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Original Article

Molecular Epidemiology of Japanese Encephalitis Virus in Mosquitoes during 2013–2014

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Abstract

Japanese encephalitis (JE) is a mosquito-borne zoonotic disease caused by the Japanese encephalitis virus (JEV). Japanese encephalitis is widespread in Asia and endemic in Taiwan. Virological surveillance in mosquitoes showed that the genotype III (GIII) strains of JEV were the predominant epidemic strains circulating in Asia before 1990; however, the genotype I (GI) strains have been introduced into China, Japan, Vietnam, South Korea, and Thailand, and cocirculated with or replaced the GIII strains in Asia. Previous studies showed that in Taiwan, all of the JEV strains obtained during 2005–2007 belonged to GIII of JEV, but the predominant genotype has shifted from GIII to GI during 2008–2012. This study continued to report the genotype distribution, genetic variation, and mosquito species potentially involved in the transmission of JEV during 2013–2014. Overall, 37,637 mosquitoes were collected; 96 pools were tested JEV positive by RT-PCR, including *Culex tritaeniorhynchus* (94 pools) and *Cx. annulus* (2 pools). Phylogenetic analysis of envelope gene sequences of JEV isolated from mosquitoes demostrated that GI was the predominant genotype of JEV between 2013 and 2014, whilst only a few GIII strains of JEV were found in Eastern Taiwan. We will continue the monitoring of endemic and newly introduced JEV in Taiwan.

Keywords：Vector-borne infectious diseases, Surveillance, Japanese encephalitis virus

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First Dengue Cluster in Eastern Taiwan

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Abstract

From October 2014 to January 2015, Kinglun Village of Taimali Township in Taitung confirmed 13 cases of dengue fever, which was the first cluster occurred in Eastern Taiwan when the disease was notifiable since 1998. Epidemiological investigation showed that the majority of cases were reported by local clinics after viremic stage, which missed the crucial period to prevent virus transmission. Daily activities and locations of first-wave patients during their incubation and viremic period were not investigated, which led to lost timing for intervention. Besides, residents showed carelessness for vector breeding sources elimination and local clinics were not alert to suspected dengue patients, which accelerated the transmission in the small community. In summary, when the risk of transmission increases, measurements to control dengue fever should be implemented, which include strengthening case reporting from clinics, thorough vector breeding sources elimination, and risk communication with local residents.

Keywords: Dengue fever, Cluster, Small community

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Numbers of New Cases and Cumulative Cases of Notifiable Infectious Diseases （by week of diagnosis）

Case diagnosis week		Week 11		Week 1—11	
Classification	**Disease Diagnosed[1]**	**2016**	**2015**	**2016**	**2015**
Category I	Plague	0	0	0	0
	Rabies	0	0	0	0
	SARS	0	0	0	0
	Smallpox	0	0	0	0
Category II	Acute Flaccid Paralysis	0	0	7	3
	Acute Viral Hepatitis type A	23	0	106	18
	Amoebiasis	4	12	52	82
	Anthrax	0	0	0	0
	Chikungunya Fever	0	0	2	1
	Cholera	0	0	0	0
	Dengue Fever	1	7	495	167
	Diphtheria	0	0	0	0
	Enterohemorrhagic E. coli Infection	0	0	0	0
	Epidemic Typhus Fever	0	0	0	0
	Hantavirus Pulmonary Syndrome	0	0	0	0
	Hemorrhagic Fever with Renal Syndrome	0	0	1	0
	Malaria	0	1	3	3
	Measles	0	0	0	0
	Meningococcal Meningitis	0	0	1	1
	Paratyphoid Fever	0	0	0	3
	Poliomyelitis	0	0	0	0
	Rubella	0	1	3	2
	Shigellosis	4	5	39	56
	Typhoid fever	0	2	1	9
	West Nile Fever	0	0	0	0
Category III	Acute Viral Hepatitis type B	1	0	19	24
	Acute Viral Hepatitis type C[5]	5	10	34	42
	Acute Viral Hepatitis type D	0	1	1	1
	Acute Viral Hepatitis type E	0	0	4	1
	Acute Viral Hepatitis untype	0	0	0	0
	Congential Rubella Syndrome	0	0	0	0
	Enteroviruses Infection with Severe Complications	0	0	1	1
	Haemophilus Influenza type b Infection	1	0	2	1
	Japanese Encephalitis	0	0	0	0
	Legionellosis	1	1	25	41
	Mumps[2]	9	20	109	144
	Neonatal Tetanus	0	0	0	0
	Pertussis	0	2	2	34
	Tetanus[2]	0	0	1	1
Category IV	Botulism	0	0	1	1
	Brucellosis	0	0	0	0
	Complicated Influenza	110	18	1587	173
	Complicated Varicella[4]	1	2	10	18
	Endemic Typhus Fever	0	0	3	0
	Herpesvirus B Infection	0	0	0	0
	Invasive Pneumococcal Disease	9	13	193	166
	Leptospirosis	2	1	11	16
	Lyme Disease	0	0	0	0
	Melioidosis	0	0	2	7
	Q Fever	0	0	6	6
	Scrub Typhus	0	3	69	91
	Toxoplasmosis	1	0	2	0
	Tularremia	0	0	0	0
Category V	Ebola Virus Disease	0	0	0	0
	Ebola-Marburg Hemorrhagic Fever	0	0	0	0
	Novel Influenza A Virus Infections[6]	0	0	0	0
	Lassa Fever	0	0	0	0
	Rift Valley Fever	0	0	0	0
	Middle East Respiratory Syndrome Coronavirus	0	0	0	0
	Yellow Fever	0	0	0	0

1. The following 8 chronic diseases are excluded from the table: MDR-TB, Tuberculosis, Syphilis, Gonorrhea, HIV Infection, AIDS, Hansen Disease and Creutzfeldt-Jakob Disease.
2. Reported cases.
3. Since 2014/1/1, "Varicella" was modified to "Complicated Varicella".
4. Since 2014/3/6, the case definition for confirmed Acute hepatitis C was changed from "meet the clinical and laboratory conditions" to "meet the clinical or laboratory conditions".
5. Since 2014/7/1, various subtypes of human cases of avian influenza are reported as "novel influenza A virus infections", a Category V Notifiable Infectious Disease. The original "H5N1 flu" and "H7N9 flu", which were respectively listed as a Category I Notifiable Infectious Disease and a Category V Notifiable Infectious Disease were removed from the list on the same day.

Suspected Clusters

●Thirty-five clusters were reported, including 18 diarrhea clusters, 6 upper respiratory tract infection clusters, 5 influenza-like illness clusters, 3 tuberculosis clusters, 2 varicella clusters, and 1 pertussis cluster.

Imported Infectious Diseases

●11 confirmed cases were imported from 7 countries during Week 11 of 2016.

Country / Disease	Indonesia	China	Philippines	Vietnam	Kenya	Thailand	Malaysia	Total
Shigellosis	4							4
Hepatitis A		1					1	2
Dengue Fever					1	1		2
Amoebiasis			1	1				2
FluSC		1						1
Total	4	2	1	1	1	1	1	11

Note: The statistics listed in this table include imported cases that were either confirmed or updated★ in the previous week.

●A total of 129 confirmed cases were imported from 18 countries in 2016.

●Top 3 imported diseases：Dengue fever (67), Amoebiasis (23), Shigellosis (15).

●Top 3 countries responsible for most imported cases：Indonesia (50), Philippines (17), Vietnam (14).

Summary of Epidemic

●**Influenza**：During Week 11, 115 cases of severe complicated influenza have been confirmed, and 47 deaths have been reported. The number of visits to outpatient services for influenza-like illness and the number of severe cases reported have decreased gradually. Influenza virus type B (approximately 60%) is currently the dominant strains circulating in the community. Thus far, none of the viruses identified has shown drug resistance.

●**Dengue Fever**：New indigenous cases have been confirmed in Tainan City and Kaohsiung City. The number of imported cases was higher than that during the same period in the past year, increasing the risk of dengue importation. The public is urged to clean up and remove any vector breeding sites. Doctors are advised to stay vigilant for suspected cases to ensure timely case reporting.

●**Zika Virus Infection**：Taiwan CDC has issued a travel notice of Level 2: Alert for Zika virus for Dominica and Cuba and a travel notice of Level 1: Watch for Zika virus for Papua New Guinea and Bangladesh.

●**Lassa Fever and Yellow Fever**：Taiwan CDC has issued a travel notice of Level 1: Watch for Lassa fever for Nigeria, Benin and Togo and a travel notice of Level 1: Watch for yellow fever for Angola.

Weekly Data of Notifiable Infectious Diseases（by week of diagnosis）

Case diagnosis week		Week 12		Week 1—12	
Classification	**Disease Diagnosed[1]**	**2016**	**2015**	**2016**	**2015**
Category I	Plague	0	0	0	0
	Rabies	0	0	0	0
	SARS	0	0	0	0
	Smallpox	0	0	0	0
Category II	Acute Flaccid Paralysis	1	1	8	4
	Acute Viral Hepatitis type A	22	5	128	23
	Amoebiasis	6	11	58	93
	Anthrax	0	0	0	0
	Chikungunya Fever	0	0	2	1
	Cholera	0	0	0	0
	Dengue Fever	4	5	498	172
	Diphtheria	0	0	0	0
	Enterohemorrhagic E. coli Infection	0	0	0	0
	Epidemic Typhus Fever	0	0	0	0
	Hantavirus Pulmonary Syndrome	0	0	0	0
	Hemorrhagic Fever with Renal Syndrome	0	0	1	0
	Malaria	0	0	3	3
	Measles	1	1	1	1
	Meningococcal Meningitis	1	0	2	1
	Paratyphoid Fever	0	0	0	3
	Poliomyelitis	0	0	0	0
	Rubella	0	0	3	2
	Shigellosis	7	5	46	61
	Typhoid fever	0	0	1	9
	West Nile Fever	0	0	0	0
Category III	Acute Viral Hepatitis type B	1	2	20	26
	Acute Viral Hepatitis type C[5]	3	4	37	46
	Acute Viral Hepatitis type D	0	0	1	1
	Acute Viral Hepatitis type E	0	0	4	1
	Acute Viral Hepatitis untype	0	0	0	0
	Congential Rubella Syndrome	0	0	0	0
	Enteroviruses Infection with Severe Complications	0	0	1	1
	Haemophilus Influenza type b Infection	0	0	2	1
	Japanese Encephalitis	0	0	0	0
	Legionellosis	1	1	26	42
	Mumps[2]	12	20	121	164
	Neonatal Tetanus	0	0	0	0
	Pertussis	0	6	2	40
	Tetanus[2]	1	0	2	1
Category IV	Botulism	0	0	1	1
	Brucellosis	0	0	0	0
	Complicated Influenza	91	40	1678	213
	Complicated Varicella[4]	0	0	10	18
	Endemic Typhus Fever	0	0	3	0
	Herpesvirus B Infection	0	0	0	0
	Invasive Pneumococcal Disease	12	11	205	177
	Leptospirosis	0	0	11	16
	Lyme Disease	0	0	0	0
	Melioidosis	0	1	2	8
	Q Fever	1	0	7	6
	Scrub Typhus	0	0	69	91
	Toxoplasmosis	1	0	3	0
	Tularremia	0	0	0	0
Category V	Ebola Virus Disease	0	0	0	0
	Ebola-Marburg Hemorrhagic Fever	0	0	0	0
	Novel Influenza A Virus Infections[6]	0	0	0	0
	Lassa Fever	0	0	0	0
	Rift Valley Fever	0	0	0	0
	Middle East Respiratory Syndrome Coronavirus	0	0	0	0
	Yellow Fever	0	0	0	0

1. The following 8 chronic diseases are excluded from the table: MDR-TB, Tuberculosis, Syphilis, Gonorrhea, HIV Infection, AIDS, Hansen Disease and Creutzfeldt-Jakob Disease.
2. Reported cases.
3. Since 2014/1/1, "Varicella" was modified to "Complicated Varicella".
4. Since 2014/3/6, the case definition for confirmed Acute hepatitis C was changed from "meet the clinical and laboratory conditions" to "meet the clinical or laboratory conditions".
5. Since 2014/7/1, various subtypes of human cases of avian influenza are reported as "novel influenza A virus infections", a Category V Notifiable Infectious Disease. The original "H5N1 flu" and "H7N9 flu", which were respectively listed as a Category I Notifiable Infectious Disease and a Category V Notifiable Infectious Disease were removed from the list on the same day.

Suspected Clusters

●Twenty-five clusters were reported, including 14 diarrhea clusters, 4 upper respiratory tract infection clusters, 3 varicella clusters, 2 tuberculosis clusters, and 2 influenza-like illness clusters.

Imported Infectious Diseases

●13 confirmed cases were imported from 4 countries during Week 12 of 2016.

Country / Disease	Indonesia	China	Thailand	Philippines	Total
Dengue Fever	3		1	1	5
Hepatitis A	1	1	2		4
Amoebiasis	2				2
Measles		1			1
Shigellosis	1				1
Total	7	2	3	1	13

Note: The statistics listed in this table include imported cases that were either confirmed or updated★ in the previous week.

●A total of 140 confirmed cases were imported from 18 countries in 2016.

●Top 3 imported diseases：Dengue fever (67), Amoebiasis (25), Shigellosis (16).

●Top 3 countries responsible for most imported cases：Indonesia (57), Philippines (17), Vietnam (14).

Summary of Epidemic

●**Influenza**：During Week 12, 83 cases of severe complicated influenza were confirmed, and 49 deaths were reported. The numbers of visits to outpatient services and ER for influenza-like illness and the number of severe cases reported have decreased gradually. Influenza virus type B (approximately 70%) is currently the dominant strains circulating in the community. Thus far, none of the viruses identified has shown drug resistance.

●**Dengue Fever**：The number of imported cases was higher than that during the same period in the past year, increasing the risk of a local dengue outbreak. The public is urged to clean up and remove any vector breeding sites. Doctors are advised to stay vigilant for suspected cases to ensure timely case reporting.

●**Zika Virus Infection**：The global epidemic of Zika virus infection has continued to increase. Thus far, at least 61 countries and/or territories worldwide, have reported local outbreaks of Zika virus infection, mainly in 33 countries and/or territories in Latin America and the Caribbean region. In Asia, Thailand, Maldives and the Philippines have reported local outbreaks of Zika virus infection. Taiwan CDC has issued a travel notice of Level 2: Alert for Zika virus for countries and/or territories in Latin America, Caribbean region and Asia.

●**Measles**：The epidemic in Mongolia has increased significantly than that during the same period last year. Taiwan CDC has issued a travel notice of Level 1: Watch for measles for Mongolia.

Weekly Data of Notifiable Infectious Diseases（by week of diagnosis）

Case diagnosis week		Week 13		Week 1—13	
Classification	**Disease Diagnosed[1]**	**2016**	**2015**	**2016**	**2015**
Category I	Plague	0	0	0	0
	Rabies	0	0	0	0
	SARS	0	0	0	0
	Smallpox	0	0	0	0
Category II	Acute Flaccid Paralysis	1	0	9	4
	Acute Viral Hepatitis type A	21	0	149	23
	Amoebiasis	11	3	69	96
	Anthrax	0	0	0	0
	Chikungunya Fever	1	2	3	3
	Cholera	0	0	0	0
	Dengue Fever	8	2	506	174
	Diphtheria	0	0	0	0
	Enterohemorrhagic E. coli Infection	0	0	0	0
	Epidemic Typhus Fever	0	0	0	0
	Hantavirus Pulmonary Syndrome	0	0	0	0
	Hemorrhagic Fever with Renal Syndrome	1	0	2	0
	Malaria	0	0	3	3
	Measles	0	0	1	1
	Meningococcal Meningitis	0	0	2	1
	Paratyphoid Fever	0	0	0	3
	Poliomyelitis	0	0	0	0
	Rubella	0	0	3	2
	Shigellosis	4	1	50	62
	Typhoid fever	0	1	1	10
	West Nile Fever	0	0	0	0
Category III	Acute Viral Hepatitis type B	1	0	21	26
	Acute Viral Hepatitis type C[5]	8	1	45	47
	Acute Viral Hepatitis type D	0	0	1	1
	Acute Viral Hepatitis type E	0	0	4	1
	Acute Viral Hepatitis untype	0	0	0	0
	Congential Rubella Syndrome	0	0	0	0
	Enteroviruses Infection with Severe Complications	1	0	2	1
	Haemophilus Influenza type b Infection	0	0	2	1
	Japanese Encephalitis	0	0	0	0
	Legionellosis	2	5	28	47
	Mumps[2]	16	11	137	175
	Neonatal Tetanus	0	0	0	0
	Pertussis	0	1	2	41
	Tetanus[2]	0	0	2	1
Category IV	Botulism	0	0	1	1
	Brucellosis	0	0	0	0
	Complicated Influenza	51	31	1729	244
	Complicated Varicella[4]	1	1	11	19
	Endemic Typhus Fever	0	0	3	0
	Herpesvirus B Infection	0	0	0	0
	Invasive Pneumococcal Disease	14	11	219	188
	Leptospirosis	0	0	11	16
	Lyme Disease	0	0	0	0
	Melioidosis	1	1	3	9
	Q Fever	1	3	8	9
	Scrub Typhus	1	2	70	93
	Toxoplasmosis	0	0	3	0
	Tularremia	0	0	0	0
Category V	Ebola Virus Disease	0	0	0	0
	Ebola-Marburg Hemorrhagic Fever	0	0	0	0
	Novel Influenza A Virus Infections[6]	0	0	0	0
	Lassa Fever	0	0	0	0
	Rift Valley Fever	0	0	0	0
	Middle East Respiratory Syndrome Coronavirus	0	0	0	0
	Yellow Fever	0	0	0	0

1. The following 8 chronic diseases are excluded from the table: MDR-TB, Tuberculosis, Syphilis, Gonorrhea, HIV Infection, AIDS, Hansen Disease and Creutzfeldt-Jakob Disease.
2. Reported cases.
3. Since 2014/1/1, "Varicella" was modified to "Complicated Varicella".
4. Since 2014/3/6, the case definition for confirmed Acute hepatitis C was changed from "meet the clinical **and** laboratory conditions" to "meet the clinical **or** laboratory conditions".
5. Since 2014/7/1, various subtypes of human cases of avian influenza are reported as "novel influenza A virus infections", a Category V Notifiable Infectious Disease. The original "H5N1 flu" and "H7N9 flu", which were respectively listed as a Category I Notifiable Infectious Disease and a Category V Notifiable Infectious Disease were removed from the list on the same day.

Suspected Clusters

●Twenty-three clusters were reported, including 14 diarrhea clusters, 4 influenza-like illness clusters, 3 tuberculosis clusters, 1 upper respiratory tract infection cluster, and 1 varicella cluster.

Imported Infectious Diseases

●15 confirmed cases were imported from 5 countries during Week 13 of 2016.

Country / Disease	Indonesia	Malaysia	Philippines	China	Thailand	Total
Dengue Fever	3	2			1	6
Shigellosis	4					4
Amoebiasis	2		1			3
Chikungunya Fever	1					1
Hepatitis A				1		1
Total	10	2	1	1	1	15

Note: The statistics listed in this table include imported cases that were either confirmed or updated★ in the previous week.

●A total of 155 confirmed cases were imported from 18 countries in 2016.

●Top 3 imported diseases：Dengue fever (73), Amoebiasis (28), Shigellosis (20).

●Top 3 countries responsible for most imported cases：Indonesia (67), Philippines (18), Vietnam (14).

Summary of Epidemic

●**Influenza**：The numbers of visits to outpatient services and ER for influenza-like illness and the number of severe cases reported have decreased gradually. Influenza virus type B (approximately 80%) is currently the dominant strains circulating in the community. Thus far, none of the viruses identified has shown drug resistance.

●**Dengue Fever**：Imported cases have continuously been reported. Recently, the average temperature of southern Taiwan is 25℃, which favors mosquito growth. The public is urged to clean up and remove any vector breeding sites and avoided mosquito bites.

●**Zika Virus Infection**：Two indigenous cases of Zika virus infection have been reported in Vietnam. Thus far, Taiwan CDC has issued a travel notice of Level 2: Alert for Zika virus for countries in Asia, including Thailand, Maldives, Vietnam and the Philippines.

●**Enterovirus**：We have not yet entered the epidemic season of enterovirus infection. During Week 13, 2 cases infected by enterovirus 71 have been confirmed. The public is urged to enhance personal hygiene and stay vigilant for suspicious symptoms of enterovirus infection with severe complications in infants.

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