The incidence of Ross River virus disease in South Australia, 1992 to 2003

Christopher M Horwood,[1] Peng Bi[2]

Abstract

Ross River virus (RRV) disease is the most frequently notified arboviral disease in Australia, and the burden of this disease to Australian society is significant. We have studied the incidence of RRV disease between 1992 and 2003 in South Australia. Our findings suggest that the incidence of the disease in South Australia over the study period was relatively stable. There were four epidemics in the study period, with the majority of cases acquired from regions along the River Murray. There was some evidence of spread of the disease to regions in which activity of RRV had not been previously recognised, such as the Mid-North and the South-East. In terms of disease distribution amongst the population, it was found that the highest rates occurred in the 30–49 year age range. There was no significant difference in disease rates between males and females. In order to facilitate further research into RRV disease transmission, we recommend that the suspected region of acquisition be a mandatory component of the national notification dataset. *Commun Dis Intell* 2005;29:291–296.

Keywords: Ross River virus disease, South Australia, epidemiology

Introduction

Ross River virus (RRV) causes a non-fatal disease in humans, and it has been estimated that between 70 and 90 per cent of people infected with RRV have either mild symptoms or no symptoms at all.[1,2] The typical features of RRV disease are joint pain and swelling (mainly in the extremities), lethargy, myalgia, rash (involving the trunk and limbs), fever, headache and depression.[3–6] With thousands of cases occurring in Australia each year, the burden of this disease to Australian society is significant; for example, it has been estimated that the direct and indirect health costs are in the tens of millions of dollars per year, and this is without taking into account the significant but intangible costs of the pain and suffering of the individual cases.[3,7–9]

RRV disease is the most common arboviral disease in Australia, and the virus has been isolated from more than 40 species of mosquito. Being a mosquito-borne disease, the distribution of RRV disease is closely tied to environmental conditions, as the availability of habitat and factors such as rainfall and temperature have a large influence on mosquito populations. The disease is endemic in the tropical regions of Australia, where the climate is conducive to mosquito breeding during the wet season. In the more temperate southern regions of Australia, the disease occurs relatively infrequently outside of epidemics.

In South Australia, the first reported epidemic occurred in 1956, when approximately 200 cases were reported from regions along the River Murray.[10,11] The disease has been notifiable in South Australia since 1980.[5]

The purpose of this study was to describe the incidence and distribution of RRV disease in South Australia for the period July 1992 to June 2003, and so extend the work done by Mudge, Cameron, Weinstein and others, whose descriptions of RRV disease in South Australia cover the period from its first detection in 1956 up to the summer of 1992/93.[5,12,13]

Methods

Data regarding notified cases of RRV disease for the study period were sourced from both the Australian Government and South Australian health departments (see acknowledgements). Data were obtained at the national level so that disease rates in South Australia could be compared with other parts of Australia. This national dataset consisted of the age and sex of the cases, as well as the Statistical Local Area (SLA) of their residence and the date of onset of symptoms. In addition to these fields, the South Australian dataset recorded the SLA where the infection was thought to have been acquired, as recorded on the form completed by the notifying

1. Communicable Disease Control Branch, Department of Human Services, Adelaide, South Australia
2. Senior Lecturer, Department of Public Health, The University of Adelaide, Adelaide, South Australia

Corresponding author: Mr Christopher Horwood, Department of Clinical Epidemiology, Flinders Medical Centre, Bedford Park, SA 5066. Telephone: +61 8 8204 6288. Email: chris.horwood@fmc.sa.gov.au

medical practitioner. For cases where this suspected region of acquisition had not been recorded, the place of residence was used as a substitute.

The analytical approach applied to these data was the traditional epidemiological method of classifying and comparing cases by time, person and place. Disease rates were derived from 2001 census data (SLA residential populations by age and sex) obtained from the Australian Bureau of Statistics. Electronic maps were produced using a computer software tool ('Csmart') developed by the South Australian Department of Health.

Results

There were 2,294 notifications of RRV disease to the South Australian health department during the study period (Figure 1), with the median annual rate being 3.8 cases per 100,000 population (Figure 2); these were considered confirmed cases on the basis that there was either a fourfold or greater change in serum antibody titres between acute and convalescent-phase serum specimens or there was demonstration of specific IgM antibodies in cerebrospinal fluid (CSF) or acute-phase serum or there was isolation of the virus from blood, CSF or tissue specimens.

Temporal distribution

Figure 1 highlights the four epidemics that occurred during the study period, which accounted for almost 90 per cent of the cases during the study period. The 1992/93 epidemic, with over 800 notifications, was the largest epidemic in South Australia on record.[10,11] Epidemics followed in 1996/97, with over 650 cases notified, and in 1999/00 and 2000/01, with more than 250 cases notified in each. These data suggest a general pattern of epidemics in South Australia every three to four years, and that over the study period the epidemics became smaller in terms of the number of notified cases.

Figure 1. Ross River virus notifications per month, South Australia, July 1992 to June 2003

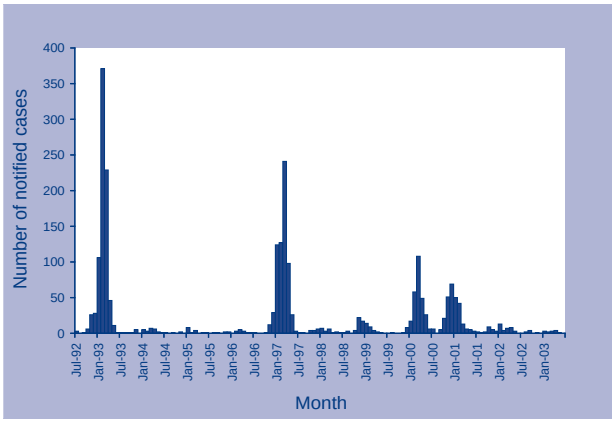
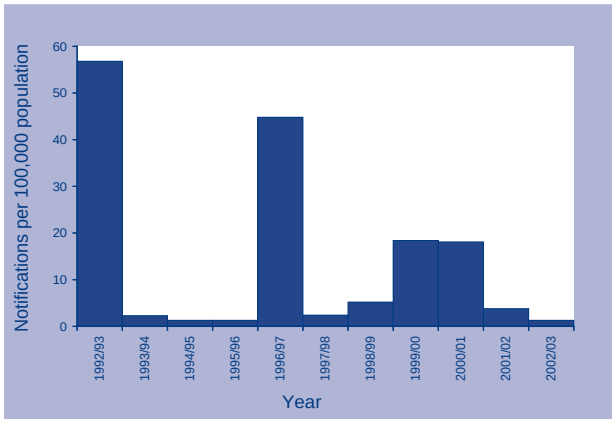


Figure 2. Ross River virus notifications per 100,000 per year, South Australia, July 1992 to June 2003

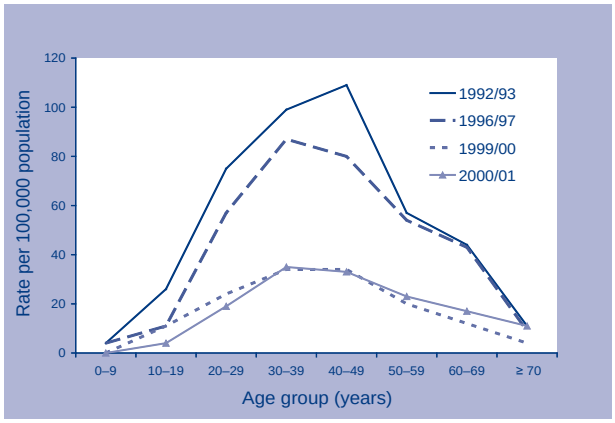


The peak months for the first three epidemics were February and March. For the 2000/01 epidemic however, the peak period was between November and February (Figure 1). Across the entire study period, over half the cases occurred in February and March, and almost 80 per cent occurred in the months January to April.

Age and sex distribution

Figure 3 shows the age-specific rates for each of the four epidemic years. In each of these epidemics the rates in young children, teenagers and people aged over 70 years were relatively low, and the highest rates consistently occurred in the 30–49 years age range. For Australia for the study period, the highest annual rates also occurred in the 30–39 years (38 cases per 100,000 population) and the 40–49 years (37 cases per 100,000 population) age ranges.

Figure 3. Ross River virus age-specific rates per 100,000 per epidemic year, South Australia, July 1992 to June 2003



The male to female ratio for the study period was 1.1:1, which was consistent with an underlying ratio of 1 (χ^2 = 2.26, df = 1, p > 0.1) and with the ratio for Australia for the same period (1:1).

There was no significant difference in the male: female ratio across age groups (Figure 4). The age group with the male to female ratio furthest from one was children aged less than ten years; this age group had a ratio of 1.7:1, but this value was based on only 16 cases.

Geographical distribution

Of the 2,294 South Australian notifications, 208 had a suspected region of acquisition outside of South Australia, and another 32 had neither a region of acquisition nor a place of residence recorded. Of the remaining 2,054 cases, 538 cases had no region of acquisition recorded and a further 155 cases had region of acquisition recorded as 'indeterminate' (e.g. 'Riverlands (indeterminate)', 'Far north (indeterminate)'). For these 693 cases (34% of 2,054), the region of acquisition was set to the place of residence. For the 1,569 cases where the region of acquisition had been recorded, the region of acquisition differed from the region of residence in 647 (41%) cases.

The regions of acquisition most commonly reported were the Riverland (730 cases) and the Murray Mallee (321 cases). The next most prominent regions were the Eyre Peninsula, Adelaide, the Far North and the Flinders Ranges, with 151, 143, 127 and 117 cases respectively (see Figure 5).

Figure 4. Ratio of males to females, South Australia, 1992 to 2003, by age group

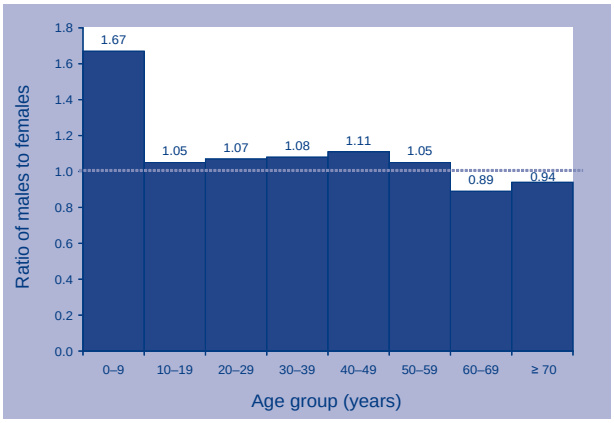
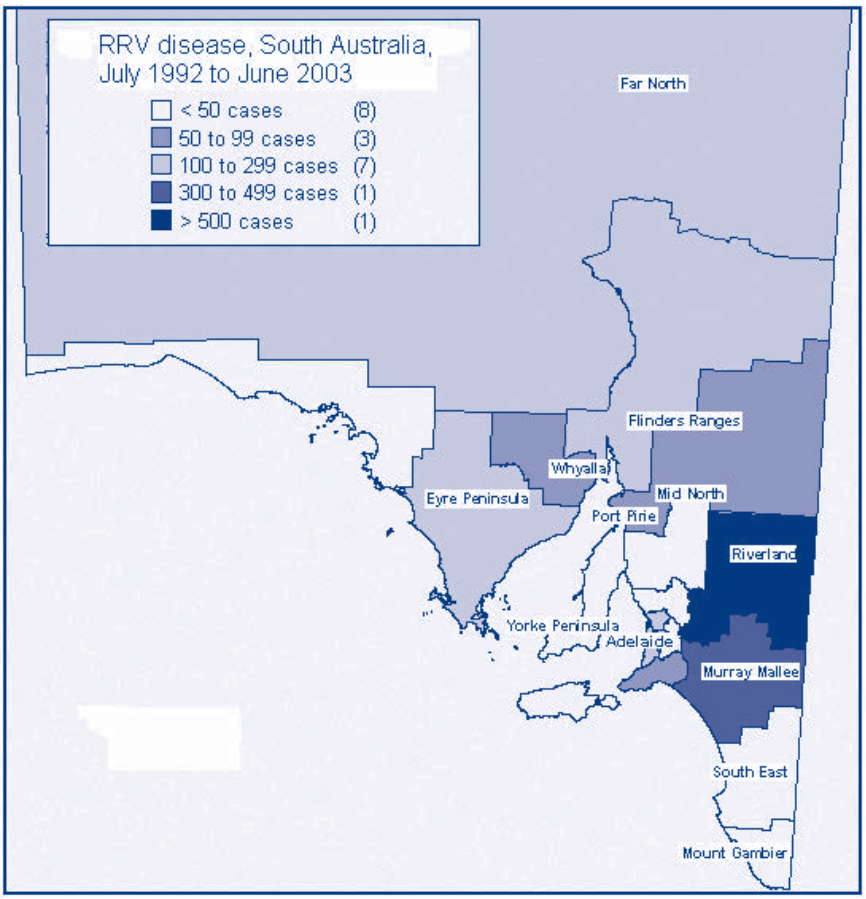


Figure 5. Distribution of Ross River virus cases, South Australia, July 1992 to June 2003, by suspected region of acquisition



Regions along the River Murray were major foci of RRV disease in each of the four epidemic years. In 1992/93, there was also significant activity (at least 10 cases) in coastal regions such as Whyalla, the Lower Yorke Peninsula and the Lower Eyre Peninsula. In 1996/97, the activity tended to be further north, with no cases in either the Lower Yorke Peninsula or the Lower Eyre Peninsula. In 1999/00, activity again tended to be further north, with few cases in the south and again, no cases in either the Lower Yorke Peninsula or the Lower Eyre Peninsula. However, the following year, there were few cases in the northern part of South Australia, many more cases in the southern part, and cases re-appeared in the Yorke Peninsula and the Eyre Peninsula.

Over the study period, cases were acquired from every region in rural South Australia. Compared to the 1992/93 epidemic, the proportion of cases in the Riverland and Murray Mallee regions post-1992/93 dropped from 56 per cent to 42 per cent; in contrast, there was a greater proportion of cases post-1992/93 arising from the Eyre Peninsula, the Flinders Ranges and the Far North (Table).

Table. Percentage of Ross River virus cases, South Australia, 1992/93 and post-1992/93, by suspected region of acquisition

Region	1992/93	1993/94 to 2002/03
Riverland	37	30
Murray Mallee	19	12
Adelaide	12	11
Far North	1	9
Lincoln	5	8
Flinders Ranges	3	7
Whyalla	2	4
Pirie	4	3
Lower South East	1	3
Fleurieu	5	3
West Coast	1	2
Upper South East	3	2
Lower North	3	2
Barossa	2	1
Yorke	3	1
Kangaroo Island	0	1
Onkaparinga	1	0

Discussion

There were three epidemics of RRV disease in South Australia in the decade following the record-level outbreak of 1992/93. The mean number of notifications for these three epidemics was over 400 cases per year, compared to over 800 cases in 1992/93. For the seven non-epidemic years, the average number of cases was less than 40 per year. While the study period was relatively short, the notification data suggest that the incidence of RRV disease in South Australia is not rising. This may not be the case for other parts of Australia, as a number of authors have recently stated that the incidence of RRV disease in Australia is increasing.[3,14]

The number of notified cases is generally considered an under-estimate of the true incidence of RRV disease, i.e. the notification fraction is less than one.[8] The fraction itself is very difficult to precisely estimate, but some researchers have estimated it to be less than 50 per cent.[15] It is therefore always difficult to meaningfully interpret incidence rates which are derived from notification data. Furthermore, the national notification dataset for RRV disease only covers the period since 1991, and so the time-frame of available data may not be sufficient to reveal underlying trends. Prior to 1991, the methods for diagnosis and reporting of RRV disease were less standardised, and so meaningful comparisons would be difficult to make.[8]

Selden and Cameron concluded that in the 1992/93 South Australian epidemic the virus was being acquired in regions well away from the traditional areas along the River Murray, suggesting that the virus was spreading to regions in which activity of RRV had not been previously recognised.[5] The data in this study also suggest that RRV disease has spread into more regions of South Australia over the study period, particularly the northern parts of South Australia.

Of the 68 rural and 56 metropolitan SLAs in South Australia, 53 and 34 of them, respectively, reported cases during the epidemic of 1992/93. Four rural SLAs reported cases for the first time in the epidemic of 1996/97 and four more SLAs reported cases for the first time during the following three years. Of these eight SLAs, three were in the south around Mount Gambier and three were around Port Pirie in the mid-north. Such a finding might be due not only to spread of the virus, but also the result of increased awareness and recognition by medical practitioners, improved laboratory diagnostic methods, and increased encroachment by humans into areas conducive to mosquito breeding, such as wetlands.[7]

In order to study the spread of the virus, it is important that the suspected region of acquisition be collected for all cases. One of the limitations of the national dataset is that the suspected region of acquisition is not routinely collected, and so studies which have utilised these data have generally been required to use the place of residence as a proxy for the region of acquisition. Such approximations may not be very problematic in the endemic, northern regions of Australia, where the region of acquisition is often likely to be the same as the place of residence,

but may be more problematic for a region such as South Australia, where most of the population lives in metropolitan Adelaide where the disease is not endemic, and so for many cases the disease is acquired as a result of travel to an endemic region. It is therefore recommended that the routine collection of suspected region of acquisition be carried out in all Australian states and territories, and that this information then also be recorded at the national level. More precise and complete data regarding the suspected region of acquisition will enable researchers to better understand the geographical distribution of RRV disease.

Epidemics occurred approximately every three to four years, with a large proportion of cases occurring along the River Murray. The distribution of cases away from the River Murray varied in each epidemic, with two epidemics affecting mainly the northern parts of South Australia, and the other two affecting the southern regions. The size of the epidemics, in terms of the number of notified cases, decreased over the study period. This reduction may reflect, at least in part, increasing levels of immunity in the South Australian population, particularly in endemic regions along the River Murray. While it is generally considered that RRV infection confers lifelong immunity, immunity to RRV is not well understood. A general practitioner in Berri (one of the major towns in the Riverland), noted that some patients reported symptoms of RRV disease during epidemics in both 1971 and 1974, suggesting that infection with RRV may lead to only partial immunity in some people.[16,17]

This study showed that the age and sex distribution of RRV disease in South Australia during the study period was similar to that for Australia as a whole. It appears to be a disease primarily of young to middle-aged adults (30–50 years), and the male to female ratio is essentially one to one. The relatively low rates of disease in children and teenagers are thought to be due to a combination of reduced exposure to mosquitoes and a tendency for children to experience either sub-clinical or mild infections. The relatively low rates in those aged 70 or over are thought to be due to a combination of reduced exposure to mosquitoes and increased immunity due to previous infection.[16]

Much remains to be learnt about the incidence and distribution of RRV disease across Australia. More detailed data collection, particularly with regard to the suspected region of acquisition, will assist in the development of interventions aimed at reducing the impact of this significant public health issue.

Acknowledgements

Communicable Disease Control Branch, South Australian Department of Health; for providing notification data for South Australian cases.

Communicable Diseases Network Australia – National Notifiable Diseases Surveillance System; for providing notification data for Australian cases.

References

1. Mackenzie JS, Broom AK, Hall RA, Johansen CA, Lindsay MD, Phillips DA, *et al.* Arboviruses in the Australian region, 1990 to 1998. *Commun Dis Intell* 1998;22:93–99.

2. Stocks NP, Selden SM, Cameron AS. Ross River virus infection. Diagnosis and treatment by general practitioners in South Australia. *Aust Fam Physician* 1997;26:710–717.

3. Harley D, Sleigh A, Ritchie S. Ross River virus transmission, infection and disease: a cross-disciplinary review. *Clin Microbiol Rev* 2001;14:909–932.

4. Mackenzie JS, Smith DW. Mosquito-borne viruses and epidemic polyarthritis. *Med J Aust* 1996;164:90–93.

5. Selden SM, Cameron AS. Changing epidemiology of Ross River virus disease in South Australia. *Med J Aust* 1996;165:313–317.

6. Tong S, Bi P, Parton K, Hobbs J, McMichael AJ. Climate variability and transmission of epidemic polyarthritis. *Lancet* 1998;351:1100.

7. Mackenzie JS. Emerging viral diseases: an Australian perspective. *Emerg Infect Dis* 1999;5:1–8.

8. Russell RC. Ross River virus: ecology and distribution. *Annu Rev Entomol* 2002;47:1–31.

9. Russell RC. Mosquito-borne arboviruses in Australia: the current scene and implications of climate change for human health. *Int J Parasitol* 1998;28:955–969.

10. Kelly-Hope LA, Purdie DM, Kay BH. Ross River virus disease in Australia, 1886–1998, with analysis of risk factors associated with outbreaks. *J Med Entomol* 2004;41:133–150.

11. Seglenieks Z, Moore BW. Epidemic polyarthritis in South Australia: report on an outbreak in 1971. *Med J Aust* 1974;2:552–556.

12. Weinstein P, Worswick D, Macintyre A, Cameron S. Ten years of arbovirus surveillance in South Australia, and the introduction of human sentinels. *Arbovirus Research Aust* 1992;6:258–260.

13. Mudge PR, Lim RSH, Radford AJ. Epidemic polyarthritis in South Australia, 1979–1980. *Med J Aust* 1980;2:626–627.

14. Tong S. Ross River virus disease in Australia: epidemiology, socioecology and public health response. *Intern Med J* 2004;34:58–60.

15. ABC Online. Ross River outbreak: could more Tasmanians have the virus and not know it? Available from: http://www.abc.net.au/hobart/stories/s542580.htm Accessed on 16 June 2005.

16. Woodruff RE. Climate and environment as signal predictors of Ross River virus disease. PhD thesis; 2003.

17. Mudge PR. Epidemic polyarthritis in South Australia. *Med J Aust* 1974;2:823.