# Murray Valley encephalitis in Western Australia in 2000, with evidence of southerly spread

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## Abstract

**We describe the epidemiological and clinical features of human Murray Valley encephalitis (MVE) and Kunjin (KUN) virus infections in Western Australia (WA) during March to July 2000. A case series was performed. For laboratory-confirmed cases, travel histories and clinical details were collected from patients, family members, friends or treating physicians. Surveillance data from the sentinel chicken program and climatic conditions were reviewed. Nine encephalitic cases of MVE were recorded. Eight were non-Aboriginal adults (age range, 25 to 79 years; 5 male, 3 female) and 1 was an Aboriginal boy. Four cases acquired infection in the Murchison and Midwest regions of WA from which no human cases of MVE have been reported previously. One of the 9 cases was fatal and 3 had severe neurological sequelae. Five non-encephalitic infections were also recorded, 3 MVE and 2 KUN. Encephalitis caused by MVE virus remains a serious problem with no improvement in clinical outcomes in the last 25 years. Excessive rainfall with widespread flooding in the northern two-thirds of WA provided ideal conditions for mosquito breeding and favoured southerly spread of the virus into new and more heavily populated areas. Surveillance in WA with sentinel chickens and mosquito trapping needs expansion to define the boundaries of MVE virus activity. To enable timely warnings to the public, and to institute mosquito control where feasible, continued surveillance in all Australian areas at risk is indicated. *Commun Dis Intell* 2000;24:368-372.**

*Keywords: Murray Valley encephalitis virus, Kunjin virus, arbovirus, mosquito, outbreak*

## *Introduction*

Murray Valley encephalitis virus (MVE)* is a mosquito-borne flavivirus, named after outbreaks of disease centred on the Murray-Darling River Basin in south-eastern Australia, the last and largest of which occurred in 1974.[1] Subsequently MVE was found to be endemic in the Kimberley region of far northern Western Australia (WA) and adjacent areas of the Northern Territory (NT) where it appears to be maintained in a waterbird-mosquito cycle.[2] In these areas, regular activity leads to very high infection rates within the resident Aboriginal populations.[3,4]

Only about 1 in 1,000 infections with MVE results in clinical encephalitis,[5] while the rest cause an asymptomatic infection or a non-specific febrile illness. Occasional cases of flavivirus encephalitis are due to the closely related Kunjin virus (KUN) though this manifestation of infection is much less common than with MVE. Limited published data[5] and unpublished anecdotal reports suggest that Kunjin virus more often causes a febrile illness with headache, myalgia, arthralgia and sometimes a maculopapular rash.

In clinical case series reported from WA and the NT,[5,6] MVE/KUN encephalitis had a case fatality rate of 24 per cent with a further 56 per cent having neurological sequelae. The incubation period is estimated to be between 1 and 4 weeks,[7] after which time clinical cases abruptly develop fever, headache, malaise and, possibly, altered mental state, anorexia, nausea, vomiting and dizziness. Children usually present with convulsions, while tremor and cranial nerve palsies can develop in patients of any age. Severe cases may progress to coma, respiratory failure and death.[5,6]

*Culex annulirostris* is the major vector of MVE in Australia and this mosquito species readily feeds on birds, as well as a range of mammals including humans.[8] MVE activity is monitored by detecting specific antibodies in serum samples from sentinel chicken flocks. Flocks of 12 chickens are located in populated areas or at major dams in northern WA, covering the Kimberley, Pilbara, Gascoyne, Murchison and Midwest regions (Figure). Blood samples are collected from flocks fortnightly during and immediately following the wet season and monthly at other times.

In WA, 14 cases of MVE encephalitis were notified between 1990 and 1998.[9] Nine were during the 1993 wet season. Disease typically occurred in Aboriginal children residing in the Kimberley or among those of any age travelling through, or recently moved to, the region.[5,10] In the past, epidemic activity has occasionally been recorded in the Pilbara and Gascoyne regions with cases in both areas in 1981 and a case possibly acquired in the Gascoyne in 1997.[5]

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In 2000, 9 cases of MVE encephalitis were identified which, unlike other years, occurred mainly south of the Kimberley; in addition, there were 5 non-encephalitic MVE/KUN infections in WA. In this paper we report on the epidemiological and clinical features of these MVE/KUN cases and review surveillance data from the sentinel chicken program and the environmental conditions observed during the 2000 wet season.

## *Methods*

### Case Series

We collected travel histories and clinical details from patients, family members, friends and treating physicians. For each encephalitic case, a member of the medical team was interviewed by telephone using a structured questionnaire to document the likely place of exposure, clinical severity of illness and outcome.

### Laboratory testing

Sera were tested at the Western Australian Centre for Pathology and Medical Research using a standard flavivirus haemagglutination inhibition (HI) test and IgM to MVE and KUN was detected by an indirect immunofluorescence assay (IFA) in serum and cerebrospinal fluid (CSF) samples.[5,6] Where the HI titre failed to show a rise, IgG titres were also determined by IFA. Specific IgG to MVE or KUN was titred using a competitive enzyme immunoassay (EIA).[11] MVE-RNA in CSF or brain tissue was detected using reverse transcription, then DNA amplification by polymerase chain reaction (RT-PCR).[12]

For encephalitic illness, definite and presumptive cases were included. A definite case was a patient with a rising HI titre (at least fourfold) or rising IFA-IgG in serum, and/or detection of MVE-RNA by RT-PCR in CSF or brain tissue, or a positive HI titre and IFA-IgM with an exposure history limited to this wet season. A presumptive case was a case of encephalitis with a positive flavivirus HI titre and IFA-IgM in serum and/or CSF, without a rising antibody titre or without a documented exposure history limited to this wet season.

Non-encephalitic cases were included if there was a rising HI titre or rising IFA-IgG, or if a positive HI titre and IFA-IgM with an exposure history limited to this wet season was documented.

Cases were assigned as MVE or KUN based on the competitive EIA results and the RT-PCR in the CSF or brain tissue.

## *Results*

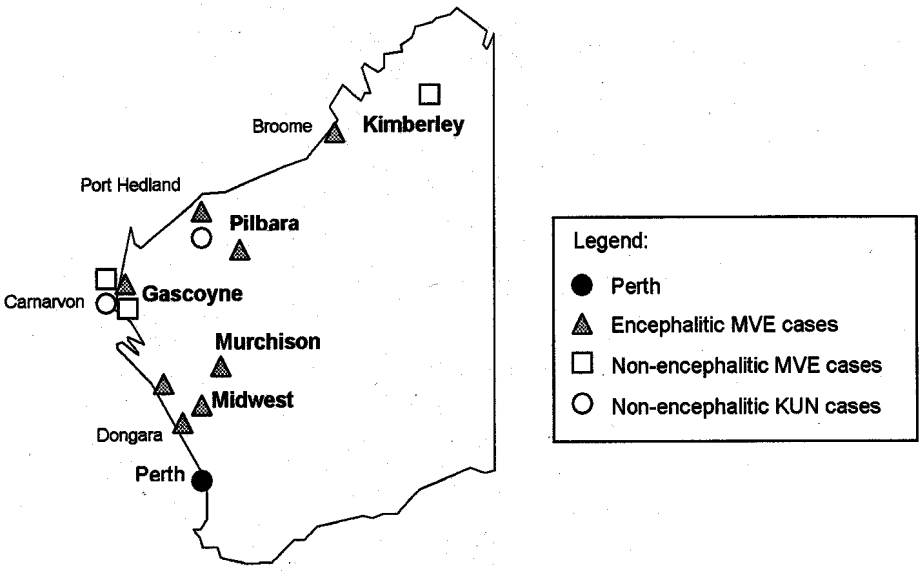
Nine cases of encephalitis caused by MVE putatively acquired in WA between March and May 2000 were recorded (Table). Six were definite and 3 presumptive. Three females and 6 males were affected. Eight cases were non-Aboriginal adults, aged between 25 and 79 years, and 1 case was an Aboriginal boy of 10 months. For the first time, MVE infection acquired in the Murchison and Midwest regions was identified, with 1 and 3 clinical cases, respectively. One case acquired the illness in the town of Dongara, only 315 km north of Perth (Figure).

### Travel histories

Four cases had not travelled in the month preceding illness and presumably acquired infection in their region of residence (Pilbara, Murchison and Midwest). Two worked on remote stations and 2 lived in towns. High numbers of mosquitoes and extensive ground water were reported near their abodes and 2 cases distinctly recalled being heavily bitten by mosquitoes in the weeks prior to illness onset.

The remaining 5 cases were travellers to northern WA. The 10-month-old child probably acquired the infection while camped south of Newman in the Pilbara. The 55-year-old male was almost certainly infected in Kalbarri in the Midwest, where he had been staying between 13 March and 6 April. The 64-year-old male went on a fishing expedition with 4 male companions in late March. The party reported being heavily bitten by mosquitoes while camping north of Carnarvon in the Gascoyne and infection presumably occurred there. The 25-year-old male travelled on a road tour from Perth to Broome between 13 and 20 April and

**Figure. Cases of Murray Valley encephalitis, Western Australia, 1 January to 20 August 2000, by region**




▲ Case 5 not shown as the most likely place of infection is unclear
Regions are shown in bold

became ill on 25 April. The 79-year-old female departed Geraldton by road on 23 April, travelling to far-north WA before arriving in Katherine in the NT on 27 April, 11 days before she fell ill. Her 2 fellow travellers reported being heavily bitten by mosquitoes at a roadside truck stop in the Kimberley and, as sentinel chicken data also showed high levels of virus activity, this was the most likely site of infection. By comparison, her companions noted few mosquitoes in Katherine and sentinel chicken data on 20 April revealed only 1 MVE seroconversion there.

**Clinical features**

All 9 cases required hospitalisation and presented with fever, 8 with headache and 7 with various other neurological signs including neck stiffness, photophobia, vomiting, irritability and decreased consciousness (Table). Seven were admitted to an intensive care unit, 5 needed mechanical ventilation and 2 remained ventilator-dependent on 30 June. There was 1 fatal case (11%), while another 3 (33%) had significant neurological sequelae. Of the others, 3 had resolving neurological manifestations and 2 had made a complete recovery by mid-June.

**Non-encephalitic MVE cases**

Two cases of non-encephalitic illness and 1 asymptomatic case were recorded in WA to August 2000. In early March, a 15-year-old Aboriginal female who lived in the north-east Kimberley, developed headache, fever and myalgia. These symptoms resolved, with documented MVE seroconversion (by competitive EIA) between November 1999 and March 2000. Of the 4 male travelling companions of the holidaying fisherman (case 3), 1 developed a non-encephalitic illness with headache, back pain and nausea but no fever. A convalescent serum sample was positive for MVE IgM and MVE-specific antibody by competitive EIA, and showed a positive flavivirus HI titre. History suggested that exposure had not occurred before the fishing trip. Another companion had similar serology results but remained asymptomatic. Laboratory testing was negative on the third, and no specimen was collected from the fourth.

**Non-encephalitic Kunjin cases**

A 37-year-old woman from Carnarvon in the Gascoyne developed fever, myalgia, rash and headache at the beginning of May. She recovered fully and samples revealed seroconversion to flavivirus between December 1999 and May 2000, with a positive HI titre to KUN and a positive KUN IgM. The competitive EIA showed antibodies to KUN only. She had not travelled recently and remembered being heavily bitten by mosquitoes prior to illness onset.

The second case involved a 62-year-old man from Port Hedland in the Pilbara, who presented to his general practitioner on 11 July with a history of intermittent myalgia and rash. Serial samples showed a rising antibody HI titre to KUN and competitive EIA confirmed specific KUN antibody only.

**Sentinel chicken surveillance and mosquito trapping in WA**

Seroconversions to MVE were first detected in sentinel chickens from 2 Kimberley flocks and 1 Pilbara flock in January 2000. MVE activity spread quickly to other areas of the Kimberley and Pilbara in February and further south to the Gascoyne and Murchison in March. In late April, MVE activity was detected 315 km north of Perth, in Dongara in the Midwest (Figure), when 4 of 12 chickens seroconverted.[13] Antibodies to MVE had not been detected previously during the 3 years of testing in the Midwest region. Mosquito collections were also carried out in late March and April in the Kimberley and Pilbara and large numbers of *C. annulirostris* were seen in the traps.

## *Discussion*

There were 9 cases of MVE encephalitis acquired in WA between 1 January and 31 August, 2000. This figure equals the previous record in 1993. A further 5 infections with MVE/KUN were identified, 4 had a non-encephalitic illness and 1 was asymptomatic. In total, this represents the highest recorded number of human infections with MVE/KUN in WA within a single season.

The marked southward migration of the virus in 2000 is of significant public health concern. 'Very much above average' monsoonal rainfall was recorded in the Kimberley and Pilbara from December 1999 to February 2000 (Source: Bureau of Meteorology). In March, there was exceptionally high rainfall resulting from tropical cyclone 'Steve' causing major flooding from the Kimberley to the Midwest. These factors provided ideal conditions for extensive mosquito breeding, allowing MVE transmission cycles to become widely established. Conditions differed significantly from the previous 'record' year in 1993 when flooding was confined to the Kimberley and Pilbara regions, and human disease to the Kimberley. Sentinel chicken monitoring, for the first time, detected MVE activity in the Midwest. Our first identified human cases of MVE infection in the Murchison and Midwest regions were also recorded.

There is evidence that MVE may persist in the desiccation-resistant eggs of some mosquito species and that this may be important in initiating activity in the Kimberley.[14] Therefore, there is concern that a similar situation may now have been established in the Murchison and Midwest. As seroconversions occurred in our most southerly and easterly sentinel flocks, opportunistic sampling of other flocks is in progress to define these limits and determine future sentinel sites.

The unusually wet weather, MVE seroconversions among sentinel chickens and subsequent occurrence of clinical disease in humans, prompted repeated health warnings from the Health Department of Western Australia to the public via the media, public health units, general practitioners and hospitals. Preventive measures against mosquito bites were advised for people living in or travelling to the Kimberley, Pilbara, Gascoyne, Murchison and Midwest regions.

When MVE virus is present in non-endemic areas, pre-existing immunity within the population is expected to be low. Therefore, in these regions, individuals of all ages are potentially at risk of infection, though our series supports the previous finding that most clinical cases have occurred in adults.[5] Few cases have occurred in adult Aboriginals. There were none in our series, or that of Burrow et al.[6] Aboriginals comprised only 2 of 9 adult cases in the series presented by Mackenzie et al[5] and there was a third case from WA in 1993 (unpublished observation). The low rates in Aboriginal adults in the Kimberley is presumed to result from the high rates of MVE infection in childhood[3,4] which renders adults non-susceptible. For adult Aboriginals in non-endemic regions there are no comparable seroprevalence

**Table. Diagnostic criteria and clinical features of encephalitic Murray Valley encephalitis cases in Western Australia, 1 January to 20 August, 2000**

| Case no. | Sex | Age | Ethnicity | Likely place of exposure | Onset date | Diagnostic criteria* | Prodrome | Neurological manifestations | Residual signs |
|---|---|---|---|---|---|---|---|---|---|
| 1 | M | 10 m | A | Newman, **Pilbara** | 6 Mar | 1, 2, 3 | Fever, irritability | Seizures, rigidity, choreiform movements, bulbar palsy, internuclear ophthalmoplegia | Bulbar palsy, hypertension, irritability |
| 2 | M | 55 y | N | Kalbarri, **Midwest** | 8 Apr | 2, 3, 4 | Fever, headache | Coma, flaccid paralysis | Quadraparesis, ventilator-dependent |
| 3 | M | 64 y | N | Carnarvon, **Gascoyne** | 16 Apr | 2, 3, 5 | Fever, headache, neck stiffness, photophobia | Decreased consciousness, confusion, memory loss | Resolving |
| 4 | M | 32 y | N | Meekatharra, **Murchison** | 20 Apr | 1, 2, 3 | Fever, headache, neck stiffness | Decreased consciousness, left-right disorientation, short-term memory loss dizziness, lethargy | Resolving |
| 5 | M | 25 y | N | **Midwest** to **Kimberley** | 25 Apr | 1, 3, 6, 7 | Fever, headache, malaise, vomiting, disorientation | Coma, flaccid paralysis | Quadraparesis, ventilator-dependent |
| 6 | F | 41 y | N | Wickham, **Pilbara** | 28 Apr | 2, 3, 5 | Fever, headache, malaise, vomiting | Confusion, short-term memory loss, dysarthria, dysphasia, extra-pyramidal gait disorder, tremor | Resolving |
| 7 | M | 69 y | N | Mullewa, **Midwest** | 3 May | 2, 3, 5 | Fever, confusion, irritability | Decreased consciousness, disorientation | Nil |
| 8 | F | 61 y | N | Dongara, **Midwest** | 5 May | 2, 8 | Fever, confusion, drowsiness, nausea | Aphasia, Parkinsonian syndrome | Nil |
| 9 | F | 79 y | N | Broome, **Kimberley** | 8 May | 1, 2, 8 | Fever, headache, malaise | Coma, spastic paralysis | Deceased 27 May |

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1, Rising serum HI titre;
2, Positive MVE IgM in serum and CSF;
3, Positive monoclonal antibody blocking EIA in serum;
4, Rising serum IFA-IgG titre;
5, Positive HI in serum;
6, Positive MVE IgM in serum;
7, Positive PCR in CSF;
8, Positive PCR in brain tissue.

M = male, F = female; m = months, y = years; A = Aboriginal, N = non-Aboriginal
regions shown in bold.

data to assess whether exposure in childhood also explains the low numbers of cases in this group, or whether it just reflects the proportion of Aboriginal to non-Aboriginal populations in these areas.

The presentation and clinical outcomes of our cases were similar to those described previously for encephalitic MVE.[5,6] Burrow et al[6] summarised the findings from both their case series and those reported by Mackenzie et al.[5] With the addition of our 9 encephalitic cases and the case reported by McMinn et al,[15] the case fatality rate of MVE/KUN encephalitis was 9/46 (19.6%). Among survivors, 8/37 (21.6%) had major neurological sequelae and 12/37 (32.4%) had minor sequelae. Only 17 of 46 (37.0%) were documented to have made a complete recovery.

The pattern of MVE virus infection in WA in 2000 occurred as a result of the unusual environmental conditions. Though these weather patterns are observed infrequently, they create an environment conducive to viral spread into new areas. There is concern that replication of these climatic conditions could pose a threat to the more populous south-western region. This includes Perth, which has a population of 1.3 million and is only 315 km south of Dongara. These events also provide a warning to south-eastern Australia about the ongoing potential for further epidemics in the Murray Valley and their likely impact among these large, and probably immunologically naïve,[16] populations.

*** Abbreviations:**

CSF, cerebrospinal fluid; EIA, enzyme immunoassay; HI, haemagglutination inhibition; IFA, indirect immunofluorescence assay; KUN, Kunjin virus; MVE, Murray Valley encephalitis virus; NT, Northern Territory; RT-PCR, reverse transcription-polymerase chain reaction; WA, Western Australia.

## *Acknowledgments*

The authors wish to acknowledge the assistance of medical staff at Fremantle, Royal Perth, Princess Margaret, Royal Darwin and St John of God (Murdoch) Hospitals and the support provided by regional Western Australian Public Health Units. We also thank Professor Aileen Plant for her comments on the manuscript.

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