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PREVALENCE OF *ONCHOCERCA VOLVULUS* NODULES IN THE SANKURU RIVER VALLEY, DEMOCRATIC REPUBLIC OF THE CONGO, AND RELIABILITY OF VERBAL ASSESSMENT AS A METHOD FOR DETERMINING PREVALENCE

PAUL AUBREY LAW, OMBA NOEL NGANDU, PETER CROMPTON, OSUMBA USUNGO, DANIEL KOSTEN, J. KIELY LAW, AND GILBERT BURNHAM

Johns Hopkins School of Medicine, Baltimore, Maryland; Projet Bateau-PRAS, Lusambo, Kasai Oriental, Congo; Médecin Chef du Zone Lusambo, Kasai Oriental, Congo; Institute Medical Chretien au Kasai; Kananga, Kasai Occidental, Congo; Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland

Abstract. The epidemiology of onchocerciasis in much of the Democratic Republic of the Congo (formerly Zaire) is not well established. We report the results of an onchocerciasis rapid assessment survey carried out in 18 villages of the Sankuru River Valley in the central part of this country in preparation for mass distribution of ivermectin. Thirty men from each village were randomly selected and examined for subcutaneous nodules. The prevalence of nodules among these men in each village ranged from 82.5% to 100% with a mean prevalence of 95.0%. This study also assessed the validity of using verbal assessment instead of physical examination to determine prevalence of nodules. This verbal method had a sensitivity of 93.5% and a specificity of 83.3%. High sensitivity and specificity for this method suggest that it might be a cost-effective approach to determine the prevalence of onchocerciasis over large areas without using physical examinations requiring medical personal. This approach could be particularly useful where the coverage of health services is poor. The use of the Global Positioning System made it possible to send coordinates and survey data electronically to World Health Organization personnel in Geneva for computer generation of prevalence maps. The use of river boats to conduct surveys and support ivermectin distribution in the Congo is discussed.

Infection with *Onchocerca volvulus* is present in 27 African countries where it causes a variety of ocular, dermatologic and systemic conditions.[1] An estimated 17.5 million persons are infected, of whom 270,000 are blind, and another 500,000 are severely visually impaired. In many areas outside the Onchocerciasis Control Program in West Africa, the distribution, prevalence, and intensity of infection have not been well documented. In the Democratic Republic of the Congo (formerly Zaire) this is particularly true, where an estimated 4,565,000 persons are infected, and 37,500 are blind as a consequence. These figures represent 12.8% and 0.1%, respectively, of the country's population.[2] The few studies done in the Congo have found onchocerciasis to be widespread in the Sankuru River Valley of the Kasai provinces.[3,4] Vector studies performed in the study area in the 1930s and in 1977 found that both *Simulium damnosum s.l.* and *S. neavei* were transmitting infection.[5] A deteriorating civil structure has prevented a more complete assessment of the prevalence and distribution of infection in this region.

The availability of ivermectin for mass distribution has highlighted the need to document the distribution and prevalence of onchocerciasis in many areas not previously examined in detail. In preparation for a community-based distribution program in the Sankuru River Valley, 18 villages along a 100-km stretch of river upstream of the town of Lusambo (4°58'S, 23°27'E) were visited (Figure 1). The prevalence of subcutaneous nodules was assessed following the standard World Health Organization (WHO) protocol.[6] Prior to the standardized physical assessment for nodules, participants were asked if they were aware of any nodules present.

METHODS

The study was carried out in June and July of 1996 in the West Kasai Province of central Congo. No passable roads exist in this area and all transportation is by river. The Sankuru River, one of the many tributaries to the Congo River (formerly the Zaire River), runs through dense tropical rain forest. The climate is typical of equatorial regions with a wet and dry season, annual rainfall of 150–200 cm per year, and an average temperature of 25°C.

In each village the purpose of the study was explained to the chief and village elders, and their permission to proceed was secured. Using the established nodule assessment protocol, in each village 30 men were randomly selected who had a rural occupation, were older then 20 years, and had lived in the village for at least 10 years. All men were advised that participation was voluntary.

The following steps were used to gather data in the field: 1) the characteristics of onchocercal nodules were described to the men as hard, mobile nodules favoring bony prominences outside the inguinal and cervical regions; 2) each participant was asked individually if they had any nodules consistent with this description (even though the local term *achuku* was used in many villages for onchocercal nodules, this term was not used in asking about nodule presence); and 3) all men were examined until at least one onchocercal nodule was detected, or until the entire body had been examined and no nodules were found. The body was systematically inspected following a standardized routine that gave particular attention to the bony prominences. Cervical and inguinal areas were excluded to avoid confusion with enlarged nodes.

The proportion of sampled men in each village with nodules was calculated. The binomial confidence intervals for each of these proportions were determined using STATA 4.0 software.[7] The confidence interval for the total prevalence was adjusted for clustering.[8]

Latitude and longitude coordinates were obtained in each village using a hand-held Global Positioning System (GPS) unit (Magellan NAV-5000 series; Jeppesen Sanderson Co.,

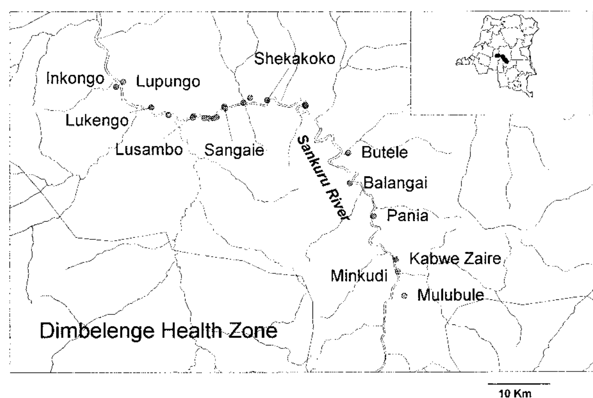

FIGURE 1. Villages surveyed by in the Lusambo Health Zone, Congo.

Englewood, CO). Along with the survey results, coordinates were sent by Internet from the Congo to the WHO in Geneva where computerized maps were generated from the data supplied.

Clearance to carry out this study in the Lusambo Zone was granted by the Zonal Chief Medical Officer and the Regional Governor.

RESULTS

The location of the 18 villages included in this study is shown in Figure 1. Total village populations ranged from 108 (Kabwe-Zaire and Mon Frere) to 1,846 (Inkongo), with a mean village size of 587. The total population for all villages included in the survey was 10,557. All villages between Lusambo and Mulubule and within 5 km of the Sankuru River were included. Results are shown in Table 1.

Of 483 men examined in the 18 villages, 95.0% (95% confidence interval [CI] = 91.7, 98.4) were found to have nodules. Nodule prevalence among the villages ranged from 82.5% to 100%. In 11 of the 18 villages, 100% of the men examined had nodules. In all but five villages, 30 or more adult males were examined. In these five villages, where there were less than 30 men resident, all men were examined, and all were found to have nodules.

When questioned about the presence of nodules prior to physical examination, 433 of 483 reported nodules, while 50 denied the presence of nodules. Of the 459 men with palpable nodules on examination, 429 had reported their presence, yielding a sensitivity for the verbal assessment of 93.5% (95% CI = 90.8, 95.5). Among the 24 men without palpable nodules, 20 denied having nodules, giving a screening specificity of 83.3% (95% C I= 62.6, 95.3). For the verbal assessment method the positive predictive value was 99.08% (95% CI = 97.7 99.8) and the negative predictive value was 40.0% (95% CI = 26.4, 54.8).

From the sensitivity and specificity of the verbal assessment method for nodule detection in our data we calculated what would be expected trends in positive and negative predictive values across a range of theoretical nodule prevalences from 5% to 95% (Figure 2). Based on our findings, where the actual prevalence of nodules is 62% and higher, the positive predictive value of the verbal method would theoretically be greater than 90%. Where the actual prevalence of nodules is less than 58%, the calculated negative predictive value of verbal assessment would be greater than 90%.

Ivermectin was distributed in all villages since the calculated community-wide prevalence, based on the adult males sampled, exceeded 20% in all villages.[2] Annual community-based ivermectin distribution by trained volunteers is being continued by the Christoffel Blindenmission (Christian Blind Mission [CBM], Bensheim-Schoenberg, Germany).

DISCUSSION

The results of this survey suggest that little change has occurred in the prevalence of onchocerciasis nodules since

TABLE 1
Prevalence of onchocerciasis nodules among men in 18 Zairian villages

Village	Population	Number examined	Number with nodules	Percent with nodules (95% confidence interval)
Mukwasa	791	30	26	86.67 (69.27, 96.25)
Lupungu	658	30	30	100.00 (88.43, 100.00)
Lunkengu	373	28	25	89.29 (71.76, 97.74)
Inkongo	1,845	31	31	100.00 (88.77, 100.00)
Kasanga	369	30	27	90.00 (73.48, 97.89)
Kidiya	166	30	30	100.00 (88.43, 100.00)
Mon Frere*	108	20	20	100.00 (83.15, 100.00)
Nundu Amwilu	409	30	30	100.00 (88.43, 100.00)
Bombai*	191	30	30	100.00 (88.43, 100.00)
Kengombe*	487	8	8	100.00 (63.09, 100.00)
Shekakoko	302	30	30	100.00 (88.43, 100.00)
Barambwe Kangulungu*	498	10	10	100.00 (69.14, 100.00)
Butele	833	30	30	100.00 (88.43, 100.00)
Balangayi	376	30	29	96.67 (82.79, 99.92)
Pania Mutombo	1,700	40	33	82.50 (67.23, 92.65)
Mulubule	740	39	34	87.18 (72.58, 95.71)
Kabwe-Zaire*	108	7	7	100.00 (58.98, 100.00)
Minkudi	603	30	29	96.67 (82.79, 99.92)
Total	10,557	483	459	95.03 (91.7, 98.4)

* Villages in which all available men were examined.

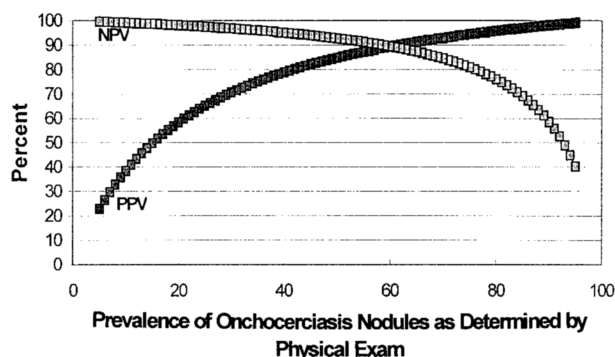

FIGURE 2. Theoretical positive and negative predictive values (PPV and NPV, respectively) of the verbal response method by levels of endemicity. The PPV and NPV were calculated using the following equations: PPV = (sensitivity × prevalence)/[sensitivity × prevalence + (1 − prevalence) × (1 − sensitivity)] and NPV = (specificity × (1 − prevalence)/[specificity × (1 − prevalence) + (1 − sensitivity) × prevalence)], where sensitivity = 0.935, specificity = 0.833, and prevalence ranges from 0.5 to 0.95.

the survey of Fain and Hallot in the 1950s, which found nodules to be present in 80% of the population.[4] In the contiguous Dimbelenge Health Zone, Brown and Shannon noted the presence of microfilariae in 82.1% of persons assessed and blindness in 5.1% during their 1989 study.[3] Although prevalence of infection in this area is very high, the prevalence of visual impairment due to onchocerciasis in not well defined. In 1976, Martens found the prevalence of blindness in the Lusambo Zone to be 6.5%,[5] while Hissette in 1931 reported a blindness prevalence of 20%.[9] With the assistance of the CBM, the extent of blindness in this area and the proportion attributable to onchocerciasis is being determined.

By selecting 30 males more than 20 years of age, sampling is biased toward the population group most likely to have nodules. The WHO protocol for determining community-wide prevalence of onchocerciasis from nodule prevalence rates calculates that for a nodule prevalence of 62.5% among the sample of adult males, the community-wide prevalence would be 100% according to the equation (community prevalence of disease = prevalence of nodules in men × 1.60). The nodule prevalence of 95.3% found in this study suggests that infection is essentially universal. Using the community registration data collected during ivermectin distribution as a sampling frame, it will be possible to sample nodule prevalence by gender and age groups in a random or systematic method to determine actual distribution in this population.

Our results show that a simple verbal assessment method is 93% sensitive and 83% specific in predicting nodule status. As can be seen in Figure 2, the theoretical negative predictive value would be greater than 90% if nodule prevalences were less than 58%. The accuracy of a nodule negative response would be particularly important in low prevalence areas where an additional positive individual could make a difference in meeting the eligibility criteria for ivermectin distribution. The average number of false-negative results per 30 men examined would be acceptably low with an average of 0.1 at 5% prevalence increasing to 1.86 at 95% nodule prevalence. The significance of one or two-false positive results in high prevalence areas would be of little practical significance since these communities would already be well above the threshold for community-wide ivermectin distribution.

Despite the initial results using the verbal assessment method, it is premature to assume that the sensitivity and specificity of this method would be constant across the range of nodule prevalences. Validation of the method is needed in other areas of different endemic levels and cultural settings. Even though the verbal survey depended on describing nodules to men at the assessment visit, the fact that the local community already had a term (*achuku*) for onchocercal nodules may have contributed to the results. Areas of lower endemicity may not have such local awareness of nodules or descriptive names, and this could diminish the utility of the verbal response method.

If this approach is validated, the assessment of onchocerciasis prevalence and subsequent distribution of ivermectin would be possible over a much wider area, require fewer resources, and be implemented in a shorter period of time. This approach has been used for identification of *Schistosoma haematobium* infection in Tanzanian school children through questionnaires to village leaders and head teachers.[10] Costs using this method to identify high risk student populations were 34 times less than using standard medical screening methods. The prevalence of onchocercal nodules could be determined over a wide area using school teachers or other educated community members. This would be an inexpensive way to targeting treatment of a disease that may have extensive local variation in prevalence. Directed community self-assessment could give communities a greater role in distribution programs, and thereby promote sustainability, a goal of on-going ivermectin control strategies.[11,12]

In this study we used river transport, an approach that will be continued for ivermectin distribution. Lusambo, despite being the seat of the Sankuru Sub-Region, has no functional roads connecting it to the Sankuru River Valley. For much of the Congo, the extensive river system remains the last reliable form of transportation. River-based ivermectin distribution holds promise for the Congo in general, since most of the country is accessible by river. The riverside corridor that can be reached through river-based distribution could be extended by using community distributors traveling on foot or by bicycle. In this way it may be easily possible to travel 10 or 20 miles back from navigable rivers using existing paths between villages. Although much of the health system in the Congo is dysfunctional, there are many experienced nongovernmental organizations that have the capacity to effectively carry out river-based distribution programs.

In West Africa, community treatment priorities can be established on the basis of distance from principal rivers which serve as breeding sites for *S. damnosum s. l.*[2,13] This approach has been incorporated into the Rapid Epidemiological Mapping of Onchocerciasis (REMO) method adopted by the African Program for Onchocerciasis Control. In the Sankuru River Valley, breeding is unlikely to occur in the sluggish Sankuru River, but probably is occurring in the myriad of small tributaries. This would make the utility of the REMO method for targeting treatment geographically of limited utility.

In this survey the position of each village was determined

by a hand-held GPS device. Coordinates and survey data were sent via Internet to the WHO in Geneva where computer-generated maps were produced. Widespread use of this approach can establish a central database from which maps can be created relating to multiple facets of the disease and its transmission. The use of GPS can improve accuracy of follow-up studies, particularly with transient populations, or when there have been long intervals between surveys, and communities have shifted, divided, or relocated. This information would also help the integration of clinical and entomologic data to form a powerful tool for global surveillance.

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Authors' addresses: Paul Aubrey Law, Peter Crampton, and J. Kiely Law, Johns Hopkins School of Medicine, Baltimore, MD 21205. Omba Noel Ngandu, Projet Bateau-PRAS, Lusambo, Kasai Oriental, Congo. Osumba Usungo, Médecin Chef du Zone Lusambo, Kasai Oriental, Congo. Daniel Kosten, Institute Medical Chretien au Kasai, Kasai Occidental, Congo. Gilbert Burnham, Johns Hopkins School of Hygiene and Public Health, 615 North Wolfe Street, Room E8006, Baltimore, MD 21205.

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