Original Article

Changing Epidemiology of Enteric Fevers in Singapore

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Abstract

Introduction: We studied the epidemiological trends of enteric fevers (typhoid and paratyphoid fever) in Singapore from 1990 to 2009 and carried out a review of the current prevention and control measures. Materials and Methods: Epidemiological records of all reported enteric fevers maintained by the Communicable Diseases Division, Ministry of Health from 1990 to 2009 were analysed. Results: A total of 2464 laboratory confirmed cases of enteric fevers (1699 cases of typhoid and 765 cases of paratyphoid) were reported. Of these, 75% were imported, mainly from India and Indonesia. There had been a significant fall in the mean annual incidence rate of indigenous enteric fevers from 4.3 per 100,000 population in 1990 to 0.26 per 100,000 population in 2009 (P <0.005) with a corresponding increase in the proportion of imported cases from 71% between 1990 and 1993 to 92% between 2006 and 2009 (P <0.0005). Imported cases involving foreign contract workers increased significantly from 12.8% between 1990 and 1993 to 40.4% between 2006 and 2009 (P <0.0005). Conclusion: Singapore has experienced a marked decline in the incidence of enteric fevers that is now comparable to that of other developed countries. Continued vigilance and proactive measures that address the changing epidemiology of enteric fevers in Singapore are necessary to sustain the milestone achieved in the past 2 decades.

Ann Acad Med Singapore 2010;39:889-96

Keywords: Imported Cases, Outbreaks, Paratyphoid, Typhoid

Introduction

Typhoid and paratyphoid fever – collectively referred to as enteric fevers - are serious systemic infections caused by *Salmonella enterica serovar* Typhi (*S*. Typhi) and *Salmonella enterica serovar* Paratyphi (*S*. Paratyphi), respectively. Humans are the reservoir of infection and transmission occurs through food and water contaminated by acute cases or chronic carriers. The illness is treatable but life-threatening complications can occur.[1]

Enteric fevers are highly endemic in impoverished countries where poor sanitation and hygiene practices coupled with the presence of undiagnosed human carriers virtually ensure an unbroken chain of transmission. In Asia where some of the poorest nations can be found, 19.5 million clinical cases of typhoid fever were diagnosed in 2000, representing 90% of the estimated global burden of typhoid fever.[2] A 2008 study involving 5 Asian countries reported an annual indigenous typhoid incidence of 412.9 to 493.5 per 100,000 person years in study sites in Pakistan and India, 180.3 in Indonesia, and 24.3 to 29.3 in Vietnam and China.[3] Data from Bangladesh also suggest a very high burden of indigenous typhoid fever.[4]

In Singapore, typhoid was a serious endemic disease with case-fatality rates as high as 12% reported in the early 1950s.[5] It was described as a 'menace' and a 'scourge'[6] with large localised outbreaks due to food, in particular, iced drinks contaminated by carriers occurring regularly.[7] The disease was highly prevalent in communities that did not have access to potable water supplies and modern sewage disposal facilities. The main national strategy implemented to bring

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this major public health problem under control was the provision for a high standard of environmental hygiene and sanitation under a new Ministry of the Environment formed in 1972. Other measures taken included identification of the large pool of undetected carriers, estimated to be around 1500 to 2000,[8] licensing of food establishments, relocation of street vendors to modern food centres, screening and vaccination of public foodhandlers, and health education.[9] The impact of these efforts was seen in the decline in the incidence rate per 100,000 population of typhoid fever from 22.8 in 1975 to 5.9 in 1980 and to 1.2 in 1989.[10]

The aim of this study is to determine the epidemiological trends of enteric fevers in Singapore during the last 20 years from 1990 to 2009, and based on these findings, review the current prevention and control measures.

Materials and Methods

Typhoid and paratyphoid are both legally notifiable diseases in Singapore. All cases, carriers and deaths are to be reported to the Communicable Diseases Division, Ministry of Health (MOH) within 24 hours. Epidemiological investigations to obtain relevant information such as age, gender, ethnic group, residential status, food and travel history, are routinely conducted by trained public health officers for each notified case using a standard questionnaire. For Singapore residents who acquired the disease locally (indigenous cases), ethnicity was classified as Chinese, Malay or Indian. Those who did not fall under these 3 main ethnic groups (e.g. Eurasians) were classified as Others. Non-Singapore residents such as tourists who acquired the disease in Singapore were classified as Foreigners. Contact tracing to look for other unreported cases in the family, place of work or school is also carried out. Close contacts and implicated foodhandlers are referred to the Communicable Disease Centre (CDC), Tan Tock Seng Hospital (TTSH), for screening of typhoid or paratyphoid infection by stool and urine cultures.

Clinical management of enteric fevers is in accordance to the guidelines published by MOH and TTSH.[11] Diagnosed cases who are local residents are scheduled for follow-up at 2 weeks after completion of treatment, and at 3 and 6 months at the CDC, TTSH, during which stool and urine cultures are taken. Convalescent carriers are defined as those who continue to excrete *S*. Typhi or *S*. Paratyphi during convalescence; temporary carriers are those who continue to excrete at 3 to 6 months; and chronic carriers are those who persist in excreting at 1 year or longer. The particulars of all carriers are recorded in the enteric fevers carrier registry maintained by MOH.

An outbreak is defined as a cluster of 2 or more cases epidemiologically linked by person, place and time. A case-control study will be undertaken in an outbreak situation to determine the vehicle and mode of transmission. Cases are classified as imported if there is a history of travel to an enteric fevers endemic country between 7 and 21 days prior to the onset of illness.

Epidemiological records of all notified cases and carriers maintained by the Communicable Diseases Division, MOH, were retrieved, collated and analysed. Deaths from enteric fevers notified to the Registrar of Births and Deaths, Ministry of Home Affairs, were also obtained. Only cases presenting with compatible clinical signs and symptoms and confirmed by positive blood, stool, urine or bone marrow culture for *S*. Typhi or *S*. Paratyphi were included in the analyses. Whenever an outbreak was detected, for epidemiological linkage, we also traced the Vi- phage types and antibiotics sensitivity test results for selected strains of *S*. Typhi undertaken by the Department of Pathology, Singapore General Hospital.[12]

For the calculation of incidence rates, the denominators used were the estimated mid-year population of the corresponding year published by the Department of Statistics, Ministry of Trade and Industry. Linear patterns in the incidence of enteric fevers over the years were assessed using χ^2 test for trend. For the case-control study, differences in food-specific attack rates between cases and controls were examined using the χ^2 or Fisher's exact test (SPSS for Windows). A P value of less than 0.05 was considered statistically significant.

Results

Epidemiological Trends

A total of 2464 laboratory confirmed cases of enteric fevers (typhoid and paratyphoid) were reported in Singapore from January 1990 to December 2009 (Fig. 1). Of these, 1850 (75%) were imported cases and 614 (25%) were indigenous cases (i.e. those without recent travel history outside Singapore). While the incidence rate of indigenous cases showed a declining trend (from 4.30 per 100,000 population in 1990 to 0.26 per 100,000 in 2009)(P <0.005), the proportion of cases classified as imported had been increasing significantly from 71% during the period between 1990 and 1993 to 92% between 2006 and 2009 (P <0.0005) (Fig. 2).

Three deaths from typhoid were reported, one in 1990 and 2 in 1991, giving a case-fatality rate of 0.4% in 1990 and 1.5% in 1991. The death occurred in 1990 involved a 77-year-old female with no recent travel history. She sought treatment from a medical practitioner for her febrile illness, but her condition continued to deteriorate. She did not seek medical treatment again until one week later when she was severely ill. She was immediately hospitalised, but died on

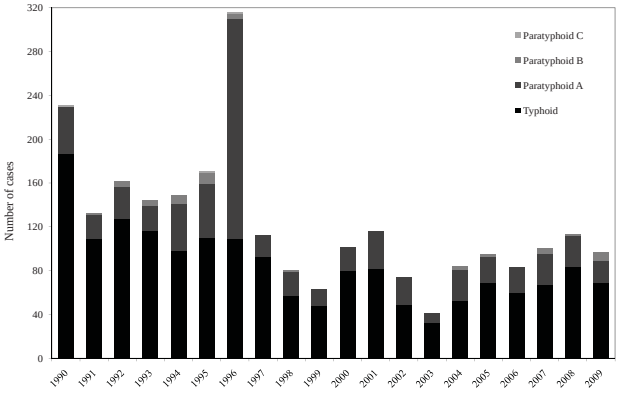

Fig. 1. Number of cases of enteric fevers and classification by aetiology, 1990 to 2009.

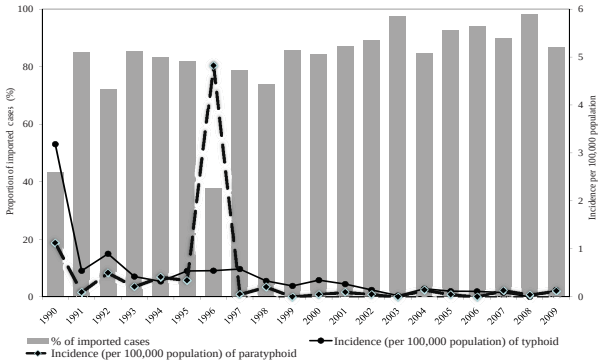

Fig. 2. Incidence (Per 100,000 Population) of indigenous typhoid and paratyphoid cases and Proportion (%) of imported enteric fevers cases in Singapore, 1990 to 2009.

the same day. The first death in 1991 was an 84-year-old lady who had no recent travel history. She succumbed to complications of septicaemia and meningitis. The second fatal case was a 27-year-old Indian tourist who died of septicaemia and adult respiratory distress syndrome. Both of them sought medical treatment late.

Indigenous Cases

Among the indigenous cases, 311 (50.6%) were due to typhoid, 259 (42.2%) paratyphoid A, 43 (7.0%) paratyphoid B, and 1 (0.2%) paratyphoid C. The unusually high proportion of paratyphoid A among the indigenous cases was due to a nationwide outbreak of 167 cases in 1996.

Among the 3 main ethnic groups, the mean annual ethnic-specific incidence rate for indigenous enteric fevers between 2000 and 2009 was highest for Indians (0.36 per 100,000 population) followed by Malays (0.21 per 100,000 population) and Chinese (0.18 per 100,000 population) (Table 1). The mean annual age-specific incidence rate among indigenous enteric fevers between 2000 and 2009 was highest in the 0 to 4 years age group (0.42 per 100,000 population) followed by the 15 to 24 years age group (0.25 per 100,000 population) and the 25 to 34 years and 55 years and above age groups (0.24 per 100,000 population) (Table 2). Overall, there were more males than females among the indigenous cases.

Imported Cases

Among the imported cases, 1388 (75.0%) were due to typhoid, 448 (24.2%) paratyphoid A, 12 (0.7%) paratyphoid B and 2 (0.1%) paratyphoid C. Between 2000 and 2009, there were 6 cases of paratyphoid B from India, Bangladesh, Sri Lanka, Indonesia and Malaysia while no cases of paratyphoid C were reported (Table 3). The 2 main population groups with imported infections were local

Table 1. Annual Ethnic-Specific Incidence Rates (Per 100,000 Population) and Ethnic Distribution (%) of Indigenous Enteric Fevers, 2000 to 2009

Ethnic group	**2000 (n = 16)**	**2001 (n = 15)**	**2002 (n = 8)**	**2003 (n = 1)**	**2004 (n = 13)**	**2005 (n = 7)**	**2006 (n = 5)**	**2007 (n = 10)**	**2008 (n = 2)**	**2009 (n = 13)**	**2000 to 2009* (n = 90)**
Residents											
Chinese	0.32	0.31	0.04	0.00	0.42	0.23	0.08	0.19	0.04	0.22	0.18
	(50.0)	(53.3)	(12.5)	(0.0)	(84.6)	(85.7)	(40.0)	(50.0)	(50.0)	(46.1)	(53.3)
Malay	0.22	0.87	0.21	0.00	0.21	0.00	0.21	0.20	0.00	0.20	0.21
	(6.3)	(26.7)	(12.5)	(0.0)	(7.7)	(0.0)	(20.0)	(10.0)	(0.0)	(7.7)	(11.1)
Indian	1.16	0.38	0.00	0.00	0.00	0.34	0.33	0.64	0.00	0.58	0.36
	(18.7)	(6.7)	(0.0)	(0.0)	(0.0)	(14.3)	(20.0)	(20.0)	(0.0)	(15.4)	(11.1)
Others	2.16	0.00	0.00	1.83	1.68	0.00	1.24	0.00	0.98	0.00	0.84
	(6.3)	(0.0)	(0.0)	(100.0)	(7.7)	(0.0)	(20.0)	(0.0)	(50.0)	(0.0)	(5.6)
Foreigners	0.40	0.25	0.76	0.00	0.00	0.00	0.00	0.20	0.00	0.32	0.23
	(18.7)	(13.3)	(75.0)	(0.0)	(0.0)	(0.0)	(0.0)	(20.0)	(0.0)	(30.8)	(18.9)

* Mean incidence was based on estimated 2004 mid-year population
Figures in brackets refer to percentage of total cases in the corresponding year(s).

Table 2. Annual Age-Specific Incidence Rates (Per 100,000 Population) and Age Distribution (%) of Indigenous Enteric Fevers, 2000 to 2009

Age group (years)	2000 (n = 16)	2001 (n = 15)	2002 (n = 8)	2003 (n = 1)	2004 (n = 13)	2005 (n = 7)	2006 (n = 5)	2007 (n = 10)	2008 (n = 2)	2009 (n = 13)	2000-2009* (n = 90)
0 – 4	1.69	0.42	0.00	0.45	0.00	0.47	0.00	0.96	0.00	0.00	0.42
	(25.0)	(6.7)	(0.0)	(100.0)	(0.0)	(14.3)	(0.0)	(20.0)	(0.0)	(0.0)	(10.0)
5 – 14	0.77	0.19	0.19	0.00	0.00	0.00	0.38	0.00	0.00	0.20	0.17
	(25.0)	(6.7)	(12.5)	(0.0)	(0.0)	(0.0)	(40.0)	(0.0)	(0.0)	(7.7)	(10.0)
15 – 24	0.32	0.31	0.48	0.00	0.32	0.31	0.15	0.28	0.00	0.25	0.25
	(12.5)	(13.3)	(37.5)	(0.0)	(15.4)	(28.6)	(20.0)	(20.0)	(0.0)	(15.4)	(17.8)
25 – 34	0.46	0.45	0.34	0.00	0.24	0.12	0.11	0.10	0.00	0.37	0.24
	(25.0)	(26.7)	(37.5)	(0.0)	(15.4)	(14.3)	(20.0)	(10.0)	(0.0)	(30.8)	(22.2)
35 – 44	0.00	0.26	0.13	0.00	0.80	0.13	0.00	0.12	0.00	0.11	0.16
	(0.0)	(13.3)	(12.5)	(0.0)	(46.1)	(14.3)	(0.0)	(10.0)	(0.0)	(7.7)	(13.3)
45 – 54	0.00	0.56	0.00	0.00	0.17	0.00	0.16	0.31	0.00	0.29	0.15
	(0.0)	(20.0)	(0.0)	(0.0)	(7.7)	(0.0)	(20.0)	(20.0)	(0.0)	(15.4)	(10.0)
55+	0.39	0.37	0.00	0.00	0.32	0.31	0.00	0.27	0.26	0.37	0.24
	(12.5)	(13.3)	(0.0)	(0.0)	(15.4)	(28.6)	(0.0)	(20.0)	(100.0)	(23.1)	(16.7)

* Mean incidence was based on estimated 2004 mid-year population
Figures in brackets refer to percentage of total cases in the corresponding year(s).

residents and foreign contract workers (Fig. 3). While the proportion of local residents with imported enteric fevers declined from 52.9% during the period between 1990 and 1993 to 33.9% between 2006 and 2009, there was a corresponding increase in the proportion of foreign contract workers with imported enteric fevers from 12.8% to 40.4%, respectively (P <0.0005). Most local residents contracted the disease through travel in Southeast Asia (64%) and the Indian Subcontinent (28%) (Table 4). One significant trend was the increase in the proportion of imported cases acquired by local residents from India with a corresponding decline of that from Indonesia (P <0.0005). The reasons for travel to the endemic countries were primarily for vacation/social visit (71%) followed by employment or business (26%).

Enteric Fevers Outbreaks

A total of 5 typhoid and 3 paratyphoid A outbreaks were detected during the last 20 years. The first typhoid outbreak occurred in a psychiatric institution in 1990, the second in a family at Delta Road (3 cases and 2 carriers, phage type B1) in October 1990, the third in a family at Telok Blangah (2 cases, phage type D2) in March 1992, the fourth in a family at Punggol (2 cases, 1 carrier, phage type USV1) in August 1992 and the last in the same psychiatric institution (2 cases) in November 1992. There were 3 outbreaks of paratyphoid A, one in March 1990 (9 cases in the Central Business District), one in August 1990 (3 cases at Kay Siang Road) and the other was a nationwide outbreak in 1996. The typhoid outbreak in the psychiatric institution in 1990 and the paratyphoid A outbreak in 1996 are described below.

i. Outbreak of Typhoid Fever in a Psychiatric Institution, 1990

This outbreak occurred in a large psychiatric institution with a population of 1120 male and 845 female patients and a staff of 936. As soon as the first confirmed case of typhoid was reported from a male ward, epidemiological investigations were conducted, and prevention and control measures concurrently carried out. These included search for fever and diarrhoea cases and rectal swabbing of all inmates, starting with contacts in the wards where confirmed and suspected cases had been detected, and subsequently

Table 3. Number of Imported Enteric Fevers by Classification, 2000 to 2009

Classification	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2000-2009
Typhoid	66	71	43	31	45	64	55	63	84	62	584
Paratyphoid A	19	30	23	9	26	23	23	25	27	19	224
Paratyphoid B	0	0	0	0	0	1	0	2	0	3	6
Paratyphoid C	0	0	0	0	0	0	0	0	0	0	0
Total	85	101	66	40	71	88	78	90	111	84	814

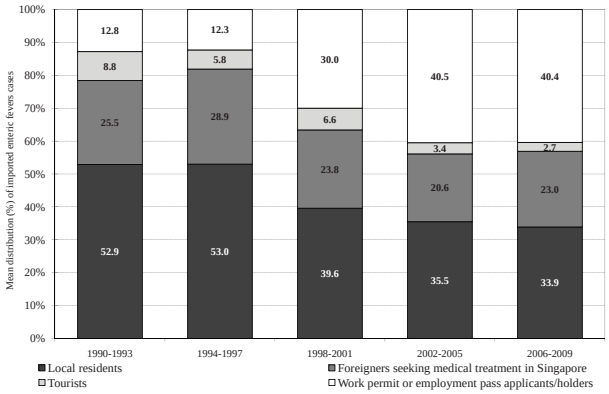

Fig. 3. Mean distribution (%) of imported enteric fevers cases by population group, 1990 to 2009.

extended to those in the adjacent wards until all the patients in the institution had been screened. To prevent clinical cases from appearing, mass immunisation with 2 doses of heat-phenol inactivated typhoid vaccine was also implemented.

A total of 95 inmates, 47 symptomatic and 48 asymptomatic, were infected from April to September 1990. All the *S*. Typhi isolates were of the same Vi-phage type D1 and of the same antibiogram, indicating a common source of infection. However, the source of infection could not be established. No infected foodhandler or contaminated food or water could be implicated. Transmission was mainly through close person-to-person contact. Three infected 'worker patients' who were deployed to assist in handling soiled laundry and other miscellaneous jobs could also have contributed to the spread of infection. Although the vaccine was found to have an efficacy of 65.8% in preventing clinical illness, it was the maintenance of a high standard of environmental sanitation, and the identification and isolation of both symptomatic and asymptomatic cases that eventually brought the outbreak under control.[13]

ii. Nationwide Paratyphoid A Fever Outbreak, 1996

This large outbreak of 167 cases occurred between February and May 1996. The attack rate was highest among the Indians. Cases were distributed all over Singapore and not clustered in any particular locality. As extensive epidemiological investigations based on a large variety of food items consumed and food outlets patronised by the cases 1 to 3 weeks prior to onset of illness did not provide any leads as to the source of infection and vehicle of transmission, special attention was given to the food history of the cases in 5 small clusters (2 to 5 cases each) identified. Cases from these clusters had patronised 9 different food establishments. On further investigations into the food supplies and methods of preparation of the various food items in these premises, a common link was the use of imported coconut as an ingredient. The coconuts were dehusked and deshelled in the country of origin and then transported to Singapore daily by lorries without proper packing and refrigeration. Some were sent to food factories for the production of pasteurised coconut milk and other products, while the others were distributed by several traders to the markets, food centres and restaurants where they were stored at ambient temperatures.

A case-control study based on the first 69 reported cases and 203 controls showed that consumption of iced 'Chendol' with black sugar and coconut milk, iced sago with black sugar and coconut milk, iced 'Ais delima' with coconut milk and other food items in which unpasteurised or uncooked

Table 4. Distribution (%) of Singapore Residents Who Contracted Enteric Fevers Overseas by Country of Origin, 1990 to 2009

	1990 to 1994 (n = 225)	1995 to 1997 (n = 187)	1998 to 2001 (n = 107)	2002 to 2005 (n = 102)	2006 to 2009 (n = 105)
Indian Subcontinent					
India	27.6	18.3	20.1	36.4	44.5
Bangladesh	0.0	0.0	3.1	3.2	4.7
Southeast Asia					
Indonesia	56.5	65.5	53.9	42.0	24.3
Malaysia	4.3	4.9	7.5	4.9	10.8
Thailand	3.9	3.0	2.8	2.7	4.9
Myanmar	0.5	1.1	2.8	2.4	3.6
Cambodia	0.0	0.8	2.1	1.6	2.3
China/ Hong Kong	0.9	2.0	1.9	2.7	1.7
Australia	0.0	0.5	0.0	0.8	1.5
Others	6.2	4.0	5.8	3.4	1.7
Total	100.0	100.0	100.0	100.0	100.0

coconut milk or partially-cooked coconut was used as an ingredient was significantly associated with the illness (P <0.001, P <0.04, P <0.04 and P <0.01, respectively). No *S*. Paratyphi A was isolated from deshelled coconut and other coconut-based products at the point of import and at various retail outlets. With the banning of the import of deshelled coconuts, no further cases were reported.[14]

A total of 54 typhoid carriers, including 48 inmates detected during the typhoid fever outbreak at the psychiatric institution in 1990, were recorded in the enteric fevers carrier registry. These comprised 49 temporary carriers and 5 chronic carriers. None of them were public foodhandlers. No paratyphoid carrier was detected.

Discussion

With vast improvements in environmental sanitation, especially personal and food hygiene, and the universal accessibility to potable water supplies and sewage disposal facilities, the incidence rate of indigenous enteric fevers (typhoid and paratyphoid) in Singapore has declined to 0.26 per 100,000 in 2009. In the case of indigenous typhoid fever, its incidence has fallen to 0.14 per 100,000, comparable to that of other developed countries such as the USA (<1per 100,000),[15] the UK (<1 case per 100,000),[16] Canada (<1 per 100,000),[17] and Australia (0.4 per 100,000).[18] No death has been reported since 1991.

As in other industrialised countries, more than 90% of the reported cases of enteric fevers in Singapore are now imported, mainly from India and Indonesia. A substantial number of typhoid fever cases imported into the USA[19] and the UK[20] were from the Indian Subcontinent. Of particular concern is the increasing proportion of the imported *S*. Typhi strains from the Indian Subcontinent with decreased susceptibility to fluoroquinolones.[20,21] In Singapore, of 158 strains of *S*. Typhi tested at the Department of Pathology, Singapore General Hospital,[22] from 2002 to 2009 (and personal communication – Tan AL), 100% remained sensitive to ciprofloxacin and ceftriaxone with varying sensitivity to ampicillin and co-trimoxazole (73% to 100%). In the case of 50 *S*. Paratyphi strains tested from 2002 to 2009, 93.5% to 100% were sensitive to ampicillin, 93.8% to 100% to ciprofloxacin and 100% to co-trimoxazole and ceftriaxone. Nevertheless, close vigilance over the antibiotics sensitivity pattern of *S*. Typhi and *S*. Paratyphi strains imported into Singapore should continue to be maintained.

Imported cases of enteric fevers involved 2 main population groups: foreign contract workers and local residents travelling to the endemic countries for vacation, social visit, business or employment without taking adequate personal protective measures. The increasing proportion of foreign contract workers with imported enteric fevers during the last 20 years could be accounted by the 4-fold increase in the number of foreign contract workers in Singapore from 248,000 in 1990 to approximately one million in 2008.[23] In the case of local residents, in a study conducted in 2002, only 20% of Singapore travellers sought pre-travel advice as it was perceived that there is a low risk of acquiring infectious diseases while overseas.[24] In the UK, visiting-friends-and-relatives (VFR)- related travel comprised 88% of all travel-associated enteric fevers in 2007, with vast majority of cases following travel to the Indian Subcontinent.[25] In the United States, VFR-related travel accounted for 40% of all travel- related enteric fevers in 1996.[26] This category of travellers has a higher risk for illness because, unlike tourists, these VFR travellers are less likely to take precautions with regard to hygiene, food and pre-travel prophylaxis while visiting home countries.[27] We strongly recommend that local residents travelling to endemic countries, especially those visiting friends and relatives, should be advised on food and personal hygiene and vaccinated against typhoid with either the live oral *S*. Typhi Ty21a vaccine strain or the parenteral Vi polysaccharide vaccine.[28] In the case of foreign contract workers in Singapore, particular attention should be given to those working as domestic maids and those engaged in the preparation and handling of food for public consumption. Employers of foreign domestic maids are given the option to have their maids tested for enteric fevers carrier status.

The last outbreak of typhoid was reported in 1992. Since then, all the reported cases who had no recent travel history occurred singly and sporadically. This is different from the situation in the past when typhoid fever was prevalent and the high endemicity of the disease was maintained by the large pool of chronic carriers. With the natural attrition of these carriers over the years, spread of infection to susceptible contacts through contaminated food within households and in the community has become infrequent. Moreover, the routine follow-up schedules for all acute cases among local residents after discharge from hospital ensures that any carrier detected is adequately treated. Public foodhandlers found to be carriers will have their personal particulars recorded in the enteric fevers carrier registry and prohibited from food handling until permanently free from infection (either through antibiotics therapy or cholecystectomy).

The occurrence of typhoid in the psychiatric institution is a matter of concern. The confirmation of a case in such an institution should be considered as a public health emergency because of the rapidity with which the disease could spread, as demonstrated in the 1990 outbreak. Despite the extensive control measures implemented, infection spread from the male to female wards and transmission was only interrupted 5 months after the first case was detected. Based on the

experience gained from this outbreak, a cluster of 2 cases from the same institution in 1992 was promptly aborted. We recommend that besides psychiatric institutions, all long-term healthcare facilities should also maintain a high degree of vigilance, as outbreaks of gastrointestinal illness, including cholera[29] have been reported periodically from these institutions.

Indigenous paratyphoid fever was uncommon in Singapore until the large nationwide outbreak which occurred in 1996. The vehicle of transmission was subsequently traced to deshelled coconut imported into Singapore without proper sanitary control. This was not the first time that imported food was responsible for outbreaks of food-borne diseases in Singapore. Imported chilled shucked oysters from the Philippines caused nationwide outbreaks of paratyphoid A in 1979[30] and hepatitis A in 1980.[31] Imported cockles from Malaysia were responsible for several nationwide outbreaks of hepatitis A.[32,33] Frozen half-shelled oysters imported from Shandong, China was the vehicle of transmission of several outbreaks of norovirus gastroenteritis from December 2003 to January 2004,[34] and contaminated dried anchovy imported from Southeast Asia caused an outbreak of multidrug-resistant *S*. Typhimurium involving mainly infants and toddlers from July to October 2000.[35] The Agri-Food Veterinary Authority, the licensing agency for importation of food into Singapore, has taken various measures to further strengthen its surveillance, including microbiological testings, and import control to prevent recurrences of food-borne disease outbreaks.

In a concerted effort to curb the rising incidence of typhoid in the 1970s, a mass screening and typhoid vaccination programme for public foodhandlers was implemented between 1977 and 1980. The screening programme was subsequently discontinued as no typhoid carrier was detected from 48,884 foodhandlers and their assistants.[7] The practice of typhoid vaccination was discontinued in September 2010 as it was noted that the current incidence of indigenous typhoid in Singapore is similar to that in other developed countries and that foodhandlers are not routinely vaccinated against typhoid in other developed countries. The vaccine does not prevent the carrier state[27] which is far more important than clinical cases from the public health point of view. Moreover, the World Health Organization (WHO) had recommended that routine vaccination should only be undertaken in areas of high endemicity among the high-risk groups or for interrupting outbreaks.[36] However, sustained efforts in educating foodhandlers to practise a high standard of personal and food hygiene should continue.

Conclusion

In conclusion, Singapore has experienced a marked decline in the incidence of enteric fevers that is now comparable to that of other developed countries, despite being situated in a region where enteric fevers remain endemic. Of particular concern is the high prevalence of multidrug-resistant *S*. Typhi and *S*. Paratyphi in the region. Through prompt epidemiological surveillance and strict food import control with the population practising a high standard of personal and food hygiene, enteric fevers in Singapore can continue to be maintained at a level comparable to other developed countries. Proactive measures that address the changing epidemiology of enteric fevers in Singapore is necessary to sustain the milestone accomplished in the past two decades.

Acknowledgements

The authors wish to acknowledge the assistance of Dr Tan Ai Ling, Senior Consultant, Department of Pathology, Singapore General Hospital for providing expert opinion and the antibiogram data covering the period between 2006 and 2009.

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