of the population in any center during the entire period. In fact 78% of centers reported hardly any of these symptoms. An incidence lower than 2.2 cases per 1000 per day of any symptom was reported in these centers. Fifty percent (27/54) of the centers had a cumulative incidence of less than 10% for all four symptoms. An additional 22% (12/54) had a cumulative incidence higher than 10% for one symptom only. Diarrhea and cough were the most likely to be
In 4/122 and 5/12 centers where the cumulative incidence was higher than 10% for one symptom only, this was for diarrhea and cough, respectively. The cumulative reported incidences for all centers combined were:

**Fever**: 4.4% or 1 reported ease of fever per 1000 population per day during a 45−day period.

**Diarrhea**: 7.3%, or 1.6 reported ease of diarrhea per 1000 population per day during a 45−day period.

**Cough**: 6.4%, or 1.4 reported ease of cough per 1000 population per day during a 45−day period.

**Skin lesions**: 4.5%, or 1.0 reported case of skin lesions per 1000 population per day during a 45−day period.

These figures are not very impressive. One can definitely argue that no massive outbreak of a disease that would manifest itself either with fever, or with diarrhea, or with cough, or with skin lesions occurred in this group of evacuation centers during this 45−day period. The reported figures are not all that reliable however. Table 5 shows how the size of a center influenced the reported incidence. The smaller the center the more likely it was to have a higher reported incidence. This was true for any of the four symptoms. It was most notable for diarrhea, very clear for cough and skin lesions, a little less marked for fever. These figures contradict our expectation that transmission of most diseases increases in larger, more crowded places. The figures would be even higher if the lower reporting rate typical of smaller centers were taken into account. If we only look at small centers (in which the population was less than 150) the reported incidences are as shown in Table 5.

Table 4: Distribution of Evacuation Centers, by Population Size, Divided Into Three Groups According to Cumulative Reported Incidence for Fever (1), Diarrhea (2), Cough (3), and Skin Lesions (4), St. Vincent, 1979

<table>
<thead>
<tr>
<th>Population size</th>
<th>Total no. of centers in this category</th>
<th>No. reporting a cumulative incidence at least 1% over (1) (2) (3) (4)</th>
<th>No. reporting a cumulative incidence equal to 1% ± (1) (2) (3) (4)</th>
<th>No. reporting a cumulative incidence at least 1% less than (1) (2) (3) (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>18</td>
<td>2 11 12 12</td>
<td>2 2 2 4</td>
<td>6 5 4 2</td>
</tr>
<tr>
<td>150−299</td>
<td>23</td>
<td>10 10 11 11</td>
<td>8 1 4 4</td>
<td>5 12 8 8</td>
</tr>
<tr>
<td>300+</td>
<td>13</td>
<td>4 1 3 2</td>
<td>2 2 3 4</td>
<td>7 10 7 7</td>
</tr>
<tr>
<td>A11</td>
<td>54</td>
<td>24 22 26 25</td>
<td>12 5 9 12</td>
<td>18 27 19 17</td>
</tr>
</tbody>
</table>

**FEVER** (1) Cumulative reported incidence for fever, all centers combined, was 4.4%, or 1 per thousand per day.

**DIARRHEA** (2) Cumulative reported incidence for diarrhea, all centers combined, was 7.6%, or 1.6 per thousand per day.

**COUGH** (3) Cumulative reported incidence for cough, all centers combined, was 6.4%, or 1.4 per thousand per day.

**SKIN LESIONS** (4) Cumulative reported incidence for skin lesions, all centers combined, was 4.5%, or 1 per thousand per day.

Table 5: Reported Cumulative Incidence* for Four Symptoms in Small Centers

Total population (small centers) = 1872

<table>
<thead>
<tr>
<th>Symptoms Reported</th>
<th>Fever</th>
<th>Diarrhea</th>
<th>Cough</th>
<th>Skin Lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>116</td>
<td>185</td>
<td>163</td>
<td>150</td>
</tr>
<tr>
<td>Cum. Inc.*</td>
<td>6.5</td>
<td>10.4</td>
<td>9.1</td>
<td>8.4</td>
</tr>
</tbody>
</table>

* Cumulative incidence over a 45−day period.

They are respectively 1.5, 1.4, 1.4 and 1.9 times higher than the cumulative reported incidence for all centers.
combined. The most apparent reason is that the larger the center the likelier the underreporting of cases: some cases were not being identified or they were not reported. The incidence figures in the smaller centers would therefore be closer to reality. Still, no massive outbreak shows in their reported figures. In fact the figures were not used retrospectively as calculated here, but immediately to detect epidemics. This was done in two ways:

a. All reports from all centers were combined and recorded graphically every day.

For the purpose of this study weekly totals for 11 syndromes reported were calculated retrospectively. These are shown in graphic form in Figures 5, 6, 7 and 8.

For sake of comparison, we have to remember that the number of refugees decreased slowly over the weeks. No exact data were available, however, on how many refugees were in the centers during each week. During the entire week of the surveillance system two outbreaks, later to be discussed, both food-borne were recognized through the diarrhea surveillance graph.

![Figure 5 Number of Cases of Fever Reported for All Evacuation Centers Combined, by Week of Report, St. Vincent 17 April–31 May 1979](image-url)
Figure 6: Number of Cases of Diarrhea Reported for All Centers Combined by Week of Report, St Vincent
April 14–May 5, 1979
Figure 7: Number of Cases of Cough Reported for All Centers Combined by Week of Report, St. Vincent April 45, 1979
A mumps and a conjunctivitis outbreak were informally reported through this system. An increase in fever cases was thought to be occurring in the second half of the emergency and was ascribed to the mass immunization program (DPT–Polio) that started then. What was not readily recognized at the time was an increasing number of akin lesions reported during the second half of the emergency. The numbers were still small and only at the same level as at the beginning of reporting. This trend was nonetheless opposite to what happened with diarrhea and cough, for which the number of cases reported tended to drop after the first weeks.

Besides the two outbreaks, diarrhea showed a slowly decreasing trend. For cough, a clear peak was noted during the second week of the emergency. This was thought to be related to the volcanic eruptions and the dust associated with them at the time.

b. For each center for which a report was received, this report was checked against the number reported on previous day(e) or weeks, as these were the only baseline surveillance data available.
When the figure clearly exceeded the normal report but was still within normal limits (e.g., three cases when normally one or none was reported) this center was kept under surveillance. If the following report was also higher the center was contacted. If the following report was normal again no further action was taken. When a report was very high (e.g., 10 cases when normally one or none was reported) the center was contacted immediately. No log was kept as to the number of times a center was put under surveillance or had to be contacted but from the report e-book the following number of alerts (or where an alert would have been necessary) was calculated:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>± 20 alerts (± since the criteria used were vague)</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>± 40 alerts</td>
</tr>
<tr>
<td>Cough</td>
<td>±40 alerts</td>
</tr>
<tr>
<td>Skin lesions</td>
<td>±25 alerts</td>
</tr>
<tr>
<td><strong>Total number of alerts</strong></td>
<td>125 (or an average of ±3 per day of reporting)</td>
</tr>
</tbody>
</table>

Except for fever (5/20), two thirds of these alerts occurred during the first ten days of the reporting system (diarrhea 26/40, cough 25/40, skin lesions 14/20). The fever alerts occurred more often once the immunization program started. They were almost all associated with, if not caused by this program. The most important reason for an increase in numbers reported was a reporting artefact: the health team had not visited the center for one or two days, or the person responsible for the information had not collected it for one or two days (e.g., weekend) and all new cases that had occurred on these days were added to the cases reported for the actual reporting day. This was very clear for diarrhea where two-thirds of the alerts (26/40) occurred on the first day the center ever reported, or on a Monday or Tuesday. (–Weekend epidemics” due to no collection of information on weekends.)

No outbreaks besides the ones already mentioned were detected. It is possible that a limited number of small outbreaks of diarrhea, respiratory illness, or akin disease involving few persons (less than 10) did occur. If so, they probably affected one or two families, or newcomers not yet accustomed to the microbiologic flora of the center. We can state with great confidence that no mayor outbreak occurred (even the outbreaks to be described were all limited to one or two centers). None of the mechanisms described in the theoretical framework seems to have had a practical influence on these populations. It is a pity no baseline figures are available regarding this population to compare with these surveillance data. In this way we could have determined whether the incidence of disease was not even lower than one would expect in this population.

### 4.1.3. Outbreaks

Four outbreaks were documented during this emergency:

**Food–borne outbreak**, probably due to *Clostridium perfringens* in two evacuation centers with common catering facilities.

One hundred out of 750 people living in both centers were reported to be affected. The investigation started promptly after the increase in reported illness was noted. It was limited in scope since it only sought to identify the most probable etiology and the most probable causes of the outbreak. Thirty-seven sick people were interviewed and no one had experienced fever or vomiting, 35 (95%) had had watery diarrhea and 26/37 (70%) experienced abdominal cramps. The age and sex distribution of cases was random, with cases in all age and sex groups. In the smaller center, however, more children than adults were reported sick. The disease was self–limited and no secondary cases were reported. Laboratory investigations of cafes and controls remained negative. No left–overs of the incriminated food could be examined in the laboratory.

The incubation period was estimated at between 10 to 18 hours with a median of 12 hours. The meal that was assumed to be involved was lunch. This was easily ascertained since lunch was the only meal both centers shared and cases occurred in both. Specific food histories were difficult to obtain. From a tentative comparison between sick and not–sick (only seven controls were willing to cooperate), chicken at lunch proved to be the dividing line (the alternative was mackerel.) The number of chicken portions served also connected more or less closely to the number of sick people (100/750), and a number of the people recalled that the chicken had tasted bad.

The majority of cases in the smaller center were children and all of these had chicken broth for lunch, something which nobody else got. Analysis of food handling practices revealed several defects. Most prominent were the following:
a. Frozen chicken had arrived the previous day. It had been seasoned in that state (this involves repeated handling) and had been left to thaw overnight at room temperature (25°C) on the ground.

b. The preparation of the chicken involved cooking in the early morning, keeping the food at room temperature and then heating and repeated reheating as several shifts of evacuees came for lunch.

Due to the above, the outbreak was thought to be due to Clostridium perfringens (with Bacillus cereus as a possible alternative). This first outbreak resulted almost immediately in food hygiene education in all centers.

**Food-borne illness outbreak, associated with donated food.**

This outbreak occurred about one week later. Again it involved two centers where 50 out of 300 people were reported to have been ill. The age and sex distribution was again random, with cases in all age and sex groups. There were, however, a small preference for children. According to the case histories obtained no one experienced vomiting or fever. One 100% experienced watery diarrhea and abdominal cramps. No laboratory studies were done on cases, controls or food.

The incubation period was estimated to be 11 to 19 hours with all cases occurring in an 8-hour span. No secondary cases occurred and the disease was self-limited. The food history for all cases was strikingly similar. All of them had flying fish for lunch. Although no control histories were obtained this was considered very significant since only a limited supply of flying fish had been available. It had been served to a minority of the evacuees. Priority had been given to children where possible, and this could explain the slightly shifted age distribution of the outbreak. The flying fish had been prepared in Barbados—an island 180 km to the east—the previous night and was flown in boxes to St. Vincent the next morning. There, as it was a gift of a service group, an evacuation center catering for a middle class of evacuees* associated with the same service group in St. Vincent, was chosen as the recipient. It was transported there and reheated. No refrigeration was used between preparation and reheating—a period of ±12 hours.

In view of the above the food-borne outbreak was thought to be caused by extremely bad food handling practices associated with the disaster relief effort. The most probable agent was Clostridium perfringens or possibly Vibrio parahaemolyticus associated with the flying fish.

**An outbreak of conjunctivitis** was reported from one camp during the month of May. 15 cases were reported in all. They were in the age group between 3 and 10 years old. The cases shared the same sleeping area and (soiled) linen. Five of these cases were purulent, but no laboratory isolation was attempted. The other 10 cases were interstitial. The purulent cases were treated with antibiotic ointment and the sleeping area and linen were cleaned. The cases resolved and no further cases were reported.

* The access to evacuation centers was not subject to price or cost considerations but since a number of churches and service groups were involved in running them it was obvious that they preferentially catered for their subjects. Evacuees also preferred to stay in evacuation centers of their religious or other choice when possible.

**An outbreak of mumps** was reported from one evacuation center at the end of May. By the time the report was received (eight days later) no more cases were observed. The report mentioned 25 to 40 cases in that center (with 420 evacuees) but this could not be confirmed. At that time, most people were returning home. On checking with the medical officers it seemed that cases of mumps had been seen sporadically before the volcanic eruption in at least a part of the area that was evacuated. Sporadic cases were later seen in the evacuation centers throughout the period they were open. The outbreak reported seems to be the only one in which more than isolated cases were seen. However, the source of information about this outbreak (an educational officer) was not all that reliable and was not available for later rechecking of this story.

**4.2. Hospital surveillance – Total number of admissions, admissions to pediatric ward, admissions to medical ward(s)**

During the entire evacuation period the Kingstown General Hospital was kept under surveillance. For this purpose daily charts were kept of the total number of admissions, and the number of admissions to the pediatric and medical wards. Weekly totals calculated retrospectively are shown in Figs. 9–11.
An immediate reason for the request for epidemiologic assistance was that, on 13 April, the day of the eruption, 24 pediatric cases of gastroenteritis were to have been admitted to Kingstown General Hospital. This was seven times the average daily number of admissions to this ward in March (3.5 per day) and about 30 times the average daily number of admissions due to gastroenteritis (0.9 admissions per day in 1976 to 1978).(47) On checking this first information it was found that in fact six children had been admitted to the pediatric ward on 13 April and 11 patients to the medical wards. The total number of admissions for that day had been 45, 15 of whom were for obstetric services. Of the six children admitted only two were admitted because of gastroenteritis.

During the entire week following the eruption only 19 children (out of a total of 60 admitted) were admitted because of gastroenteritis. The rumor about an epidemic of gastroenteritis associated with the disaster was therefore quickly dismissed. The total number of admissions was higher than normal during the first weeks of the emergency but this was never due to any infectious disease problem. The main component was an increase in admissions for obstetric reasons, a fact which has been documented also in other emergencies. It could not be ascertained if this increase was due to a larger number of premature deliveries or because of a higher proportion of pregnant women seeking delivery in a hospital.
At the end of May two deaths due to meningitis (etiologic agent not isolated) occurred in three-day old infants. The infants were born on the same day in the hospital. The mothers had shared the same bed because of overcrowding of the maternity ward, a situation that was continuously repeating during the emergency. Contamination of the ward was suspected but the deaths were also ascribed at the time to inadequate postneonatal care and very rapid discharge of the infants with their mothers (one day after delivery) due to overburdening of these services.

Besides an increase in admissions to the obstetric ward an increase was noted in admissions to the pediatric and medical wards during the first week. This has been described elsewhere. The most important reason for this increase was the number of transfers from the other minor hospitals in the evacuation area. Besides this there was a striking increase in the number of cases of asthmatic bronchitis that had to be hospitalized, compared to previous years. The number of surgical admissions was continuously very low. It decreased
even later during the emergency as the number of obstetric admissions continued to burden the hospital and the number of elective surgeries was voluntary limited to a low level. All numbers were comparable to the number of admissions in normal times. Slightly higher numbers could be explained by an increase with 20% in the catchment population that lived within short distance to the hospital. In the context of this publication, it is only important that they were not caused by infectious disease problems.

Besides keeping track of the number of admissions a daily visit was made to the pediatric and medical wards to determine the causes of admission. Not a single serious infectious disease problem associated with the centers was discovered. Two suspect polio cases were notified during the emergency but virologic investigation failed to reveal poliovirus and the children recovered spontaneously.

The surveillance system was very useful. Together with the surveillance system in the centers it provided us with the entire background of infectious disease reporting. Thus, it allowed us to deny with confidence the rumors that were repeatedly circulated about epidemics of infectious disease in the evacuation centers.

4.3. Surveillance in the casualty department

Data from March 1979 were first collected as a baseline. During the eruption a threefold increase in medical attendances to the casualty department was recorded. When investigating the reason for this increase we realized no real increase could be documented. Under normal circumstances a nurse sees all the attendances to casualty and only refers some cases to the doctor−in−charge. During the emergency a doctor was assigned constantly to casualty and saw all the cases personally. In the register only cases seen by a doctor are recorded. There was thus no way to document whether a true increase occurred during the first days of the disaster.

After one week we stopped routine recording of the number of attendances and only kept an informal link with the doctor and nurses of the department. They would inform us if infectious disease problems turned up in unusual numbers. No such events were reported.

4.4. Surveillance of environmental health in evacuation centers

After the initial survey of the situation in the centers, assistance was given to the development of a form for routine inspection and reporting on sanitary conditions in the centers. No numerical figures exists on the information collected through these forms. They were mostly directly used for follow−up.

Special programs that were created for the centers involved:

− The accelerated building of pit latrines in all centers, using pre−fabricated concrete slabs (the model remaining from an earlier island−wide campaign).

− The teaching of food−hygiene in bulk preparation of food, using simple handout a and a fiat of six simple but important messages.

− A solid−waste disposal campaign to remove garbage as the fly and rodent problem became increasingly annoying to the population and the management of the centers.

A specific environmental hazard associated with the evacuation centers was identified in the number of people who besides or despite mass catering used private cookpots (charcoal pots) for cooking. This created smoke problems as well as a fire hazard. Several children had to be treated for burn wounds associated with these cooking pots. Every center dealt differently with these problems but a common approach was to limit the use of cooking pots to a certain area of the center. Thereby they controlled smoke and fire problems as well as the problem of infants and toddlers coming too easily into contact with the pots.
4.5. Surveillance of public health activities in centers

The most important public health activity was a mass immunization project in the evacuation centers. Two features of this program separated it from many other immunisation programs during natural disasters: it was directed against common childhood diseases (polio, diphtheria, tetanus, pertussis, measles) and it had been scheduled long beforehand.

The program started May 7th. In view of the special situation in the island, the first intention was only to vaccinate evacuees. Very soon, however, it became clear that the people living in areas close to evacuation centers did not take this lightly. They were very insistent that they be vaccinated as well. In principle the program was aimed at children under 10 years old (for DPT, polio and measles). It included a tetanus toxoid component for the general population. Jet injectors were used for immunization. Fifty–thousand people were reported vaccinated at the end of the program. A second round was scheduled for July.

Mass–immunization was a very attractive program to decision makers during emergencies. It is worthwhile to note here some of the deficiencies and problems we found with this program.

4.5.1. Staff

The staff necessary to carry out mass–immunisation was taken from other programs such as family planning, routine immunization programs and also the surveillance system. This meant that a number of vital activities had to be decreased or stopped. All this for a program that in fact had no immediate priority or urgency.

4.5.2. Vaccine

The origin and quality of vaccine supply was surrounded by mystery. Various brands and batches of vaccine were involved. The majority of these were close to or peat the expiration date. On testing some of these were potent but because of the variety and often the small quantities of each it was not worthwhile to test them all. Instructions on the method of usage and dosage were not always in English. They also varied between brands of vaccine. The mass program was an initiative originated outside St. Vincent (a voluntary or service group) and the source and quality of vaccine was not easily questioned. Probably they were left–overs from either pharmaceutical companies, private doctors or vaccine stocks from an industrial country.

4.5.3. Record keeping

Hardly any records were kept. When they were, they were limited to name, age and sex. Scores of people (mostly those from outside the centers) were vaccinated but never registered. The latent had been to deliver each person with an individual vaccination card after the program but this could hardly ever be done for the people who were recorded since no home address or even village of origin was recorded.

All the above comments are based on casual observations. Therefore they represent minimal comments. A detailed analysis of the cold chain and the vaccination techniques, or a description of complication rates following the immunization was not attempted during this emergency.

Another important public health activity concerned water quality. One of the first problems faced was the intriguing question of whether volcanic ashfall had contaminated the water supplies of St. Vincent. In the main, these were surface water supplies. We found no evidence that the water supply was significantly affected by the ashfall or that people had become acutely ill from drinking water that could have been contaminated. In fact the bacterial quality of water was of a bigger concern to us since this had been a long–standing problem in St. Vincent. Throughout the emergency, water outlets at the different centers were monitored for the levels of free chlorine at the outlet. Where necessary, the authorities from the respective Ministry immediately reacted. Moat certainly no water–borne outbreaks occurred at any center. This was evident in the surveillance of diarrhea at the centers.
4.6. Routine surveillance

The routine epidemiologic surveillance system based on physicians reporting patients with certain infectious disease seen at health centers continued −to work during and after the emergency. We analyzed the figures for the one year period following the return home of the evacuees.

Gastroenteritis – reported incidence started to rise about fourteen days after all evacuees had returned home. This lasted about three months (July, August, September). It must be said that this coincides with the rainy season and that a similar peak was noted also in 1977.

An epidemic of influenza−like illness occurred in the third quarter with a peak in October.

Most amazingly a measles epidemic began late 1979. It went on through June 1980. This despite the fact that all children under ten reportedly had been immunized against measles in the program described earlier. No other unusual occurrences were noted. The analysis includes hepatitis with sporadic cases throughout 1979 in not unusual numbers (25 per 100,000 population for 1979) and two sexually transmitted diseases (syphilis and gonorrhea) for which nothing special was noted.

In all, no delayed effect of the emergency was noted through the routine surveillance system. During the emergency low numbers of all infectious diseases were reported. This coincides with the findings of our postdisaster surveillance system--no outbreaks occurred during the emergency.

Jamaica floods, June 1979

1. Background information (48−50)

Jamaica is one of the moat densely populated countries in the world with a population density of over 195 people per km . On arable land this comes to more than 1,000 per km . The total population numbers around 2,200,000 of which close to half is younger than 15; 39% of these live in towns of 1,000 or more (1970).

Jamaica lies in the Caribbean sea to the south of Cuba and to the east of Hispaniola (Haiti and Dominican Republic).

The original inhabitants of Jamaica were Arawak indians. Presently the Creole population (African and African−mixed) accounts for 90–95% of the population. Caucasian, Chinese, Eastindian and mid−Eastern communities make up the remaining 5–10%.

Administratively Jamaica is divided into parishes, with pariah councils administering local affairs (Figure 12). For preventive health purposes a pariah Medical Officer of Health is in charge of pariah affairs.

The economy is dominated by bauxite mining, manufacturing and tourism. The Gross National Product (1978) stood at US$ 921 per capita. Vital statistics were as follows :

<table>
<thead>
<tr>
<th>Health Statistics</th>
<th>Year</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Birth Rate</td>
<td>(1976)</td>
<td>29/1000</td>
</tr>
<tr>
<td>Crude Death Rate</td>
<td>(1976)</td>
<td>7/1000</td>
</tr>
<tr>
<td>Infant Mortality Rate</td>
<td>(1976)</td>
<td>22/1000 live births</td>
</tr>
<tr>
<td>Life expectancy at birth</td>
<td>(1979)</td>
<td>70.6 years</td>
</tr>
<tr>
<td>Literacy rate</td>
<td>(1976)</td>
<td>86/100</td>
</tr>
</tbody>
</table>

The mortality pattern is rapidly becoming similar to that found in developed countries. One report states, however, that malnutrition contributes directly or indirectly to 60–85% of deaths among children six months to two years old. Malaria was eradicated from the island in the 60's.

Immunization programs had been carried out against diptheria, polio, tetanus and whooping cough but with a coverage of only around 30% (1978) in infants before one year of age. A massive epidemic (20% attack rate) of dengue type 1 struck in 1977−1978 and Aedes aegypti remained abundantly present. A large typhoid outbreak (97 confirmed cases) occurred late 1978 in one of the western parishes.
88% of the population was considered to have access to potable water (1977). There were 3.6 hospital beds per thousand population in 1979. A network of health centers and dispensaries throughout the island supplements hospital services. In the Montego Bay area a 400−bed regional hospital was completed in 1974 and provided specialized services for the five Cornwall County Parishes. A serious health manpower shortage existed in Jamaica at the time of the disaster, mostly in the category of physicians and trained nurses.

Jamaica had previous disaster experiences: in 1907 the capital was extensively damaged by an earthquake; the previous capital, Port Royal, was destroyed by an earthquake, fire and tidal waves in 1692; a hurricane kilt the capital in 1951, and floods are frequent during the rainy season. Jamaica flea at mid−center of southern hurricane tracks and is frequently struck by storms between August and November.

1.1. The floods

On the 12th of June, after five months of above−normal rainfall in Western Jamaica torrential and sustained showers associated with a tropical depression flooded the already saturated arena. This resulted in forty−two deaths (31 of them in one parish in Westmoreland) and extensive damage to infrastructure. Nearly 160,000 people were estimated to be affected. Up to 40,000 were reported homeless and another 50,000 experienced severe losses. At one point the damage was estimated at 114 million Jamaican Dollars (= 60 Mill. US$).

Most affected were water supply systems, roads, bridges, houses, agricultural crops and livestock in the parishes of Westmoreland, Hanover, St. Elizabeth, St. James and Trelawny (see map) (Cornwall county parishes). Westmoreland was the worst kilt area. The total population in this area la around 350,000. After the first impact the floods started to recede except in a few areas where they would remain for several weeks. Immediately following the first impact a small number of evacuation centers (nineteen later reduced to seven) were set up for people who could not find refuge with relatives. These were disbanded as soon as the floods started to recede and people went back home.

There was serious concern in Jamaica at the time about the risk of epidemics. Floods had washed out everything in many places, including sewerage pits (pit latrines) and graveyards. There had been electricity problems, a sewerage plant had been flooded and water supply systems were affected. This also occurred in an area where an extremely large outbreak of typhoid was seen only 6 months earlier. This outbreak had been ascribed to a breakdown of the water supply with people turning to alternative water sources.

Since flood water could have been contaminated in many ways and people had no choice but to have repeated contact with this flood water, the public was also very concerned. Despite considerable pressure from the public and politicians no mesa immunization campaign against typhoid was undertaken. In making this decision the advice of national and international epidemiologists was accepted. Public concern was partially addressed through the massive distribution of water purification tablets.
2. Surveillance system

One week after the impact a CAREC epidemiologist was requested to assist the national Jamaican epidemiologist with the development of an effective disease surveillance system in the areas affected by flooding. First a rapid situation survey was undertaken to assess existing damages (including health infrastructure) and ascertain if certain disease problems had arisen. Second, a surveillance system was set up in the Cornwall Regional Hospital, little affected by the floods.

The surveillance system was based on an analysis of high risk diseases and high risk areas. It used available records such as the typhoid register and mapping of flooded areas. While the entire area would be kept under surveillance special attention was given to the risk areas identified (mostly in Westmoreland). Two diseases were considered to be especially troublesome—typhoid and leptospirosis. Dengue would be added to this flat later.

An operations center was established in the hospital with a large map of the Western Region. The following information was registered and updated daily:

- Operative health centers and hospitals.
- Inoperative health centers and hospitals.
- Inoperative water systems.
- Areas originally flooded, with pins indicating which areas were still flooded.
- Risk areas for typhoid.
- Risk areas for leptospirosis.

Besides this a similar system to the one described for St. Vincent was proposed for surveillance in the evacuation centers. Also all health centers were requested to report daily all cases of fever, jaundice and gastroenteritis seen in the health center. Any unusual situation including any case of typhoid, leptospirosis or dengue had to be communicated immediately through whatever means. The cooperation of the senior public health nurses in each parish was obtained and they would pass on the instructions to the nurses-in-charge of the health centers.

At the hospital the surveillance staff personally surveyed daily outpatient visits and in-patients.

Twice weekly a meeting was held of senior pariah staff to review the situation. Surveillance and disease control data were discussed at This meeting. The meetings were also attended by staff of the environmental control unit of the Ministry of Health. In This way an eye was kept on the environmental conditions in the disaster area.

The one public health activity under surveillance consisted of the distribution of water purification tablets.

Routine surveillance of infectious diseases also continued as usual in these areas. We had to realize however this had not been adequate in several places for several months or years.

3. Results and analysis

3.1. System

In the entire surveillance operation very few reports came in. Also very few records were kept. Therefore, the following analysis will be mostly a qualitative one.

Most flood waters had retreated about one week after onset. As flood waters retreated, normal activities resumed in most places. In this way the intensive surveillance system was stopped (or newer started) in these places. In practice the entire surveillance system functioned for about one month after which it was discontinued. During This entire period at least one person from the national Epidemiology Unit remained constantly present in the affected area.

Formal reporting proved very difficult. A minority of centers and/or pariah headquarters reported and even then only after repeated phone calls and personal visits. This could at least partly be explained by the rather
large delay in starting intensified surveillance.

The main value in the surveillance system could be considered to be that it existed if something serious occurred people knew where to report and ask for assistance. For the routine collection of reports however, it was not very successful. Little value can be given to the accuracy of the reported numbers. The effort of installing emergency surveillance in four different parishes). with a population of almost 350,000 people covered by almost one hundred different health centers with varying communication facilities was most certainly very much underestimated at the time.

3.2. Results

First of all no outbreak of infectious diseases of any importance was recognized during this period. One outbreak of fish poisoning possibly related to disaster–induced changes in marine ecology was described elsewhere. (51)

The evacuation centers were visited daily by a public health nurse. After 15 days only one of them had reported any communicable disease (three cases of gastroenteritis). At this date, the number of centers had already dwindled to sex, with a total population of 319. Whatever reports were received from these centers later were included in the health center surveillance reports. From informal contacts with the nurses who visited these centers we knew no outbreaks occurred there.

Despite the poor reporting two surveillance reports were issued on health center surveillance. (52,53) one in early July and one in mid–July. Each covered approximately 10 days. The purpose was threefold:

− To give feedback to decision makers and to people at the reporting level.

− To strengthen the surveillance system by showing that the information was being used.

− To contradict rumors that circulated in the public and in the media about epidemics. in the affected area.

As in St. Vincent, the figures were mainly used to detect outbreaks and not so much for statistical analysis. No baseline data to compare with were available. Thus, the criteria against which they were analyzed had to be constructed as follows:

The absolute number of cases reported was set against the population size, the number of unite that were supposed to have reported and the health facilities available in that region. It was attempted to determine if the number was "reasonable," that is, if the normal facilities could cope with this load.

Time trends were analyzed to see if increases occurred. Pseudo–increases due to better reporting were to be excluded.

The geographical location of cases was investigated to determine if clusters occurred.

A few pseudo–epidemics were seen, with a striking increase in the number of cases reported from one center or parish for one or more days. When investigated, these could all be ascribed to artifacts of intensity of surveillance. For example from June 23 to 25 high numbers of cases of gastroenteritis were reported for Westmoreland. These were all associated in time with the vials of an epidemiologist to that area and the active search for cases he initiated. Similarly, other temporary increases could be explained through abrupt surveillance activity. One decided to phone several health centers on one day to foid out what they were seeing. Most of the time this enthusiasm had disappeared one day later. The number of cases reported decreased correspondingly.

It cannot be stated if more or less infectious disease occurred following the disaster. We can only say that no geographic clustering of reported cases occurred, no consistent time trends were observed and the treatment facilities could easily cope with the case–load. An outbreak of akin rash was reported but never investigated. It consisted of 16 cases in one day and was acid to be associated with water contact.
4. Specific surveillance

4.1. Disease-specific surveillance

DISEASE-SPECIFIC SURVEILLANCE for typhoid, leptospirosis and dengue failed to reveal any confirmed cases of dengue or leptospirosis in the affected areas. Considerable assistance had been given to provide adequate diagnostic facilities for these two diseases since it would have been possible to confirm more cases than in normal times.

Following the same rains a leptospirosis epidemic with 30 cases was reported from another Jamaican parish where no flooding occurred. The typhoid situation will be discussed later under routine surveillance results. In the worst affected parish not a single case of typhoid was reported in the months following the flood.

4.2. Hospital surveillance

HOSPITAL SURVEILLANCE (outpatients and inpatients) was done on an informal basis. No records were kept. Unusual occurrence of infectious disease was not documented. There was an apparent increase in the number of patients with centipede bites. No similar impression existed for snake and/or dog bites, which have been reported for other flood and/ or disaster situations. In fact, very few snake bites were presented for treatment during this period.

4.3. Environmental health activities

ENVIRONMENTAL HEALTH ACTIVITIES focused on water and food quality. A major health hazard presented itself in the form of flood-damaged foods. They were presented as disaster sales at discount prices. Flood-damage was suffered directly (e.g., flour, auger) or indirectly through the power failure following the floods (e.g., meat, milk, etc.). Vigorous and rapid action by the food-quality and/or public health inspector was necessary to condemn these supplies and counteract this dangerous practice.

4.4. Water supplies

WATER SUPPLIES for the parishes) are served by numerous small water systems (more than one hundred). This limits the health hazards associated with defective water systems to small population groups. In a summary on the status of water supply in the affected parishes presented by the Environmental Health Department the three mayor deficiencies found were:

a. Poor disinfection practices (sometimes related to unavailability of chlorine).
b. Lack of proper protection of sources.
c. Absence of sanitary conveniences for the water operators.

These were known to have been in existence long before the floods and bore no relation to the floods at all.

Of the 95 water supply systems visited after one month only 14 were not yet working (15%). There was reason to think that normally the percentage of water supply systems out of operation la higher. Still 9/14 defective systems were located in Westmoreland and constituted 40% of the systems there. Because of concern about the quality of water a massive health education program was started to promote the use of safe drinking water. Leaflets were distributed (see copy), and the Division of Health Education of the Ministry of Health made this issue a main task. A massive distribution program for water purification tablets was started. This was also propagated and monitored by the Health Education Department.

Theoretically, chemical water disinfection is adequate to assure water quality when boiling water is impractical or impossible. A number of conditions have to be met however, among them we can cite the following:

a. The tablets need to be available at the time they are needed, which is the days when water
quality can be assumed to be poor—the first few days following the disaster.

b. People need to know how to use them, and they need to be willing to use them.

c. People need to have adequate receptacles in order to allow adequate dilution.

In Jamaica at least the first two conditions were not met.

a. Nine days passed before the tablets were available at the distribution center in the pariah. This was still one step removed from reaching the household level.

b. A massive health education effort was mounted to explain the proper use of the tablets. It is not known how far this was effective in convincing people to use them or in teaching them how to use them. Anecdotal information exists to the contrary: one reported incident involves people in leading positions in the community (teachers) that refused to use the tablets since they represented chemical pollution of the water (sic). Another common story was that people would use the tablets for bleaching clothes. It was later found that in some batches other tablets with higher chlorine content than the water purification tablet were erroneously distributed. Finally, the rapid decoloration of the tablets when exposed to air also induced wastage and large amounts had to be discarded.

An analysis of the routine surveillance results as reported to CAREC shows that no increase was detectable up to one year later for typhoid, gastroenteritis, influenza, diphtheria, tetanus, meningococcal infections, measles, dengue, malaria and tuberculosis. No data are available for syphilis and gonococcal infections.

The only possible effect involved a cluster of 8 infectious hepatitis cases during the week ending 7th July 1979, i.e. three weeks after the floods. Eight cases were about 5 times the normal number of cases reported per week during the first 23 weeks of the year. The figure still only amounts to an extrapolated yearly incidence of 20 per 100,000 population, a normal figure in the USA where it is thought to represent 10% of all hepatitis cases. (54) After the first twelve weeks hepatitis incidence was reported below its usual level, as was the case for all other diseases under surveillance.

Typhoid deserves special mention since this was a disease of particular concern in Jamaica. This concern repeatedly has prompted mass immunization campaigns in other countries. In Jamaica, no mass vaccination campaign was started despite considerable public and political pressure. Instead, it was decided to strengthen surveillance and if necessary to control outbreaks. This was all in accordance with the most recent technical concepts of typhoid fever control. The weekly number of typhoid cases reported for the entire country dropped by 50% in the 29 weeks following the disaster. The total number of cases reported for 1979 (140) was lower than both the preceding year (1978: 223 cases) and the following year (1980: 163 cases).

Also, the distribution of these cases showed a smaller percentage than normal was reported from the affected parishes: 4% in 1979 against 12–14% in 1977–1980. (55)

Surveillance bias cannot be discounted in these numbers. Still these decreases were noted while the general public and the health authorities were afraid of a typhoid outbreak and more active surveillance for this disease was instituted.

Dominica hurricane, September 1979

1. Background information

Dominica is an island in the Eastern Caribbean located between the French overseas departments of Martinique and Guadeloupe (see map Fig. 3). It has a surface of 751 km and a total population estimated to be around 81,000 in 1978. At the time of the disaster it had just become independent of the United Kingdom.

The island is extremely mountainous with a low population density (108 per km ) according to Caribbean standards. There are two main population centers both on the Neat Coas: Roseau, the capital in the Southwest (18–20,000 people) and Portsmouth in the Northwest. (Fig. 13)
Some vital statistics follow:

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life expectancy at birth</td>
<td>67.4 years (1975–1980)</td>
</tr>
<tr>
<td>Crude Death Rate</td>
<td>5/1000 (1978)</td>
</tr>
<tr>
<td>Infant Mortality Rate</td>
<td>21.9 per 1000 live births</td>
</tr>
<tr>
<td>Rate of natural increase</td>
<td>16.2 per 1000 population (1978)</td>
</tr>
<tr>
<td>Percentage of deaths from infectious</td>
<td>9.7%</td>
</tr>
<tr>
<td>and parasitic diseases</td>
<td></td>
</tr>
</tbody>
</table>

The adult literacy rate was estimated at around 802 in 1970. The country has an open economy and is dependent upon one major export crop: bananas. Existing industry is also agriculture-based, with tourism recently becoming a second industry.

The indigenous inhabitants of Dominica were the Carib Indians. It is the only island in the Caribbean where a significant part of the population still has Carib blood. However, the great majority of the population is now of African descent or of mixed blood. Small Eastindian and White minorities are also present.

The existing health facilities in Dominica consisted of one large hospital in Roseau with approximately 200 beds, a smaller 40-bed hospital in Portsmouth and two cottage hospitals with a limited number of beds. Forty-four health centers island-wide provided outpatient services. In 1978 there were 1.8 physicians per 10,000 population. In an analysis of communicable disease problems in Dominica in 1972, infections and infestations were found to be major health problems, with gastroenteritis, typhoid fever, amebiasis and helminthiasis most prominent. Malaria was eradicated from the island since 1962 but several isolated cases had been documented since. Diphtheria, tetanus and yaws were also reported to be highly prevalent. No schistosomiasis was seen although the vector snail is known to exist in the island and the disease is endemic in neighboring islands.
Two large outbreaks of typhoid fever occurred in Dominica in 1977 (28 confirmed cases) and in 1978 (13 confirmed cases). Also in 1977–1978 a country-wide dengue outbreak occurred due to the introduction of dengue type 1 to the island.

At the end of 1977, 45% of children two years of age were reported to be immunized against DPT. For polio, this figure was much lower (less than 10%). The country is extremely disaster-prone, in the middle of the hurricane path, on the earthquake belt and with still active volcanoes on the island. Yet no major disaster had occurred in recent history.

1.1. Hurricane David, with almost complete destruction of the island

From 11 a.m. to 5 p.m. on 29 August 1979 Hurricane David, reported to be one of the strongest hurricanes of this century, with winds that at times exceeded 250 km per hour, swept the island of Dominica. The eye of the
hurricane went straight over the island in a northwest to southeast direction. The population was caught unprepared although disaster warnings had been issued over regional broadcasting stations.

Thirty-eight persons died and some 3000 were treated for injuries. An additional number practiced self-help or received help from village nurses. The majority of these injuries were of a minor nature.

When the hurricane had passed people were confronted with almost complete destruction of their island. Dominica, known as a green island gifted with extremely luxurious nature, had turned gray overnight with most trees broken and/or completely defoliated. The scene was one of complete desolation. What happened to nature also happened to homes, utilities and agriculture. Roads had become impassable, homes were destroyed (most commonly the roof blown off), no electricity or running water was available or would be available for some time, pit latrines were destroyed, the telephone communication system had ceased to exist. The majority of crops as well as a large part of the livestock was destroyed. All of this was worsened by the heavy rains that usually follow a hurricane.

Everyone and everything was soaking wet for several days. This included government offices, public buildings and their archives if they had not been destroyed. A national emergency was declared almost instantly by the government.

2. The surveillance system

Five and a half days after impact a CAREC epidemiologist reached the island to assist with the establishment of post disaster epidemiologic surveillance. The trip took three days and he was instructed to be self-reliant because of the extreme shortage of food, accommodation and transportation. On the island the decision had already been taken to start a measles vaccination campaign against typhoid fever. A number of circumstances made the establishment of surveillance extremely difficult:

a. At the time of the hurricane the function of the Chief Medical Officer was vacant. A special Health Coordinator who had come from outside the island was appointed to direct health services.

b. The main hospital of Roseau, usually a central point where from medical actions radiate, had been badly hit. By the time of the epidemiologist's arrival it had only been rebuilt partially.

c. Volunteer health personnel were coming into the country in such a number and way that coordination and evaluation of their activities proved close to impossible.

d. Transport and communication problems prevented both organized field trips and regular communication with places outside the capital.

e. Epidemiologic surveillance seemed to be low on the flat of priorities.

Instructions had been issued nonetheless to all health workers to keep track of fever and diarrhea in their areas and to report any increase or unusual occurrence.

During the first two weeks surveillance was performed on an informal basis. Little or no collection or analysis of numerical data was undertaken. Still later we found a mini-surveillance system had been operational in Roseau. A senior nurse from the Ministry of Health of Jamaica happened to be in Dominica at the time of the hurricane and assisted with the disaster relief effort. During the floods in Jamaica (see previous section) she had been involved professionally though superficially with the surveillance system used there. She had promptly implemented a similar one in her area of responsibility in Dominica.

The epidemiologist used the transport assigned to the typhoid immunization campaign to survey the island and its health centers. In return he had to get involved in the immunisation campaign and provide routine health care to the localities he visited. This frequently implied care for patients with chronic diseases, such as hypertension and diabetes. In the evening he visited the wards of the Roseau Hospital to analyze new admissions. After two weeks the first epidemiologist returned. No massive outbreak had occurred so far. A second epidemiologist was sent to strengthen surveillance.

The following considerations were taken into account:
– Besides Roseau Hospital, two other hospitals were more or less functional: Portsmouth (28 beds) and Marigot Hospital (6 beds).

– The activity in health centers was irregular. Some worked, some did not, but no organized schedules were followed. The impression existed that some voluntary medical teams operated completely on their own initiative, with no coordination.

– In Roseau, the Health Centre was functional but many patients preferred to attend the Casualty Department of the Princess Margaret Hospital for primary care.

– Monitoring of sentinel stations rather than complete disease reporting was considered acceptable. The purpose of the system would be to detect epidemics affecting a large part of the population and not minor variations in disease occurrence.

– The hospital laboratory was intact and had resumed its functions fully about 6 days after the disaster. Part of the laboratory was a well-equipped and reliable bacteriology laboratory.

A headquarters office was established at the laboratory to start a sentinel surveillance system that would report on simple symptoms (fever and gastroenteritis). Hospital outpatient departments were chosen first as sentinel stations since they consistently had been providing health care to the population from the beginning. In the hospitals, inpatient departments would also be monitored.

The flat of sentinels and the indicators chosen for surveillance is shown in Table 6.

The existing records in the sentinel stations were analyzed in order to have baseline data.

A public health nurse from Dominica was put in charge of the surveillance system. The system operated until about 50 days after the disaster. Informally an eye was kept on environmental health conditions and on the activities of the main public health program i.e. typhoid immunisation.

3. Results and analysis

3.1. Operation of the system

In view of the above the surveillance system worked relatively well. There was regular contact with three of the four sentinel reporting units. In the case of Portsmouth and Marigot this contact was difficult to maintain because of the communication and transport breakdown. A major difficulty was that record keeping had stopped almost completely. Medical care was being given without anyone taking notes on what kind of complaints were being presented or even how many patients registered.

In the hospital, up to 17 September no data had been recorded on admissions to the different wards. Two reasons could be identified:

– The destruction of existing logbooks and the unavailability of typewritten paper, or books afterwards.

– The influx of foreign personnel, unfamiliar with the recording practices in the country or even with the language.

Many also thought that treatment was the most important task ahead and record keeping was a low-priority area. This contrasted with the admission by many that there was ample time available for eventual record keeping. Also, a retrospective survey showed only 4.3% of the sample population was in the immediate need of medical services. On the other hand, many nurses in the rural area noted the number of people they treated and often also the main reason for attendance.

Table 6: Sentinel Stations and Indicators Used, Dominica 1979

<table>
<thead>
<tr>
<th>1. Princess Margaret Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>− casualty department: a. total number of attendances</td>
</tr>
</tbody>
</table>
b. number of attendances with gastroenteritis as main complaint.
c. number of attendances with fever as main complaint.

- medical ward:
  a. number of admissions.
  b. admission diagnosis.

- pediatric ward:
  a. number of admissions.
  b. admission diagnosis.

- laboratory:
  a. microbiology results.

2. Roseau Health Center
   a. total number of attendances.
   b. number of attendances with gastroenteritis as main complaint.
   c. number of attendances with fever as main complaint.

3. Marigot Hospital
   a. total number of attendances.
   b. number of attendances with gastroenteritis as main complaint.
   c. number of attendances with fever as main complaint.

4. Portsmouth Hospital
   a. total number of attendances.
   b. number of attendances with gastroenteritis as main complaint.
   c. number of attendances with fever as main complaint.
   - hospital admissions:
     a. total number of admissions.
     b. admission diagnosis.

For the duration of the system two feedback reports were issued, one about four weeks after the hurricane and a second one two weeks later. No final report was issued when the system closed.

During the period between 24th August and 16 October no major outbreak was detected. At the end of the period a slowly starting increase was seen in the number of dysentery samples submitted to the laboratory. When the surveillance system was discontinued strong recommendations for fly control were issued.

3.2. Casualty and health center surveillance

Figures 14 and 15 show the total number of attendances to the Casualty Departments of the Princess Margaret Hospital and the Portsmouth Hospital and the number of attendances due to fever and gastroenteritis. The numbers are shown in three–day periods for ease of analysis. In actual practice they were charted and analyzed on a daily basis. Only normal variations are seen. A sharp decrease in the number of patients seen at the Princess Margaret Hospital Casualty Department following the first three–day period is due to the fact that until 18 September everybody who attended was seen. After this date only "emergencies" in a broad sense of the word were seen. Both casualty departments, however, fulfill a primary health–care function in the way they normally operate.

Figures are also available from the Portsmouth Health Center and from Marigot Hospital and Health Center. The former only opened a few days a week. The reports from the Casualty Department are therefore a better source of information. The reports from Marigot were irregular but are shown in Fig. 16. The numbers were correlated with the availability of a physician. An immediate increase was seen when a physician was posted there and an immediate decrease when he was transferred again. Marigot had been without a permanent physician for some time when the disaster took place. The influx of volunteer medical personnel permitted temporary assignment of a physician to that poet.

In all, no signs of any infectious disease outbreak were detected through casualty and health center surveillance.
Figure 14: Number of Attendances to the Casualty Departments of the Princess Margaret Hospital, Roseau and Portsmouth Hospital, Pe Three-Day Periods in Dominica, September 16–October 18, 1979
Figure 15: Number of Cases of Gastroenteritis and of Few Seen at Casualty Departments of Princess Margareth Hospital and Portsmouth Hospital, Per Three Day Periods, Dominica, 16 September–18 October 1979
Figure 16: Number of Attendances to Marigot Hospital and Health Center.

Because of Fever and Gastroenteritis Per Three-Day Periods, Dominica, 16 September–18 October 1979
Department (PMH) and the number of attendances due to gastroenteritis. At first, the Casualty Department was the major, if not the only primary health care facility operational in the capital. Figure 17 shows the evolution over time. The total number of attendances varied sharply in the first few days after the hurricane. They reached a peak the fourth day, by which time more than 1000 people had been attended. About two weeks later it decreased to a daily average of 100–200 patients. On 18 September the Casualty Department was closed for nonemergencies and the daily load decreased to 40–80 patients a day. In no instance the number of attendances due to gastroenteritis accounted for more than 18% of the total number. On most days it was less than 10%.

In a span of 17 days 316 cases of gastroenteritis were medically attended in this department for an estimated incidence of 21 per thousand population in this period, assuming the entire population of Roseau was served by this facility. On a yearly basis this would amount to an incidence of 450 per thousand (all age groups).

Both figures seem within normal limits even when taking into account considerable under-reporting.

No massive outbreak of gastroenteritis causing people to seek medical attention occurred during the first three weeks following the disaster in the capital area. A retrospective analysis of the reason for attendance showed injuries and nail pricks to account for the majority of attendances only the first three days. On the fourth day they accounted for 44% of the attendances and decreased steadily afterwards. During the second half of the first week vaccinations (mostly against tetanus) in the absence of injuries were the single most important reason for attendance (30–50% of the attendances). By the end of the first week, medical diagnoses had replaced both and remained the single most important reason. It is interesting to note that infected wounds also had become an important part of the case load in the casualty department by this time. (59)

In other places where records had been kept and were analyzed (Wesley and Marigot a similar pattern was seen. No outbreaks occurred.
3.3. Hospital admission surveillance

Figure 18 shows the number of admissions to the medical and pediatric wards of Princess Margaret Hospital and Portsmouth Hospital, respectively. Figures were also available from Marigot Hospital.

Before 16 September no admission registry was kept in the hospital. Only emergencies were admitted since various wards had been destroyed. The patients were partly housed in tents. Thereafter, the number of admissions also depended on the relocation of wards, or on an increase in the number of available beds. When this was taken into account no unusual features were seen in the admission pattern.

Another element of surveillance was a regular check on the nature of admissions. A status check had been made on 17 September. On that day 50% of the ten patients in the medical ward were considered to be chronic (diabetes, cancer, hypertension) and five were infectious (two pneumonia, one acute glomerulonephritis, one dysentery and a query typhoid.) The pediatric ward had 20 patients of which seven were admitted for gastroenteritis, two for disaster-related trauma and two for tuberculosis. The other nine suffered from a variety of conditions. The overall situation was considered to be within normal limits by the consultant pediatrician except a case of neonatal tetanus. He had not seen this in the hospital in three years. It was clearly disaster-related. The child was a troy born on 6 September in the hospital under disaster conditions. It started to develop symptoms 11 days later. Neonatal tetanus is not considered to be a public health problem in Dominica and tetanus-toxoid vaccination of pregnant women is not practiced on a wide scale.
In both wards a high suspicion existed for typhoid and query typhoid fever cases were always immediately cultured and reported. As will be discussed, later no unusual typhoid occurrence was seen.

On 25 September about four weeks after the hurricane, a US Navy soldier was admitted to the medical ward for amebic dysentery. He belonged to the Seebees and was involved in reconstruction activities as part of the US assistance. At the time it was reported his case was the third in this group. All had violated regulations by consuming food or beverages purchased from street vendors. In the following weeks four more (native) people would be admitted to the medical ward and one to the pediatric ward with a diagnosis of dysentery. Four more cases of amebic dysentery were reported in the Seebees (outpatient). The admitted cases originated from four different localities throughout the island. The dysentery situation will be discussed further under laboratory surveillance.

On 17 October a case of P. malariae malaria was diagnosed in a 26 year old female. No additional cases were discovered and the case was thought to have originated from a blood transfusion given early August (before the hurricane). It was the sixth case of malaria discovered in the island since it was declared free of malaria in 1461.

3.4. Laboratory surveillance

Daily contact was maintained with the laboratory to check on unusual situations and to keep surveillance on certain diseases.

3.4.1. Typhoid fever

Five cases of typhoid fever confirmed in the laboratory (4 by culture, 1 by single WIDAL) were seen in the two months following the hurricane. This is well within normal limits for Dominica, in fact compared to previous years quite low. Two of the five cases were known to have been vaccinated in the emergency typhoid vaccination campaign. The first two cases occurred in a hospital orderly and his sister. In the subsequent investigation their father was found to be a carrier. Cases three and four were also related and case five was related to a case early in 1979. In the last two months of 1979 only three cases of typhoid were culture−confirmed. The typhoid situation was essentially unchanged from earlier years.

3.4.2. Amebic dysentery

By the end of October Entamoeba histolytica had been identified in the examination of fresh stool of 26 cases of dysentery. The last identification in the laboratory was reported to have been some years earlier. The origin of these cases was geographically widespread except that 7/26 (27%) of them were Seabees (US Navy). The distribution in time of positive samples is shown in Fig. 19C. From this graph it could be concluded that an outbreak of amebiasis peaked six−weeks after the disaster. There were several problems however, mostly with the laboratory confirmation:
Figure 19: Number of Stool Samples Positive for Entamoeba Histolytica (C) Shigella Sonnei (B) or Shigella Flexneri (A) Princess Margareth Hospital Laboratory, Dominica, 30 August–31 October 1979

a. The lab: The lab had little recent experience with the diagnosis of amebic dysentery.
b. **Criteria:** No stringent criteria were used to label A amebic dysentery: the presence of trophozoites or cysts in the fresh stool of a patient with dysentery or gastroenteritis was considered to be diagnostic. In a CAREC survey earlier in 1979 5.57. of five year old children and 7.5% of 9 year old schoolchildren were found to be excreting *Entamoeba histolytica cysts.* It is therefore not unprobable that a number of cases of gastroenteritis of other etiology were diagnosed as of amebic origin.

c. **Cases:** At that time, no unusually high numbers of gastroenteritis cases were presented at the Casualty Department, the Roseau Health Center, or even the general practitioners that were consulted. It is however possible that an outbreak of amebic dysentery occurred in a subsample of the population that was relatively better off in normal times. Not enough data were available in the laboratory to check this hypothesis, but the Seabee experience is definitely suggestive. No data could be collected for the Seabee group as a whole. Neither could it be confirmed that at least one Seabee had to be evacuated because of amebic dysentery.

### 3.4.3. Shigellosis

Throughout the emergency phase sporadic isolations of *Shigella sonnei* were made (Fig. 19B). This was not considered unusual. The situation was more or less similar to September and October 1978 when four isolates were obtained.

The situation for *Shigella flexneri* was different (Fig. 19A). While in September only one isolate was obtained, during the second and third week of October four isolates were found. The latter ones were of a different type than the former ones, however, all had the same antibiogram. This situation was considered explosive as massive infestation of flies and because of undisposed garbage heaps were widespread, discontinued and the public health nurse assigned to the program was transferred. Thus we have no direct follow-up on this event.

In the survey on the effects of the hurricane conducted five months later, the laboratory data on shigellosis were analyzed retrospectively. It was found that the shigellosis outbreak continued and in fact peaked afterwards. Six isolates were obtained the last week of October, 14 isolates during November, and six in December, all of *Shigella flexneri*. When the *Shigella flexneri* outbreak stopped *Shigella sonnei* resumed its normal place of prominence. Still, a tenfold increase in isolates was found for the first six months of 1980 over In the first four months of any of the three previous years (ten compared to 1, 0 and 1, respectively). Shigellosis seemed therefore to have returned to an endemic level but at a higher level than before.

To what degree this sigellosis outbreak was disaster-related is difficult to determine. It remains that both the fly problem and the beginning of the outbreak had been recognized very early (September) through the emergency surveillance system. Adequate methods could have prevented or controlled the outbreak at an early stage.

### 3.5. Environmental health and public health activities

Most attention was paid during the existence of the surveillance system to water quality surveillance. As the water distribution system had been disrupted, a number of portable water tanks had been installed with U.S. assistance which were very useful in the beginning. Chlorination was actively pursued and monitored and the water was protected from contamination. To guarantee the quality, constant guards would have been necessary. The population (at least partially) preferred riverwater or water from other sources for drinking.

An active publicity campaign was started to promote the use of the tank-water for drinking. This included a warning not to drink water from the main B. Ironically, about three weeks after the hurricane these messages continued to be broadcasted. At this time, bacteriologic testing of water quality was introduced in the Roseau's Hospital Laboratory of the and the quality of the water from the mains was found to be good. On the other hand, the water tested from the portable water-tanks was found to have "Coliforms Too Numerous To Count" and was considered unsafe for drinking. The reason for this was obvious. A number of them had partially collapsed because of lack of maintenance or guards. A number of them were used as swimming pools for children. Water quality testing then directed future use of water supplies.

For the whole of environmental health an emergency work plan was drafted by a PAHO/CARICOM team with local counterparts to guarantee adequate water supply, sewerage and solid waste disposal and vector control.
activities. By the end of October very little of this work plan had been carried out. Not all of the damage to be repaired, however, was disaster-related. Seventeen out of 35 rural water supply systems were said to had been out of order in early September. A similar percentage was found one year earlier when no disaster had occurred.

The major public health activity conducted was a mass typhoid immunization campaign. The vaccine had arrived and the campaign was started about one week after the hurricane. Since it WAS thought that not enough vaccine was available, a 0.1 ml. intradermal injection method was advised by a foreign volunteer and widely practiced. Two weeks later 23,000 people (about 30% of the population) had received a first dose, after which the campaign slowly subsided. A second dose was never given to my knowledge. Records were kept on the number of people vaccinated, their age and sex (in two age groups), but were not analyzed. The organization and coordination of the campaign took most of the time of the Medical Coordinator and used most of the resources assigned to health in transport and manpower. It is not known what the effect of this campaign had on disease occurrence. Its impact is thought to be negligible on theoretical grounds.

3.6. Routine surveillance

Routine surveillance broke down completely after the hurricane because of a number of reasons:

a. The person responsible for it was assigned other tasks as well, limiting the time available to reorganize surveillance activities.

b. The office and files were destroyed (water damage) and there was a scarcity of administrative material such as paper.

d. For indigenous health personnel the resumption of routine surveillance when they had not reported anything for several months proved difficult.

Three cases of typhoid and one case of tetanus were the only diseases reported for the four months following the hurricane. In 1980 the reporting slowly returned to normal.

III : Summary of practical experiences: Lessons learned

A number of practical lessons can be learned from the experiences as described in the previous sections and--from my personal participation in them. I will try to systematize them here:

1. Regarding the surveillance system

1.1. It will have to use whatever health system is available, whatever services are functioning. It is therefore dependent on the type and magnitude of the disaster. In this limited experience refugee situations proved to be relatively easy populations among which to collect numerical information. In a disaster affecting an entire country both collection and interpretation of data presented mayor difficulties.

1.2. Even when nothing can be collected on a regular basis, the introduction or reestablishment of systematic record keeping at all possible health care levels (health center, hospital, casualty department) will at least permit the periodic analysis of these records and provide valuable information.

1.3. Wherever possible local people should be employed and/or be put in charge of the surveillance system. Optimally the person in charge of routine surveillance activities should also assume the responsibility of emergency surveillance. This not only facilitates the interpretation of data, but improves the continuity of data gathering.

1.4. The earlier a surveillance system is established, the better it works. Not only is it better to have data from the first days, it is also easier to introduce a system at that time to the health workers. During a disaster, a family of sorts grows out of the workers--of--the--first--hour. People who come later than the first few days are considered outsiders.
1.5. Similarly, an emergency is no time for bureaucratic procedures. Letters and memoranda to health workers are not very much appreciated. Personal visibility and personal communication are the most effective means of establishing a system. These are more easily accomplished during the first days following the disaster when a general sense of goodwill is present among relief workers.

1.6. Feedback is important as in any surveillance system. However, feedback does not simply consist of issuing a report to the providers of information. It also consists of what I would call "emotional" feedback: show people that their reports are being utilized, that rumors are being followed-up, as well as whatever unusual occurrence they report. Simply said, show them that the numbers are not being collected for the files but for disease control.

1.7. The emergency surveillance system should continue at least two months after the disaster, or at least as long as disaster relief activities take place on any scale. When it is discontinued its role should be taken over by a normal epidemiologic surveillance system, which should be strengthened where necessary.

1.8. Whenever possible public health laboratory facilities should be strengthened or provided to form an integral part of the surveillance system.

1.9. At various levels lay people can be utilized for the reporting and/or collection of information.

1.10. Final reports analyzing the total experience should be made and distributed on a wide scale.

1.11. In the surveillance system it is of paramount importance to include environmental health and public health activities that are taking place. They form the background with which to orient disease-control programs indicated by the surveillance system as necessary.

2. Regarding the capacity to detect outbreaks

2.1. In order to detect outbreaks the presence of a system is more important than its organization or its actual functioning. The fact that somebody has been assigned to the teak of epidemiologic surveillance (and eventually disease control), if this is

2.2. Rumors are always present in a post-disaster situation. One of the main benefits of any emergency surveillance system is that it can detect rumors quickly, check their validity and defuse them if unfounded.

2.3. The possibilities to detect pseudo-outbreaks, that is, to detect outbreaks where they don’t exist, are plentiful. To mention a few:

- compared with what was in place before the disaster, the surveillance system is probably stronger in many instances. It will therefore detect more cases of more diseases.

- the provision of new laboratory facilities (such as dengue and leptospirosis in Jamaica) will detect endemic problems as if they were epidemic.

- epidemiologists unfamiliar with the situation have difficulty with the interpretation of data.

- changes in the recording system can be introduced following the disaster (e.g., Casualty Department, St. Vincent).

The system that was used in these experiences varied somewhat, but was always based on symptom-reporting of numbers only. It is probably too crude to detect small but scientifically significant outbreaks.

3. Regarding the occurrence of outbreaks

3.1. No wide-scale outbreaks affecting a majority of the population were detected with the surveillance system.
3.2. The outbreaks that were detected were focal.

3.3. None of the outbreaks was directly due to the disaster but rather to the secondary effects of the disaster.

3.4. All of the outbreaks court have been prevented by adequate disease control measures following the disaster.

3.5. The majority of the outbreaks detected were associated with the disaster relief efforts (food-borne outbreaks in St. Vincent and amebiasis in Dominica.)

4. Regarding the overall usefulness of post–disaster epidemiologic surveillance

An information system alone is not enough. The authorities who requested or established the surveillance system (mostly from the Ministry of Health) need to understand and utilize the system. They need to be willing to act on the information it provides if outbreaks are to be prevented. Similarly environmental health and/or public health measures cannot just be taken (on the initiative of external agencies) and left to function. Their impact (which might be negative) needs to be monitored and evaluated constantly.

Annex A – Control of infectious diseases following natural disasters

Based on the theoretical framework as proposed in Section I the following was used as a model for disease control following natural disasters in the experiences described in Section II.

Three elements are essential:

1. EPIDEMIOLOGIC SURVEILLANCE

2. DISEASE CONTROL

3. ENVIRONMENTAL HEALTH MEASURES

4. RESUMPTION OR STRENGTHENING OF PUBLIC HEALTH PROGRAMS

1. Epidemiologic surveillance

1. EPIDEMIOLOGIC SURVEILLANCE is the cornerstone of the program. It serves to identify outbreaks or potential disease problems early in order to orient the disaster relief activity appropriately. A recent PAHO publication deals with setting up epidemiologic surveillance systems following natural disasters.\(^{33}\) We will not expand on this subject here, However the following points should be restated:

– The system has to be based on the local situation and take full advantage of local resources, as well as respect existing institutions or systems. A “mobile” postdisaster epidemiologic surveillance team can only be used to strengthen local resources, not replace them.

– It is difficult to establish something where nothing exists. Ideally post–disaster surveillance should only be a strengthening or an extension of existing surveillance systems. At least all surveillance units in disaster–prone countries should have some introduction or knowledge
about the reality of infectious disease problems following natural disasters.

− The system should be problem–oriented, i.e. not only collect information but collect it with a specific purpose. This purpose at a minimum should be outbreak–detection.

− Whatever the system developed or the methods of information collection used, information will circulate (even if only as rumors). If the system has reached any credibility the information will channel itself through it.

2. The most immediate effect of most disasters is on environmental health

Activities should be developed to maintain or repair the damaged facilities or services. Two kinds of priorities can be established,(1) one depending on population density and one depending on the kind of services disrupted or unavailable. The higher the population density in an area the higher priority these areas should get more so when high population density is compounded by an element of temporary settlement, such as is the case with refugee camps.

As to kind of services first priority should be given to:

− adequate quantities of safe water
− basic sanitation facilities
− disposal of excrete
− disposal of liquid and solid wastes

On a second level are:

− food protection measures
− vector control measures
− personal hygiene

These measures should of course get more attention when they are identified through surveys or epidemiologic surveillance as the most important risk factors for actual disease outbreaks or potential disease problems. For these activities also specific guides were written.(67) A very recent PAHO publication deals with one aspect of environmental health, namely vector control following natural disasters.(68)

3. the third element is the immediate resumption or the strengthening of routine public health programs

3. THE THIRD ELEMENT IS THE IMMEDIATE RESUMPTION OR THE STRENGTHENING OF ROUTINE PUBLIC HEALTH PROGRAMS program; anti–malaria activities or yellow fever control programs; water quality; food quality; drug quality; veterinary public health or sanitary inspection can also be considered here.

These programs are designed to protect the health of people in normal times and to prevent unnecessary disease. In times of disaster, when so many more influences are threatening their importance is ever greater. Unfortunately it is often from these programs that personnel is drawn for so called relief–programs, thereby leaving the public vulnerable. An additional problem is that many people in these programs do not feel they are fulfilling essential Jobs in disasterrelief. They are supposed to continue their routine activities but many want to Join special disaster forces which probably have more glamour but are less effective.

Annex B – Disease control and disaster–relief
1. Disaster-relief activities should in no way be exempt from the attention of disease control programs

As seen earlier in our experience disaster relief accounted for most of the disease outbreaks. It also caused a considerable part of potential disease problems (such as the contaminated portable water tanks in Dominica). Epidemiologic surveillance should also focus on disaster relief activities and personnel. They should be monitored for their environmental health impact and should be subject to the routine public health program analysis or standards of the country.

2. At the same time full advantage should be taken of disaster relief and personnel to obtain longterm impact on disease occurrence and control

As discussed in the first section, a disaster does not usually result in infectious disease problems. It is also possible that disasters cause some problems to disappear or never to show up. One of the main opportunities a disaster provides is in the huge inflow of resources, in manpower, money and materials. Often alternatives are available for emergency measures. They all have a similar short-term impact at about the same price. Some have a long term beneficial impact as well. This should be discounted in emergency relief.

In order for such an infectious disease control program to be effective it needs to have been prepared in advance, both politically and technically. Decision-makers, in the health field as well as in other fields, need to be familiarized with modern thinking about infectious disease problems following natural disasters and appropriate disease control programs. Technical units in the health and related ministries need to be provided with the background and skills they will need to function effectively in a disaster.

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