Epidemiology of Human Health Effects of Exposure to the 1979 Eruption of Mt. Soufriere, St. Vincent, W.I.

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INTRODUCTION

On Good Friday 13 April 1979, Mt. Soufriere volcano in northern St. Vincent started erupting and remained active until late May. The total population living within a ten Km radius from the volcano crater was evacuated. On Sunday 15 April a two-man team from the Caribbean Epidemiology Centre, PAHO/WHO, Trinidad arrived to assist the national health authorities with the development of post-disaster epidemiological surveillance.

BACKGROUND[1]

St. Vincent, at the time of the eruption an Associated State with the United Kingdom, lies among the Windward Islands of the Caribbean, some 13° North of the Equator, between St. Lucia and Grenada. The population in 1979 was estimated to be 110.000 with more than 50% younger than 15. The total surface covers less than 300 km^2 with a major population concentration in the south.

The island is of volcanic origin and has one active volcano, the Soufrière, located in the northern part of the island.

Following very little premonitory activity the volcano erupted at dawn on 13 April 1979 with a column of steam and ash[2,5] A series of seven vertical explosions between 13 and 26 April generated ash falls, pyroclastic flows and mud flows. The first eruptionswere so powerful that transport of the ashplume resulted in ash fall on Barbados an island 180 km to the east. At each eruption the mushrooming clouds reached up to 9000 m and were readily visible from the capital Kingstown 20 kilometres away from the volcano crater. Each explosion was followed by the deposition of a thin layer of ash over the entire island, heavier in the norther part. Ash could fall for several hours resembling light snow and was irritating to the eyes and mucous membranes of the upper respiratory tract.

Evacuation of the entire population first within 5 km and later within 10 km of the volcano crater was started almost immediately. In total some 15000-20000 people were relocated temporarily in the already densely populated south.

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The volcano remained active until late May - early June after which the evacuated population was allowed to resettle.

The last evident activity of the volcano had been seen in 1902 when it killed about 2000 people. It was then dormant until 1972 when it rumbled to life, not causing an eruption, but creating a new island of lava rock on the crater lake.

HUMAN HEALTH EFFECTS

Two types of effects on the health of human population by these volcanic eruptions could be observed.

One concerned the direct effects of the eruption, as seen in an association with respiratory problems and in the possible pollution of water supplies. The second one resulted indirectly from the eruption, when it caused the evacuation and resettlement of that part of the population living close to the volcano and thought to be in physical danger from the eruptions. An effect that could not easily be discussed is the effect on health services.

a. DIRECT EFFECTS

1. Potential pollution of water supplies[3]: a major reason to invite the epidemiological assessment team was concern by public health authorities in St. Vincent that water supplies were contamined by air borne ash from the eruption. Part of this concern was based on a paper describing the chemistry of the crater lake during the 1971-1972 eruption. Pending an assessment of the public health risk it was decided to halt water distribution temporarily.

In St. Vincent virtually all piped water supplies are from surface sources and purification consists of either sedimentation and chlorination or chlorination alone. An additional problem was the clogging of storage outlets by volcanic ash. This also necessitated shutting off piped water supplies following the eruption to allow the ash to sediment. There was therefore both a quantity and quality problem.

The quality problem was evaluated by sending water samples from various supplies to Panama, Barbados and Trinidad. The results are summarized in table one:

Table one: Results from chemical water analysis, St. Vincent Surface water supplies - April 1979.

Laboratory where tested	Ministry of Agriculture Barbados	University of West Indies (St.Augustine) Trinidad	Military Hospital Panama
Number of samples tested	4	1	9
Standards used	WHO International Standards for Drinking Water	WHO International Standards for drinking water	US Standards
Number of tests including testing for	14 Mercury, Copper, Lead Iron, Cadmiun,Manganese, Zinc, Nickel	8 Lead, Mercury	14 Phosphorus, Nitrate, Cadmium, Barium Lead,Silver, Arsenic, Copper, Iron
Results indicating contamination; against standard used	5/56	none	36/126
Results indicating contamination when set against WHO Standards	N/A	N/A	None
Possible problem areas	Lead concentration in 3 samples higher than Upper limit (0.4 mg/l against 0.1 mg/l) Cadmium concentration in 2 samples higher than Upper limit (0.06 and 0.03 mg/l against 0.01 mg/l)	none	Trace elements of Copper, Iron and presence of Phosphorus and calcium carbonate which are not allowed in US Standards.
Conclusion	Acceptable	Acceptable	Acceptable

Pending the analysis it was decided to release the water for public consumption warning however not to use it as potable water. Once the results were in these warnings were stopped. No ill effects from drinking water were reported or observed. It is known if the slightly higher levels of lead and cadmium reported by one lab were temporary. Since during the sanitary surveys of the various water supplies several problems were recognized in the protection from human contamination of these reservoirs, more attention was then given to adequate chlorination at all outlets.

The quantity problem mentioned above continued to play for the next week as water supplies had to be shut off for some time following every eruption.

2. Respiratory effects: nuisance from air borne ash were prominent after every eruption. They caused people to wear surgical or self-made masks to minimize the irritation of airways and mucous membranes, as documented in several popular magazines.[4,8]

More significantly an increase was noted in the number of children that had to be admitted with a diagnosis of asthmatic bronchitis to the pediatric ward of the only functioning hospital . This has been described in detail elsewhere.[6]

The increase was noticed when hospital admission surveillance was installed as part of an overall post-disaster epidemiological surveillance system[7]. The first element was that the number of admissions to the pediatric ward had almost doubled during the first week that followed the eruptions, as compared to the previous weeks but also to previous years' average. (Fig. one).

When analyzing the increase gastroenteritis was the principal reason for admission closely followed by asthmatic bronchitis and respiratory infections (Fig. two). For asthmatic bronchitis this was a highly unusual situation with fourteen admissions in one week as compared to three in the previous six weeks combined (Fig. three). Also when compared to two previous years at the same time period this was highly in excess of the expected. This pattern continued during the second week of the eruptions when asthmatic bronchitis accounted for seven admissions.

Following this week no more eruptions occurred and only 3 admissions for asthmatic bronchitis were noted for the two weeks between 26 April and 3 May 1979.

The age-distribution of the cases of A.B.* where this was known is shown in fig. four. It was not tried to acknowledge if these were exacerbations of known cases of A.B. or newly diagnosed cases.

A similar increase in admissions for A.B. was noted in the medical wards but at a much smaller scale.

On the third day of the eruptions a 21 year old man was admitted to the medical ward with signs of marked chest congestion and tachypnea. He had been in the evacuation zone during the volcanic explosions the previous day and developed cough and pleuritic pain on his return home.

A diagnosis was made of toxic pneumonitis without lower respiratory tract infection and he was treated accordingly.

3. Trauma associated with eruptions: no reports or observations were made on trauma due to the volcanic eruptions. Neither could deaths due to the eruptions be confirmed. In fact only 31 out of 234 visits to the casualty ward (= only available Emergency Care facility) on day 2, 3 and 4 were related to trauma. (No register was kept on day one). This could of course be due to the very rapid evacuation of the population out of the danger zone.

b. INDIRECT EFFECTS

1. Associated with the evacuation: at least one accident was reported to have occurred during the evacuation. Consequently the evacuation caused more trauma than the eruptions when a truck with evacuees drove down the road. Only 27 admissions were made to the surgical wards during the first five days. 14 of these were for traumatology occurred in accidents during the evacuation. 7 patients with fractures (4 of radius and ulna, 1 Humerus, 1 Base of skull, 1 Ribs) had to be hospitalized.

* A.B. = asthmatic bronchitis

2. Associated with resettlement: some 15000 people had to be resettled in temporary evacuation centres during six weeks. Some 3000 more resettled in private homes. Schools, churches and community centres were most often used as evacuation centres. In many instances they did not have the necessary sanitary facilities and a rapid public health assessment of these facilities had to reorient relief assistance quickly. Mass feeding was necessary and coincidentally caused two outbreaks of food-borne illness, resp. involving 100 and 50 evacuees. Both were thought to have occurred because of inadequate time-temperature control.

An epidemiological surveillance system was set up in these camps almost immediately and besides a minor outbreak of conjunctivitis no further outbreaks were detected.

c. Effects on health services: because of the emergency situation primary health care facilities were at first massively redirected to the evacuation centers and six health teams consisting of at least one physician and one nurse visited the evacuation centres on a rotating basis. When it was found health needs of this population were not significantly greater than in the surrounding population and also because of complaints about the privileged position of the evacuees the normal situation was more or less returned to. Some of the larger centres continued to receive special visits from these teams but for the majority of health problems the population was referred to the neighbourhood health centre.

The number of admissions to the hospital was higher than normal during the first week of the emergency (Fig. five) but this was never due to traumatological or infectious disease problems. 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. Because of the overburdening of the services mothers were discharged very rapidly after delivery.

Smaller increases were noted in the medical and pediatric ward, mainly because of the transfer from the other minor hospitals that were located in the evacuation area. The increase in cases of asthmatic bronchitis was already described. A small increase in admissions to the medical ward with a diagnosis of acute psychiatric disorder was also seen.

The number of surgical admissions was continuously very low. It decreased even later during the emergency when the number of electic surgeries was voluntarily limited. This was done to accommodate the continuing high number of obstetrical admissions.

DISCUSSION

The only specific effect we could ascribe to the volcanic eruptions was a relatively high number of hospitalized cases of asthmatic bronchitis, especially in small children. No data are available on cases in ambulatory care. In how far these cases were due to toxic-chemical or mechanical irritation by airborne ash particles, or related to psychological disturbances causing exacerbation of existing asthmatic bronchitis is left to speculation.

The possibility of water contamination by ash from volcanic eruption is forwarded. Of course this is only true where surface-water is the main supplier of potable water. Also in case of contamination long-term effects are what we should look for rather than acute toxicity.

All other effects are more related to the consequences of the volcanic eruption, namely the evacuation and subsequent movement. In many instances these problems can and will be greater than the immediate effects of the volcanic disaster. A question that has not been addressed here and perhaps should become a joint field for research by sociologists and epidemiologists, is the impact of such a disaster on human behaviour and consequently on mental health. Besides the unnatural living conditions in the evacuation centers, there is a continuous uncertainty among the evacuees, when and if they will be allowed to return home. Serious concern existed also in the evacuation centers and the surrounding population about the lack of useful work to do, the idleness. Health authorities were expecting STD problems and family planning services tried to expand their work into the centers. Rape was signalled from the centers as a problem.

Finally for all of us, i.e. the population in the south and the relief workers one question kept popping up: what if the volcano keeps on erupting and takes down the island with it? Can 110.000 people be evacuated rapidly if necessary from one of these islands? This is a key question for secondary prevention.

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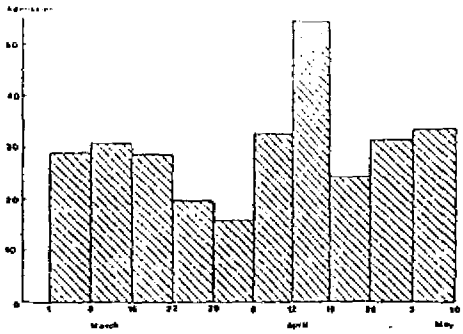

Fig. 1. Admissions to the paediatric ward, Kingstown General Hospital, St. Vincent, by week of admission, March - May 1979. Source: Ward Admission Books.

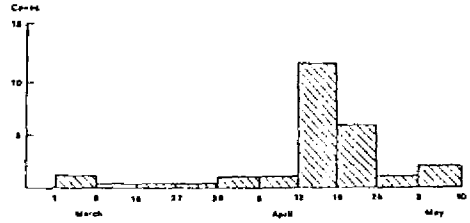

Fig. 3. Asthmatic bronchitis as the cause for admission to the paediatric ward, Kingstown General Hospital, St. Vincent, March - May 1979, by week. Source: Ward Admission Books.

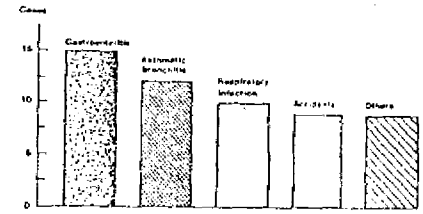

Fig. 2. Admission diagnosis for admissions to The paediatric ward, Kingstown General Hospital, St. Vincent, during the week of 13 - 19th April 1979. Source. Ward Admission Books.

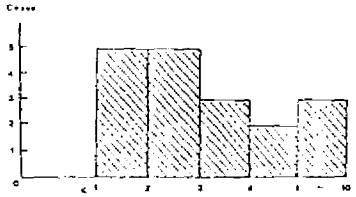

Fig. 4. Age distribution of cases of asthmatic bronchitis admitted to the paediatric ward, Kingstown General Hospital, St. Vincent, during the two weeks of the 13 - 26th April 1979. Source: Ward Admission Books.

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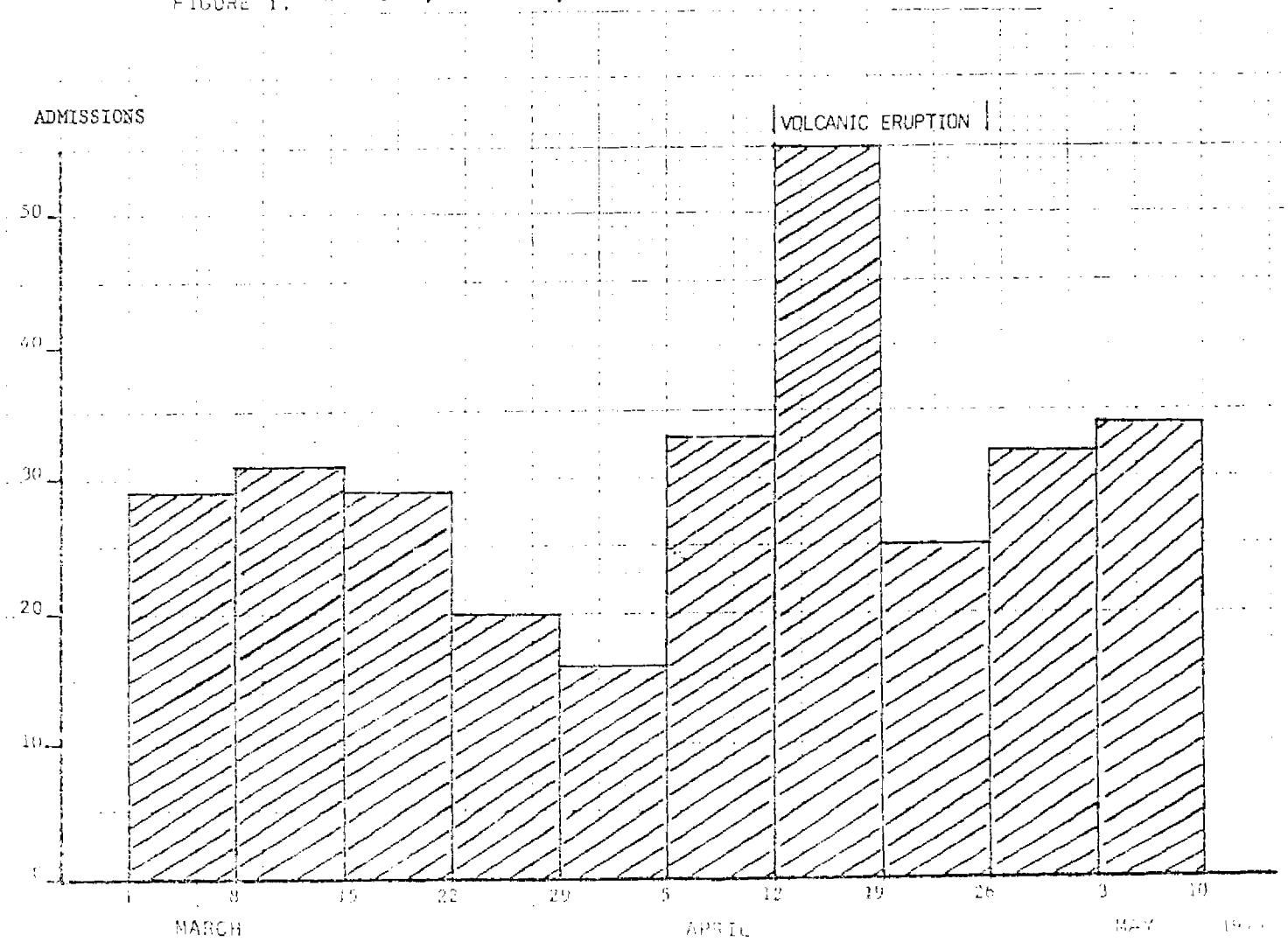

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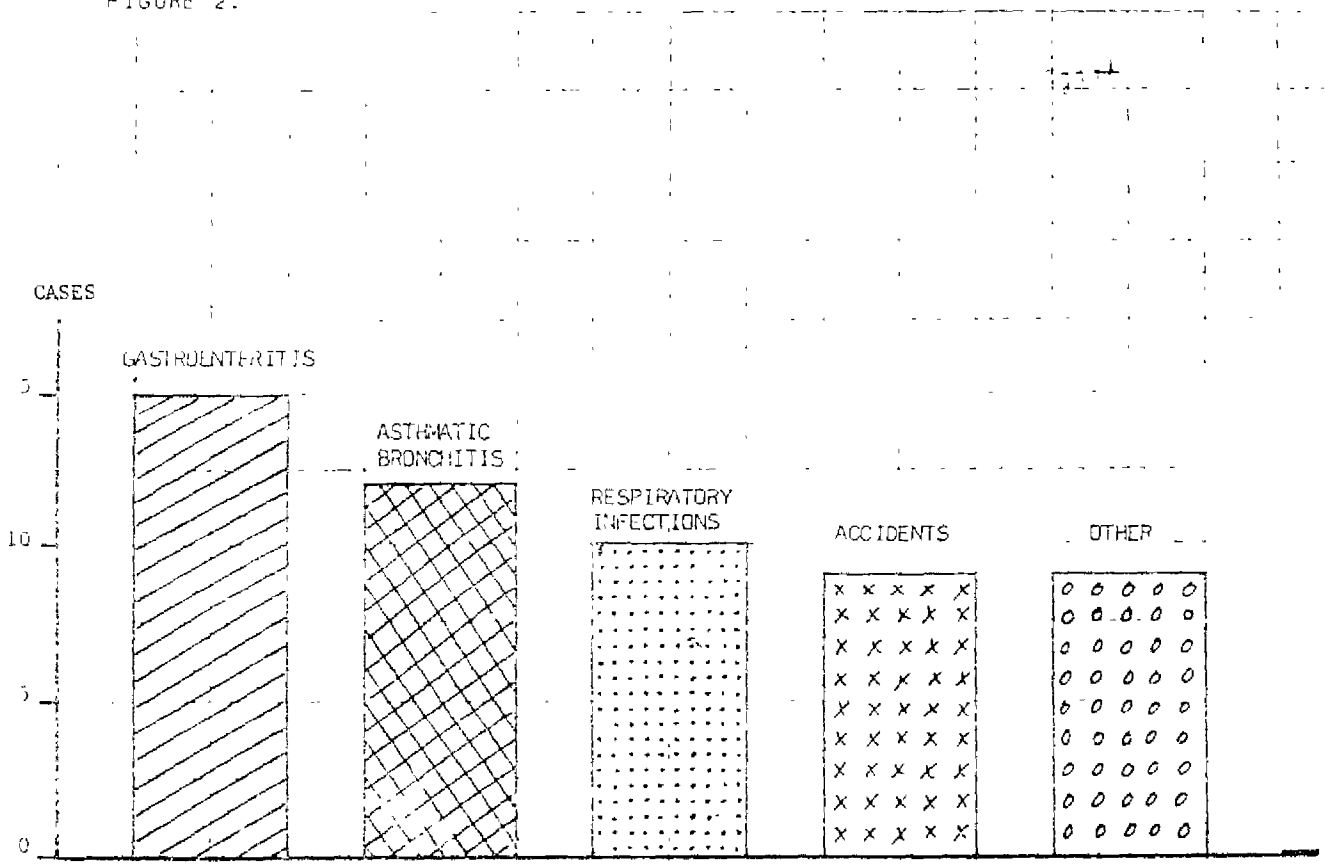

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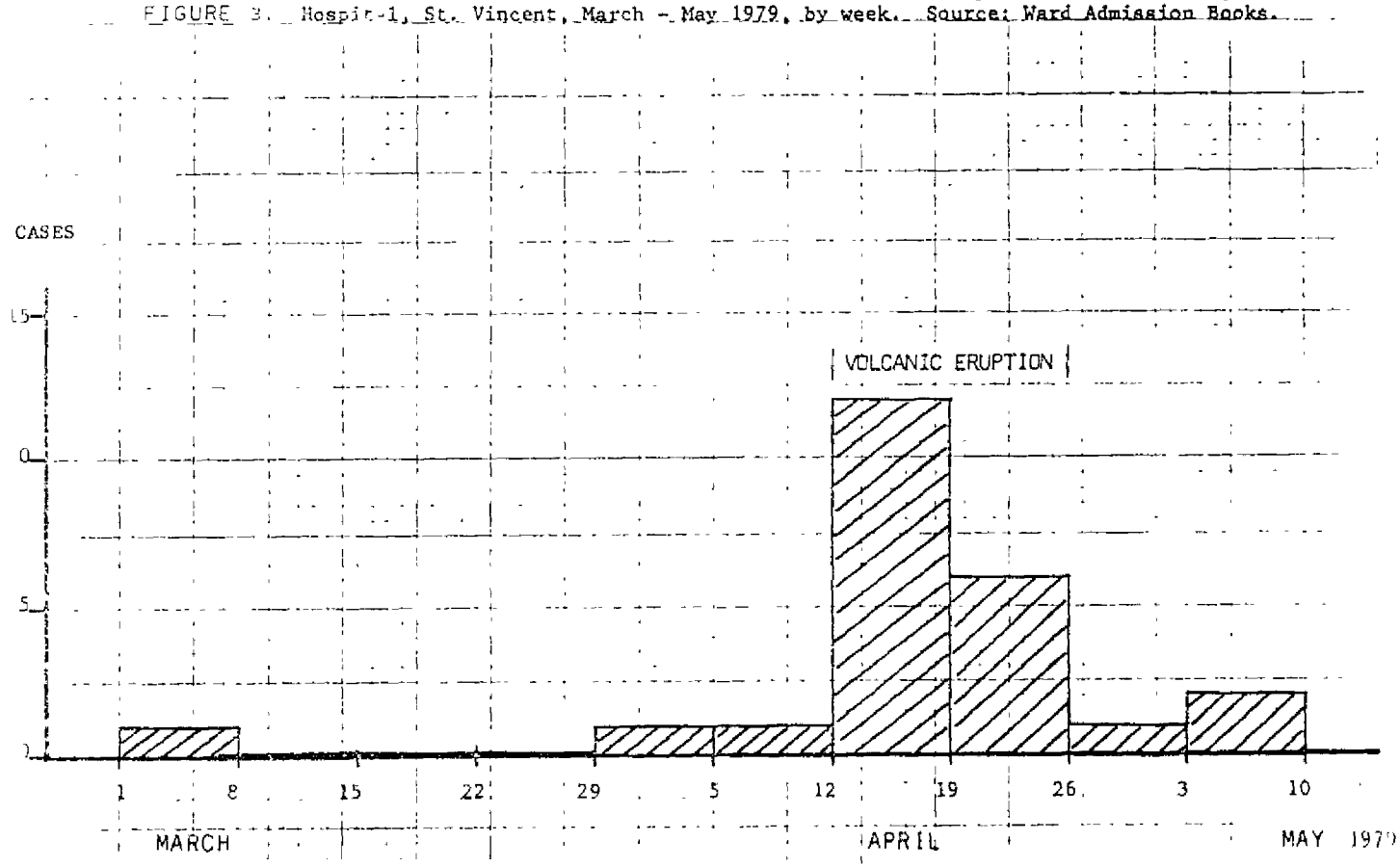

FIGURE 4. [illegible] during the two weeks of the 13-26th April 1979.
Source: Ward Admission Books.

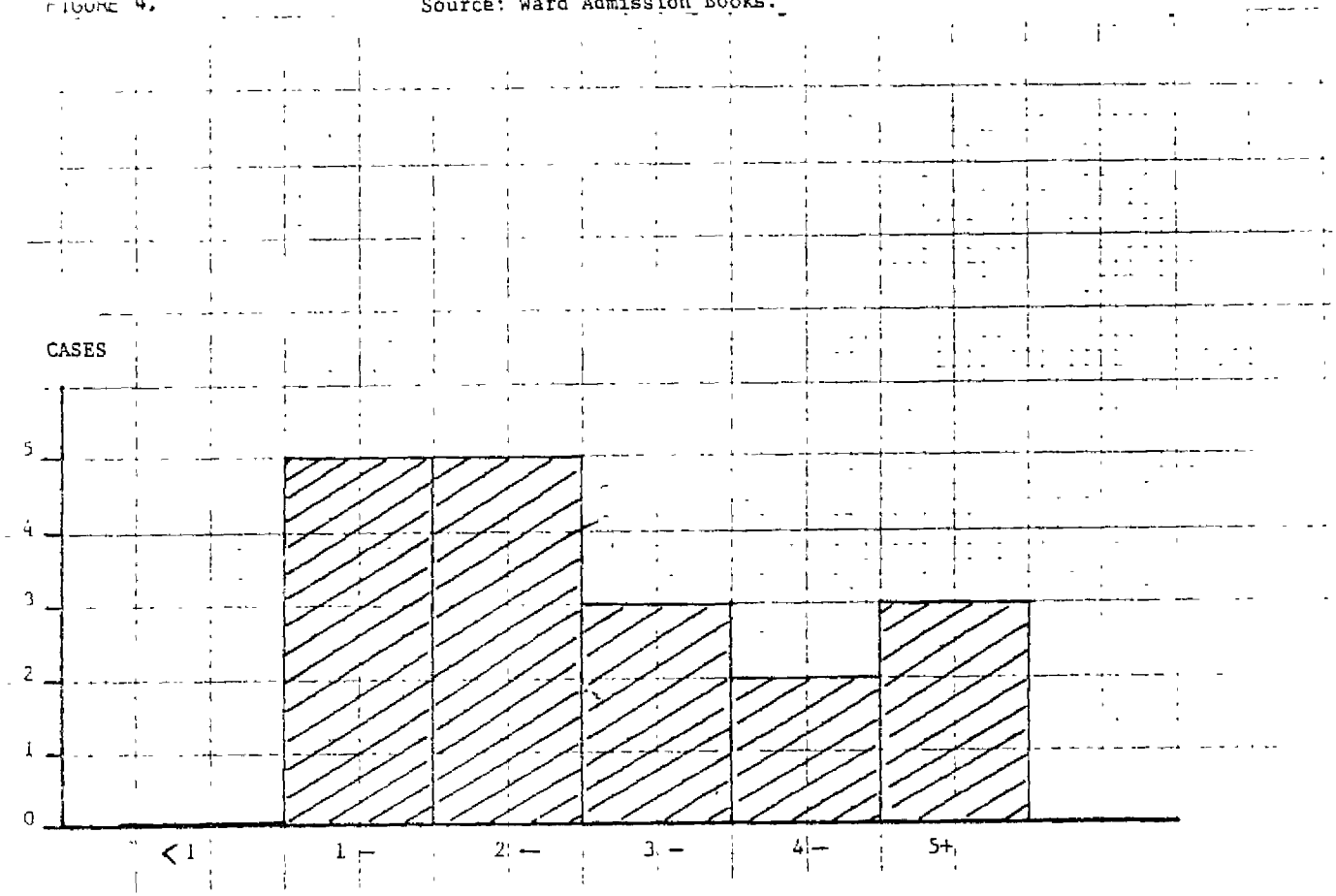

Fig: Five

NUMBER OF ADMISSIONS PER WEEK

ST. VINCENT, KINGSTON HOSPITAL, 13/4 - 31/5/ 1979

ALL ADMISSIONS TO THE HOSPITAL