

## A WATER-BORNE HEPATITIS A OUTBREAK IN RIO DE JANEIRO

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*An excess of hepatitis cases, in the research center of Petrobrás located in the Fundão Island, within the city of Rio de Janeiro, was notified during the second half of March 1980. In recent years this center has had an average of four cases per year, but between March 5th and April 25th, sixteen cases were reported. The cause and possible source of infection were investigated.*

*A serologic diagnosis of hepatitis A was made by showing IgM serum antibodies against this virus in patients. No subclinical cases among a group of 60 healthy employees could be identified. A questionnaire was circulated to investigate a possible common source of infection. Evaluation of the water supply system indicated that it had recently been contaminated. Information obtained from other medical services in the island failed to reveal that the episode was part of a larger outbreak.*

Viral hepatitis has long been recognized as a clinical syndrome but only in the 1940's did it become clear that at least two types of hepatitis existed. At that time, no diagnostic procedures were available and the disease was diagnosed on clinical and epidemiological grounds. In the early 1960's with the discovery of the first hepatitis B marker (Australia antigen) a probable differential diagnosis between this and other types of hepatitis could be made. In the early 1970's viral particles were visualized by electron microscopy in faeces from patients with hepatitis A (Feinstone, Kapikian & Purcell, 1973). This finding made possible the preparation of antigen necessary for serological techniques, such as immunoelectron microscopy, radioimmunoassay and enzyme linked immunosorbent assay to establish a specific diagnosis.

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Hepatitis A is a world-wide disease but its true incidence is not yet well established. No official data is available in Brazil but from a few studies done in our laboratory, the disease seems to be endemic in Rio de Janeiro (Morgado, 1980). At present many centers in different countries are doing serological investigations to get a better idea about the pattern of infection in order to analyse factors involved in the transmission of this disease (Dienstag et al, 1978; Frosner et al, 1979; Szmuness et al, 1976).

In the present study we relate the clinical aspects of hepatitis A during an outbreak. Efforts were made to identify subclinical cases and special attention was given to the mode of transmission.

#### LOCATION AND DESCRIPTION OF THE POPULATION INVOLVED

The research centre of Petrobrás (the Brazilian oil company) is located in the Fundão Island within the city limits of Rio de Janeiro, and consists of a complex of buildings of high architectural standards, and about 7 years old. It is largely self sufficient containing research areas, office spaces, medical services, restaurant, bank, etc.

The company employs 1183 people with a high percentage of highly skilled workers, with a good standard of living. The average age is about 30 years old and the ratio male to female is approximately 3:1. The majority of the employees live in the city or suburbs of Rio de Janeiro and commute to work.

Not included in the group mentioned above are the 223 workers employed by other companies which subcontract services such as cleaning, catering and gardening. On March 1<sup>st</sup> a new catering service with 43 employees was given the contract to provide meals at the restaurant.

The plant is connected to both water supply and sewage system of the State Company for Water and Sewage (CEDAE). The water entering the plant is deposited in four underground reservoirs and later pumped to an elevated reservoir from where it is distributed throughout the plant.

#### MATERIAL AND METHODS

Blood samples were collected from 14 patients during the acute phase of the disease and tested for the presence of hepatitis B surface antigen (HBsAg), antibodies against hepatitis B surface antigen (anti-HBs) and antibodies against hepatitis A virus (anti-HAV). For anti-HAV, tests were performed to study both IgG and IgM class antibodies. Information was also collected on their age, sex, address, occupation, place of work within the complex and other data such as dates when absent from work, recent travels, clinical data and attendance at hospitals.

In a search of possible subclinical cases, sera were collected from 60 subjects of which 21 were not present during the month of February when the infection presumably occurred. They were also tested for HBsAg, anti-HBs, anti-HAV and IgM class antibodies.

The presence of HBsAg and anti-HBs was tested by reverse-passive-hemagglutination test (RPHA), and the passive-hemagglutination test (PHA), respectively. The reagents used were obtained from the Hepatitis B diagnostic unit (Bio-Manguinhos/FIOCRUZ) and the tests were performed as described by Kimura et al (1978). For the RPHA, sheep erythrocytes were sensitized with glutaraldehyde and tagged with anti-HBs gamma globulin. The PHA also used sheep cells but were tagged with glutaraldehyde and sensitized with purified HBs antigen. The anti-HAV antibodies were tested according to Purcell et al (1976) by solid phase competitive binding radio-immuno assay (Abbott, USA). This

qualitative test considers a serum sample reactive for anti-HAV when scintillation count rates in less than the cutoff value (cutoff=one half of the combined negative control mean and the positive control mean). The IgM class antibodies were detected after treating the sera with Staphylococcus protein A according to the WHO procedures (Almeida et al, 1979).

The water supply system was analyzed by the State Foundation for the Environment (FEEMA) and later by the Sanitary Engineering Department of the Oswaldo Cruz Foundation. Where the investigation was done according to methods developed within this Department, whereby the physical and chemical composition of the water entering the system (CEDAE water, point of collection number 1 in Table II) is compared to the data obtained from the different localities within the plant. Twenty water points were analyzed for residual chlorine, Nessler assay and colimetric assay. Ten of the 20 samples were analyzed for both physical and chemical composition of the water. The laboratory methods employed were done in accordance to the "Standard Methods for examination of Water and Sewage" as described by the American Water Works Association.

## RESULTS

### DESCRIPTIVE EPIDEMIOLOGY

Telephone interviews with the medical service and the Department of Infectious Diseases of the University also located in the island and information obtained from the Public Health authorities confirmed that there was no increased incidence of hepatitis at that time in Rio de Janeiro. During 1979, four cases were reported among the university personnel while in the first semester of 1980 only one case was notified at the medical center.

Fig. 1 presents the number of cases per day during the outbreak. Fourteen cases occurred between March 5th and March 14th, with the highest incidence on March 11th and 12th when three cases occurred per day. A month later two other cases were reported commencing with jaundice on April 11th and 26th. Unfortunately no blood samples were obtained from the last two cases. In the first week of May a child of one of the clinical cases had an episode of jaundice and a disease compatible with a diagnostic of hepatitis.

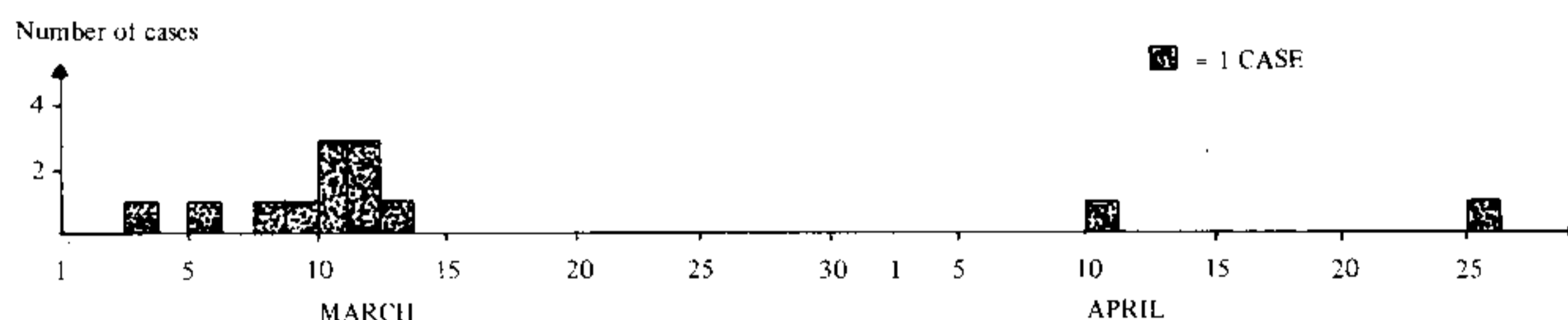


Fig. 1 – Number of hepatitis cases per day during the outbreak – Rio de Janeiro, 1980.

The majority of the patients were in their 20's, the average age being 26.3 years old. The ratio woman/man was 1/15. Except for an administrative aid all had higher education and all lived in different areas of the city. There had been no recent outings or parties at which all the patients were present.

The cases were spread throughout the plant except for some clustering at the central building. They all ate their lunch almost exclusively at the firm's restaurant consisting of a choice of two courses and an assortment of salads and desserts. Drinks served were milk, soft drinks and or mineral water and the frequency of consumption for each one was 50%, 81%, 50%, respectively.

Information about attendance to work showed that between March 4th and March 11th the first 14 cases were all present. The two cases that occurred in April were absent during this period, one being on holidays and the other only being admitted on March 13th.

### CLINICAL ASPECTS

The clinical picture presented by the patients showed that the prodromal stage of the disease is an average of 8.4 days (1-12 days). All patients had fever averaging 38.4°C (37°C – 39.5°C). The vast majority complained of nausea, anorexia and vomiting, while one third had diarrhoea. Three cases were hospitalized as a precaution but none presented complications.

### SEROLOGY

All fourteen patients in the primary outbreak had IgM class antibody against HAV and none were positive for either HBsAg or anti-HBs. Blood samples were collected on the average of 15.6 days after the first sign of jaundice, and all of them already contained IgM class antibodies against HAV, while none had IgG antibodies. After 2 1/2 months sera collected from 8 patients presented only IgG antibodies to HAV.

The sixty serum samples of apparently healthy workers were also tested for the presence of anti-HAV, anti-HBs and HBsAg. Thirty-nine were present during February, while 21 were on vacation or on maternity leave. None had HBsAg, while three (5%) were positive for anti-HBs indicating a past infection with Hepatitis B. Forty-six had anti-HAV antibodies indicating that 77% of this population had had a past infection. Determinations of IgM class antibodies were all negative excluding the possibility of subclinical infection in this group, during this outbreak.

As shown in Table I, there was a significantly different incidence in the results for anti-HAV when comparing healthy employees with different levels of education. Employees with university education were 65% positive for anti-HAV while employees with only secondary school degree were 89% positive. ( $P > 0.05$ ).

TABLE I

Number and percentage of anti-HAV (+) subjects according to professional levels

<i>Level of education</i>	<i>n<sup>o</sup> of subjects</i>	<i>anti-HAV (+)</i>
University	32	21 (65%)
Secondary	27	24 (89%)
Total	59	45

### WATER ANALYSES

After the preliminary study by the FEEMA which showed a contamination in the four subterranean water reservoirs on March 14th and 21st with total and faecal coli-

forms, the Department of Sanitary Engineering of this institute carried out a more detailed study of the water supply.

The results of the water's physical and chemical analyses (Table II), obtained from 10 points located throughout the plant, showed that the water entering the system was of potable quality but had a low PH and a low residual chlorine content, and that the water at the different locations came from the same source (CEDAE water).

TABLE II

Physical-chemical analysis of water obtained (Rio de Janeiro, 07/04/80)

Item	Unit	Points collection									
		1	2	3	4	5	6	7	8	12	15
Colour	Hazen	0,0	2,0	0,0	0,0	0,0	2,0	0,0	0,0	2,0	0,0
Turbidity	Jackson	8,5	6,8	5,0	5,0	8,5	8,5	6,7	6,5	6,5	5,0
pH	0 - 14	6,6	6,7	6,6	6,7	7,0	6,9	6,7	6,7	6,8	7,0
Alkalinity (OH <sup>-</sup> )	mg/l	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Alkalinity (CO <sub>3</sub> <sup>=</sup> )	mg/l	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Alkalinity (HCO <sub>3</sub> <sup>-</sup> )	mg/l	14,0	12,0	12,0	12,0	12,0	14,0	10,0	12,0	12,0	12,0
Total hardness	mg/l CaCO <sub>3</sub>	15,0	18,0	15,0	14,0	15,0	16,0	15,0	14,0	14,0	15,0
Calcium hardness	mg/l CaCO <sub>3</sub>	10,0	12,0	10,0	0,0	10,0	11,0	10,0	10,0	10,0	10,0
Magnesium hardness	mg/l CaCO <sub>3</sub>	5,0	6,0	5,0	5,0	5,0	5,0	5,0	4,0	4,0	5,0
Calcium	mg/l Ca	4,08	4,80	4,08	3,60	4,08	4,40	4,08	4,08	4,08	4,08
Chlorides	mg/l	9,0	33,0	9,0	8,0	9,0	9,0	9,0	9,0	9,0	9,0
Total iron	mg/l	0,8	0,3	0,8	0,7	0,7	0,7	0,8	0,9	1,2	1,2
Nitrates (N)	mg/l	0,1	0,1	0,09	0,09	0,09	0,07	0,07	0,06	0,09	0,1
Nitrates (NO <sub>3</sub> )		0,44	0,44	0,40	0,40	0,40	0,31	0,31	0,26	0,40	0,44

Resultado em 11/04/80

The Nessler assays were negative excluding the possibility of a recent massive contamination. The colimetric studies (Table III) showed positive results at the 3rd subterranean reservoir for both total coliforms and fecal coliforms, while water from the kitchen filter which was used to make the refreshments, and a water faucet in the maintenance area were positive for total coliforms but negative for fecal coliforms.

Inspection of the reservoir showed no ruptures; yet extra precautions were taken to protect the reservoirs and colimetric studies were later performed at the company at regular intervals and were consistently negative.

Information obtained at the company showed that on February 1st the plant was without water.

## DISCUSSION

Hepatitis A is probably an endemic disease in Brazil. No accurate data exists but a serological study among volunteer blood donors, in the city of Rio de Janeiro, showed that 98% were positive for anti-HAV indicating a past infection (Lopes, 1979). In a study

TABLE III

Residual chlorine and the total and faecal coliform determination

Samples	14/03/80 (FEEMA)			21/03/70 (FEEMA)			07/04/70 (FIOCRUZ)		
	A	B	C	A	B	C	A	B	C
1 – CEDAE Water							0,1	0,0	0,0
2 – Lake (fire reservoir)							0,0	<u>4,5</u>	<u>2,0</u>
3 – Reservoir 1	0,6	0	0				0,0	0,0	0,0
4 – Reservoir 2	0,3	<u>8</u>	0	0,1	2	0	0,0	0,0	0,0
5 – Reservoir 3	0,5	<u>790</u>	<u>170</u>	0,0	<u>13</u>	0	0,0	<u>46,5</u>	1,8
6 – Reservoir 4	0,6	<u>230</u>	<u>33</u>	0,0	<u>2400</u>	<u>79</u>	0,0	0,0	0,0
7 – Elevated reservoir							0,1	0,0	0,0
8 – Kitchen faucet							0,05	0,0	0,0
9 – “ filter							0,0	17,0	0,0
10 – Water faucet							0,0	0,0	0,0
11 – “ “							0,05	0,0	0,0
12 – “ “							0,05	<u>2,0</u>	0,0
13 – “ “							0,05	0,0	0,0
14 – Water fountain							0,0	0,0	0,0
15 – “ “							0,0	0,0	0,0
16 – “ “							0,0	0,0	0,0
17 – “ faucet							0,0	0,0	0,0
18 – “ fountain							0,0	0,0	0,0
19 – “ faucet							0,05	0,0	0,0
20 – “ “							0,05	0,0	0,0

A – Residual chlorine (ng/l)

B – Total coliform por 100 ml

C – Faecal coliform por 100 ml

by Nath et al (1979) 7,342 blood sera, obtained from 13 Latin American countries also showed very high incidences for anti-HAV. All countries had percentages higher than 94 percent except for Puerto Rico, Surinam and Barbados which were 84,81 and 69 percent positive, respectively. These incidences are much higher than those observed in New York (Szmunn et al, 1976) where 45% of the general population was anti-HAV positive. Also data from European countries (Frosner et al, 1979) showed that Scandinavian countries had a low incidence of 10–20%, while countries in southern Europe, such as France and Greece, had 75 and 82 per cent respectively. In the serological studies reviewed by Dienstag et al (1978) it was shown that Israel and Yugoslavia had the highest incidence rates being 94 and 97 per cent, respectively.

In this study we found that only 77% of the population had evidence of past infection and probably reflects the high socio-economic standards of this group. In New York city, Chinese-Americans and poor blacks had much higher antibody prevalences

against HAV than middle class volunteer blood donors. Also years of completed education was shown to be a sensitive method to evaluate socio-economic level in that study. Dividing the 60 sera of healthy workers into levels of education a significant difference was encountered. Sixty-five per cent of the university graduates had anti-HAV compared to eighty-nine per cent of the employees with only secondary level education.

During this outbreak 16 cases of hepatitis A were observed. The first cases occurred in a unimodal curve, and had its peak on March 11th and 12th. This curve is characteristic of a common source outbreak. Accepting that incubation period for hepatitis A is 30–35 days we may assume that the infection must have taken place sometime in the first half of February. Data obtained from the patients showed that they were all present during the period of 29 to 36 days before infection.

IgM class antibodies were determined in the 45 anti-HAV positive employees. None were positive in this group, indicating the absence of subclinical infection. This fact is not surprising because it seems that the large majority of adults have symptomatic disease, while the inverse is found in young children. A recent study in Arizona among day care center infants showed that asymptomatic infection was predominant in children one and two years old and accounted for 84 per cent of this age group. In contrast it only represented 50 per cent in the three and four years old and 20 per cent in children aged five years and older (Hadler et al, 1980). In a day care center in Rio de Janeiro with an average age of 1.5 years, 4 children were sick out of a population of 46 children, while 67% had asymptomatic infection as indicated by a study of IgM class antibodies (Morgado, 1980).

No important reservoir for hepatitis A is known at the present time and the virus probably maintains itself by human transmission via the fecal-oral route. This occurs either by direct person-to-person or by indirect transmission.

The person-to-person transmission is usually encountered in areas where people are confined in small areas and or maintains poor hygiene as it is frequently encountered in the lower socio-economic groups. This mode of transmission was not involved in this epidemic because many patients had no contact with each other and maintained a high standard of living. It is possible that the child, whose father was sick in March and had an episode of jaundice in May was infected by direct contact.

The possibility of a food-borne contamination in an institution that serves food is always present, but the large assortment of food offered at this company and the incapacity to remember what was eaten at the time of infection, made it impossible to study this possibility accurately. Foodborne infection is caused usually by the manipulation of food by an infected person after cooking or by raw food (Levy et al, 1975; WHO, 1977).

Water-borne transmission has long been recognized as an important mechanism of spread of HAV. Mosely (1959) reported 33 epidemics mostly involving summer camps. The largest epidemic to date was in New Delhi in 1955 when 29300 people were infected by massive sewage contamination of the city's water system (Viswanathan, 1957).

In our outbreak there are indirect indication that the failure of the water supply on February 1st contaminated the subterranean reservoirs. On March 14th all four reservoirs were contaminated including two that also contained fecal coliforms. Three reservoirs were retested on March 21st all still contained total coliforms and one had fecal coliform. Tests done on April 7th still showed contamination in one reservoir but failed to reveal fecal coliforms. Of significance is the persistence of positive results although they tended to decline. This suggests that a large contamination took place and the contamination declined by the successive intake of clean water.

Another possible cause for this contamination is an interconnection between the drinking water and the fire extinguishing water system, but no data was obtained to prove this possibility. The emergency fire system receives its water from the elevated water reservoir, the lower one-third of this reservoir being only available for the extinguishing system. During a fire, extra water is made available by pumping water to the elevated reservoir from an artificial lake. An interconnection occurs during a fire episode and is considered possible during the weekly testing of the pumps. These pumps have very high manometric pressures and can pump water against the water pressure obtained from the elevated reservoir. In case of poor valve maintenance and/or operation, the lake water could enter directly into the elevated reservoir causing a contamination of the drinking water.

The contaminated filter in the kitchen, which supplied water for the refreshments is significant and can probably be attributed to poor cleaning procedures. The small contamination in the faucet in the maintenance area could be attributed to the fact that no flames are allowed in that area.

## RESUMO

Durante a 2ª quinzena de março de 1980, foi notificada a ocorrência de casos de hepatite, no Centro de Pesquisa da Petrobrás localizado na Ilha do Fundão, na cidade do Rio de Janeiro.

Nos últimos anos, este Centro apresentou uma média de ocorrência de quatro casos de hepatite por ano, mas no período de 5 de março a 25 de abril foram observados 16 casos. A causa e a possível fonte desta infecção foram investigadas.

O diagnóstico sorológico para Hepatite A, dos pacientes, foi feito pela determinação de anticorpos IgM específicos para este vírus. Não foi identificado nenhum caso subclínico entre um grupo de 60 empregados saudáveis.

Uma possível fonte de infecção comum foi investigada por meio de um questionário. As análises feitas no sistema de água indicaram uma contaminação recente. As informações obtidas de outros serviços médicos da mesma localidade não mostraram nenhuma ocorrência que sugerisse um surto.

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