Annals of Internal Medicine | ARTICLE

The Cost-Effectiveness of Screening the U.S. Blood Supply for West Nile Virus

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Background: **The spread of West Nile virus across North America and evidence of transmission by transfusion prompted the U.S. Food and Drug Administration to encourage the development of methods to screen the blood supply.**

Objective: **To assess the cost-effectiveness of nucleic acid amplification testing for West Nile virus in the U.S. blood supply.**

Design: **Markov cohort simulation.**

Data Sources: **Outcome probabilities estimated from nucleic acid testing done for West Nile virus in 2003, data from the Centers for Disease Control and Prevention, and published literature. Costs were taken from an economic study of West Nile virus infection and from estimated test costs.**

Target Populations: **Transfusion recipients, 60 years of age or older, with and without underlying immunocompromise.**

Time Horizon: **Lifetime.**

Perspective: **Societal.**

Interventions: **The authors compared 6 strategies, taking into consideration minipool (pools of 6 to 16 donations) versus individual donation testing, and the geographic and seasonal nature of West Nile virus activity.**

Outcome Measures: **Costs and effects of each strategy based on the prevention of transfusion-transmitted West Nile virus.**

Results of Base-Case Analysis: **The cost-effectiveness of annual, national minipool testing was $483 000 per quality-adjusted life-year (QALY), whereas the cost-effectiveness of annual, national individual donation testing was $897 000/QALY. The cost-effectiveness of targeted individual donation testing in an area experiencing an outbreak coupled with minipool testing elsewhere was $520 000/QALY.**

Results of Sensitivity Analysis: **In 1-way analyses, the most important influences were the prevalence of West Nile virus and the cost of minipool testing and individual donation testing. The 95% range of results from probabilistic sensitivity analysis for targeted individual donation testing was $256 000 to $1 044 000/QALY.**

Limitations: **The outcomes of West Nile virus infection were based on data from the general population rather than from the population who received transfusions. The results are most useful in the context of geographically focused outbreaks of West Nile virus infection.**

Conclusions: **Using targeted individual donation testing to interdict blood donations that are positive for the West Nile virus is relatively cost-effective but is highly dependent on West Nile virus prevalence.**

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Current screening regulations for donated blood require tests for the direct presence of HIV and hepatitis C virus (HCV) and for the serologic response to infection. The adoption of nucleic acid amplification testing technology (nucleic acid testing) for HIV and HCV RNA dramatically advanced the state of the art in screening donated blood. As a result, the risk for HIV or HCV transmission by transfusion has been reduced to levels that seemed inconceivable 10 years ago (1). Two groups of investigators have estimated the cost-effectiveness of nucleic acid testing for HIV and for HCV. Jackson and colleagues (2) reported results of $5.8 million/quality-adjusted life-year (QALY) for combined HIV and HCV testing. Marshall and colleagues (3) reported results for combined testing and for HIV alone at $9.6 million/QALY and for HCV alone at $1.9 million/QALY. In neither of these studies did the cost-effectiveness of HIV or HCV screening alone or in combination approach the boundary of $50 000/QALY suggested for clinical medicine (4, 5) or the decision rule of approximately $75 000/life-year used by the U.S. Federal Aviation Administration for airplane safety (6).

When nucleic acid testing for HIV and HCV was implemented, West Nile virus emerged as another threat to the safety of the blood supply, and the U.S. Food and Drug Administration encouraged blood banks and test developers to collaborate in developing appropriate assays (7). Under investigational new drug status, blood banks since June 2003 have used minipool nucleic acid testing (the size of the pool consists of 6 to 16 donations depending on the test manufacturer), individual donation testing, or a combination of both to screen for West Nile virus RNA (8).

The yield of testing for West Nile virus has varied depending on whether a region experiences an outbreak. In some states, the yield has been exceptionally high with a

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peak prevalence per 10 000 donations of 68 in Colorado, 78 in South Dakota, and 102 in North Dakota during 2-week intervals in 2003 (9). Strong evidence of transfusion-transmitted West Nile virus (10, 11) and the high yield from screening donated blood (12, 13) suggest that nucleic acid testing for West Nile virus may be more cost-effective than nucleic acid testing for HIV or HCV. We assessed the cost-effectiveness of blood screening strategies for West Nile virus from the societal perspective.

Context

Since June 2003, U.S. regulations have required blood banks to screen donated blood for West Nile virus using nucleic acid amplification tests. The cost-effectiveness of such screening is unknown.

Contribution

The most cost-effective strategy was annual, national minipool testing, which pools 6 to 16 donations and tests for West Nile virus. Individual donations are tested only when the pool tests positive. This strategy cost $483 000 per quality-adjusted life-year saved, substantially more than society pays for other health care interventions.

Implications

Eradicating West Nile virus from the blood supply is an inefficient use of resources.

–The Editors

METHODS

Cost-effectiveness was determined by using a Markov cohort simulation model (**Appendix Figure**, available at www.annals.org) designed to assess safety interventions for donated blood (2, 14–17). Each patient in the cohort receives 1 unit of whole blood or an equivalent amount of component (erythrocytes, platelets, or fresh-frozen plasma) from a single donor. We assumed that each donated unit of blood is processed into 1.45 units of transfused components (18) and that each transfusion occurs in patients who are 60 years of age and carries the independent risk of a transfusion-transmitted infection. The core structure of the model and values for all variables are provided in the Appendix (available at www.annals.org).

Testing Strategies

We analyzed 6 strategies for blood screening that account for 3 factors: 1) minipool or individual donation testing; 2) seasonal outbreaks; and 3) geographically focused activity (**Table 1**). No testing (strategy 1) is included to establish the cost-effectiveness of other strategies relative to a common baseline. We included 2 minipool-only strategies: half-year testing and year-round testing (strategies 2 and 3). Mixed testing strategies assume that minipool testing will be conducted when individual donation testing is not conducted. We included 2 periods for individual donation testing, year-round and one third of the year. Also, we divided the United States into 4 geographic regions with undefined boundaries, so that individual donation testing could be targeted to one quarter of the country experiencing an outbreak or to the entire country. The current practice at the American Red Cross and at Blood Systems Laboratories, which together screen more than 70% of donated blood for West Nile virus, is approximated by strategy 4: seasonal, geographically targeted individual donation testing. Strategies 5 and 6 represent increasing use of individual donation testing, and strategy 7 represents individual donation testing only.

Risk for Transfusion by Transmission

Transfusion-transmitted West Nile virus is a function of the donations that test positive for West Nile virus and is incorporated into the model as the residual risk for transfusion-transmitted West Nile virus resulting from each strategy. We assumed that all approximately 1000 confirmed positive donations identified in 2003 (19, 20) would lead to transfusion-transmitted West Nile virus infection had testing not been in place (**Appendix Table 1**, available at www.annals.org).

Each testing laboratory resolves initial West Nile virus–reactive donations through confirmatory testing algorithms that vary from blood bank to blood bank; however, these algorithms typically include replicate nucleic acid testing and testing for serologic response to West Nile virus

Table 1. **Summary of Blood Supply Screening Strategies Evaluated in the West Nile Virus Nucleic Acid Testing Cost-Effectiveness Analysis**

Strategy	Description of Each Strategy	Abbreviated Description
1	No screening	–
2	National minipool testing for half of the year	½ minipool
3	National minipool testing over the entire year	1 minipool
4	Individual donation testing for one third of the year in one quarter of the country with minipool testing for the rest of the country and the remainder of the year	1/12 individual donation + 11/12 minipool
5	Individual donation testing for the entire year in one quarter of the country with minipool testing for the rest of the country	¼ individual donation + ¾ minipool
6	Individual donation testing for one third of the year in the entire country with minipool testing for the remainder of the year	⅓ individual donation + ⅔ minipool
7	National individual donation testing over the entire year	1 individual donation

Table 2. **Cost and Effects of Strategies for Screening the Blood Supply for West Nile Virus Using Nucleic Acid Testing Relative to No Screening and in Strict Incremental Analysis***

Strategy†	Relative to No Screening			Incremental		
	Cost (95% Range), *$ U.S.*	Effectiveness (95% Range), *QALYs*	Cost-Effectiveness (95% Range), *$ U.S./QALY*	Cost (95% Range), *$ U.S.*	Effectiveness (95% Range), *QALYs*	Cost-Effectiveness (95% Range), *$ U.S./QALY*
1‡	0.19 (0.09–0.35)	3.850 (3.370–4.393)				
2	3.84 (2.50–5.08)	0.0000155 (0.0000075–0.0000255)	272 000 (127 000–533 000)	3.84 (2.50–5.08)	0.0000155 (0.0000075–0.0000255)	272 000 (127 000–533 000)
3	6.77 (4.54–8.91)	0.0000155 (0.0000075–0.0000255)	483 000 (227 000–965 000)	2.96 (2.04–5.08)	0	Dominated
4	7.36 (5.30–9.34)	0.0000156 (0.0000076–0.0000258)	520 000 (25 600–1 044 000)	0.59 (0.33–0.85)	0.00000013 (0.0000006–0.00000023)	31 900 000 (14 787 000–64 323 000)
5	8.75 (6.98–10.43)	0.0000158 (0.0000077–0.0000264)	609 000 (309 000–1 190 000)	1.39 (0.82–1.96)	0.00000025 (0.00000012–0.00000046)	6 237 000 (2 442 000–12 956 000)
6	9.98 (8.22–11.69)	0.0000160 (0.0000077–0.0000266)	688 000 (346 000–1 301 000)	1.22 (0.82–1.64)	0.00000013 (0.00000006–0.00000023)	11 028 000 (4 707 000–22 306 000)
7	13.84 (11.55–16.14)	0.0000170 (0.0000082–0.0000282)	897 000 (465 000–1 687 000)	3.81 (1.90–5.88)	0.00000102 (0.00000046–0.00000182)	4 330 000 (1 504 000–9 040 000)

* In strict incremental analysis, each strategy is compared with the preceding strategy in the list as though each could be implemented as a stand-alone intervention. A 95% range is an approximation of the 95% CI for the cost-effectiveness ratio, representing the 2.5 to the 97.5 percentile of the distribution of results from probabilistic sensitivity analysis. QALY = quality-adjusted life-year.
† Strategies: 1 = no testing; 2 = half-year minipool; 3 = year-round minipool; 4 = 1/12 individual donation with 11/12 minipool testing; 5 = 1/4 individual donation with 3/4 minipool testing; 6 = 1/3 individual donation with 2/3 minipool testing; and 7 = year-round individual donation testing.
‡ Baseline no-screening values provided for context.

infection on samples obtained at donation and on subsequent samples obtained from donors enrolled in follow-up studies. The positive predictive value of the confirmatory process has been reported to be 99%, with a negative predictive value of 87% (9). The consequences of donations discarded because of initial false-positive results were not included in this analysis because the loss of these donations has minimal cost implications and does not represent a threat to the sufficiency of the blood supply.

Infection Outcomes

The modeled outcomes of West Nile virus infection are detailed in the Appendix and in **Appendix Table 2** (available at www.annals.org).

Costs

The total cost, on a per donation screened basis, to perform each minipool or individual donation test is $7 or $14, respectively, based on projected postlicensure vendor reagent price and assuming labor and related costs of $3 per donation tested by minipool and $5 per individual donation (**Appendix Table 3**, available at www.annals.org). We assumed that 2 months of additional laboratory preparation costs would be incurred for partial-year minipool testing. For each mixed testing strategy, we also assumed that additional laboratory preparation costs would be incurred to transition between minipool and individual donation testing. The costs of treating West Nile virus infection and associated morbidity, including short-term lost productivity, were estimated in a study by Zohrabian and colleagues (21) that determined the cost of the West Nile virus outbreak in Louisiana in 2002. All illness-related costs are rounded to the nearest $100 amount and updated to 2003 dollars by using the medical care component of the Consumer Price Index (22). As part of the societal cost of West Nile virus infection, we included the mortality cost resulting from death attributable to severe West Nile virus infection using productivity loss tables that were published previously (23).

Statistical Analysis

We discounted costs and effects in subsequent years at 3% per year, as recommended by the U.S. Panel on Cost Effectiveness in Health and Medicine (24, 25). To estimate the influence of variable-specific and overall uncertainty, we used 1-way and probabilistic sensitivity analysis. We used DATA 4.0 (TreeAge Software Inc., Williamstown, Massachusetts) to conduct all analyses.

Role of the Funding Source

This work was supported by an unrestricted grant from Blood Systems Foundation, Scottsdale, Arizona, which had no control over the design, analysis, or content of the research and report.

RESULTS

By analyzing strategies for nucleic acid testing that included combinations of both minipool and individual donation testing with increasing intensity, we implicitly incorporated incremental analyses into the screening strategies. In **Table 2**, we report the cost, effectiveness, and cost-effectiveness of each strategy under 2 analytic approaches: 1) Each strategy is compared directly with the no-testing strategy; and 2) each strategy is compared with the preceding strategy in the list, providing strict incremen-

tal results. Relative to the common baseline of no testing, the cost-effectiveness of minipool testing for half of the year is $272 000/QALY. The 2 least costly year-round testing strategies are strategy 3, national year-round minipool testing, at $483 000/QALY and strategy 4, seasonal, geographically targeted individual donation testing, at $520 000/QALY. In strict incremental analysis, the cost-effectiveness of any year-round testing strategy is dominated by minipool testing for half of the year or exhibits cost-effectiveness ratios in excess of $4 million/QALY.

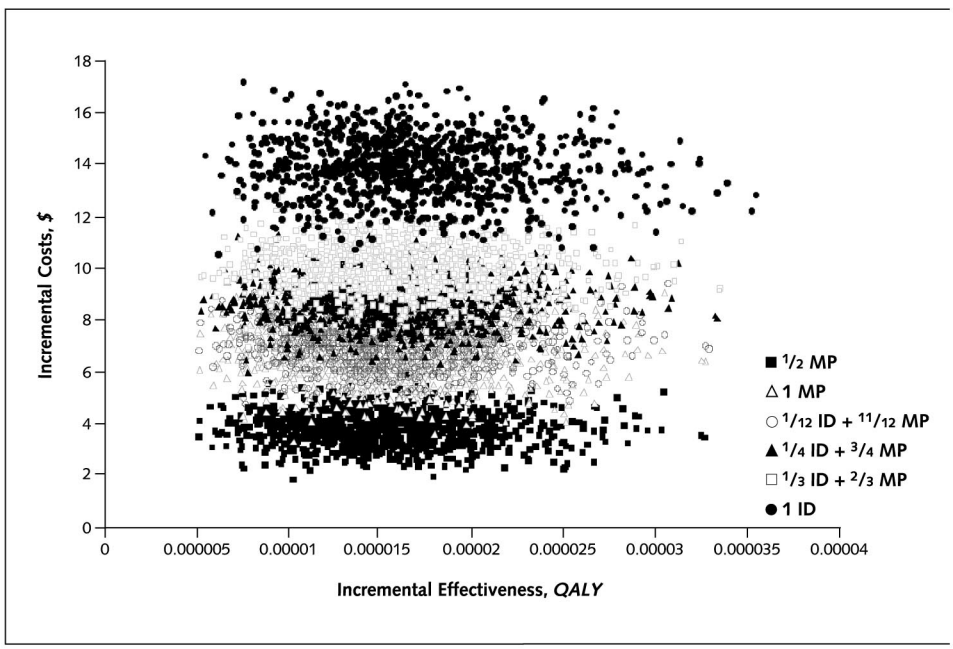
If only no testing and year-round minipool or individual donation testing were available, the incremental cost-effectiveness of minipool testing would be $483 000/QALY and the incremental cost-effectiveness of individual donation testing would be $5 283 000/QALY (results not shown in **Table 2**). In 1-way sensitivity analyses, the most important influences on the cost-effectiveness of screening donated blood for West Nile virus were the prevalence of West Nile virus–positive donations and the cost of minipool and individual donation testing. The outcomes and associated costs of transfusion-transmitted West Nile virus infection had little influence on the overall results.

Using probabilistic sensitivity analysis, we allowed values of variables in the model to vary simultaneously. **Figure 1** shows the incremental costs and incremental effects of each strategy relative to no screening, and **Figure 2** shows the cost-effectiveness acceptability curves for each strategy relative to no screening. The acceptability curves indicate that it is highly unlikely that any screening strategy will be more cost-effective than $150 000/QALY, and in no case does the cost-effectiveness of screening for West Nile virus approach $50 000/QALY. Under values that favor screening (low values for cost and high values for West Nile virus–positive unit interdiction), the cost-effectiveness of screening at the 2.5% lower bound of the results distribution was $227 000/QALY for year-round national minipool nucleic acid testing and $256 000 for seasonal, geographically targeted individual donation testing. Alternately, for variable values that do not favor screening for West Nile virus, the cost-effectiveness of any year-round strategy is approximately $1 million/QALY or higher.

We assumed a modest decrease in quality of life (0.1 lower than perfect health) for persons requiring transfusion. To assess the impact of quality of life, we forced this value to be 0.5, which represents greatly reduced quality of life. The cost-effectiveness of the least resource-intensive strategy (half-year minipool testing) was reduced by $3800/QALY, and the cost-effectiveness of the most resource-intensive strategy (year-round individual donation testing) was reduced by $12 000/QALY, demonstrating the insensitivity of this variable on the overall results ratios.

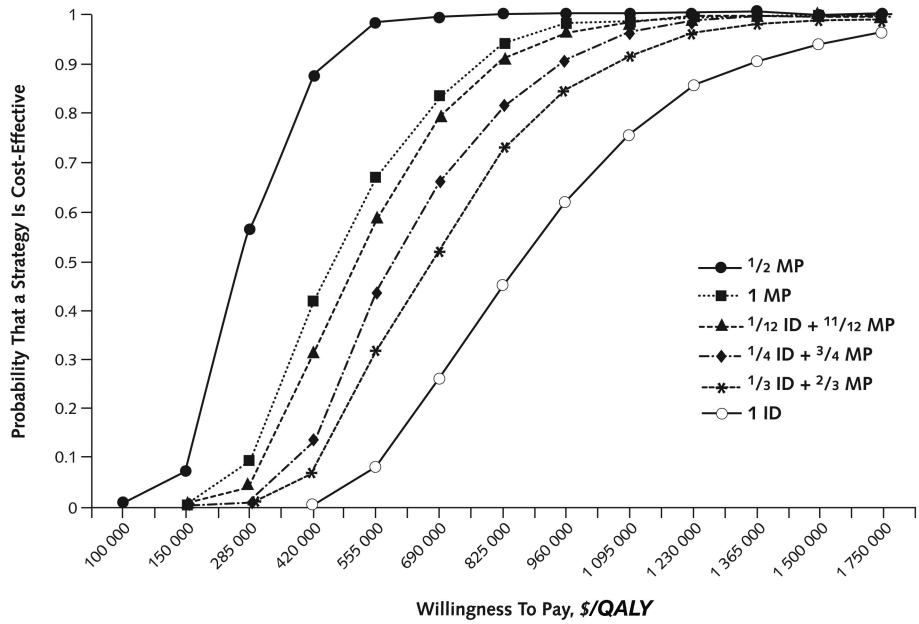
Except for persons who develop long-term sequelae related to neuroinvasive disease, nearly all costs and outcomes of infection are experienced within the first year. If future health outcomes are not discounted, the cost-effectiveness ratios for national minipool testing, targeted indi-

Figure 1. **Incremental costs versus incremental effects from probabilistic sensitivity analysis for each strategy relative to no screening.**



During probabilistic sensitivity analysis, 1000 incremental effectiveness and incremental cost results were calculated for each West Nile virus testing strategy. Each point on the graph represents the cost-effectiveness result for 1 iteration for the corresponding strategy. ½ MP = half-year minipool testing; 1 MP = year-round minipool testing; 1/12 ID + 11/12 MP = 1/12 individual donation testing with 11/12 minipool testing; ¼ ID + ¾ MP = ¼ individual donation testing with ¾ minipool testing; ⅓ ID + ⅔ MP = ⅓ individual donation testing with ⅔ minipool testing; 1 ID = year-round individual donation testing.

Figure 2. **Cost-effectiveness acceptability curves demonstrating the probability that a strategy is cost effective at the willingness to pay value listed.**



Values on the x-axis are the cost-effectiveness thresholds. ½ MP = half-year minipool testing; 1 MP = year-round minipool testing; 1/12 ID + 11/12 MP = 1/12 individual donation testing with 11/12 minipool testing; ¼ ID + ¾ MP = ¼ individual donation testing with ¾ minipool testing; ⅓ ID + ⅔ MP = ⅓ individual donation testing with ⅔ minipool testing; 1 ID = year-round individual donation testing; QALY = quality-adjusted life-year.

vidual donation testing, and national individual donation testing compared with no screening improve to $332 000, $357 000, and $611 000/QALY, respectively.

Our analysis is based on 2003 results of screening for West Nile virus. In 2004, West Nile virus activity continued to be seasonal and geographically localized, with outbreaks in Arizona and southern California. However, the national yield of screening for West Nile virus, a direct measure of the prevalence of infection in blood donors, was not as great as that observed in 2003, with approximately 250 viremic donations (360 potentially infectious components) using combined minipool and targeted individual donation testing strategies. **Figure 3** highlights the influence of the residual risk for West Nile virus infection on the cost-effectiveness of each strategy. If the residual risk for West Nile virus infection increases to 1000 per 1 million components under the no-screening strategy, any screening strategy would be highly cost-effective. If the residual risk with no screening decreases to less than 25 per 1 million components, the cost-effectiveness of any strategy would exceed $1 million/QALY.

DISCUSSION

We assessed the cost-effectiveness of screening donated blood for West Nile virus using nucleic acid testing and found that screening was more expensive than interventions adopted in other health care settings. The strategy of minipool testing for half of the year is the most cost-effective. If future West Nile virus activity remains seasonal and declines in magnitude, partial-year screening may represent a way to reduce the cost. This study suggests that year-round national testing of individual donations is not justified based on the effectiveness achieved for the resources consumed. Among plausible strategies in the current regulatory environment, seasonal, geographically targeted individual donation testing seems to be the most rational because it is more effective than year-round minipool screening at approximately the same cost.

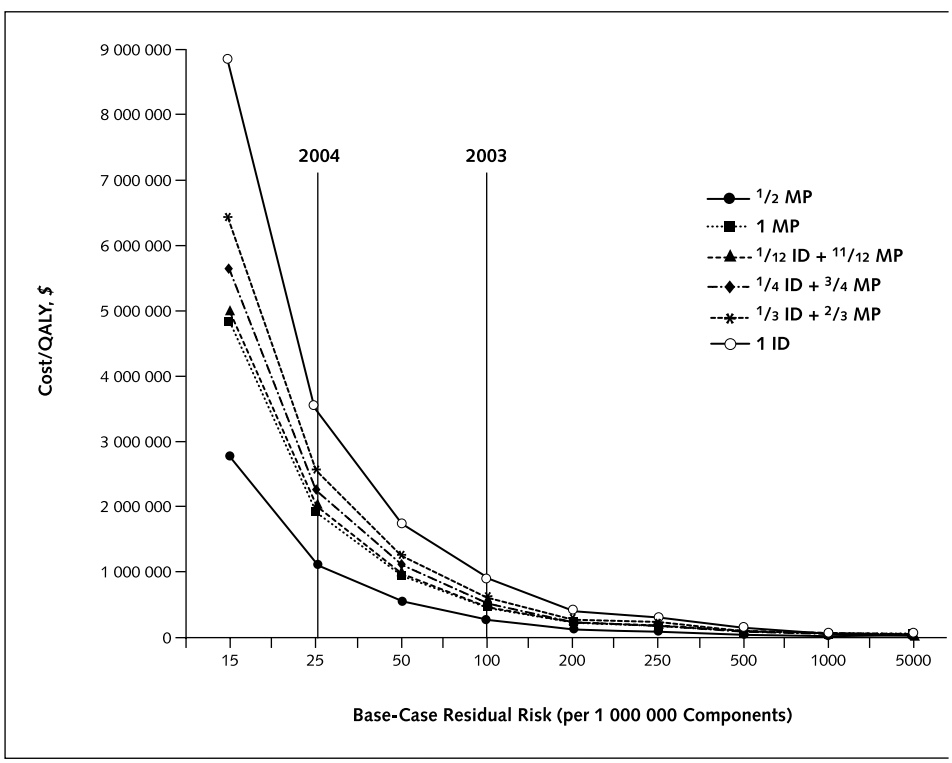
Our analysis has several limitations. First, we had to use outcomes of West Nile virus infection reported for the general population. Although transfusion-transmitted West Nile virus infection has been documented, the number of cases is insufficient to model West Nile virus infection in persons who received transfusions. We separated transfusion recipients into 2 groups, those with and without underlying immunocompromise, and accounted for the increased likelihood of symptomatic and more severe outcomes among immunocompromised persons; these calculations were based on outcomes data reported by Iwamoto and colleagues (10) and Pealer and colleagues (11) using data from the United Kingdom (26). However, because West Nile virus infection is frequently asymptomatic with full resolution, the cost-effectiveness of any testing strategy is not as favorable as may have been expected given the number of donations interdicted in 2003. Second, the reagent cost for West Nile virus minipool and individual donation testing is based on projected postlicensure costs. Higher reagent costs would make any testing

strategy less cost-effective than reported here. Third, the cost of illness for West Nile virus infection comes from 1 study in 1 state. The cost of illness in transfusion recipients may be higher because of the potential for more severe West Nile virus infection and the underlying disease or conditions for which the patient requires transfusion. Higher treatment costs for West Nile virus infection would make any testing strategy more cost-effective than reported here. Fourth, an inherent assumption of our analysis is that activity of West Nile virus will be regional and that individual donation testing could be applied in the geographic region experiencing an outbreak. Our justification for this assumption is the nature of the activity of West Nile virus observed in the United States from 1999 through 2004. If future epidemic activity of West Nile virus is not seasonally and geographically focused, a targeted individual donation testing strategy would not be as cost-effective.

On the basis of the model and disease assumptions, we estimate that in 2003, as many as 362 symptomatic infections (217 in immunocompetent persons and 145 in immunocompromised persons) and 5 severe West Nile virus infections (2 in immunocompetent persons and 3 in immunocompromised persons) may have been prevented by using minipool and individual donation testing of donated blood. Similarly, in 2004, 90 symptomatic infections and 2 severe West Nile virus infections may have been prevented. Prevention of West Nile virus transmission through blood products is an important public health endeavor. However, relative to the estimated 940 000 total infections since 1999 acquired through direct transmission from mosquitoes, including the 2866 cases of neuroinvasive disease reported to the Centers for Disease Control and Prevention in 2003 (27), limiting transmission of West Nile virus through increased mosquito control may have more public health value than screening donated blood.

In comparison with nucleic acid testing for HIV and HCV, testing for West Nile virus is more cost-effective. Two factors contribute to this. First, some overhead costs, such as sample collection and pooling costs and the construction of facilities for nucleic acid testing, were already absorbed by testing for HIV and HCV. Second, nucleic acid testing is the only appropriate screening tool for West Nile virus because of the short duration of viremia. Therefore, the incremental yield of screening includes all donations, in contrast to nucleic acid testing for HIV and HCV in which the incremental yield of nucleic acid testing is that obtained over serologic testing. However, although screening for West Nile virus is more cost-effective than nucleic acid testing for HIV or HCV, it would not be

Figure 3. **Cost-effectiveness of each screening strategy as a function of the residual risk of West Nile virus in blood components with no screening.**



The 2 vertical lines represent the approximate residual risk that would have been observed if testing had not been in place in 2003 and 2004. ½ MP = half-year minipool testing; 1 MP = year-round minipool testing; 1/12 ID + 11/12 MP = 1/12 individual donation testing with 11/12 minipool testing; ¼ ID + ¾ MP = ¼ individual donation testing with ¾ minipool testing; ⅓ ID + ⅔ MP = ⅓ individual donation testing with ⅔ minipool testing; 1 ID = year-round individual donation testing.

considered cost-effective by generally accepted guidelines used in other areas of health care.

The public expects maximum blood safety for major pathogens such as HIV and HCV and aggressive responses to emerging agents such as West Nile virus. The successful adoption of nucleic acid testing of blood donations for West Nile virus represents a remarkable collaboration among blood banks, regulators, and industry. Within 2 years after the confirmation that West Nile virus could be transmitted by blood or tissue, screening tests were in place that greatly reduced the risk for transmission. Nonetheless, public health experts, physicians, and those responsible for resource allocation decisions in health care should be aware of the relatively poor cost-effectiveness of many recently adopted blood safety initiatives, including screening for West Nile virus.

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Appendix

Residual Risk for Transfusion-Transmitted West Nile Virus

To estimate the residual risk for transfusion-transmitted West Nile virus with minipool and individual donation testing, we used retrospective nucleic acid testing and serology data from units that tested positive by individual donation but not by minipool testing at Blood Systems Laboratory in 2003. These units had viremia below the minipool testing detection limit. Minipool nucleic acid testing failed to detect approximately 25% of viremic units that were detected by individual donation testing; approximately one third of these individual-donation nucleic acid–positive units lacked detectable West Nile virus antibody and therefore were probably infectious, whereas two thirds contained West Nile virus IgM, IgG, or both, which may neutralize infectivity or alter severity of infection (19, 29). Therefore, for the residual risk for transfusion-transmitted West Nile virus infection with minipool testing, we assumed that 10% of the risk of no screening would remain based on the approximately one third individual-donation nucleic acid–positive, antibody-negative units identified in retrospective studies. In sensitivity analysis, we allowed this percentage to range from 6% to 14% of the 1000 total viremic donations from 2003. Likewise, for the residual risk for transfusion-transmitted West Nile virus infection for units screened by individual donation testing, we assumed that 1% of the risk of no screening for West Nile virus infection would remain. In sensitivity analyses for the residual risk for West Nile virus infection with individual donation testing, we included the individual-donation nucleic acid–positive units containing IgM, IgG, or both that were believed to be neutralized but possibly were infectious, allowing the risk to range from 0.6% to 2.5% of the 1000 viremic donations.

Post-Transfusion Survival

In comparison with the general population, transfusion recipients have a reduced life expectancy (34). On the basis of the results from a recent post-transfusion survival study of a large managed care population in the United States, we used a 31.5% mortality probability within the first year after transfusion, 14% mortality in the second year after transfusion, and approximately 10% per year thereafter (30).

West Nile Virus Infection Outcomes

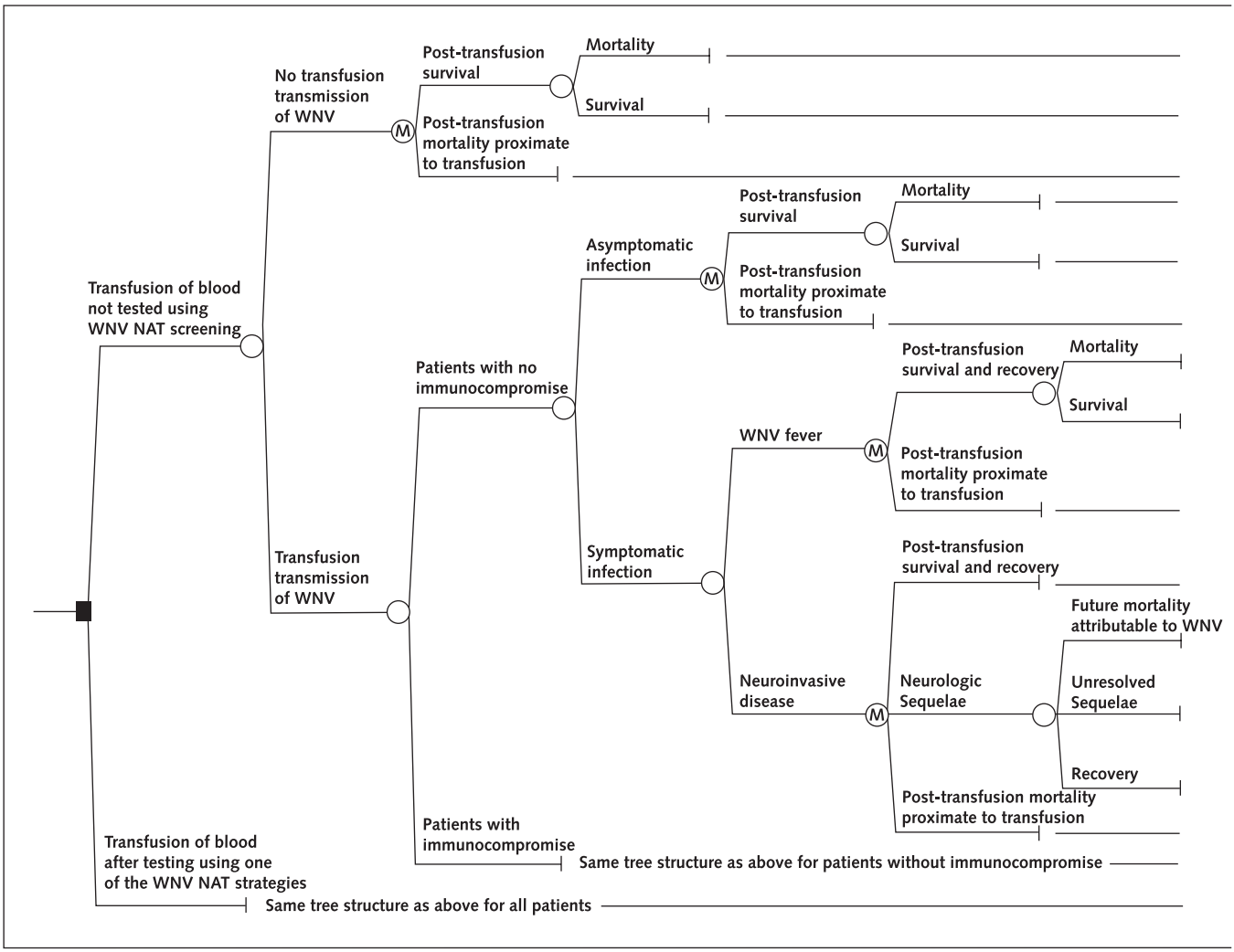
Approximately 20% of individuals develop symptoms consistent with West Nile fever, whereas 1% develop neuroinvasive disease (31). For persons who develop neuroinvasive disease, 4 outcomes are possible: 1) recovery from acute infection and subsequent life history consistent with post-transfusion survival; 2) recovery after neurologic sequelae; 3) sequelae that do not resolve, where we assume that a person could experience neuroinvasive disease effects, such as gait and movement disorders, for as long as 10 years after infection; and 4) death attributable to West Nile virus infection.

A subset of the population requiring transfusion may be immunocompromised because of cancer, organ transplantation, or HIV infection and may be at increased risk for more severe infection outcomes (11). Estimates of the size or course of West Nile virus infection in this subpopulation are not available. Transfusion of certain components may be an indicator of the degree of immunocompromise. Recent research from the National Blood Service in the United Kingdom suggests that as many as 50% of blood recipients are immunocompromised to some degree and that platelet recipients (a relatively small proportion of persons who received transfusions) are twice as likely to be immunocompromised as erythrocyte recipients (26). To include this in our analysis, we assumed that 25% of all transfused components are administered to immunocompromised patients. We assumed that the risk for symptomatic infection, neuroinvasive disease, and death attributable to West Nile virus would be double the probability of those events in the population of immunocompetent persons.

Health State Preference Weights

Quality-of-life preference weights are not available for a generalized health state for which a person requires a blood transfusion or for the health states in people with West Nile virus infection. We used weights based on data presented in the catalog of preference scores from the Cost Effectiveness Registry (33). We assumed that persons requiring transfusion, on average, would have a decreased quality of life (0.9) compared with the general population. We did not include additionally reduced quality of life for persons who develop symptomatic infection unless they developed neuroinvasive disease. In such cases, the preference weight was 0.75.

Appendix Figure. **Core structure of the West Nile virus (*WNV*) cost-effectiveness model displayed using a decision tree format for the no-testing strategy.**



Nodes marked with an "M" represent Markov process chance nodes. NAT = nucleic acid testing.

Appendix Table 1. **Base-Case Values and Distributions Applied in Probabilistic Sensitivity Analysis of Screening the Blood Supply for West Nile Virus**

Description of Model Variable	Baseline Value Estimate	Uncertainty Range and Distribution for Probabilistic Analysis	Source of Variable Estimate or Assumption
Donation to blood component adjustment factor	1.45	1.0–1.9, triangular	Wallace et al. (18)
Probability of West Nile virus transmission in a donated blood unit	1000/13.6 million donations	Standard deviation, 0.00000636; normal	National observed yield of West Nile virus nucleic acid testing in 2003 (19, 20, 28)
Probability of West Nile virus in a donated blood product tested by minipool nucleic acid testing	10%	6%–14%, triangular	Busch et al. (19)
Probability of West Nile virus in a donated blood product tested by individual-donation nucleic acid testing	1%	0.6%–2.5%, triangular	Assumption: 1% of West Nile virus infections would be missed by individual-donation nucleic acid testing (19, 29)

Appendix Table 2. **Base-Case Values and Distributions Applied in Probabilistic Sensitivity Analysis for West Nile Virus Infection Outcomes***

Description of Model Variable	Baseline Value Estimate	Uncertainty Range and Distribution Probabilistic Analysis	Source of Variable Estimate or Assumption
Age at transfusion	60 years		Birkmeyer et al. (15)
Probability of post-transfusion mortality during first year after transfusion	0.315	21%–43%	Kleinman et al. (30)
Probability of post-transfusion mortality during second year after transfusion	0.14	10%–18%	Kleinman et al. (30)
Annual probability of post-transfusion mortality after second year after transfusion	0.10		Kleinman et al. (30)
Probability of symptomatic West Nile virus infection	0.20	Standard deviation, 0.0021; normal	Petersen et al. (31)
Probability of neuroinvasive West Nile virus infection	0.01		Petersen et al. (31)
Increased risk for death after transfusion for persons ≥ 55 years of age who develop neuroinvasive disease	0.127	Standard deviation, 0.0084; normal	Unpublished CDC data (Montgomery S. Personal communication. 9 March 2005)
Percentage of components transfused to persons with immunocompromise	0.25	10%–40%, triangular	Based on Llewelyn et al. (26)
Probability of symptomatic West Nile virus infection for immunocompromised persons	0.40		Assumption: risk for symptomatic infection is 2 times greater
Increased risk for death after transfusion for persons ≥ 55 years of age who develop neuroinvasive disease and have underlying immunocompromise	0.254		Assumption: risk for death is 2 times greater
Probability of recovery after neuroinvasive disease	0.227	5, 17, β distribution†	Klee et al. (32)
Average quality-of-life preference weight for persons receiving a transfusion	0.90	± 10%, triangular	Assumption
Average quality-of-life preference weight for persons with neuroinvasive West Nile virus infection	0.75	± 10%, triangular	Assumption based on other neurologic conditions (33)

* CDC = Centers for Disease Control and Prevention.
† Five of 22 patients with neuroinvasive disease recovered; 17 of 22 did not. The numbers 5 and 17 define the "shape" of the β binominal distribution for the probabilistic sensitivity analysis: The range of values this variable can take during each simulation are based on 5 and 17.

Appendix Table 3. **Base-Case Values and Distributions Applied in Probabilistic Sensitivity Analysis for the Costs of Screening and Treatment for West Nile Virus**

Description of Model Variable	Baseline Value Estimate	Uncertainty Range and Distribution Probabilistic Analysis	Source of Variable Estimate or Assumption
Minipool nucleic acid testing			
Reagent cost per donation	$4	$2–$6, triangular	Geist and Lai (35)
Estimated labor and facilities cost per donation	$3	$1–$5, triangular	Assumption based on unpublished data (Caglioti S. Personal communication. 15 August 2004)
Individual-donation nucleic acid testing			
Reagent cost per donation	$9	$7–$11, triangular	Geist and Lai (35)
Estimated labor and facilities cost per donation	$5	$3–$7, triangular	Assumption based on unpublished data (Caglioti S. Personal communication. 15 August 2004)
Cost of lost productivity while recovering from symptomatic West Nile virus infection	$5100	± 25%, triangular	Zohrabian et al. (21), updated to 2003 dollars using the Consumer Price Index (22)
Outpatient cost for symptomatic West Nile virus	$1900	± 25%, triangular	Zohrabian et al. (21)
Transportation and miscellaneous costs for symptomatic infection	$300	± 25%, triangular	Zohrabian et al. (21)
Cost of rehabilitation for neuroinvasive West Nile virus infection	$22 400	± 25%, triangular	Zohrabian et al. (21)
Inpatient cost for neuroinvasive West Nile virus infection	$18 200	± 25% triangular	Zohrabian et al. (21)
Productivity loss (mortality cost) for a person 60 years of age	$500 000	± 25%, triangular	Grosse (23)
Annual discount rate for future costs and outcomes	3%	1%–5%	U.S. Panel on Cost Effectiveness in Health and Medicine (24, 25)