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Dengue surveillance by proxy: travellers as sentinels for outbreaks in the Pacific Islands

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SUMMARY

Sensitive surveillance systems are crucial for effective control of infectious disease outbreaks, and regional surveillance could provide valuable data to supplement global systems, improve sensitivity and timeliness of reporting, or capture otherwise undetected outbreaks. In New Zealand (NZ), there are no endemic arboviral diseases in humans, and the majority of dengue cases are imported from neighbouring Pacific Islands where comprehensive surveillance systems are under development. From 1997 to 2009, 679 cases of dengue were reported in NZ (74.2% acquired from the Pacific Islands), and the patterns of reported incidence of dengue acquired from different islands closely reflected local reported incidence in those areas. NZ is therefore in a unique position to provide early alerts on dengue outbreaks in the Pacific Islands. Such a strategy would reduce disease burden in both the Pacific Islands and NZ, and provide a model for transnational collaboration in disease surveillance with regional as well as global benefits.

Key words: Dengue fever, public health emerging infections, surveillance, travellers' infection, tropical diseases.

INTRODUCTION

Dengue is an emerging infectious disease with 50 million cases per year in over 100 countries, and incidence has increased by 30-fold over the past 50 years [1]. Over the past decade, unprecedented numbers of cases have been reported from Asia, Central America and South America. The emergence of dengue has also been observed in the Pacific, with all four dengue strains circulating over a series of outbreaks [1, 2]. Although surveillance in the Pacific Islands is currently limited, 14 countries

and territories in the region reported dengue outbreaks in 2009 [3].

Factors contributing to dengue emergence include international travel and trade, urbanization, overcrowding, virus evolution, limited vector control, and changing climate [4–8]. The global geographical expansion of dengue together with the co-circulation of multiple strains have also resulted in increasing risk of dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS) [1]. Travellers to dengue-endemic areas are not only at risk of infection and illness, but also play a major role in transporting dengue viruses around the world, with the risk of introducing dengue to new areas if suitable mosquito vectors are present or become established [9]. Globally, the main vectors involved in dengue

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transmission are *Aedes aegypti* and *Aedes albopictus* mosquitoes, with *Aedes polynesiensis* identified as being important in the Pacific region [1, 10].

There are no endemic mosquito-borne diseases in humans in New Zealand (NZ), and all arboviral infections including dengue are acquired overseas [11]. Dengue in NZ's nearest neighbours therefore poses a significant health risk to New Zealanders, many of whom travel to other Pacific Islands as favoured destinations for holidays, business, and family reasons. Dengue is a leading cause of post-travel fever and hospitalizations in New Zealanders [12, 13], and with the unprecedented growth in international travel and tourism, the number of dengue infections reported in NZ is likely to increase in the future. By helping to reduce the impact of dengue emergence in the Pacific, NZ would therefore be protecting the health of its own citizens as well as providing a useful model for transnational collaboration in public health. Such a strategy is important in supporting developing countries to increase regional capacity to detect and control disease outbreaks, with the aim of reducing local disease burden as well as limiting the global spread of infectious diseases [11, 14].

Sensitive surveillance systems are crucial for providing intelligence to effectively and efficiently control infectious disease outbreaks [14], and regional surveillance systems could potentially provide valuable data to supplement global surveillance, improve sensitivity and timeliness of reporting, or capture outbreaks that might not otherwise be detected [15]. Timely reporting of dengue in travellers has been shown to provide important sentinel information on outbreaks in the countries or regions where the infection was acquired [9, 16, 17]. In this paper, we present epidemiological data on all reported cases of dengue diagnosed in NZ from 1997 to 2009, and discuss the use of such surveillance data as sentinel information for dengue outbreaks in the Pacific Islands.

METHODS

Dengue is a notifiable disease in NZ, and all cases reported to the Notifiable Disease Surveillance System (NDSS) [18] from 1997 to 2009 were included for analysis. Anonymized information on demographics, travel history, mosquito avoidance behaviour, and diagnostic tests used were obtained from the NDSS. The travel history included up to three recently visited countries or territories. Because dengue has a short incubation period of 3–8 days,

the last dengue-endemic area visited by a case was recorded as the probable place of infection. Cases were asked to classify the frequency with which they practised mosquito avoidance behaviour (insect repellents, protective clothing, bed nets, or sleeping in screened accommodation) as 'always', 'occasionally', 'rarely', or 'never'.

A 'probable' case was defined as a clinically compatible illness in a person who has travelled to a dengue-endemic area. If the diagnosis is confirmed or excluded by laboratory tests, a case may be subsequently defined as a 'confirmed case' or 'not a case'. All 'confirmed' and 'probable' cases were included for analysis, and those defined as 'not a case' were excluded. Laboratory tests used to define a 'confirmed case' were positive dengue IgM, or significant rise in dengue IgG levels, or isolation of dengue viruses, or a combination of the above. Unfortunately, limited clinical data were available, and no data were available on the dengue serotypes responsible for infections.

Data for NZ travellers (short-term departures) and visitors to NZ from 1997 to 2009 were obtained from Statistics New Zealand [19], and included information on age and sex of travellers, annual and monthly travel patterns, destinations of NZ travellers, and home countries of NZ's visitors.

The approximate country-specific incidences (cases/100 000 travellers and visitors/year) were calculated for travellers and visitors who acquired their dengue infection from the Cook Islands, Samoan Islands (Samoa and American Samoa), Fiji, Tonga, or French Polynesia. Data for Samoa and American Samoa were combined for analyses because travellers often visited both destinations, and travel from NZ to American Samoa involves transiting through Samoa. Country-specific incidences were calculated using the total number of cases reported to the NDSS in NZ as the numerator; and data from Statistics New Zealand [19] on the number of short-term departures that NZ residents made to each of the countries plus the number of visitors received from the countries for each reporting year as the denominator. The annual incidences of dengue in Pacific Island countries were obtained from the WHO emerging disease surveillance and response database [20] for 2000–2009, and from the WHO DengueNet [21] for 1997–1999. Where data were only reported as the number of cases, the annual incidence/100 000 population were estimated using population data for each country [22].

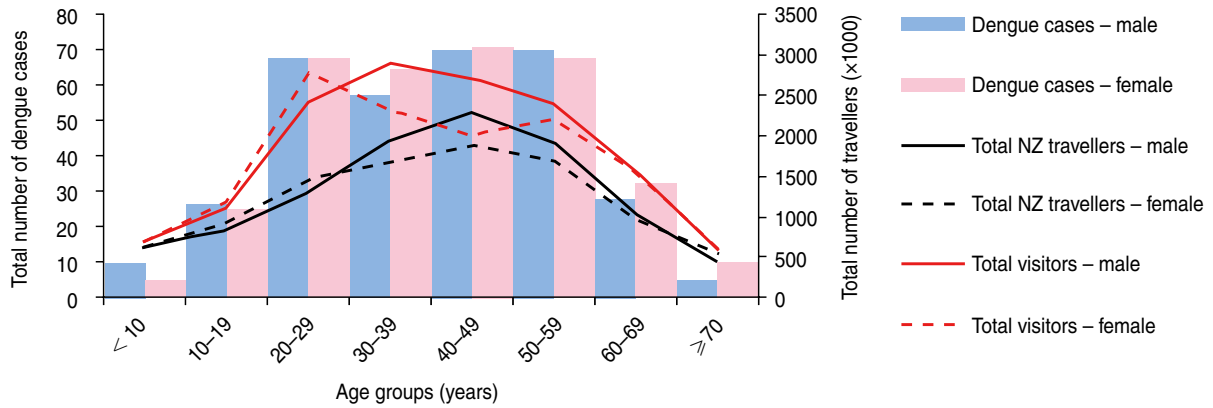


Fig. 1 [colour online]. Dengue cases reported in New Zealand by age and sex, 1997–2009.

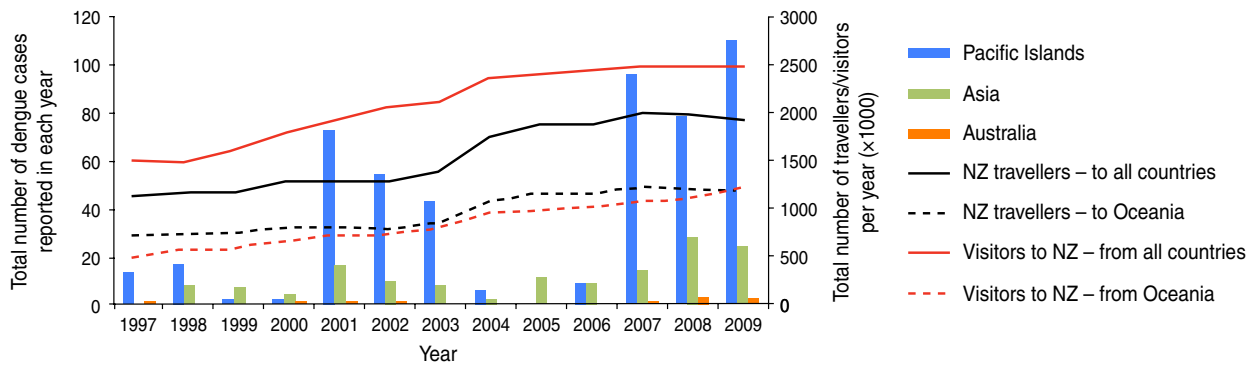


Fig. 2 [colour online]. Dengue cases reported in New Zealand by year, 1997–2009, for cases acquired from Pacific Islands, Asia, and Australia.

RESULTS

A total of 679 ‘confirmed’ and ‘probable’ cases of dengue were reported from 1997 to 2009, with 644 (94.8%) cases in NZ residents and 35 (5.2%) in international visitors. Approximately equal numbers were reported in males (50.4%) and females (49.2%), and 538 (79.2%) cases were diagnosed in travellers aged 20–59 years (Fig. 1). There were 333 (49.0%) cases of European ethnicity, 165 (24.3%) Pacific Islanders, 53 (7.8%) Asian, 13 (1.9%) Māori, and 115 (16.9%) of other or unknown ethnicity.

The most common regions where dengue was acquired were Pacific Islands (504 cases, 74.2%), Asia (141, 20.8%), and Australia (10, 1.5%). The most common Pacific Islands where infections were acquired were Cook Islands (168 cases), Samoan Islands (115 cases), Fiji (95 cases), Tonga (90 cases), and French Polynesia (21 cases). Most travellers (610 cases, 89.8%) had only visited one dengue-endemic area, but 49 (7.2%) had travelled to

two areas, and 20 (2.9%) to three areas. The number of cases reported from the Pacific Islands, Asia, and Australia in each year and each month are shown in Figures 2 and 3, respectively. Figure 4 shows the estimated country-specific annual incidences of dengue in travellers arriving from the Cook Islands, Samoan Islands, Fiji, Tonga, and French Polynesia compared to WHO-reported incidences of dengue for those areas.

Of the 679 dengue cases, 591 (87%) were laboratory-confirmed, and 88 (13%) were probable cases. Of the confirmed cases, 578 (97.8%) had positive IgM, 31 (5.2%) had a significant rise in IgG levels, and dengue virus was isolated from 58 (9.8%) cases. Some cases were confirmed by more than one positive laboratory test.

Fever was reported in 204 (30%) cases, encephalitis in 33 (4.9%), and arthritis and/or rash in 108 (15.9%) cases. There were no reported deaths, but 193 (28.4%) cases required hospitalization. The main sources of reporting were laboratories (354 cases, 52.1%), general practitioners (224, 33.0%), and hospital-based

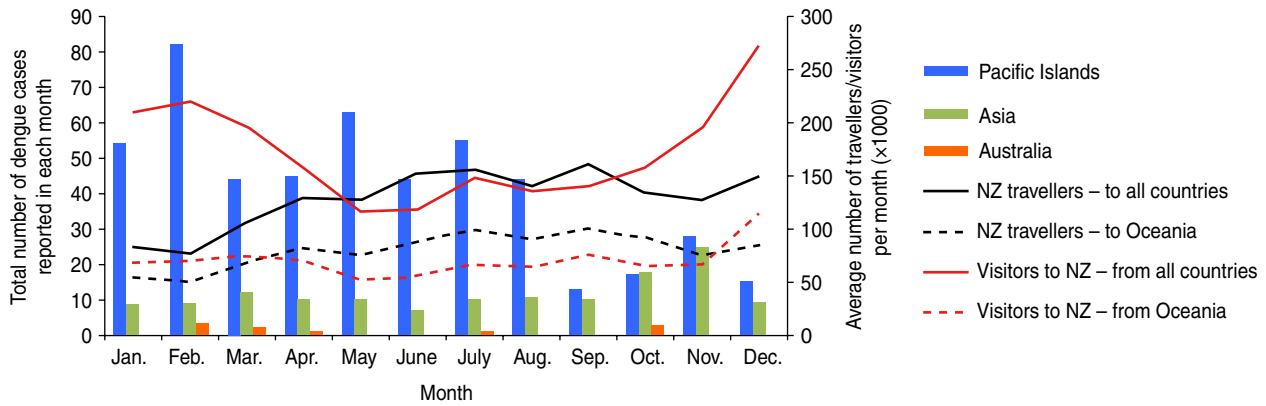


Fig. 3 [colour online]. Dengue cases reported in New Zealand by month, 1997–2009, for cases acquired from Pacific Islands, Asia, and Australia.

practitioners (61, 9.0%). Fourteen (2.1%) cases, including 13 NZ residents and one international visitor, reported a history of previous dengue infection.

Mosquito avoidance behaviour was unknown for about half of the cases. For travellers who provided information on the protective measures used, only 59.9% (218/364) always or occasionally used repellents, 36.5% (125/342) wore protective clothing, 53.5% (183/342) slept in screened accommodation, and 29.0% (99/341) used bed nets.

DISCUSSION

Dengue is an important cause of post-travel infections reported in NZ. Nearly 75% of cases were acquired in Pacific nations, reflecting the close proximity and cultural links between the Pacific and NZ, and the associated frequent exchange of travellers. Figure 3 shows that most cases from the Pacific Islands were diagnosed between January and August even though the number of travellers and visitors to and from Oceania did not vary significantly between months. Figures 2 and 4 show that travel to and from Oceania has steadily increased over the years, but the number of cases varied significantly between years. The highest numbers were reported from 2001 to 2003 (which coincided with a large outbreak of DENV-1 in multiple Pacific Islands [2]), and from 2007 to 2009 (which coincided with the appearance of DENV-4 in the Pacific Islands [23]). Monthly and annual variations in the number of dengue cases reported in NZ are therefore likely to reflect true variations in risk rather than changes in travel patterns over time.

In dengue cases reported in this paper, 28.4% required hospitalization and 4.9% developed enceph-

alitis, but there were no reported deaths. Encephalitis is not a common feature of dengue infection, and dengue serological tests are known to cross-react with other flavivirus infections [24]. It is therefore possible that at least some of the encephalitic cases were not true dengue infections. Globally, the reported percentage of dengue infections in returned travellers resulting in severe dengue (DHF or DSS) vary between countries [13, 25–28], and might be a reflection of differences in destinations, and the proportion of people travelling for recreation or work compared to those returning to home countries to visit families and friends. People who have lived in endemic areas are more likely to have previous exposure to dengue, and therefore are at higher risk of severe dengue. With increasing immigration from the Pacific Islands and South East Asia to NZ [19], the incidence of severe dengue in NZ might increase. Clinicians should be made aware of dengue outbreaks; encourage travellers to use insect repellents, protective clothing, bed nets, and screened accommodation; and have a high diagnostic suspicion for dengue in returned travellers with fever.

The GeoSentinel Network established by the International Society of Travel Medicine and the Centers for Disease Control and Prevention [16] has shown that the epidemiology of dengue in returned travellers reflects the seasonality, oscillations, and epidemics of dengue around the world [17]. Peaks in the number of dengue cases in travellers corresponded with epidemics in local populations, and GeoSentinel data on travellers who acquired dengue from Thailand in 2002 heralded an epidemic before local surveillance systems managed to detect the outbreaks and report them to the international community [4, 17]. Such

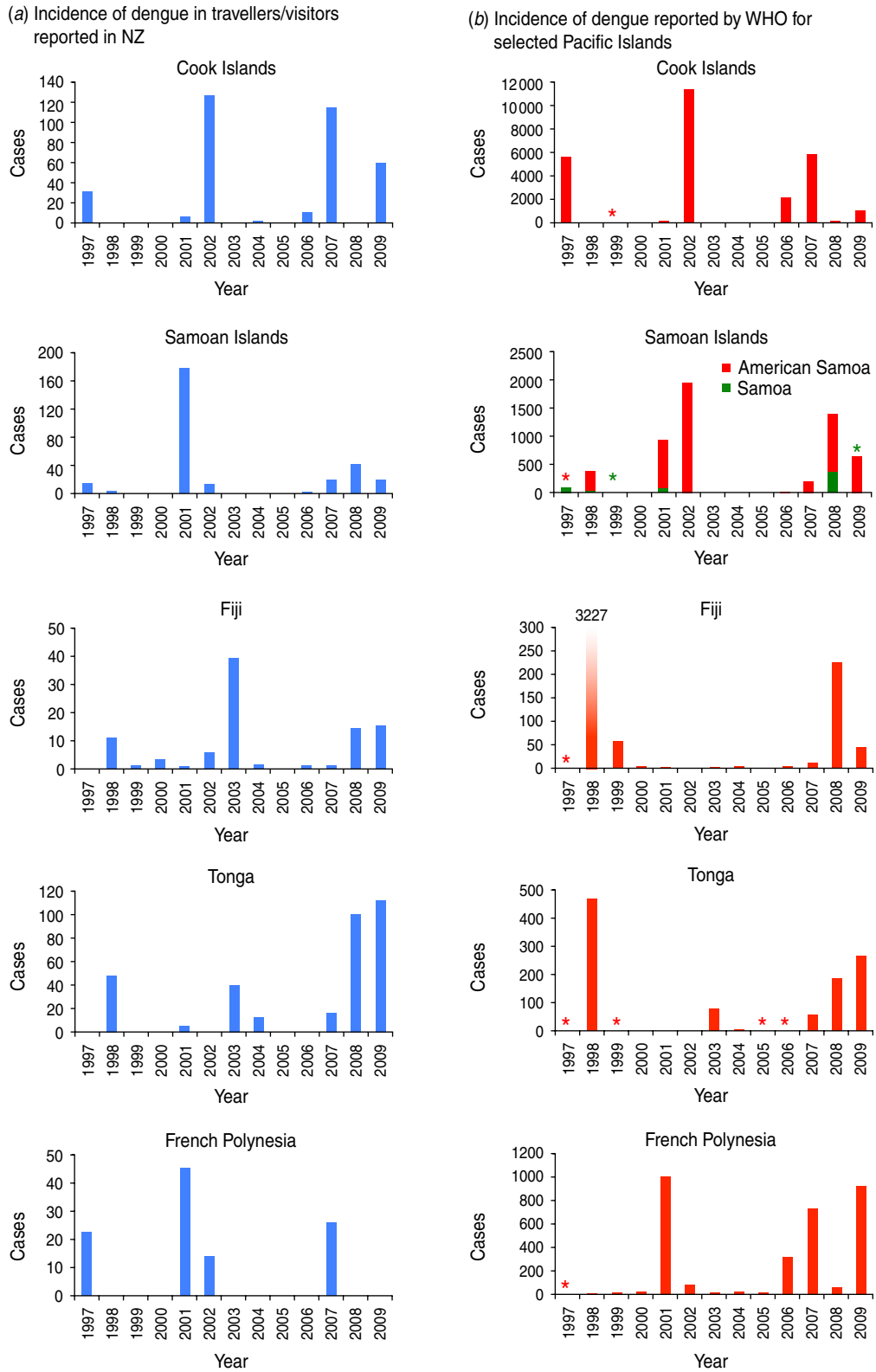


Fig. 4 [colour online]. Estimated incidence of dengue in (a) travellers/visitors (cases/100 000) arriving in New Zealand from Cook Islands, Samoan Islands, Fiji, Tonga, and French Polynesia compared to (b) WHO-reported incidence (cases/100 000 population), 1997–2009. * No data reported.

sentinel information is particularly useful for providing information on dengue and circulating serotypes in areas where there are limited laboratory facilities and surveillance systems.

Over the past decade, dengue has emerged as a more frequent diagnosis than malaria in ill returned travellers from all tropical regions except for Africa [29]. A survey of almost 25000 patients from 1996 to 2004 at 33 GeoSentinel clinics around the world found that dengue accounted for 31.5% of systemic febrile illnesses in travellers returning from South East Asia, 23.8% from the Caribbean, and 13.8% from South America [29]. However, the majority of the clinics in the study were located in North America, Europe, and Asia, and did not include sufficient numbers of ill returned travellers who had visited the Pacific Islands to provide information on the risk of dengue in the Pacific region. A report from GeoSentinel clinics in NZ from 1997 to 2001 found only one case of dengue in 205 ill returned travellers [30]. However, there were only two GeoSentinel sites in NZ (both located at travel medicine clinics), and the data would not be expected to capture the total number of dengue cases reported in NZ as reflected in the NDSS data. NZ is in a unique position to provide sentinel information on dengue outbreaks in the Pacific Islands because of the large number of people who travel to and from the neighbouring islands, the availability of laboratory diagnostic tests (including IgM, IgG, NS1 antigen, PCR, and virus isolation), and an established real-time surveillance system for notifiable diseases [18].

Figure 4 shows that patterns of reported incidence of dengue acquired in the Pacific Islands and reported in NZ closely reflects WHO-reported incidences in those islands. For example, there were peaks in dengue incidence in travellers and visitors who acquired dengue from Tonga in 1998, 2003, 2008, and 2009. Compared to WHO-reported dengue incidence for Tonga, peaks were also noted in the same years. Dengue surveillance data from NZ have been reported weekly to the WHO Western Pacific Regional Office since October 2008, providing valuable sentinel information on dengue incidence and outbreaks in the Pacific region and helping to expedite public health responses on a number of occasions, e.g. in Samoa and Tonga. Anomalies in reported incidences of dengue in NZ can therefore provide alerts to Pacific Islands and the global community about possible outbreaks, particularly for countries where comprehensive surveillance systems are developing.

As argued by previous authors [14, 15], from a public health perspective, timely surveillance reports of infectious diseases such as dengue in travellers provides useful sentinel information on outbreaks, and supplies epidemiological information that might not otherwise be available. Depending on the country of origin, this information may be important for preparing public health responses where the infection was acquired, and supporting developing countries to increase regional capacity to detect and control outbreaks.

CONCLUSION

Dengue is a significant health risk for New Zealanders travelling to the Pacific Islands, Asia, and Australia. The patterns of reported incidence of dengue acquired from the Pacific Islands and reported in NZ closely reflects reported incidences in those islands. Timely reporting of dengue in NZ's travellers and visitors could provide sentinel information and early warning on outbreaks to facilitate more effective public health interventions. Importantly, such collaboration would reduce morbidity from outbreaks both at the source and in the country of importation, providing a dual rationale for investment by more affluent countries.

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DECLARATION OF INTEREST

None.

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