

Hospital *Salmonella Johannesburg* infection and its possible role in the community spread of the infection in Hong Kong

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SUMMARY

Salmonella johannesburg (1, 40: b: e, n, x), a previously rare salmonella serotype, has established itself rapidly as an important and highly prevalent cause of gastroenteritis among children. The clinical features of the infection are usually mild but chronic. It has been suggested that *S. johannesburg* was introduced into Hong Kong through imported foods but no common vehicle could be traced as the source of infection. A thorough investigation of one paediatric ward in a general hospital revealed that non-infected patients admitted to the ward usually acquired *S. johannesburg* infection within 3–7 days, with or without symptoms. Thus hospital cross-infection could be a significant factor in contributing to its rapid spread in the community. Furthermore, the rapidity with which *S. johannesburg* spread was facilitated by (a) its tendency to produce a chronic infection, (b) its multiple resistance to antibiotics, and (c) the higher infectivity of *S. johannesburg* over other salmonellas endemic in this locality. These factors combined with the overcrowded conditions in many of the hospitals in Hong Kong facilitated the occurrence of hospital infection, which in its turn contributed to the spread of the infection in the local community.

INTRODUCTION

Salmonella johannesburg (1, 40: b: e, n, x), an uncommon salmonella serotype for the most part of the world, has risen rapidly in recent years from none before 1971 to become the most prevalent salmonella serotype in Hong Kong. It was first detected in late 1971 with 4 isolations. Thereafter the number of isolations increased rapidly to 783, 1433 and 1411 in 1972, 1973 and 1974 respectively (Fig. 1). By contrast, during the same period the number of isolations of other gastroenteric salmonellas remained about the same. *S. johannesburg* infection was chiefly found in children, rarely in adults, and was widely scattered throughout Hong Kong. Although it has been suspected that a common vehicle could be responsible for the outbreak, routine examination by the local public health authorities of foods and animal feeds, including the imported ones, failed to detect this salmonella from any of them. A preliminary survey showed that the epidemiological,

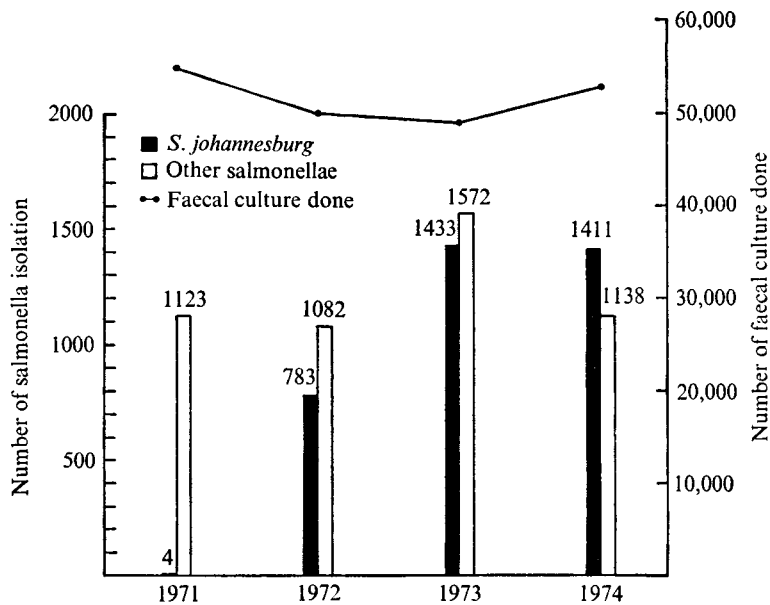


Fig. 1. Isolations of *S. johannesburg* and other salmonellas from human faeces in Hong Kong, 1971-4. Repeated isolations from the same patient are disregarded (Data from the Institute of Pathology, Hong Kong Government.)

clinical and bacteriological characteristics of infection with this salmonella appeared to differ appreciably from those of other salmonella infections. An investigation was therefore begun in August 1974 by a systematic study of cases admitted to a paediatric ward in a general hospital. The results of this investigation are reported in this paper in the hope that these might be of some reference value for places where *S. johannesburg* infection is as yet not a problem.

THE PAEDIATRIC WARD AND METHODS OF INVESTIGATION

The paediatric ward

The ward investigated was one of the two paediatric wards in a general hospital. In each ward there are 42 beds with a side ward for infective cases. Extra camp beds and cribs are, however, often added as overcrowding is a chronic problem in most hospitals in Hong Kong. The turnover of patients was rapid, with an average length of stay in the ward of about 4-5 days. Normally cases of diarrhoea were admitted to the side ward for isolation but when the number exceeded six an unsatisfactory situation arose in which diarrhoeic patients had to be admitted into the general ward. Partition screens separated them from non-diarrhoeic patients, who shared, however, the same ward facilities and were attended by the same nursing staff.

Methods of investigation

The investigation started on 1 August 1974. Rectal swabs or stool specimens were collected from each child on admission for culture for salmonellas. The first stool specimens were collected on admission and the second or third specimens 1 or 2 days later (referred to as 'primary isolations'). Subsequent specimens were obtained twice a week thereafter until discharge (referred to as 'subsequent isolations'). Only those patients who stayed in the ward longer than 1 week and whose stool specimens were systematically collected as described were included in the data for analysis. Patients with positive salmonella cultures on primary isolations were arbitrarily regarded as infected before admission, while those with positive salmonella cultures only on subsequent isolations were regarded as infected in the ward.

Stool specimens were also collected from the medical and nursing staff of the ward and various objects in the ward were sampled by swabbing with cotton-tipped swabs (referred to as 'environmental swabs'). These objects included baby cribs, infant incubators, trays, trolleys, tables, chairs, sinks, disposable bins, baby weight balances, hand towels, bed linen, doctor's white gowns, history record boards and hands of the hospital staff. All the stool specimens and environmental swabs were cultured for salmonellas by a selective migration procedure described by Chau & Huang (1976) except that these swabs were inoculated in Gram negative broth and incubated at 37° C for 6-8 h before being transferred to the semi-solid enrichment-indicator medium tube.

RESULTS

Epidemiological findings

From 1 August to 30 September, 115 newly admitted patients were studied. *S. johannesburg* was recovered on primary isolations from 24 (20.9%). In 15 of these infected children the admission diagnosis was given as 'diarrhoea' or 'gastro-enteritis'. All except two were under 6 months of age. Two babies with positive primary cultures, one aged 2 days and the other aged 4 days, were born in and transferred from, the maternity ward of the same hospital so that they were apparently infected in the same hospital but not in the paediatric ward. Two other infected babies were transferred from two other hospitals where *S. johannesburg* infection was also prevalent. The remaining 20 children were apparently infected in their own homes. Of the total 24 infected children, 22 were fed on milk powders of 9 different brands, and 2 on sweetened condensed milk of 2 different brands. Thus, no common baby food could be traced as the source of infection.

S. johannesburg was subsequently isolated from 22 of the remaining 91 initially non-infected children, giving a cross-infection rate of 24.2%. All of them were under 6 months of age. Twelve of these infected cases developed diarrhoea during their stay in the ward. Successive cultural examination of the stool specimens of these positive cases showed that *S. johannesburg* could be regularly detected once the first positive stool cultures were obtained. It may therefore be assumed that

Table 1. *Salmonella* isolations from environmental swabs taken in a paediatric ward

Date of collection of specimens	No. of swabs taken	No. of salmonella isolations	Objects from which <i>Salmonella</i> was isolated
30 Sept. 1974	182	<i>S. johannesburg</i> (15) <i>S. anatum</i> (1)	Infant incubators, bedside cupboards, bed linen and spreads, doctor's white gown, nurse's hand, baby weight-balance, washing basin, tray, rack, baby's body surface
2 Oct. 1974	198	<i>S. johannesburg</i> (5) <i>S. anatum</i> (12)	Baby crib's railings, infant incubators, bedside cupboards, bed linen and spreads, doctor's white gowns, floor, chairs for children, history record boards, baby's body surface
10 Oct. 1974	185	<i>S. johannesburg</i> (2) <i>S. derby</i> (1) <i>S. newport</i> (1)	Bedside cupboards, baby weight balance, office desk.

the 22 cases with two or three negative stool cultures on admission but with positive stool cultures on subsequent isolations were infected in the ward. Over the same period there were primary isolations of *S. anatum* from 3 patients, *S. derby* from 1 and *S. newport* from 2. None of these salmonellas were subsequently isolated from other patients.

Of 182 swabs from various objects in the ward examined on 30 September 15 yielded *S. johannesburg*, including one from a nurse's hand. *S. anatum* was isolated from one of these swabs. On 2 October another batch of 198 environmental swabs was examined: *S. johannesburg* was isolated from 5 and *S. anatum* from 12 swabs (Table 1). It was thus evident that the ward was widely contaminated with these salmonellas. On the other hand, of the 30 staff examined, only 2 proved to be symptomless faecal salmonella carriers: 1 of *S. anatum* and the other of *S. derby*. None carried *S. johannesburg*. Cross-infection by *S. johannesburg* was therefore most probably through contaminated fomites or hands of the hospital staff since sick babies under 6 months of age were not in direct contact.

The ward was then closed, cleansed and fumigated on 7 October, the patients were either discharged or transferred to other wards. After the ward was re-opened, vigorous measures were taken to prevent the spread of salmonellosis, including washing the hands before and after attending every sick baby. Examination of environmental swabs taken on the day after fumigation yielded no salmonellas, but that of 185 environmental swabs taken 2 days after re-admission of the transferred patients to the ward yielded two isolations of *S. johannesburg*, one of *S. derby* and one of *S. newport*. After introducing stricter measures to prevent further spread, examination of 108 environmental swabs on 22 October did not detect any salmonellas. Cross-infection of salmonellosis in the ward came gradually under control, the number of cases infected with *S. johannesburg* in the ward being two in November and none in December.

Clinical findings

Of the total 46 cases infected with *S. johannesburg*, 19 had no symptoms referable to the infection while 27 had diarrhoea. On the whole this was mild, with loose stools only, but in some cases, often the newborn babies, there were mucus and blood in the stools. Fever and vomiting developed in six of the diarrhoeic cases, but this was also mild. Blood culture was done for 11 of the infected children all with negative results. Only in one infected baby, aged 4 days, was there indication of septicaemia, although this blood culture was also negative. A remarkable feature of *S. johannesburg* infection was its chronicity. Of the 15 diarrhoeic cases infected outside hospital, four had already had chronic or recurrent diarrhoea for 2 weeks to 2 months before admission. Although most of the salmonella-infected babies were discharged after the acute symptoms had subsided or the general condition had improved, usually without follow up, there were five patients who stayed in the ward for various reasons and were observed to excrete *S. johannesburg* persistently for 1–4 months. Not included in this study, one infected baby who had to be confined to hospital because he could not be returned to his orphanage while infected was found to excrete *S. johannesburg* for 11 months (personal communication with Dr A. C. H. Chan of the Infectious Disease Unit, Princess Margaret Hospital, Hong Kong Government). The chronicity of the carrier state with or without diarrhoea was apparently a salient feature of *S. johannesburg* infection.

Antibiotic resistance

Many of the isolated *S. johannesburg* strains were found to be resistant to ampicillin, kanamycin and chloramphenicol but sensitive to gentamicin and co-trimoxazole by routine disk antibiotic sensitivity test. In a more detailed study, 24 strains of *S. johannesburg*, 20 isolated from patients and 4 from the ward environment, were all found to be resistant by the disk sensitivity test method to ampicillin (25 µg), streptomycin (25 µg), tetracycline (25 µg), kanamycin (30 µg), carbenicillin (100 µg) and minocycline (30 µg). In addition, 19 were resistant to chloramphenicol (25 µg) and 11 to cephaloridine (25 µg). All were sensitive to gentamicin (10 µg) and co-trimoxazole (25 µg). The multiple antibiotic resistance of *S. johannesburg* was not common for strains of other salmonella serotypes isolated over the same period which were usually sensitive to ampicillin, kanamycin and chloramphenicol in addition to gentamicin and cotrimoxazole.

DISCUSSION

Hospital patients, especially newborn babies and children, appear to be more susceptible to salmonella infection than the population at large. Baine, Gangarosa, Bennett & Barker (1973) reported that in the United States acute-care hospitals, paediatric wards and neonatal nurseries accounted for almost two-thirds of all reported institutional outbreaks but that institutions ranked second to the home in frequency of reported salmonella outbreaks. In Hong Kong, hospital-acquired salmonellosis may be a more serious problem than in the United States because

most hospitals are overcrowded with patients. In the present study, it was found that the ward investigated was heavily contaminated with *S. johannesburg* as well as other salmonella organisms. A large number of excretors, with and without symptoms, of *S. johannesburg* were detected among the paediatric patients but not the hospital staff.

S. johannesburg was first isolated in South Africa and identified by Kauffmann & Henning (1952). It has since been isolated in various parts of the world but appears to be rare in most countries to the best of our knowledge (Silberstein & Gerichter, 1964; Taylor *et al.* 1965; Center for Disease Control, 1975). An exception is probably that the incidence of *S. johannesburg* infection appears to have increased in recent years in South Africa as well. Furthermore, the strains isolated, like those encountered in the present study, were found to be resistant to a multiplicity of antibiotics (personal communication, Dr R. Cassel, Department of Bacteriology, Johannesburg University Hospital, Johannesburg, South Africa). Incidentally, *S. johannesburg* has been isolated from a dog imported from South Africa under quarantine in 1974 in Hong Kong.

S. johannesburg was probably introduced into Hong Kong from other parts of the world via imported foods or animal feeds, because it was not isolated before 1971. However, as no common baby food could be traced as the source of infection as indicated in this study, there must be other factors responsible for the endemic of *S. johannesburg* infection in this locality. Hospital infection is apparently one such factor contributing to its spread, especially among young children, in the community. Although not described here, hospital infections with *S. johannesburg* also occurred in other paediatric wards of the same hospital, and in paediatric wards of other general hospitals in Hong Kong at the same time. Because of the shortage of paediatric beds, children infected in hospital, including many undetected carriers, were frequently discharged after the acute symptoms subsided. Infection of other children at home, in nurseries or in kindergartens could form a vicious circle with hospitals in increasing the infectious pool.

The question arises why infections due to *S. johannesburg* spread more rapidly and widely than those due to other salmonella serotypes endemic in Hong Kong. The possible contributing factors are firstly the chronicity of its infection. *S. johannesburg* could be regularly detected in the faeces for a rather long period once the first positive culture was obtained. The second factor is its multiple resistance to antibiotics, which was uncommon for other salmonella serotypes, and multiple antibiotic-resistant strains appear to spread more easily than sensitive strains. The third possible factor is the evident higher infectivity of *S. johannesburg*, which is indicated by the fact that although the paediatric ward investigated was contaminated with a variety of salmonellas (Table 1), cross-infection occurred frequently only with *S. johannesburg*. This might be partially due to the fact that the local population is less immune to this exotic *Salmonella*, which belongs to O antigenic group R, than to other salmonellas endemic here, which belong to O antigenic groups A to G. Thus, these contributing factors, combined with the overcrowded condition in many of the hospitals, might have facilitated the endemic of *S. johannesburg* infection in Hong Kong.

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