The 2003 West Nile virus United States epidemic: the America's Blood Centers experience

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BACKGROUND: A detailed assessment of West Nile virus (WNV) yield is needed to evaluate the effectiveness of the WNV nucleic acid amplification technology (NAT) screening implemented in 2003.

STUDY DESIGN AND METHODS: WNV NAT screening and donation data were compiled from members of America's Blood Centers, which collect nearly 50 percent of the US blood supply. WNV RNA screening was performed with either the Gen-Probe/Chiron Procleix transcription-mediated amplification assay or the Roche TaqScreen polymerase chain reaction. Results of alternate NAT and WNV immunoglobulin M (IgM) antibody assays conducted on index and follow-up samples were obtained from test manufacturers. Presumed WNV positivity was based on NAT repeat reactivity of the individual index donation whereas confirmatory status was based on additional IgM testing of the index donation and NAT and serology testing of follow-up samples.

RESULTS: From July through October 2003, 2.5 million donations were screened for WNV RNA. Of 877 NAT-reactive donations (screening positivity rate of 3.5 per 10,000 units), 430 (49%) were confirmed positive, whereas 68 (8%) lacking follow-up data remained presumed positive. The sensitivity and positive predictive value of a presumed viremic result relative to final confirmatory status were 92 and 99 percent, respectively. WNV activity was highest in the central plains with prevalence per 10,000 peaking August 1 to 15 in Colorado (67.7) and South Dakota (77.5) and August 16 to 31 in Wyoming (74.1) and North Dakota (102.0).

CONCLUSIONS: WNV screening interdicted many viremic units, thereby reducing transfusion-transmitted infections. This study demonstrates that a national collaborative effort facilitates timely surveillance of blood donor infectious disease prevalence rates.

A significant geographic and temporal variation in clinical West Nile virus (WNV) cases was reported by the Centers for Disease Control and Prevention (CDC) in 1999 through 2002 and similar variability was observed in retrospective nucleic acid amplification technology (NAT) screening of US blood donors in the latter stages of the 2002 epidemic.[1,2] Based on these data, the need was recognized for a detailed geographic, temporal, and demographic national assessment of WNV yield following the implementation of WNV minipool (MP) NAT screening under FDA approved investigational new drug (IND) protocols in late June to early July 2003.[3] Furthermore, such assessment could define the potential usefulness of real-time donor screen-

ABBREVIATIONS: ABC = America's Blood Centers; ARC = American Red Cross; ID(s) = individual donation(s); IND = investigational new drug; MP(s) = minipool(s); TMA = transcription-mediated amplification; WNV = West Nile virus.

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ing data for epidemiologic surveillance. To achieve these goals, a collaborative program was established to collect and analyze such data during the peak WNV season from members of America's Blood Centers (ABC).

During the summer of 2003, an interagency West Nile Task Force (consisting of blood organizations and PHS agencies), in conjunction with the two WNV NAT manufacturers, developed a case definition for presumptively West Nile viremic donors. This definition was used for rapid assessment of index-donation WNV NAT results to decide if modifications of WNV blood safety policies were needed; subsequently, the CDC published data on presumptive viremic donors in its WNV activity reports.[4,5] An additional aim of this study was to use data from follow-up visits of WNV NAT–reactive donors to evaluate the usefulness (i.e., the sensitivity and positive predictive value [PPV]) of the presumptive viremic definition.

MATERIALS AND METHODS

Compilation of WNV NAT–reactive donations and total donations screened

Data were obtained from 72 ABC member blood centers comprising 90 US blood collection facilities (this included 18 United Blood Services/Blood Systems centers) (Fig. 1); all but 2 ABC members participated in this study. (Data were also received from an additional participating ABC member center in Canada [Héma-Québec, Quebec, Canada] but were not included in the data analysis.) Information on the number of screened donations and WNV NAT results obtained between July 1 (when most sites implemented WNV NAT screening) and October 31, 2003 (when WNV activity had substantially decreased), was compiled by all participating sites on a semimonthly basis with a data-capture system designed by Westat (Rockville, MD), the coordinating center for the study. Microsoft Excel and

Fig. 1. Participating ABC US collection sites: 72 members representing 90 collection facilities.

Word templates, designed for uniform capture of information on the number of donations screened, and number and demographics (age, sex, ZIP code) of donations that were reactive for WNV RNA, were distributed to all collection sites. Each participating site entered relevant information into one of these templates on a semimonthly basis and transmitted these files to Westat. The coordinating center used computer software (SAS System, Version 8.2, SAS Institute, Cary, NC) to compile all data received from the 90 sites in a data set to allow for further analysis.[6]

WNV RNA testing was performed at 24 laboratories under FDA-approved IND protocols, with either the Procleix transcription-mediated amplification (TMA) assay (Gen-Probe Inc., San Diego, CA; Chiron Corporation, Emeryville, CA) conducted on MPs of 16 or on individual donations (ID) or polymerase chain reaction (PCR) assay (TaqScreen, Roche Molecular Systems, Pleasanton, CA) conducted on MPs of 6 donations. Sixty-one and 39 percent of donations were screened by the TMA and TaqScreen PCR assays, respectively. Two centers performed ID NAT on all donations for all or part of the study period based on local policy decisions and three centers temporarily implemented ID NAT based on an observed high MP NAT rate.

WNV NAT presumed positive and confirmatory case definitions

Each WNV laboratory resolved all reactive MPs to the individual donation level. Reactive ID samples (either from MP or from ID NAT screening) were then retested to allow for further classification into presumptive viremic donors (probable true-positive donations) and presumed negative donors (i.e., false-positive NAT screening results) in a timely fashion. For the Gen-Probe assay system, a donation was classified as presumptive viremic if a repeat Gen-Probe TMA conducted on the NAT-reactive donation was also reactive. In the Roche testing system, a donation was presumptive viremic if an alternate PCR (National Genetics Institute, Los Angeles, CA) conducted on the index NAT tube or a Roche TaqScreen PCR conducted on an alternate plasma source from the index donation was reactive.

Additional testing was conducted according to the IND protocols of the NAT manufacturers. These data were provided to the coordinating center, which then added the data to the SAS database. Each manufacturer used a similar confirmatory algorithm. For Gen-Probe users, repeat Gen-Probe TMA and alternate NAT (a target-capture, real-time PCR assay developed by Chiron Corp. and performed by Bayer Diagnostics Division [Tarrytown, NY]) assays and WNV immunoglobulin M (IgM) (and immunoglobulin G [IgG]) antibody enzyme-linked immunosorbent assays (Focus Technologies, Cypress, CA) were conducted on both index and follow-up samples. For the Roche assay system, additional NAT was conducted on the original index specimen and/or an alternate plasma source from that donation and on follow-up samples with a repeat Roche TaqScreen PCR and the alternate National Genetics Institute PCR. IgM and IgG antibody testing and plaque neutralization testing for positive IgM or IgG results was performed on both index and follow-up samples at the California Department of Public Health with the protocol and reagents supplied by the Centers for Disease Control and Prevention (CDC). Donations evaluated by either manufacturer were confirmed as WNV-positive if the index donation was positive for IgM or if the follow-up samples were reactive on a NAT assay and/or were IgM positive. Donations whose index sample was IgM-negative and whose follow-up samples tested did not react by all supplementary assays (NAT and IgM) were deemed confirmatory negative (i.e., false-positive). If follow-up sample data were not available, donations were classified as presumed positive or presumed negative based on index donation results. Donations were classified as indeterminate if they either lacked most supplementary test result information or had contradictory findings (such as an isolated reactive alternate NAT on a follow-up sample with otherwise negative results).

Collecting the demographic distribution of donations

Westat sent each center an Excel spreadsheet template designed to capture information on the age (at the time of donation), sex, and the first 3 digits of the ZIP code of residence of donors who had given blood at their center in each of the 4 months of interest (July through October 2003). These data were then compiled in a SAS data set. The 3-digit ZIP code was used because this parameter captures a broader geographic area than does the standard 5-digit ZIP code, i.e., all 5-digit ZIP codes with the same first 3 digits are aggregated together in one 3-digit ZIP code. Not all centers were able to provide demographic information. Hence, 3-digit ZIP code, sex, and age information were obtained on 2.35 (93%), 2.33 (93%), and 2.29 (91%) of 2.51 million donations, respectively. To identify the state of residence, we used the zipname (zip) SAS function[7] to assign each ZIP code to its corresponding state. Geographic information system mapping software (ArcView 8.2, ESRI Redlands, CA) was used to map prevalence estimates within states or 3-digit ZIP code areas with 3-digit ZIP code and state boundaries provided by Geographic Data Technology (GDT, Lebanon, NH, October 2002).

Human subjects approval

The IND protocols, which included donor consents for WNV NAT screening and follow-up testing, were reviewed

and approved by multiple institutional review boards and the FDA. The REDS/ABC Surveillance study protocol was reviewed by Westat's Institutional Review Board before implementation and was found exempt from the regulation requirements because all data were devoid of personal identifiers. Some participating blood centers also obtained approval from their institutional review boards before releasing identifier-free data to the coordinating center.

Statistical analysis

The prevalence of WNV NAT–positive donations (i.e., viremic rate) per 10,000 donations was derived by dividing the number of WNV NAT confirmed plus presumed positive donations by the number of donations screened and multiplying by 10,000. To estimate the number of donations screened within each age, sex, or geographic (state, 3-digit ZIP code area) stratum, we applied the monthly demographic distribution supplied by each center to the total number of donations screened. We assumed that the centers' monthly demographic distributions were similar in the first and second halves of each month. Hence, if Center A reported that 45 percent of their donations were given by female donors in July 2003 and stated that WNV NAT screening was conducted on 3000 and 2500 donations for the periods July 1 to July 15 and July 16 to July 31, respectively, we estimated that the number of WNV NAT screened female donations at Center A was 1350 (0.45×3000) for the July 1 to July 15 period and 1125 (0.45×2500) for July 16 to July 31. To calculate the 95 percent confidence interval (CI) around prevalence estimates with known denominators (e.g., total number of donations screened), we assumed that the number of positive donations was binomially distributed.[8] When the denominator was estimated (i.e., number of screened donations in a demographic stratum), the estimated number of donations was conservatively assumed to be Poisson-distributed, and an approximate 95 percent CI around the prevalence estimate was obtained by combining the CIs for the binomially distributed numerator and the Poisson-distributed denominator.[8]

RESULTS

A total of 2,512,218 donations were screened by WNV NAT between July 1 and October 31, 2003, at the 90 US participating collection facilities shown in Fig. 1. There were 877 NAT-reactive donations, for an overall NAT-reactive screening rate of 3.5 per 10,000 donations (95% CI, 3.3-3.7). This also represented the unit discard rate because all such donations were removed from distribution. These rates increased from 2.1 per 10,000 donations in the first half of July to 6.2 in the latter half of August and gradually decreased thereafter.

Presumed and confirmed positive donations

As indicated in Table 1, MP NAT screening was conducted on 96 percent of donations and ID NAT on 4 percent. MP NAT identified 60 percent of the NAT screening reactive donations (n = 523), of which 384 (73%) were positive by the confirmatory algorithm. ID NAT identified the remaining 40 percent (n = 354), of which only 13 percent were positive by the confirmatory algorithm. Of the 877 NAT-reactive donations identified by either method of screening, 430 (49%) donations were confirmed positive and an additional 68 (8%) were classified as presumed positive because they met the presumptive viremic definition but lacked follow-up data.

Figure 2 shows the confirmatory results for donations whose classification at the time of index donation was presumptive viremic or presumptive negative. Of 392 presumptive viremic donors with follow-up data, only 6 (1.5%) were reclassified: 4 as presumed negative and 2 as indeterminate. In contrast, of 252 NAT screening–reactive presumptively negative donors, 32 (12.7%) were reclassified as confirmatory positive. These data allow us to compute that the sensitivity of a presumptive viremic designation compared to confirmatory results is 92 percent and its PPV is 99 percent. We also calculated that the negative predictive value of a NAT screening–reactive, presumed negative result when compared to final confirmation testing was 87 percent. The high PPV of a presumptive viremic result allowed us to include both

TABLE 1. WNV status of MP and ID NAT–reactive donations based on the confirmatory algorithm*

Method of screening	Number of donations screened (in millions)	Number (and rate) of NAT screening–reactive donations	Confirmed positive†	Presumed positive†	Confirmatory negative†	Presumed negative†	Indeterminate†
MP NAT	2.42	523	384 (73)	54 (10)	43 (8)	29 (6)	13 (3)
ID NAT	0.09	354	46 (13)	14 (4)	173 (49)	115 (32)	6 (2)
All	2.51	877	430 (49)	68 (8)	216 (25)	144 (16)	19 (2)

* Data are reported as number (%). Percentages may not add to 100 percent due to rounding.
† These are percentages of NAT screening–reactive donations for each method (i.e., MP or ID) of screening.

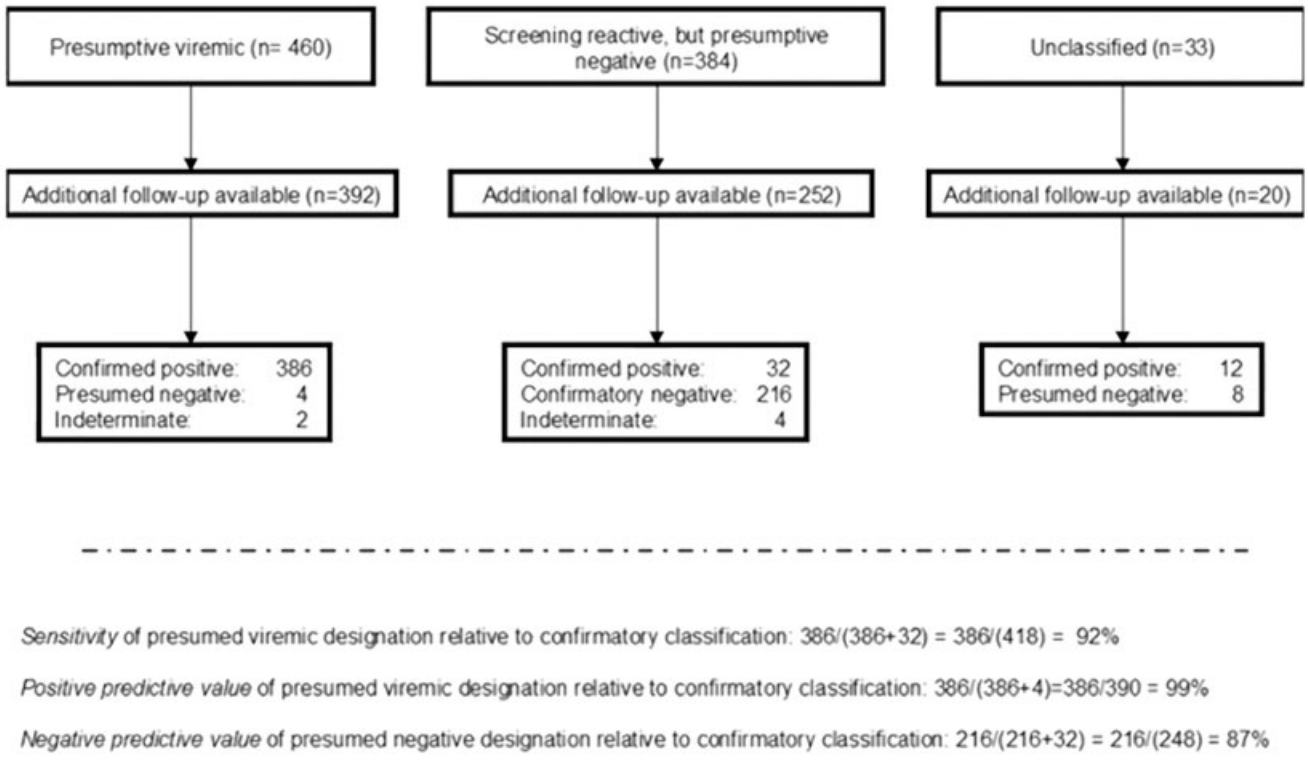

Fig. 2. Relationship between presumptive and final classification of NAT screening–reactive donations.

confirmed viremic and presumptive viremic donations in the detailed analysis of WNV viremic rate presented below.

Rate of WNV RNA–positive donations by time, demographics, and geographic region

Temporal, demographic, and geographic correlates of WNV infection rates were analyzed based on 498 WNV-positive donations, including 430 confirmed viremic and 68 presumed viremic donations. WNV viremic rate was slightly higher in male (2.3; 95% CI, 2.0-2.6) than in female (1.8; 95% CI, 1.6-2.1) donors ($p = 0.02$). WNV NAT prevalence were not significantly different among age groups with point estimates ranging from 1.8 in 26 to 35-year-old donors to 2.3 in 36- to 45- and 46- to 55-year-old donors ($p = 0.41$).

There was significant temporal variation in the epidemic with the highest rates observed in August WNV viremic rates per 10,000 donations at ABC collection sites increased from 0.7 (95% CI, 0.4-1.1) in the first half of July to 4.5 (95% CI, 3.7-5.3) and 4.4 (95% CI, 3.7-5.2) in the first and second halves of August, respectively; these rates decreased to 0.2 (95% CI, 0.1-0.4) by the end of October (Fig. 3).

Figure 4 illustrates monthly WNV NAT prevalence estimates for 23 states where ABC data indicated that ABC members collect at least 50 percent of the blood

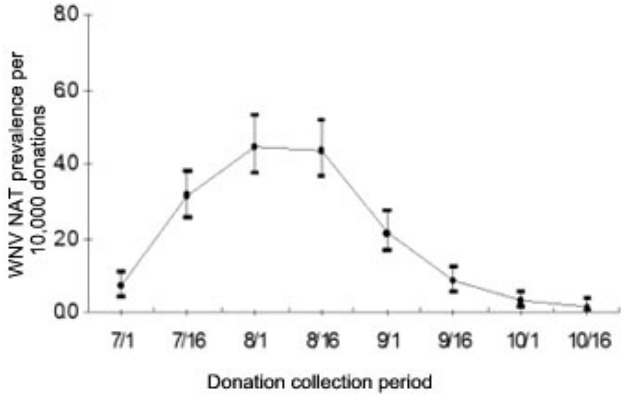

Fig. 3. Prevalence of WNV NAT–positive donations per 10,000 donations for participating ABC US collection sites. WNV NAT prevalence was estimated by dividing the number of WNV NAT cases by the number of donations screened and multiplying by 10,000. The WNV cases consisted of donations that were either confirmed positive or had remained classified as presumed positive because of incomplete follow-up information. The first day of each semimonthly collection period is shown.

donations made in the state. WNV activity was high (defined as >30.0 per 10,000 donations in at least one of the 4 months) in North and South Dakota, Wyoming, and Colorado; moderate (>4.0 to ≤30.0 per 10,000) in New

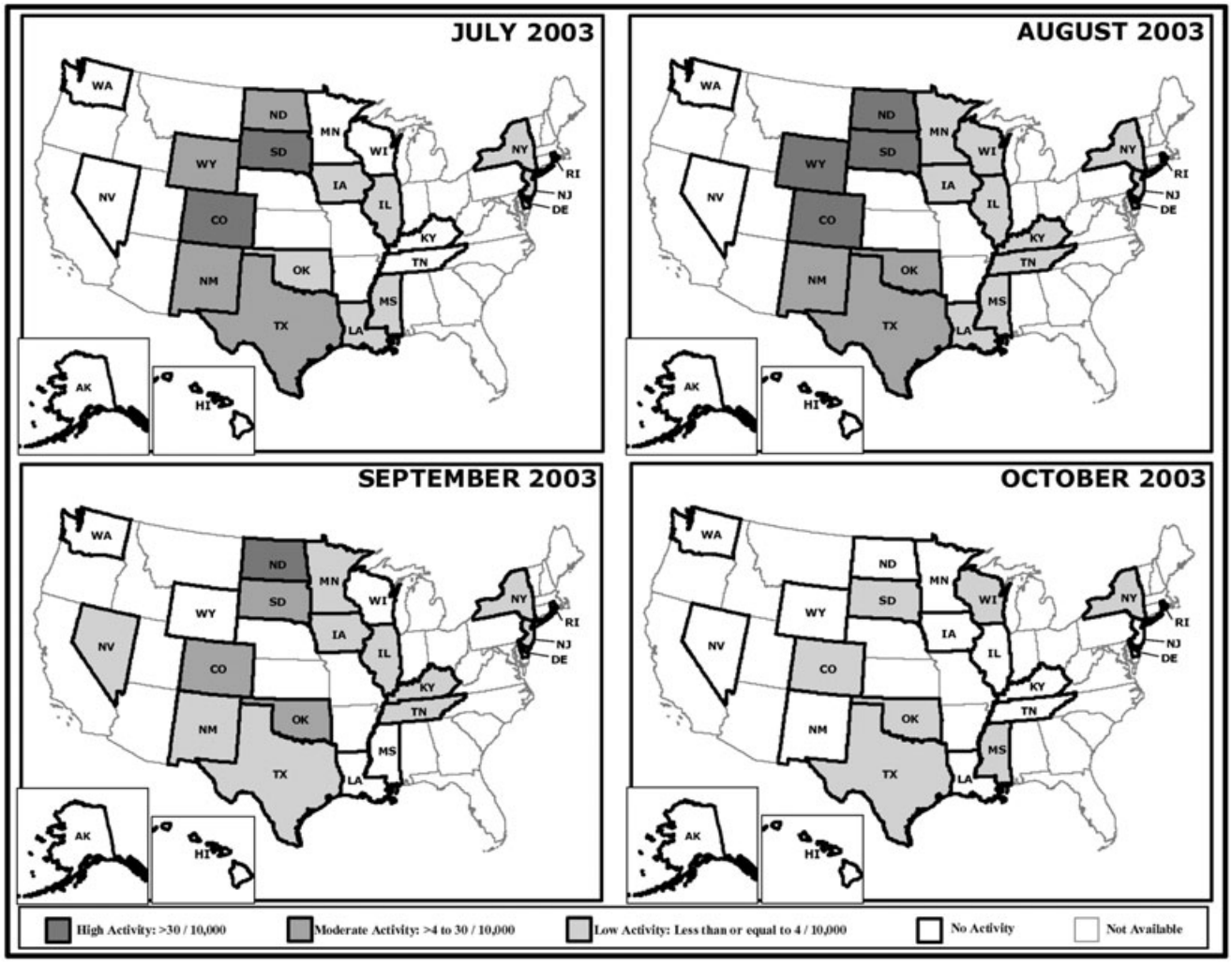

Fig. 4. Monthly prevalence of WNV NAT–positive donations in states where ABC data indicated that ABC members collect at least 50 percent of the blood donations. Based on its distribution across states, monthly WNV NAT prevalence was categorized as high (>30.0/10,000 donations, corresponding to the upper 10th percentile of the distribution of nonzero monthly prevalence estimates per state), moderate (>4/10,000 to £10/10,000, corresponding to the 75th and 90th percentiles, respectively), low (>0.0 to £4/10,000), and zero (0.0/10,000).

Mexico, Oklahoma, Texas, and Delaware; and low (≤4.0 per 10,000) in Mississippi, Minnesota, Tennessee, Louisiana, Illinois, Wisconsin, New York, Kentucky, Iowa, Nevada, and New Jersey. WNV was not detected in donors who resided in Alaska, Washington, Rhode Island, and Hawaii. We also found relatively high WNV viremic rates in 3 additional states (Montana, Nebraska, and Kansas) where ABC member centers collected less than 50 percent of the donations (data not shown), further establishing that WNV activity was highest in the central plains states in 2003.

Data for seven selected states with moderate to high viremic rates are plotted by semimonthly periods in Fig. 5, which shows that point estimates peaked July 16 to 31 in Texas (7.0); August 1 to 15 in New Mexico (10.1), Colorado (67.7), and South Dakota (77.5); and August 16 to 31 in Wyoming (74.1), North Dakota (102.0), and Oklahoma (8.3). For most of the states shown, the epidemic appeared to increase and decrease rapidly with a return to a very low rate of WNV NAT–positive donations within 6 to 8 weeks of onset. The highest semimonthly rate exceeded 1 percent in the latter half of August in North Dakota.

We further characterized WNV NAT prevalence by 3-digit ZIP code areas for the four central plains states (North and South Dakota, Colorado, and Wyoming) with highest activity. As shown in Fig. 6, there was significant variation in WNV activity within these states by area and over time. Some areas showed persistently high rates for 4 to 6 weeks, whereas other areas showed more transient activity peaks. ZIP code areas with high activity could be

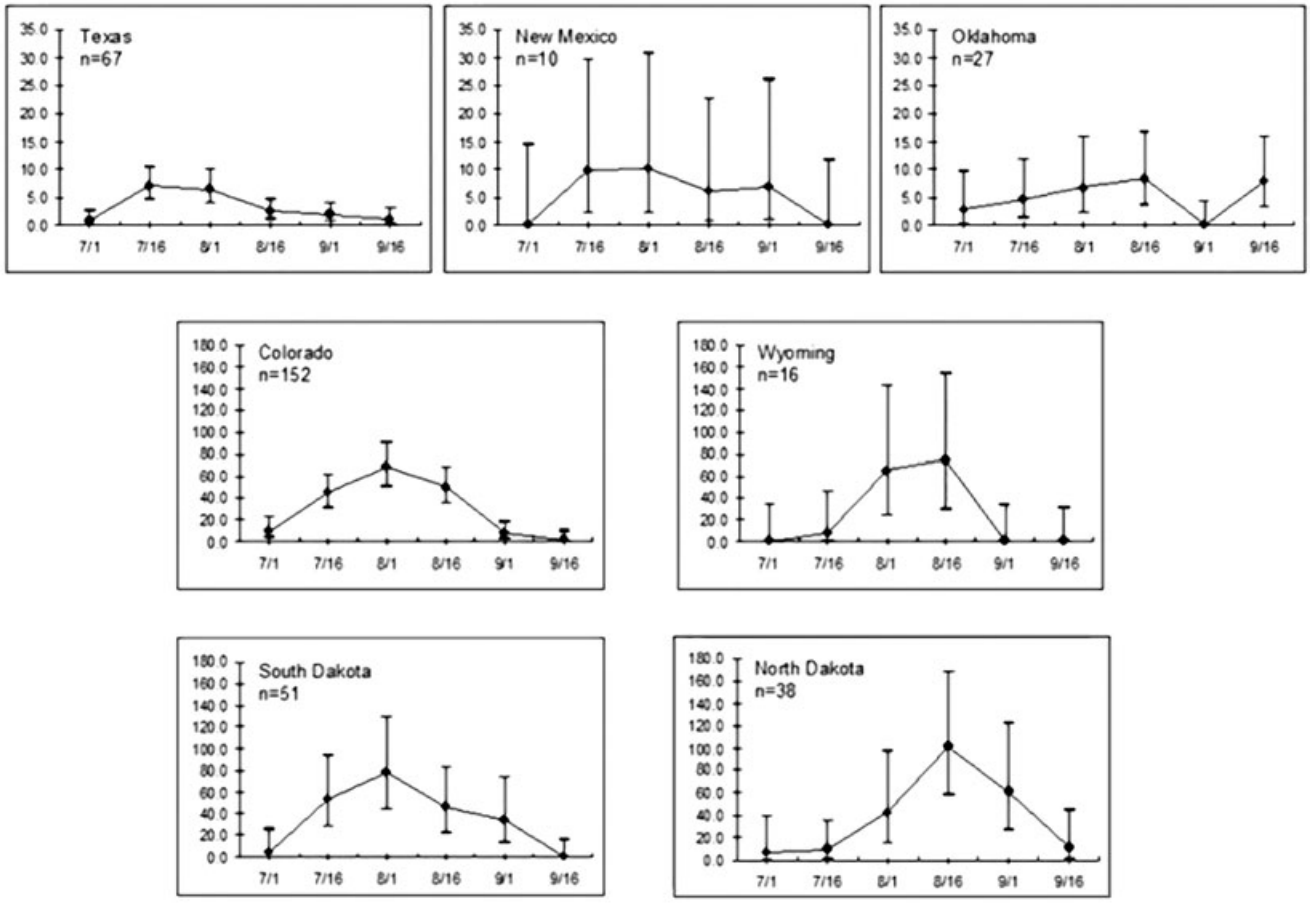

Fig. 5. Semimonthly WNV NAT prevalence per 10,000 donations for seven selected states where ABC members collect at least 50 percent of the blood donations. WNV NAT prevalence estimates per 10,000 donations are shown on the Y axis and the donation collection period on the X axis. The first day of each semimonthly collection period is shown with data plotted for July through September.

contiguous with areas of no detectable activity, even at the height of the epidemic in August.

DISCUSSION

This project collected WNV RNA prevalence data for nearly 50 percent of US blood donations during the 2003 epidemic through the voluntary participation of 72 of the 74 US members of Americas Blood Centers. The 498 viremic donations identified in this study can be combined with the 416 viremic donors reported by the American Red Cross (ARC) to generate a total of 914 prospectively identified West Nile viremic donors nationally.[10] This represents a slight underestimate of 2003 WNV testing yield because it excludes viremic donors identified by participating ABC centers outside of the July 1 to October 31 study time frame as well as viremic donors identified at nonparticipating ABC centers, non-ABC community blood centers, and hospital-based blood collection centers and through the military blood program. Also, donors identified by retrospective studies that applied individual donation NAT to MP NAT–negative specimens from high-yield regions are not included.[2,9,10] These aggregate ABC and ARC data therefore support the published estimate that there were approximately 1000 West Nile viremic donors identified in the US in 2003 by prospective ID or MP NAT screening and that approximately 1500 potentially infectious blood components were interdicted before transfusion.[5]

A major goal of this project was to monitor the demographic, geographic, and temporal rates of confirmed WNV viremia in the US blood donor population. WNV infection rates, as indicated by RNA-positive donations, were slightly higher in men than in women but did not vary significantly with age. Significant geographic and temporal variation was observed, as had been previously observed for clinical WNV cases in the 1999 to 2002 epidemics.[1] The statewide WNV NAT–positive prevalence patterns documented in asymptomatic viremic donors in this study were reflective of the rates of symptomatic clin-

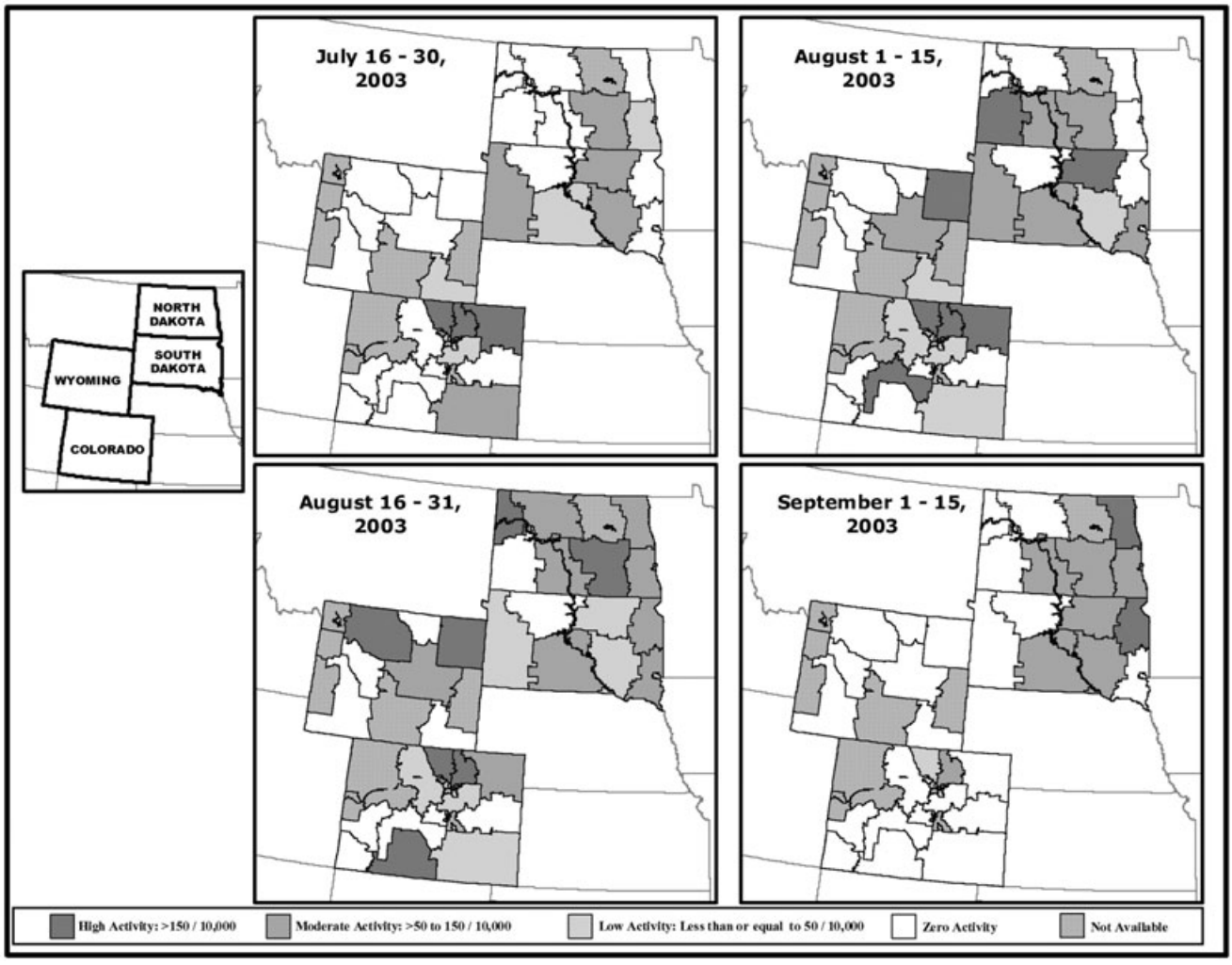

Fig. 6. Semimonthly prevalence of WNV NAT–positive donations in four central plains states by 3-digit ZIP code areas. Based on its distribution across 3-digit ZIP code areas, semimonthly WNV NAT prevalence was categorized as high (>150/10,000 donations, corresponding to the 75th percentile of the distribution of nonzero semimonthly prevalence estimates per 3-digit ZIP code), moderate (>50/10,000 to £150/10,000, corresponding approximately to the 40th and 75th percentiles, respectively), low (>0/10,000 to £50/10,000), and zero (0.0/10,000). WNV NAT prevalence for 3-digit ZIP code areas with <50 donations per semimonthly period are not presented.

ical cases reported by state health departments to the CDC for the same time interval for 2003.[4,5] In addition, we performed a more detailed 3-digit ZIP code analysis in the four states with the highest WNV prevalence and documented substantial intrastate variability. Ideally, the next step in an analysis would be an intrastate comparison of blood donor data and CDC clinical case data. The CDC, however, tabulates case data on a county basis, whereas this information is not routinely available for blood donors. Thus, a more detailed analysis was not currently possible since a given 3-digit ZIP code can overlap several counties and there is no simple way to transform 3-digit ZIP code data to county data. In an attempt to derive additional insight regarding the public health significance of blood donor screening data, we have forwarded ZIP code and date of detection data for WNV-positive donors for six states with significant 2003 epidemic activity to CDC (all states shown in Fig. 5 except for Oklahoma) to allow for correlations with other data elements (e.g., time of detection and reporting of clinical cases of WNV disease and sentinel animal activity) collected by the CDC ArboNET system.

This study documented a high sensitivity (92%) and a very high PPV (99%) of a presumptive viremic result relative to confirmatory testing, thus substantiating the use of this definition to inform policy decisions in 2003 and 2004. These decisions include initiating targeted ID NAT blood donor screening in areas of high WNV incidence and the implementation of mosquito control programs by county or state health departments.[11] For purposes of our geo-

graphic and temporal analysis, the high PPV supported grouping presumed positive cases (in which adequate donor follow was not available) with confirmed positive cases. The lower negative predictive value (87%) of a presumed negative result emphasizes the importance of donor follow-up for accurately notifying donors of their infection status and for capturing all viremic cases for epidemiologic analysis.

The false positivity and unit discard rate for units screened by ID NAT (which was performed primarily with the TMA assay) was much higher than for MP screening. This is a consequence of a false-positive ID result occurring based on a single screening assay determination, whereas a false-positive MP result requires two successive reactive results (one at the level of MP screening and the second on resolution ID testing). The increased ID-NAT discard rate observed in our 2003 data has been significantly reduced for NAT screening in 2004, owing to reformulation of the TMA assay to increase its specificity.[12]

A recent NHLBI-sponsored collaborative effort among ARC, ABC, and NAT manufacturers resulted in a national compilation of hepatitis C virus and human immunodeficiency virus MP NAT yield data,[13] but no formal ongoing mechanism exists in the US to compile and analyze national infectious disease blood donor screening data. Most US analyses have either relied on data from the ARC (representing approx. 40% of US blood collections) or the Retrovirus Epidemiology Donor Study (representing 8% of US blood collections obtained at five blood centers). In this study, the collaboration of multiple independent blood centers, the two NAT manufacturers (who supplied confirmatory data acquired as part of their IND program), a central coordinating center, and an external funding source was necessary to optimize data collection. Data were obtained from blood collection organizations rather than from testing laboratories to capture the geographic (ZIP codes of residence) and demographic (age, sex) distribution of all donations tested by WNV NAT as well as for WNV NAT–positive donations.

A similar data collection activity has not been undertaken in 2004 because of lack of ongoing funding. Compared to 2003, NAT manufacturers have improved their data compilation programs from their client laboratories and these data have been shared with the WNV interagency task force in 2004. A possible mechanism for more in depth analysis of West Nile viremic blood donors may be accomplished through close collaboration of blood collectors with state and county health departments, which may lead to a more complete national reporting of WNV presumptive viremic donors to the CDC. While local collaboration should permit timely local monitoring of the epidemic, a detailed national geographic and demographic analysis of 2004 donor WNV NAT screening data will not be possible.

We support establishment of a national system that compiles and combines ARC and ABC data enabling ongoing and timely surveillance of all infectious disease marker rates. Such data, which are currently available from a number of other countries, would allow epidemiologic analyses of donor infection rates and tracking of test performance for established agents, as well as more effective response to emerging agents such as WNV.

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APPENDIX

ABC Blood Collection Facilities and Key Participants:
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Kevin Land, Carter BloodCare, Bedford, TX
Louise Franco, Patrick Sadler, Central California Blood Center, Fresno, CA
Carla Potts, Cathy Mikus, Central Illinois Community Blood Center, Springfield, IL
Susan Hatley, Kristi Wright, Central Kentucky Blood Center, Lexington, KY
Cindy Grigoryan, Central Pennsylvania Blood Bank, Hummelstown, PA
Lois Knafler, Anna Lea Spaulding, Coastal Bend Blood Center, Corpus Christi, TX
Mary Townsend, Deb Anderson, Coffee Memorial Blood Center, Amarillo, TX
Joseph Hulina, Community Blood Center (Dayton), Dayton, OH
Michelle Tompkins, Blood Bank of Delaware/Eastern Shore, Newark, DE
Alejandro Rey, Florida Blood Services, St Petersburg, FL
Marsha Bertholf, Florida Georgia Blood Alliance, Jacksonville, FL
Susan Rossman, Richard Plumlee, Gulf Coast Regional Blood Center, Houston, TX
Janet Clark, Blood Bank of Hawaii, Honolulu, HI
Kathie Clark, Judy Pestavento, Heartland Blood Centers, Aurora, IL
France Bernier, Hema-Quebec, Saint-Laurent, Quebec, Canada
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Gregg Boothe, Jody Hupp, Hoxworth Blood Center, University of Cincinnati Medical Center, Cincinnati, OH
Bobbie Burr, Community Blood Services of Illinois, Urbana, IL
Linda White, Indiana Blood Center, Indianapolis, IN
Kristen Hoekendorf, Central Blood Bank, Pittsburgh, PA
Carolyn Houk, Lane Memorial Blood Bank, Eugene, OR
Edward Scott, Marie Broy, Mid-South Regional Blood Center, Memphis, TN
Nikki Watlington, Lifeline Blood Services, Jackson, TN
Gary Levy, Marie Sanders, LifeShare Blood Centers, Shreveport, LA
Sharon Gordon, LifeSource Blood Services, Glenview, IL
Marek Fried, Monica Kaczmarek, LifeSouth Community Blood Centers, Gainesville, FL
Lisa Robertson, Memorial Blood Centers, Minneapolis, MN
Judy Kremers, Michigan Community Blood Centers, Grand Rapids, MI
Dale Driver, Mississippi Blood Services, Jackson, MS
Linda Gerber, Lisa Holdorf, Mississippi Valley Regional Blood Center, Davenport, IA
Laurie Sieg, Community Blood Bank of the Lancaster County Medical Society, Lincoln, NE
Eric Senaldi, The Blood Center of New Jersey, East Orange, NJ
Debra Kessler, New York Blood Center, New York, NY
Amy Weed, Northern California Community Blood Bank, Eureka, CA
Mary Bowden, Northern Illinois Blood Bank, Rockford, IL
Janet Comi, Community Blood Bank of Northwest Pennsylvania, Erie, PA
Kelli Riggins, Oklahoma Blood Institute, Oklahoma City, OK
Nora Hirschler, Artina Chinn, Blood Centers of the Pacific, San Francisco, CA
Margy Flowers, San Diego Blood Bank, San Diego, CA
Bruce Lenes, Sharon Edie, Community Blood Centers of South Florida, Fort Lauderdale, FL
Debbie Nennstiel, Southeastern Community Blood Center, Tallahassee, FL
Jerome Gottschall, JJ Rauter, Carla Beck, The Blood Center of Southeastern Wisconsin, Milwaukee, WI
Fran Mooney, Stewart Regional Blood Center, Tyler, TX
Michael West, Texoma Regional Blood Center, Sherman, TX
Julie Bouchard, Virginia Blood Services/Astraea, Richmond, VA
Juanita Roesslet, Community Blood Center of the Ozarks, Springfield, MO
Gary Tegtmeier, Cherie Erickson, Community Blood Center of Kansas City, Kansas City, MO
Dawn Factor, Bonfils Blood Center, Denver, CO
Ange Strollo, Bill Lachenauer, United Blood Services, Phoenix, AZ, Scottsdale, AZ, El Paso, TX, Albuquerque, NM, Lubbock, TX, Meridian, MS, McAllen, TX, Cheyenne, WY, Reno, NV, Lafayette, LA, Las Vegas, NV, Billings, MT, Rapid City, SD, Fort Smith, AR, Fargo, ND, Tupelo, MS, Ventura, CA
Vicki Finson, United Blood Services, Santa Barbara, CA

Sandy Linauts, Darla Ayala, Puget Sound Blood Center, Renton, WA
Mike Pratt, Yvonne Rios, Florida's Blood Centers, Orlando, FL
Gale Hurley, Blood Bank of Alaska, Anchorage, AK
Volker Dube, Shepeard Community Blood Center, Augusta, GA
Janet Howard, Western Kentucky Regional Blood Center, Owensboro, KY
Helene Laufer, Central Jersey Blood Center, Shrewsbury, NJ
Richard Cluck, Michael Dash, LifeShare Blood Centers–Ohio, Elyria, OH
Stacy DelGrosso, Miller Memorial Blood Center, Bethlehem, PA
Ben Reynolds, Blood Assurance Inc., Chattanooga, TN
Marshall Cothran, Blood and Tissue Center of Central Texas, Austin, TX
Norman Kalman, Annette Emmons, South Texas Blood and Tissue Center, San Antonio, TX
Elaine Tober, Inland Northwest Blood Center, Spokane, WA
Diane Carlson, The Blood Center of North Central Wisconsin, Wausau, WI
Cathy Bryan, Scott Montrose, Blood Bank of the Redwoods, Santa Rosa, CA
Joan Barker, Delta Blood Bank, Stockton, CA
Marcia Mueller, The Blood Center of Iowa, Des Moines, IA
Sally Cornwall, South Bend Medical Foundation, South Bend, IN
Lucille Carbone, Manatee Community Blood Center, Bradenton, FL
Darlene Folan, Rhode Island Blood Center, Providence, RI
Scott Robertson, Northwest Florida Blood Center, Pensacola, FL
Mark Magenheim, Suncoast Communities Blood Center, Sarasota, FL
Kenneth Nollet, Sherri Aceituno, Hospital of Fairbanks, Fairbanks, AK