

Trends in Importation of Communicable Diseases into Singapore

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Abstract

Introduction: Singapore is a transition country in Southeast Asia that is both vulnerable and receptive to the introduction and re-introduction of imported communicable diseases. **Materials and Methods:** For a 10-year period between 1998 and 2007 we studied the trend, epidemiological characteristics, proportion of imported versus local transmission of malaria, viral hepatitis (hepatitis A and E), enteric fevers (typhoid and paratyphoid), cholera, chikungunya and SARS. **Results:** Of a total of 4617 cases of the above selected diseases notified in Singapore, 3599 (78.0%) were imported. The majority of the imported cases originated from Southeast Asia and the Indian subcontinent. Malaria constituted the largest bulk (of which 95.9% of the 2126 reported cases were imported), followed by hepatitis A (57.1% of 1053 cases imported), typhoid (87.6% of 596 cases imported), paratyphoid (87.6% of 241 cases imported), and hepatitis E (68.8% of 231 cases imported). Furthermore, there were 14 cases of imported cholera, 6 cases of imported severe acute respiratory syndrome (SARS) and 13 cases of imported chikungunya. **Conclusion:** This study underlines that diseases such as malaria, viral hepatitis and enteric fever occur in Singapore mainly because of importation. The main origin of importation was South and Southeast Asia. The proportion of imported diseases in relation to overall passenger traffic has decreased over the past 10 years.

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Introduction

Singapore is a city-state in Southeast Asia, with a total population in 2007 of 4,839,400, of which 3,642,700 (75.3%) are Singaporean residents.¹ The remaining 25% constitute of immigrant workers on work permit, foreigners on employment pass, and student pass holders. Singapore is a major air hub with 17,639,556 passengers arriving, and 1,480,353 passengers in transit in 2007.² It is also a major sea port with 128,568 sea vessel arrivals in 2007.² The increasing affordability of air travel in addition to Singapore's favourable climate for tourism, business, and trade, has resulted in a significant increase in passenger traffic through its shores, especially to and from countries in the region which are endemic for many tropical infectious diseases. Changes in the pattern of visitor arrivals in

Singapore have been observed over the past 10 years. From 1997 to 2007, annual air passenger arrivals from Southeast Asia have increased by 25%, from 5,235,000 to 6,520,000; and annual arrivals from South Asia have doubled, from 755,000 to 1,585,405.² Singapore also has a highly mobile workforce and a large proportion of immigrant workers.

Singapore has implemented several measures over the past few decades to prevent and control communicable diseases in the country. As a result of rapid urbanisation and industrialisation, environmental sanitation and hygiene, comprehensive coverage of the national childhood immunisation programme and active surveillance of communicable diseases, the incidence of most endemic environment-related communicable diseases has been greatly reduced, and some vaccine-preventable diseases

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(i.e. diphtheria, poliomyelitis, and neonatal tetanus) have been eliminated.³⁻⁸ The World Health Organization (WHO) has declared Singapore free of indigenous malaria on 22 November 1982.⁹ Having reached these milestones, imported communicable diseases have now assumed greater public health importance in Singapore, as in other developed countries.⁴

The objectives of this study are to determine the epidemiological characteristics of food-borne and vector-borne as well as emerging communicable diseases and to assess the impact of their introduction into Singapore between 1998 and 2007.

Materials and Methods

We obtained data on annual air arrivals and departures from the annual reports compiled by the Research and Statistics Department, Planning Division, Singapore Tourism Board, and the Department of Statistics of the Ministry of Trade and Industry. We selected the following notifiable communicable diseases for our study on the basis of their public health significance, obtainable travel history and existing data on importation versus local transmission: malaria, viral hepatitis (Hepatitis A and E), enteric fevers (typhoid and paratyphoid), cholera, and newly emerging diseases such as severe acute respiratory syndrome (SARS) and chikungunya. Chikungunya was not notifiable during our study period and we obtained the information from the National Environment Agency of Singapore. Dengue was excluded as a large proportion of cases in Singapore are indigenous.¹⁰ We also excluded human immunodeficiency virus (HIV), tuberculosis and other diseases with a long incubation time as the association with travel is difficult to ascertain.

We retrieved relevant epidemiological data of the selected communicable diseases from the ‘Communicable Diseases Surveillance in Singapore’, the annual report published by the Quarantine and Epidemiology Department (QED),

Ministry of the Environment (ENV), from 1998 to 2002 and the Communicable Diseases Division (CDD), Ministry of Health (MOH), from 2003 to 2007. Additional data were obtained from the ‘Epidemiological News Bulletin’, which is published monthly by the QED, ENV from 1998 to 2002, and quarterly by the CDD, MOH from 2003 to 2007. All the reported cases were laboratory-confirmed. An ‘imported disease’ was defined as a disease that was highly likely to be acquired outside Singapore, based on the incubation period of the particular disease, the onset of illness and travel history. We recorded the country of origin of the travellers, the specific population group they belonged to (local residents, migrant workers and other foreigners), as well as their ethnicity.

We grouped the countries of origin into several geographical regions, and defined them as follows: ‘Southeast Asia’ which includes Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand, and Vietnam; ‘South Asia’ which includes Bangladesh, India, Maldives, Nepal, Pakistan, and Sri Lanka; ‘East Asia’ which includes China, Hong Kong, Japan, North Korea, South Korea, and Taiwan; the ‘Middle East’ which includes the Arabian Peninsula, Jordan, Iran, Iraq, Israel, Lebanon, Syria, and Turkey; and Africa which refers to the entire African continent, Indian Ocean Islands and Madagascar.

Results

I Frequency and Trends

Between 1998 and 2007, there were 4617 notified cases of the studied communicable diseases in Singapore, of which 3599 (78.0%) were imported. The vast majority of the imported cases were malaria (2162 cases in total, 95.9% imported), followed by hepatitis A (1053 cases, 57.1% imported), typhoid (596 cases, 87.6% imported), paratyphoid fever (241 cases, 87.6% imported), and hepatitis E (231 cases, 68.8% imported) (Fig. 1).

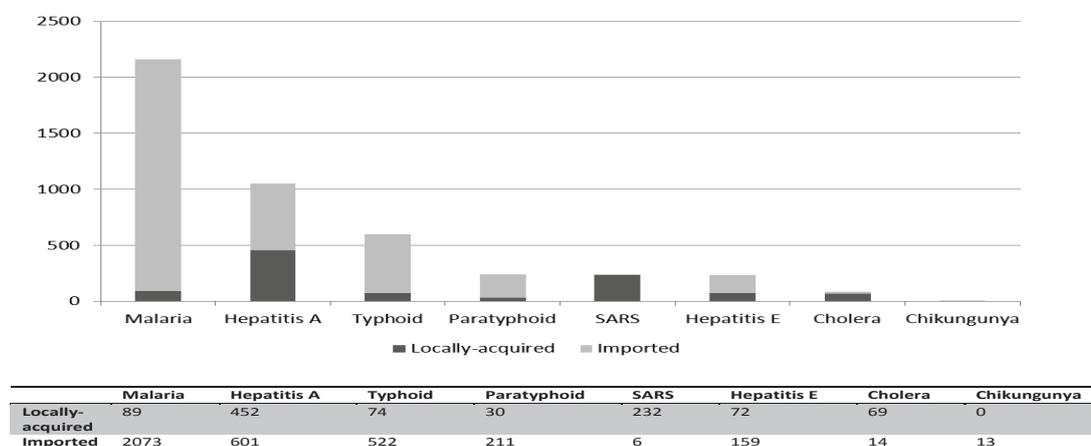


Fig. 1. Communicable disease burden in Singapore from 1998 and 2007.

Of the 3599 imported cases, the 3 most frequently imported diseases were malaria (n = 2073, 57.6% of the total number of imported communicable disease cases), hepatitis A (n = 601, 16.7%) and typhoid fever (n = 522, 14.5%) (Fig 2). The 10-year disease trends are shown in Figure 3. There was a significant decrease in imported malaria cases in Singapore, from 369 cases in 1998, to a low of 113 cases in 2003. From 2004 to 2007, the annual number of malaria cases have held steady at between 148 and 166 cases. For the other imported diseases, the annual incidence remained similar throughout with some insignificant year-to-year variation. The years 2003 and 2006 saw cases of new emerging infectious diseases occurring for the first time in Singapore (SARS and Chikungunya, respectively).

The yearly number of passenger arrivals in Singapore has steadily increased during the period 1998 to 2007, with the exception of 2003 due to the global SARS epidemic, yet the rate of most imported cases per million arrivals remained stable. In other words, the proportion of imported disease against passenger traffic has actually decreased. In 1998, the proportion of imported malaria, hepatitis A and typhoid fever was 59, 12, and 7 per million arrivals, respectively; whereas in 2007 it was 14, 6, and 6 per million arrivals, respectively.

The main regions from which imported communicable diseases originated were Southeast and South Asia. Table 1 describes the origin of the importations of malaria, enteric fevers (typhoid and paratyphoid), and viral hepatitis

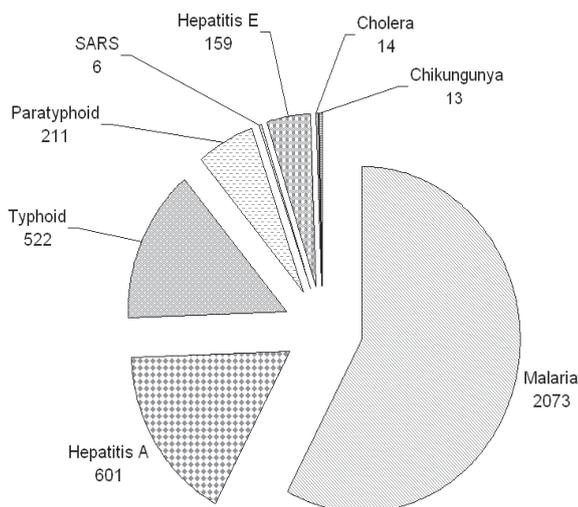
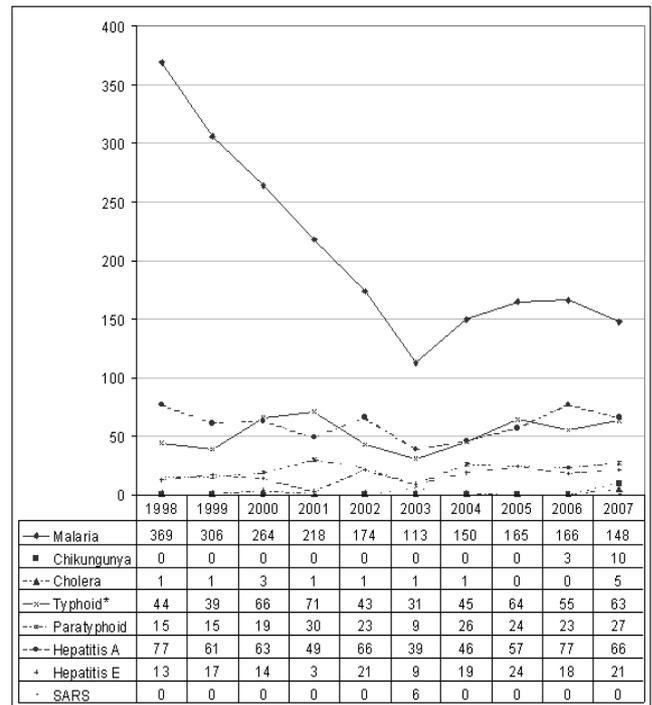


Fig. 2. The distribution of imported communicable diseases between 1998 and 2007.



*exclude one case

Fig. 3. Yearly trends of imported communicable diseases into Singapore between 1998 and 2007.

Table 1. Imported Communicable Diseases by Geographical Area of Origin, 1998-2007

Geographical Area of Origin	Malaria (%)	Enteric Fevers* (%)	Viral Hepatitis (%)
Southeast Asia	1206 (58.2)	305 (62.8)	397 (52.2)
South Asia	701 (33.8)	167 (34.4)	276 (36.3)
East Asia	33 (1.6)	7 (1.4)	52 (6.9)
Africa	127 (6.1)	2 (0.4)	1 (0.1)
Middle East	0	0	3 (0.4)
Others	6 (0.3)	5 (1.0)	22 (2.9)
Unknown	0	0	9 (1.2)
Total	2073 (100)	486 (100)	760 (100)

*For Enteric Fevers, figures from 2003 onwards, only Singapore Residents were included.

(hepatitis A and E).

The vast majority of these imported diseases were acquired by local residents who contracted these diseases while travelling, followed by foreign workers (mainly from South East Asia and South Asia), foreigners seeking medical treatment in Singapore, and overseas tourist travellers which

Table 2. Classification of Imported Communicable Diseases by Population Groups, 1998-2007

Population Group	Malaria (%)	Enteric Fevers (%)	Viral Hepatitis (%)
Local residents who contracted the disease overseas	619 (29.8)	260 (35.5)	443 (58.3)
Tourists from other countries	177 (8.5)	27 (3.7)	15 (2.0)
Foreigners seeking medical treatment in Singapore	475 (22.9)	157 (21.4)	112 (14.7)
Work permit / employment pass holders	573 (27.6)	203 (27.7)	157 (20.7)
Student pass holders	Data unavailable	77 (10.5)	Data unavailable
Other categories of foreigners	229 (11.0)	9 (1.2)	33 (4.3)
Total	2073 (100)	733 (100)	760 (100)

II Specific Diseases

Malaria: 2162 cases of malaria were reported in the period 1998 to 2007, of which 2073 cases (95.9%) were imported. The distribution of parasite species was *P. vivax* (n = 1391, 67.1%), *P. falciparum* (n = 614, 29.6%), mixed infection (n = 58, 2.8%) and *P. malariae* (n = 10, 0.5%). The age-specific incidence rate was highest in the 25 to 34 age group, and the male-to-female ratio was 3.6 : 1. The proportion for the Chinese, Malays, Indians, and other ethnic groups were 44.5%, 36.6%, 14.9% and 3.9%, respectively. The majority of the imported cases were from Southeast Asia (58.2%).

Of the imported cases, 29.8% were local residents, 27.7% were work permit/employment pass holders, 22.9% were foreigners seeking medical treatment in Singapore, 11.1% were foreigners from other categories, and 8.5% were tourists from other countries (Table 2).

Viral Hepatitis (hepatitis A and E): 1284 cases of hepatitis A and hepatitis E were reported in the period 1998 to 2007, of which 760 (59.2%) were imported. There were 601 cases of imported hepatitis A and 159 cases of imported hepatitis E. The proportion of imported cases of hepatitis A in relation to overall hepatitis A cases in Singapore rose from 55.8% in 1998 to 75.0% in 2007.

Hepatitis A is more frequently imported from Southeast Asia (59.2%) than South Asia (28.8%). Conversely, hepatitis E is more frequently imported from South Asia (64.8%) than Southeast Asia (26.4%).

constituted the smallest proportion (Table 2).

Of the imported cases of hepatitis A, 66.6% were Singapore residents, 14.8% were foreigners seeking medical treatment in Singapore, 12.3% were work permit / employment pass holders, 4.5% comprised other categories of foreigners, and 1.8% were tourists from other countries.

Of the imported cases of hepatitis E, 48.0% were work permit / employment pass holders, 32.9% were Singapore residents, 13.3% were foreigners seeking medical treatment in Singapore, 3.5% comprised other categories of foreigners, and 2.3% were tourists from other countries.

Enteric Fevers (typhoid and paratyphoid): Between 1998 and 2007, 837 cases of enteric fever were reported, of which 733 (87.6%) were imported. Of the 733 imported cases, 522 cases were typhoid fever and 211 were paratyphoid fever. The proportion of imported cases of typhoid fever showed a minimal decline from 77.2% in 1998 to 73.1% in 2007, but the proportion of paratyphoid fever rose markedly from 65.2% in 1998 to 81.8% in 2007.

The proportion for Chinese, Malays, Indians, and other ethnic groups affected by enteric fevers were 41.8%, 19.1%, 25.9%, and 13.1%, respectively. Of the imported cases, 35.5% were Singapore residents, 27.7% were work permit / employment pass holders, 21.4% were foreigners seeking medical treatment in Singapore, 10.5% were student pass holders, 3.7% were tourists from other countries and 1.2% comprised other categories of foreigners.

The majority of imported enteric fevers cases were from Southeast Asia (62.8%) and South Asia (34.4%).

Cholera: It is an uncommon imported disease with an average rate of only one case per year. No local transmission occurred due to the importation of these cases. Between 1998 and 2007, 69 local cases occurred unrelated to importation.

III Newly Emerging Infectious Diseases

In 2003, there were 6 imported cases of SARS, comprising 3 cases from Hong Kong, 2 cases from Guangdong and 1 case from Beijing. Imported cases led to secondary transmission and the overall number of SARS cases in 2003 was 238, meaning 6 out of 238 cases were imported (2.5%). Three cases of chikungunya were imported mostly from India (2) and Sri Lanka (1) in 2006 and 10 cases were imported mostly from India in 2007. No local transmission occurred, all (100%) of the chikungunya cases in 2006 and 2007 were imported.

Discussion

Our findings show that importation of communicable diseases such as malaria, viral hepatitis and enteric fever into Singapore account for the vast majority of these notified

national cases.

The example of malaria, the most frequently imported disease, highlights the vulnerability of an industrialised and modern city in the tropics where the vector for malaria is still present.¹¹ Singapore was declared malaria free in 1982, and currently all malaria cases reported in Singapore are due to importation, except for rare instances of local non-sustainable transmission, usually among foreign workers in Singapore.^{12,13} Despite the extremely low *Anopheles* vector population, a total of 24 localised outbreaks involving 179 cases occurred between 1983 and 2007.¹⁴ Most of these local outbreaks can be traced to foreign workers with imported relapsing vivax malaria who did not seek medical treatment early. In 2007, 3 malaria cases were caused by *Plasmodium knowlesi*, a newly recognised simian malaria which was probably acquired in a forested area where long-tail macaques had been sighted.¹⁵ However, swift public health interventions led to rapid containment of all local outbreaks.

There has been an increase in malaria cases imported from Africa since the previous study⁴ from 1.6% (1977 to 1982) to 6.1% (1998 to 2007), possibly reflecting increasing travel to Africa or more adventurous travel patterns.¹⁶

With increasing access to sanitation and enhanced quality control of imported seafood, locally acquired hepatitis A has become a much less frequent problem,¹⁷ and our findings show that the proportion of imported cases of all hepatitis A cases is increasing rapidly. The proportion of imported typhoid and paratyphoid fever has also increased, although typhoid fever as a cause of enteric fever has decreased, whereas paratyphoid fever has increased from 65% in 1998 to 82% in 2007. The emergence of paratyphoid and relative decrease of typhoid fever has also been observed in other developed countries.¹⁸⁻²⁰ Recent data indicate that *S. paratyphi A* is an increasingly important cause of enteric fever, in particular in Asia.²¹⁻²³ Unlike *S. typhi*, there is no commercially available vaccine against *S. paratyphi*. It has been postulated that *S. paratyphi* is emerging as this pathogen expands to fill the niche created by the vaccine-induced reduction in prevalence of *S. typhi*.^{22,23}

The 3 most frequently imported diseases to Singapore (malaria, hepatitis A, and typhoid fever) are theoretically preventable, be it via malaria drug prophylaxis or readily available vaccines against hepatitis A and typhoid fever.²⁴ However, an airport study amongst Singaporean and other Asian travellers showed that awareness about the need for pre-travel consultation, malaria prophylaxis and travel vaccines is very low among Asian travellers, far lower than that of Western travellers.¹⁶ Only 40% carried malaria prophylaxis when traveling to definitive malaria endemic areas.¹⁶ Further decrease of cases of hepatitis A and typhoid fever in Singapore would require reduction of travel-

related cases through greater awareness of food hygiene and effective pre-travel vaccination.²⁵ Despite a substantial number of travel medicine clinics in Singapore, the overall vaccination uptake against Hepatitis A and typhoid fever in Singapore remains low.^{16, 26}

However, even if the protection of travellers could effectively be improved, the impact on reducing the importation of malaria, viral hepatitis and enteric fever would not be substantial as the majority of importations is not due to travelling Singaporean residents, but due to immigrant workers. Targeting the immigrant foreign worker populations (mainly from South Asia) for vaccination is logistically difficult and costly. The Singapore authorities have put measures in place with regard to screening of immigrant workers at entry point in addition to the mandatory annual health screening.

Furthermore, importation of diseases not only occurs via humans (by route of travellers), but also via importation of food and animals. Several outbreaks of hepatitis A were due to imported cockles and oysters.^{3,27,28} A large outbreak of 167 cases of paratyphoid A was reported in Singapore in 1996 and was due to importation of de-shelled coconut.²⁹ In 1999, Nipah virus was introduced to Singapore via imported pigs from Malaysia.³⁰⁻³² Contact with live pigs appeared to be the most important risk factor for human Nipah virus infection; and all cases occurred in abattoir workers. The outbreak was contained by banning the importation of pigs from Malaysia.³⁰

Cholera, although still of concern in Singapore in the 1980s^{4,33} is now an uncommon disease, both imported as well as locally acquired. Sporadic outbreaks that were reported in 1982 (15 cases), 1993 (12 cases), 1999 (8 cases) and 2004 (10 cases) were food-borne outbreaks and not related to importation via travellers.^{6,33,34}

Our findings related to SARS and chikungunya show that a small number of imported cases can lead to a relatively large national outbreak.

Travel was responsible for the rapid intercontinental spread of SARS.³⁵ Of the 6 imported cases of SARS to Singapore in 2003, 2 were imported before the disease was known and no infection control measures were in place. All other cases were imported at a time when infection control measures were in place.³⁶ Only the first imported case resulted in contacts and health care workers that ultimately led to the national outbreak with a total of 238 cases reported from March to May 2003.³⁷⁻³⁹ With the rapid implementation of extensive public health education on SARS, enhanced infection control measures, and early isolation, the other 4 patients were admitted much earlier and isolated immediately. There were no secondary cases most likely because of their comparatively prompt identification and

isolation.³⁶ SARS was effectively controlled in Singapore and subsequently also worldwide in the same year. SARS is easier to control than influenza because of the longer incubation time, the lack of asymptomatic cases, and the fact that transmission is highest later in the course of the disease.⁴⁰ In contrast, the peak of transmission for influenza occurs before onset of symptoms or in the first days of symptoms, thereby rendering isolation and quarantine less effective as a public health measure.⁴⁰

Singapore has been substantially affected by 3 influenza pandemics in the 20th century.⁴¹ The preventive measures instituted by the Singapore government during the pandemics included the closure of schools, promulgation of public health messages, setting up of influenza treatment centers, and screening at ports. In 2009, the H1N1 pandemic also affected Singapore. Singapore's defense against imported novel influenza A (H1N1-2009) comprised public health measures in compliance with the World Health Organization's (WHO) International Health Regulations (IHR), 2005.⁴² However, local spread occurred, despite all measures.

Arthropod-borne viral diseases are another concern. Because of the island-wide abundance of the mosquito vector of the genus *Aedes*, Singapore is vulnerable to the importation of arboviral diseases leading to indigenous transmission, for example for yellow fever and chikungunya. Fortunately, importation of yellow fever has to date not taken place, probably in part due to the international vaccine requirement against yellow fever for travellers from yellow fever endemic countries to Singapore.^{43,44} However, chikungunya was first imported in 2006 and 2007. While no local transmission occurred during these years, chikungunya caused a local outbreak in early 2008 and by the end of the year, extensive indigenous transmission occurred, resulting in more than 600 cases.⁴⁵

In summary, because of high rates of immigration and mobility, Singapore is highly vulnerable to the importation of diseases such as malaria, viral hepatitis, enteric fever, and newly emerging pathogens. In particular, mosquito-borne diseases are at risk of becoming entrenched, as seen by the example of chikungunya. Although the proportion of imported diseases in comparison to all incoming passengers/travellers is decreasing, overall the proportion of imported cases over all cases is increasing for certain diseases such as hepatitis A. The strategies adopted by Singapore in preventing transmission of imported communicable diseases are to strengthen the home defenses through improvement in vector control, environmental sanitation, vaccination of the population where applicable, and developing a comprehensive system of epidemiological surveillance. A prompt system of notification by primary care physicians and epidemiological investigation of communicable

diseases will enable the focus of disease introduction to be recognised and controlled.

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