A COMPILATION OF DATA ON ARBOVIRUS SURVEILLANCE IN MANITOBA: 1975-1991

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ABSTRACT

Data on arboviruses in Manitoba are compiled for a 17 year period, 1975-1991. The Western Equine Encephalitis virus is endemic in Manitoba yet epidemics/epizootics develop infrequently, with four epidemics recorded during the study period: 1975, 1977, 1981 and 1983. A multi-disciplinary surveillance was started in 1975 and remained active for 10 years during which mosquito populations, especially those of Culex tarsalis, mosquito arboviral infection rates, and seroconversion in sentinel chicken flocks were monitored in a number of locations throughout Manitoba. In addition, serosurveys were done on potential reservoir hosts, and serologically confirmed equine and human cases were recorded. After 1986, the surveillance was limited to the City of Winnipeg data on mosquito populations and seroconversion in chicken flocks. Crude criteria were developed to forecast epidemics and were successful in predicting the 1977, 1981 and 1983 outbreaks. Experience has shown that multiple parameters are needed for monitoring arboviral outbreaks, and that the month of July is critical in predicting epidemics. It is proposed that a multi-disciplinary surveillance be re-instituted, and that 1 - 2 locations be monitored for mosquito populations and infection rates, as well as for seroconversion in chickens. If funds are limited, the surveillance could be restricted to a 4 - 6 week period, including the month of July.

INTRODUCTION

Of the many arboviral infections of man, Western Equine Encephalitis (W.E.E.) is the most common in Manitoba. The virus seems to be endemic in the Red River Valley but it is not clear why epidemics develop only in certain years. For an epidemic to develop, two conditions must be fulfilled: (a) a large number of susceptible hosts must be available, and (b) large numbers of infected vectors must be using these hosts for blood meals. The first condition is easy to fulfill as, to date, no vaccine has been licenced for humans and serosurveys have shown that almost all the population is susceptible to W.E.E. (6). A vaccine is available for horses but the degree of compliance with vaccination guidelines is unknown. Cases of WEE are detected only in humans and horses and both are "dead end" hosts. The primary vector for

W.E.E. virus is Culex tarsalis, a mosquito species which feeds on birds early in the summer, then shifts to include mammals (including humans and horses) in mid-summer. The biting activity of Culex tarsalis appears to be dependent on atmospheric conditions, particularly temperature, humidity and wind.

As predictors of human epidemics, the relative merit of monitoring Culex tarsalis populations/virus load, versus monitoring viral activity in sentinel chicken flocks, versus monitoring virus transmission in horses, has been discussed since 1975.

Background:

During the years 1975-1991 Manitoba experienced four epidemics of W.E.E; in 1975, 1977, 1981 and 1983. In the summer of 1975 an epidemic of W.E.E. appeared imminent; to deal with this threat, the Province of Manitoba struck an ad hoc multi-disciplinary committee which remained active until 1985. The committee known as the Manitoba Arboviral Surveillance Committee (M.A.S.C.), had 2 main objectives: (a) monitor early indicators of arboviral activity to give officials time to initiate appropriate preventive measures, and (b) coordinate the diagnosis of cases (human and equine). The experience gained in 1975 was recorded in a supplement to the Canadian Public Health Association Journal (7). Following the 1981 epidemic, a workshop was organized in Winnipeg and the proceedings published in 1982 by Manitoba Health (6). Arbovirus activities in the next years were summarized annually in Canada Disease Weekly Reports (8,3) or in the Canadian Medical Association Journal (4). Human infections were reported only in late summer (i.e. August onwards) in epidemic years. In 1985 M.A.S.C. was dissolved by the Province of Manitoba, mainly because of concern about the cost and efficacy of the aerial spraying used to control the mosquito vector; however, some degree of surveillance was maintained. The City of Winnipeg continued collecting data on mosquito populations and viral activity in sentinel chicken flocks. The Cadham Provincial Laboratory continued providing laboratory services for the diagnosis of human and equine cases of W.E.E., as well as performing serological tests on sentinel chicken flocks (except for 1986 when tests were performed by Dr. H. Artsob of the National Arbovirus Centre in Toronto), and on field sparrows collected from 1983-1986 (5). Laboratory procedures were refined over the years to provide accurate and rapid results for the monitoring and diagnosis of arboviral diseases.

Objectives:

The following is a consolidation of the results obtained since 1975 and an attempt at reviewing the relative value of data on mosquito populations, sentinel chicken flocks, and equine cases in predicting human epidemics of W.E.E. Our objective is to determine if a single parameter can be used for monitoring, whether a combination of parameters is needed, or alternatively, to determine if prediction of epidemics by monitoring is possible.

METHODOLOGY

Minutes of M.A.S.C., annual reports of the various agencies involved, and publications (1 to 8) were used to compile the following tables.

RESULTS

Table 1: Mosquito population data obtained by the City of Winnipeg using standard New Jersey-style light traps and larval collections from 1975-1991.

Table 2: Mosquito population data obtained through the Provincial Surveillance Program, 1976-1981: (a) flock trap data, (b) light-trap data.

Table 3: Virus isolations from mosquitoes, 1975-1985.

Table 4: Serological testing performed on sentinel chicken flocks, 1975-1991.

Table 5: Serological testing performed on sparrows, 1983-1986.

Table 6: Serological testing performed on suspected W.E.E. reservoir hosts, 1976-1983.

Table 7: Serological testing performed on suspected equine cases, 1975-1991.

Table 8: Serosurveys for W.E.E. on human sera submitted to the Cadham Provincial Laboratory, 1968-1985.

Table 9: Results of serological testing done on suspected human cases 1975-1991.

Table 10: A summary of the warning signals used to predict an epidemic of Western Equine Encephalitis by members of the Manitoba Arbovirus Surveillance Committee.

DISCUSSION AND CONCLUSIONS

The sentinel chicken data confirm that the W.E.E. virus is endemic in Manitoba since seroconversion was detected every year from 1975 to 1991 with the exception of 1982. Assuming that W.E.E. is endemic in Manitoba and that human outbreaks occur periodically, two questions need to be addressed: (I) How many parameters need to be monitored to provide an effective early warning system? and (II) Is it possible to forecast a human epidemic?

I. The data compiled suggest that we cannot rely on a single parameter for arbovirus surveillance; four examples will be given.

(1) The actual number of Culex tarsalis mosquitoes may be high, but if the mosquitoes are not infected, epizootics/epidemics do not develop (e.g. 1982).
(2) Culex tarsalis mosquitoes may be present and infected, as evidenced by virus isolation or seroconversion of chicken flocks, yet epidemics do not develop because the mosquitoes become infected only in late summer (e.g. 1984).
(3) Sentinel chicken flocks may seroconvert indicating transmission of the W.E.E. virus, yet an epidemic/epizootic does not develop because at the time of seroconversion the number of Culex tarsalis was low (e.g. 1986) or almost nil in the light traps (e.g. June

1983). It is intriguing to speculate on the species of mosquitoes responsible for infections in the chickens.

(4) Finally, human epidemics do not always follow epizootics in horses (e.g. 1988).

II. The experience of the last 17 years indicates that in Manitoba, when all the monitors listed in Table 10 give a positive signal, (especially when these warnings are synchronized in the month of July), an epidemic of W.E.E. is imminent. The 1977, 1981 and 1983 outbreaks were predicted a few days before the first human cases were diagnozed.

The complexity of Table 10 suggests that, for an epidemic of W.E.E. to be predicted in Manitoba, a number of parameters need to be monitored. Our experience has shown that when W.E.E. epidemics occur, cases are widespread. Since the multi-disciplinary surveillance used prior to 1985 was not costly, such a monitoring system could be re-instated in one or more locations in the Red River Valley to focus mainly on data collected during July or, preferably, data collected from mid June to the end of July. Once an epidemic starts, human cases may be expected as long as infected Culex tarsalis need a blood meal. Most outbreaks end by September but weather conditions may prolong the duration of transmission of W.E.E. infections to humans (as in 1983).

In conclusion, a number of parameters are necessary for predicting an outbreak of W.E.E. in Manitoba, but when properly monitored can accurately give advance warning of the disease.

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Table 1. Mosquito population data obtained by the City of Winnipeg using standard New Jersey-style light traps (NJLT) and larval collections from 1975 - 1991.

		All species		Culex tarsalis				
Year	No. of NJLT locations	Date of first larval collection	Average No. of females per trap	Date of first larval collection	Date of first adult collection	Average No. of females per trap	Peak No. of females/trap/ night (date)	
*1975	17	15/4	1950	N/A	26/6	172	16.5	(31/7)
1976	21	5/4	1963	16/6	28/5	81	4.1	(7/7)
*1977	19	7/4	2045	24/5	11/5	198	14.5	(18/7)
1978	19	11/4	3242	8/6	14/6	127	24.3	(19/7)
1979	19	18/4	1357	18/7	13/6	21	1.7	(24/7)
1980	19	8/4	301	6/5	6/6	11	1.0	(24/7)
*1981	19	1/4	1409	12/6	7/6	106	8.8	(4/7)
1982	24	14/4	6060	24/6	24/6	202	15.3	(7/8)
*1983	24	6/4	8998	4/8	13/6	534	50.5	(16/7)
1984	25	28/3	9591	2/7	29/5	264	17.0	(1/8)
1985	25	29/3	2506	8/7	9/5	34	4.1	(6/8)
1986	25	2/4	5588	15/7	10/6	494	64.5	(4/8)
1987	25	6/4	1944	1/6	16/5	76	4.8	(1/8)
1988	25	13/4	1175	2/6	29/5	152	11.6	(8/7)
1989	25	12/4	5630	28/6	22/6	387	21.6	(21/7)
1990	25	9/4	6047	18/6	23/5	227	15.0	(28/8)
1991	25	2/4	22008	19/6	†14/5	1751	445.0	(21/7)

* W.E.E. Epidemic Years

† 1st day of NJLT collection was May 14, 1991

Table 2a. Number of Culex tarsalis and percent of all species collected in five chicken flock traps in Manitoba during 1976 - 1981.

DATE		1976		1977		1978		1979		1980		1981	
		NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
JUNE	1-8	0	0	18	9	0	0	1	<1	0	0	0	0
	9-15	2	<1	21	14	0	0	0	0	0	0	1	4
	16-23	15	3	119	16	3	<1	8	1	0	0	1	1
	24-30	40	5	278	27	33	8	2	<1	2	7	14	17
JULY	1-8	81	20	515	38	12	4	23	3	4	11	336	69
	9-15	73	25	866	64	31	11	97	11	9	24	603	50
	16-23	233	45	1246	79	329	48	76	8	10	16	451	53
	24-31	268	63	795	70	374	53	118	54	3	50	912	78
JULY TOTAL:		655	40	3422	63	746	37	314	15	26	18	2302	62
AUGUST	1-8	29	44	1174	69	149	43	115	44	8	61	143	59
	9-15	75	56	207	49	73	24	42	19	0	-	57	56
	16-23	78	67	6	7	18	51	40	35	-	-	8	3
	24-31	-	-	2	3	-	-	-	-	-	-	27	4
SEASONAL TOTAL:		894	23.7	5247	52.5	1022	25.7	522	13.8	36	16	2553	48.2

Table 2b. Number of Culex tarsalis and percent of all species collected in five standard New Jersey- light traps in Manitoba during 1976 - 1981.

DATE		1976		1977		1978		1979		1980		1981	
		NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
JUNE	1-8	1	<1	156	15	0	0	1	<1	2	2	8	5
	9-15	8	3	124	20	0	0	0	0	7	3	9	2
	16-23	9	5	232	19	12	<1	6	1	6	5	23	2
	24-30	25	8	133	20	63	8	1	<1	7	6	52	5
JULY	1-8	22	8	156	18	32	4	35	6	5	10	100	18
	9-15	23	8	589	63	192	11	42	21	15	14	176	42
	16-23	46	27	1423	68	504	48	73	21	68	32	419	42
	24-31	65	38	1029	44	419	53	215	35	44	43	349	43
JULY TOTAL:		156	16	3197	51	1147	37	365	21	132	23	1044	37
AUGUST	1-8	47	40	1570	50	47	43	244	22	56	33	449	34
	9-15	33	34	327	27	121	24	160	30	47	26	204	27
	16-23	13	21	27	7	38	51	14	4	11	10	103	7
	24-31	-	-	10	4	-	-	1	-	-	-	179	7
SEASONAL TOTAL:		292	13.7	5776	39.2	1428	7.2	792	12.4	268	17.6	2071	17.4

Table 3: Virus isolations from mosquitoes, 1975-1985.

YEAR	Number of pools tested	Number of virus isolations	Percentage of pools positive	Virus identifications✲					Date of first collected W.E.E. infected mosquito
				WEE	CEV	CVV	TURLOCK	HPF	
*1975	72	5	6.9	5	0	0	0	0	§N/A
1976	882	0	0.0	0	0	0	0	0	-
*1977	1045	†73	7.0	71	0	2	0	0	July 18
1978	581	1	0.2	1	0	0	0	0	N/A
1979	450	7	1.6	4	‡2	0	0	1	N/A
1980	395	0	0.0	0	0	0	0	0	-
*1981	728	35	4.8	32	0	2	0	1	July 6
1982	822	1	0.1	0	0	0	0	1	-
*1983	1663	72	4.3	50	2	6	0	14	July 13
1984	1079	5	0.5	5	0	0	0	0	N/A
1985	1484	19	1.3	3	0	3	12	1	August 7
TOTAL	9201	218	2.4	171	4	13	12	18	-

*Epidemic years (1975 surveillance started in August)

†In addition, a new rhabdovirus was identified (Artsob *et al.* 1991).

‡Includes first isolate of California Encephalitis serotype in Canada (Artsob *et al.* 1985a)

✲Western Equine Encephalitis Virus (WEE)
California Encephalitis Virus (CEV)
Cache Valley Virus (CVV)
Hart Park Flanders Virus (HPF)

§Information is unavailable

Table 4: Serological testing performed on sentinel chicken flocks, 1975 - 1991

Year	Number of locations	Number tested	Number positive	Percent positive	Date of first significant seroconversion
*1975	11	820	214	26.1	‡N/A
1976	20	1080	8	0.7	N/A
*1977	15	830	135	16.3	August 1st week
1978	10	600	19	3.2	N/A
1979	10	1041	6	0.6	N/A
1980	10	743	5	0.7	N/A
*1981	5	344	63	18.3	July 21
1982	10	150	0	0	None
*1983	10	272	90	33.1	June 29
1984	10	658	14	2.1	N/A
1985	10	563	5	0.9	July 24
†1986	5	352	15	4.3	July 17
1987	5	269	2	0.7	August 18
1988	5	491	12	2.4	July 19
1989	5	321	1	0.3	August 15
1990	5	363	7	1.9	August 7
1991	5	350	6	1.7	July 23

* Epidemic years (1975 surveillance started in August)

‡ Information is not available

† Tests performed at National Arbovirus Reference Centre

Table 5. Serological testing performed on sparrows, 1983 - 1986.*

Year	Number of locations	Number tested	Number Positive	Percent Positive
1983	24	188	10	5.3
1984	14	409	11	2.7
1985	12	435	12	2.8
1986	15	789	0	0

* Kucera 1990

Table 6: Serological testing performed on suspected W.E.E. reservoir hosts, 1976 - 1983.

Year	Suspected W.E.E. Reservosir Host	Number tested	Percent positive at screen
1976	Gophers	3	0
1977	Richardson squirrels	19	10.5
	Pigeons	11	0
1981	Turkeys	21	19.0
1982	Garter snakes	18	0
	Ground squirrels	16	24.1
	Frogs	20	15.0
	Rats	6	0
	Pigeons	4	0
1983	Community domestic chickens	152	2.6
	Geese/pheasants/turkeys	15	20.0
	Miscellaneous wild birds	97	0

Table 7: Serological testing performed on suspected equine cases, 1975 - 1991.

Year	Number Tested	Number of serologically confirmed cases	Date of first confirmation	Date of first report of ≥ 6 cases/week
*1975	261	139	†N/A	N/A
1976	19	10	N/A	N/A
*1977	80	53	N/A	N/A
1978	5	1	N/A	-
1979	6	0	-	-
1980	11	1	N/A	-
*1981	182	123	July 14	July 21
1982	16	1	N/A	-
*1983	46	23	August 2	August 10-17
1984	8	0	-	-
1985	9	0	-	-
1986	11	1	N/A	-
1987	10	1	N/A	-
1988	29	12	July 14	N/A
1989	3	0	-	-
1990	9	0	-	-
1991	10	2	August 7	-

* Epidemic Years

† Information is not available

Table 8. Serosurveys for W.E.E. on human sera submitted to the Cadham Provincial Laboratory, 1968 - 1985.

Year	Number Tested	Percent Positive
1968	1863	5.2
1975	492	0.8
1981	250	8.6
1982	277	9.0
1983	130	3.8
1984	142	2.8
1985	172	1.7

Table 9. Serological testing done on suspected human cases, 1975 - 1991.

Year	Number Tested	Number Positive
*1975	196	14
1976	111	0
*1977	256	5
1978	14	0
1979	54	0
1980	87	0
*1981	586	25
1982	231	0
*1983	855	†18
1984	159	0
1985	51	0
1986	87	0
1987	18	0
1988	55	0
1989	60	0
1990	28	0
1991	111	0

* Epidemic Years
† 2 deaths

Table 10. A summary of the warning signals used to predict an epidemic of Western Equine Encephalitis by members of the Manitoba Arbovirus Surveillance Committee.

I. **Mosquito data**

More than 50 female mosquitoes/standard New Jersey-style light trap/night for 3 consecutive nights.

Large population of mosquitoes with **Culex tarsalis** representing 25% of the mosquitoes trapped.

Early (late June/Early July) build up of **Culex tarsalis** populations.

W.E.E. virus isolation in ≥2% of the mosquitoes trapped, particularly in the week of July 8-15.

II. **Sentinel chicken flocks data**

A sustained seroconversion of 15%-20%, particularly in the month of July.

III. **Equine data**

The confirmation of W.E.E. infections in ≥6 equine cases/week, particularly if they occur in the month of July.