

Risk Factors for West Nile Virus Infection During an Outbreak — Arizona, 2010

J. Erin Staples, MD, PhD

Arboviral Diseases Branch

Centers for Disease Control and Prevention, Fort Collins, CO



Talk Outline

- ❑ Background on West Nile virus (WNV)
- ❑ Overview of the outbreak
- ❑ Risk factor study

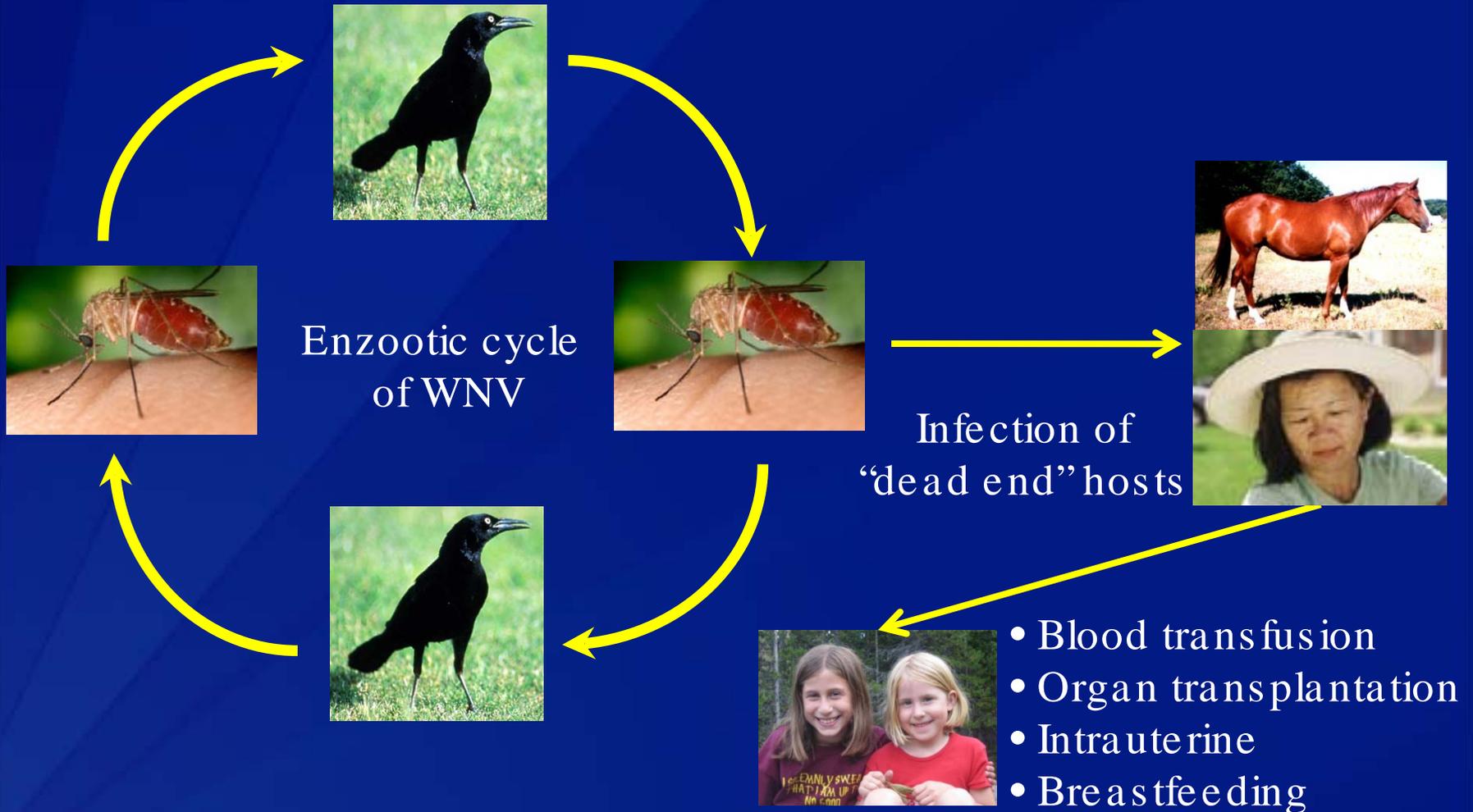
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West Nile Virus (WNV)

- ❑ Mosquito-borne flavivirus
- ❑ Leading cause of arboviral disease in the U.S.
 - >30,000 cases reported since 1999
- ❑ Causes annual seasonal outbreaks

WNV Transmission Cycle



Clinical Spectrum of Human WNV Infections

- ❑ Asymptomatic (80%)
- ❑ Non-neuroinvasive disease (20%)
 - Acute systemic febrile illness (i.e., West Nile fever)
 - Headache, myalgia, arthralgia, and rash are common
- ❑ Neuroinvasive disease (<1%)
 - Meningitis, encephalitis, acute flaccid paralysis
 - 10% case-fatality

Treatment of WNV Disease

- ❑ No antiviral medication or specific treatment
- ❑ Supportive care
- ❑ Management of complications

Prevention of Human WNV Infections

- ❑ No WNV vaccine licensed for use in humans
- ❑ Community-level mosquito control programs
 - Use of pesticides and larvae-eating fish
- ❑ Household and personal protective measures
 - Use air conditioning and install window/door screens
 - Reduce mosquito breeding sites
 - Wear long-sleeved shirts and long pants
 - Apply insect repellents
 - Limit outdoor exposure during peak biting times
- ❑ Screen and remove infected blood products

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WNV Outbreak in the East Valley, 2010

- ❑ Between May and July 2010, increased and sustained WNV activity noted
 - Unusual numbers of WNV-infected mosquitoes trapped
 - 18 human disease cases reported
- ❑ No WNV activity or cases from other areas in AZ
- ❑ Only 20 WNV cases reported in AZ in 2009

WNV infections identified in the East Valley, May–July 2010

	WNV infections (N=55)
	No. (%)
Neuroinvasive disease	31 (56)
Non-neuroinvasive disease	19 (35)
Asymptomatic viremic blood donors	5 (9)

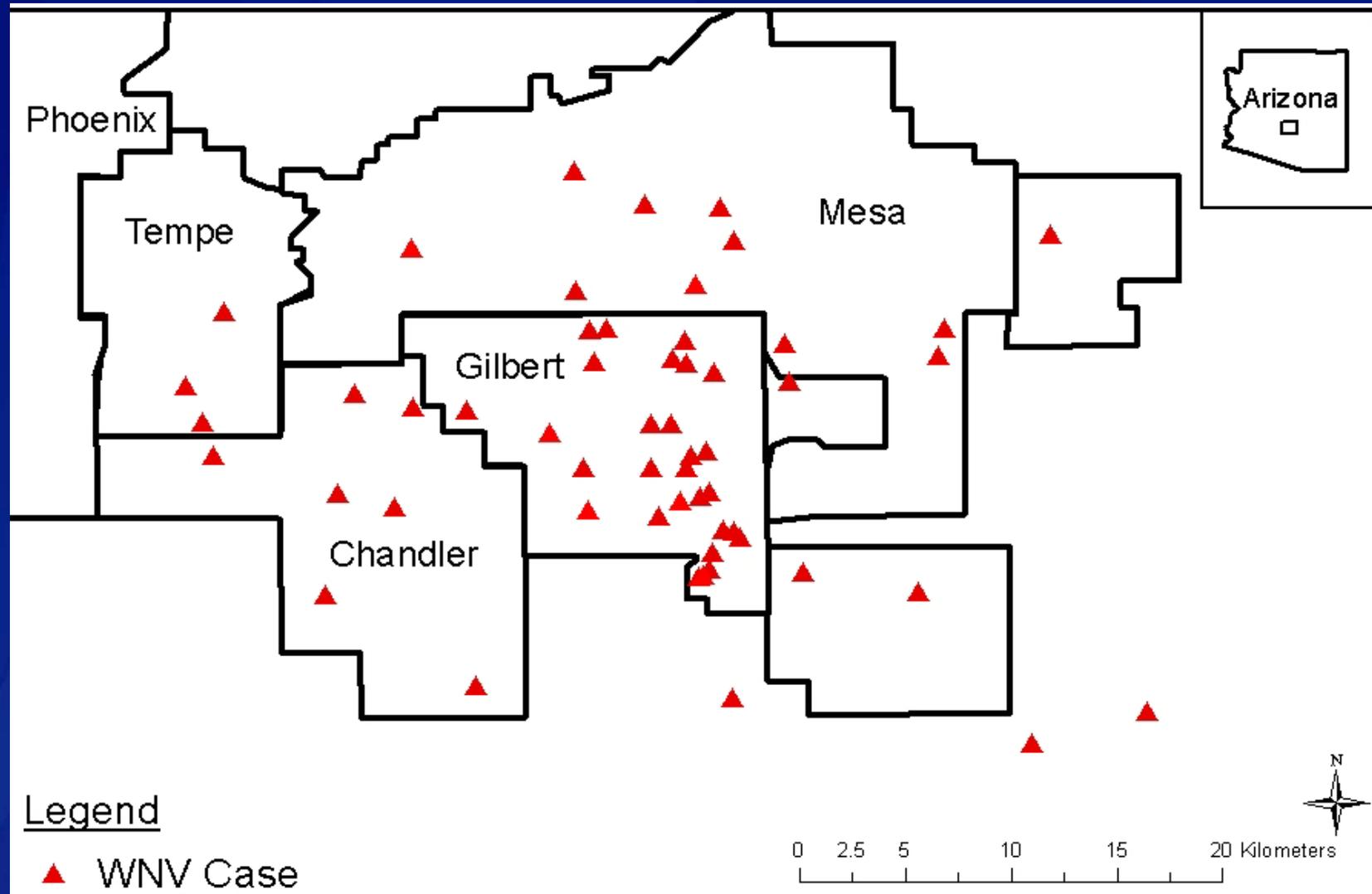
Demographics of East Valley residents identified with WNV infections, May–July 2010

	Neuroinvasive disease (N=31)	Non-neuro disease (N=19)	Viremic blood donors (N=5)
Male	55%	58%	20%
Age ≥ 60 years	29%	26%	20%
White	71%	73%	100%
Hispanic	16%	5%	0%
County			
Maricopa	90%	100%	100%
Pinal	10%	0%	0%

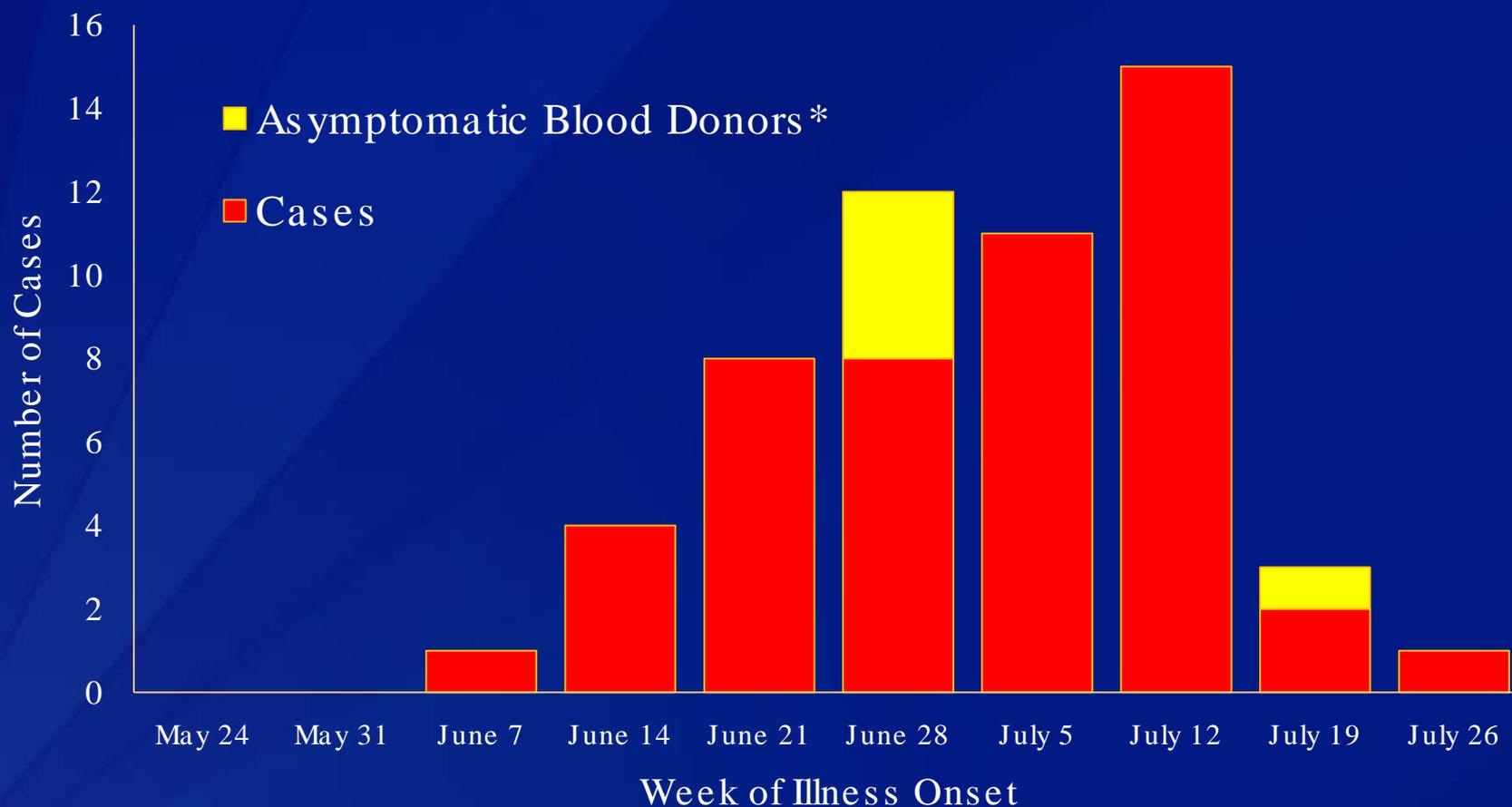
Clinical Characteristics of WNV Disease Cases (n=50)

	Neuroinvasive (n=31)	Non-neuroinvasive (n=19)
	No. (%)	No. (%)
Hospitalized	28 (90)	4 (21)
Died	3 (10)	0 (0)

Geographic Location of WNV Infections



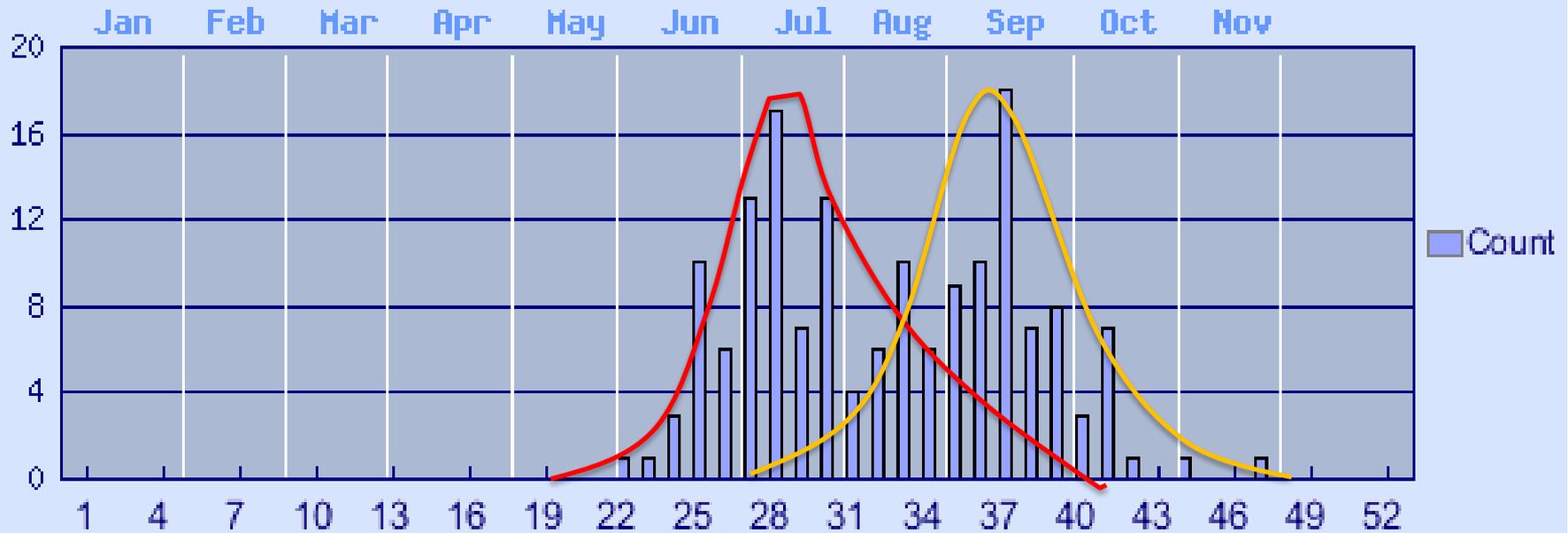
Human WNV Infections Identified in East Valley Residents by Week, May–July 2010



*Reported by collection date

WNV cases in AZ, by week, 2010

West Nile Virus - Human Disease Cases by Week - Arizona, 2010



Onset Month	Jun	Jul	Aug	Sep	Oct	Nov
East Valley cases	18	37	12	7	2	0
Non-EV cases	0	16	16	41	16	2

Data and graph courtesy of Maricopa County and AZ Health Departments

Outbreak Investigation Summary

- ❑ Unusually early and intense outbreak in East Valley
- ❑ Majority of cases had neuroinvasive disease
- ❑ Highest incidence of human disease in Gilbert

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Studies of Risk Factors for WNV Infection

- ❑ Several ecologic studies and geospatial models examined potential environmental risk factors
- ❑ Few studies evaluated behavioral risk factors
- ❑ Limited number of controlled studies

Identified WNV Infection Risk Factors

- Irrigated agriculture
 - Vegetation abundance
 - Green (unmaintained) pools
- } Environment
- Lack community mosquito abatement
 - Low average per capita income
- } Community
- Time outdoors when mosquitoes active
 - Never using insect repellent
- } Behavior

Case-Control Study

- Population-based, case-control study
- Identify environmental and behavioral risk factors for WNV infection
- Refine public health interventions and messages for prevention of WNV infection

Case Definitions

□ Case-patient

- East Valley resident
- Specimen collected May 25–July 31, 2010
- WNV IgM or WNV RNA detected
- Disease cases and asymptomatic viremic donors

□ Control-subject

- East Valley resident
- Specimen collected May 25–July 31, 2010
- WNV IgM and IgG not detected in CSF collected ≥ 4 days or serum collected ≥ 7 days after symptom onset

Data Sources, Data Collected, and Area Included

Source	Example of data collected	Area included
Telephone interview	Demographics, behaviors	
Household visit	Door and window screens	House
	Water-holding containers	Yard
	Flood irrigation, catch basins	≤100m from home
County databases	Reported green pools	≤500m from home
Irrigation maps	Irrigation areas and canals	≤500m from home
GIS	Population density, vacant houses	Census block group

Water Holding Containers



- ❑ Identified during household visits

- ❑ Defined as containers with potential to hold water



- ❑ Located in yard of study participants

Green Pools



- ❑ Unmaintained / unchlorinated pools
- ❑ Reported to county environmental services, May–August, 2010

Catch Basins



- ❑ Depressions in ground where storm water is directed
- ❑ Identified during household visits

Flood Irrigation and Open Canals



- ❑ Flood irrigation identified during household visits



- ❑ Open irrigation canals identified from irrigation maps

Data Analysis

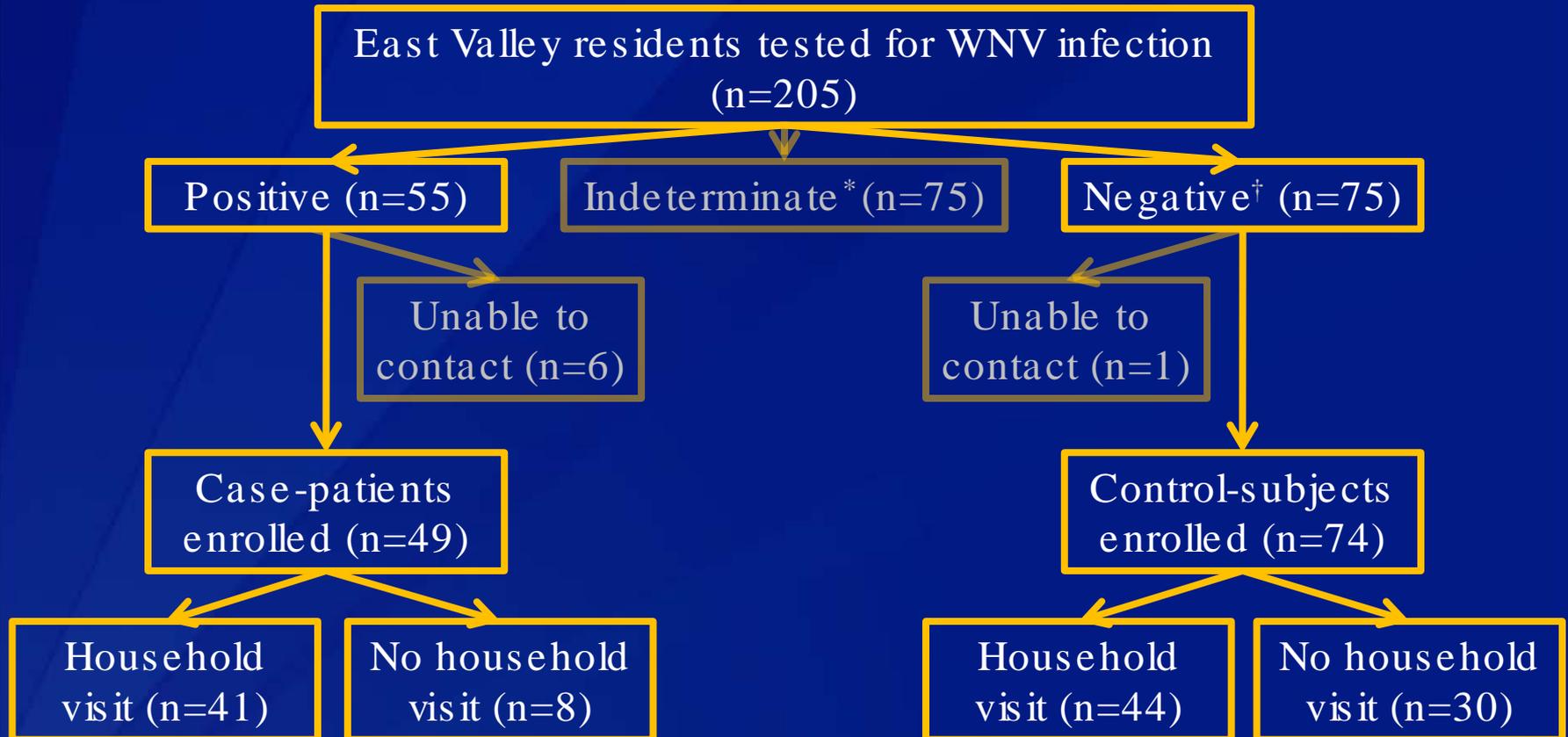
□ Univariate analysis

- Chi square or Fisher's exact tests
- Missing observations excluded

□ Multivariable analysis

- Variables with $p < 0.1$ on univariate analysis and interaction terms
- Logistic regression model using stepwise selection
- Imputation for missing data

Enrollment of Case-Patients and Control-Subjects



* Negative WNV result but timing of specimen collection unknown or inadequate to exclude WNV

† Negative WNV result on CSF collected ≥ 4 days or serum ≥ 7 days after symptom onset

Demographics – Sex, Age, and Race-Ethnicity

	Case-patient		Control-subject		<i>P</i> -value
	n/N	(%)	n/N	(%)	
Male sex	27/49	(55)	29/74	(39)	0.08
Age group (years)					
<20	3/49	(6)	3/74	(4)	
20–39	10/49	(20)	26/74	(35)	
40–59	21/49	(43)	34/74	(46)	
≥60	15/49	(31)	11/74	(15)	0.04
White, non-Hispanic	30/35	(86)	60/72	(83)	

Demographics – Education, Income, Residence

	Case-patient		Control-subject		<i>P</i> -value
	n/N	(%)	n/N	(%)	
High-school graduate	29/44	(66)	56/73	(77)	
Income ≥\$50,000/year	24/40	(60)	38/60	(63)	
Living in city of Gilbert	24/49	(49)	21/74	(28)	0.02

Behavioral Characteristics

	Case-patient		Control-subject		<i>P</i> -value
	n/N	(%)	n/N	(%)	
Stays at home during the day	33/49	(67)	33/74	(45)	0.01
Never wears long sleeves/pants	38/49	(78)	47/74	(64)	0.09
Never uses insect repellent	42/49	(86)	61/74	(82)	
Spends ≥ 1 hour/day outdoors	31/46	(67)	42/73	(58)	
Always uses air-conditioner	41/48	(85)	67/74	(91)	
Keeps windows closed	36/49	(73)	59/74	(80)	

House and Yard Characteristics

	Case-patient		Control-subject		<i>P</i> -value
	n/N	(%)	n/N	(%)	
Water-holding containers	38/41	(93)	31/44	(70)	<0.01
Home built before year 2000	25/49	(51)	49/74	(66)	0.09
Pool at residence	39/41	(55)	30/74	(41)	
Deck or unscreened porch	39/41	(95)	40/44	(91)	
Unscreened doors or windows	32/41	(78)	35/44	(80)	

Irrigation Characteristics

	Case-patient		Control-subject		<i>P</i> -value
	n/N	(%)	n/N	(%)	
Lives in or near water district X*	16/49	(33)	12/74	(16)	0.03
Open irrigation canal*	21/47	(45)	38/67	(57)	
Flood irrigation†	10/41	(24)	8/44	(18)	
Catch basins†	18/31	(58)	25/38	(66)	

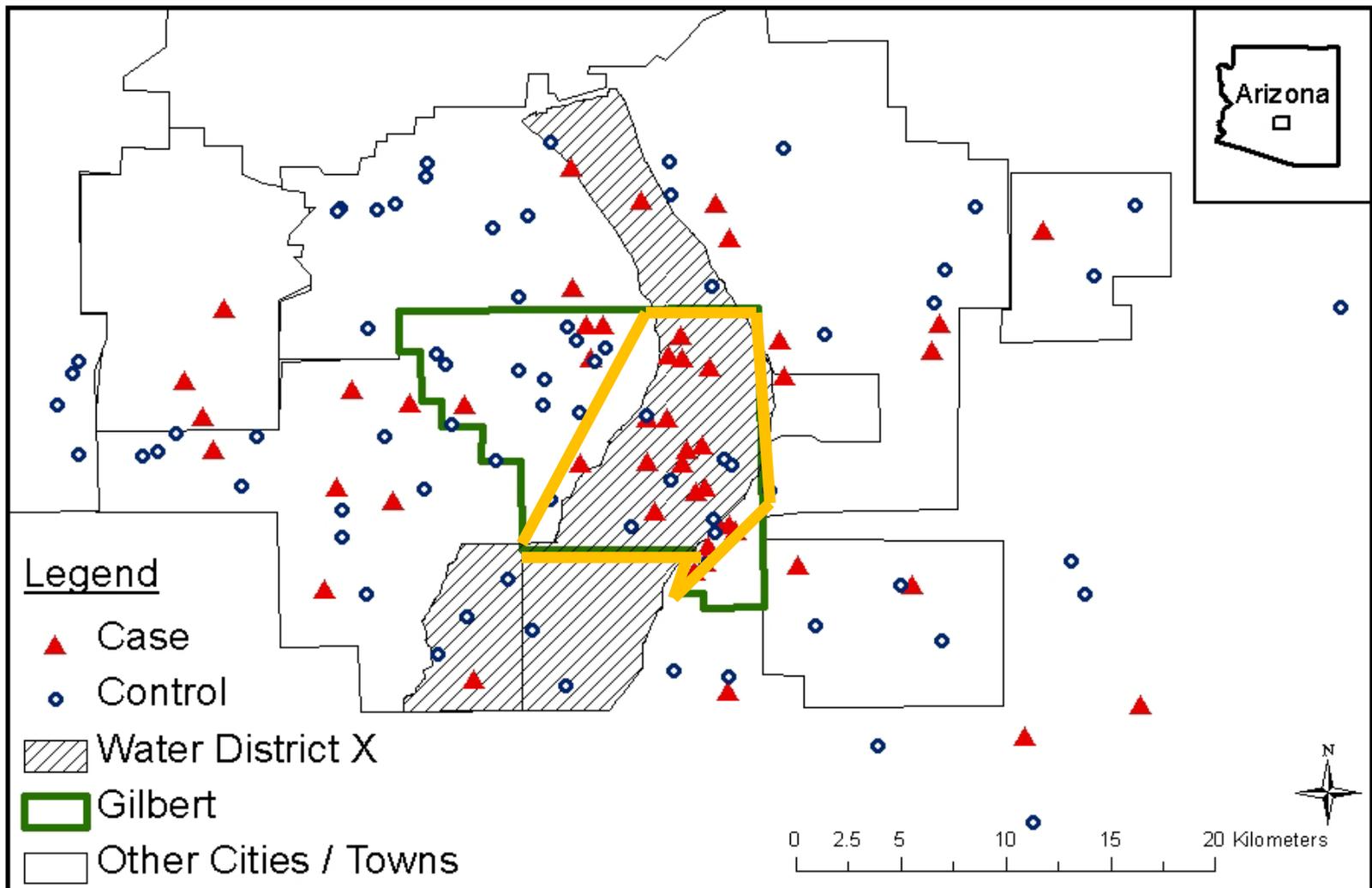
* Within 500m of home; † Within 100m of home

Other Environmental Characteristics

	Case-patient		Control-subject		<i>P</i> -value
	n/N	(%)	n/N	(%)	
Green pools*	22/49	(45)	20/74	(27)	0.04
Pop. density <1000/sq. mile†	3/49	(6)	12/74	(16)	0.08
≥25% of houses vacant†	8/49	(16)	5/74	(7)	0.09

* Within 500m of home; † Within census block group

Map of Study Participants by Residence



Risk Factors for WNV infection

Multivariable Analysis

Characteristic	Adjusted odds ratio	[95% CI]
Living in / near water district X within Gilbert	5.2	[1.5–18.1]
Water-holding containers in yard	5.0	[1.5–17.1]
Staying at home during the day	2.4	[1.10–5.5]

Limitations

- ❑ Enrollment not complete
- ❑ Sample size relatively small
- ❑ Suboptimal or missing data
- ❑ Unique climate/irrigation methods

Conclusions

- ❑ Focal outbreak of WNV disease in the East Valley of metropolitan Phoenix, 2010
- ❑ WNV infection likely acquired close to home
- ❑ Water-holding containers a modifiable risk factor
- ❑ Role of green pools in WNV transmission still unclear
- ❑ Poor compliance with personal protective behaviors

Acknowledgements

Arizona Department of Health Services

Steven Baty, Ken Komatsu, Craig Levy, Tasha Stewart , Christine Wampler, Naomi Wheeler

Maricopa County Environmental Services

Kirk Smith, John Townsend

Maricopa County Department of Public Health

Andrean Bunko-Patterson, Jamie Feld, Tammy Sylvester, Tricia Wadleigh

Pinal County Division of Public Health

Graham Briggs

CDC

James Colborn, Peggy Collins, Mark Delorey, Rebecca Eisen, Marc Fischer, Katherine Gibney, Marvin Godsey, Janeen Laven, Jennifer Lehman, Jessica Mack, Katherine MacMillan, John-Paul Mutebi, Amanda Panella

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.