The impact of charging for insecticide on the Gambian National Impregnated Bednet Programme

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During the second year of the Gambian National Impregnated Bednet Programme (NIBP) charges for insecticide ($0.50 per net) were introduced into the half of the primary health care villages in the country where insecticide had been provided free of charge the previous year. Free insecticide was provided in the remaining villages that had acted as controls during the previous year. In villages where insecticide was provided free, 77% of nets were treated with insecticide. In contrast, in villages where charges were made coverage was only 14%. During the first year of the NIBP, mortality in children was significantly lower in villages where insecticide was provided free than in the control villages. Introduction of a charge for insecticide into the first group of villages and the provision of free insecticide in the latter abolished this difference. The cash income of rural Gambians is very limited and payment of even $2–3 for insecticide treatment for all the bednets in a household represents a substantial outlay. Further education on the benefits of treatment of nets and/or the provision of cheaper insecticide will be required before the full benefits of this powerful new malaria control measure can be fully realised in The Gambia.

Introduction

Following a successful controlled trial of permethrin-impregnated bednets, which resulted in an approximate 60% reduction in overall mortality in children aged 1–5 years (Alonso et al. 1991) the Ministry of Health of The Republic of The Gambia initiated a National Impregnated Bednet Programme (NIBP) in 1992. The objectives of this programme were to introduce treated bednets into all Primary Health Care (PHC) villages in The Gambia (villages with a population of 400 or more) over a period of three years and to introduce a cost-recovery system that would allow the programme to be sustained. During the first year of the programme, insecticide delivered through the Ministry of Health’s PHC system was provided free of charge to half of the PHC villages throughout the country. A high level of coverage was obtained (Cham et al. 1996) and the programme resulted in a 25% reduction in overall mortality among children aged 1–9 years resident in villages where insecticide was provided (D’Alessandro et al. 1995). During the second year of the study, charges were introduced into the 221 PHC villages that had previously received free insecticide whilst the remaining PHC villages received free insecticide. The way that charges were introduced, the effect that this had on coverage with insecticide treated bednets and subsequent changes in mortality and morbidity are described in this paper.

Methods

Study area and population

The study was undertaken in The Gambia, a small country with a population of approximately one million situated on the west coast of Africa. The country is divided into five administrative divisions. All villages throughout the country which participate in a national PHC programme were included in the bednet programme. Surveillance for mortality and morbidity was undertaken in five sentinel zones which were chosen to represent different geographical areas of the country and which had a total population of
approximately 120,000 at the time of the study. The population of rural Gambia comprises predominantly subsistence farmers who grow rice and millet for home consumption and groundnuts as a cash crop. Malaria is seasonal, with nearly all transmission occurring during the rainy season, which lasts from July-October, and during the immediate post-rainy season (Greenwood and Pickering 1993). Over 95% of clinical malaria infections are caused by *Plasmodium falciparum*. The entomological inoculation rate ranges from 1-50 infective bites a year in different parts of the country. Children under the age of five years resident in rural areas experience an average of 1.0 clinical attack of malaria per year. Bednet usage varies from area to area but overall is high with an average of 70% of children under the age of five years resident in rural areas sleeping under bednets during the rainy (D’Alessandro et al. 1994) season. The protective effects of bednets against mosquitoes and against malaria and the additional protection provided by treatment with insecticide are well recognized as a result of personal experience and education programmes.

**Determination of a suitable charge for insecticide treatment of bednets**

A small-scale study was undertaken in 1993 to investigate attitudes to payment for insecticide since this information was needed urgently to make decisions on policy (Mills et al. 1994). Alkalos (village chiefs) and Imams were interviewed in 53 randomly selected villages covering each of the four administrative divisions of The Gambia. Alkalos and Imams were consistent in their responses suggesting that households heads would be willing to pay D5-10 ($0.5-1.0) per household for treatment of nets. As households possess on average five nets, this represents a figure of about $0.1-0.2 per net. Direct payment by household heads was cited by alkalos as the preferred method of payment (57%) followed by collective farming (23%). Regional differences in response were obtained. In Upper River Division, informants stated that they thought that household heads would be willing to pay more than D10 ($1.0) per household and collective farming was the preferred method of payment.

Costs per treatment for the NIBP were set at D5.00 ($0.5) per bednet, approximately the true cost of the insecticide when used at a dose of 200mg/m².

**Methods of payment for insecticide**

Two systems of payment were evaluated: purchase of vouchers at the beginning of the year, entitling the owner to have his or her bednet impregnated subsequently, or direct payment at the time of impregnation. The former method was tried because cash is more readily available at the beginning of the year, shortly after the harvest, than at the beginning of the rainy season. Payment was made to the Village Health Worker (VHW) resident in each PHC village by the heads of households, sometimes in the presence of the treasurer of the Village Development Committee (VDC). A receipt was issued at the time of payment. At regular intervals, villages were visited by a representative of the Divisional Health Team (DHT) and payments and receipts collected. Funds collected were deposited in a special NIBP account opened at the NIBP programme office, and at the MRC field stations up-country. Registers were kept in each PHC village which recorded payments made by individuals, the number of bednets paid for, the signatures of the payees and the date that payment was made. Non-governmental organizations (NGOs) with an interest in a particular village were given the opportunity to purchase coupons, entitling a specified number of nets in that village to be treated.

**Impregnation of bednets**

During July 1993, permethrin was made available for treatment of bednets in PHC villages throughout the country. Similar sensitization and implementation programmes to those used previously were employed (Cham et al. 1996). Insecticide was provided free in 152 villages which had not received free insecticide previously but was provided only after payment in 221 villages where permethrin had been provided free during the previous year. The target dose for permethrin was 200 mg/m² of netting.

**Evaluation of coverage with impregnated bednets**

In September 1993, a national survey of bednet usage was carried out using a stratified cluster sampling procedure similar to the one described previously (D’Alessandro et al. 1994). A total of 145,706 beds in 373 PHC villages distributed throughout the country were surveyed.

**Surveillance for mortality and morbidity**

Surveillance for mortality was undertaken in 104 villages in five zones, chosen to represent different ecological regions of The Gambia, for a period of seven months after treatment of bednets had been offered using a system of village reporters and project field staff as described previously (D’Alessandro et al. 1995). Surveillance zones differ from the administrative divisions of the government. A census
recording births, deaths and migrations was undertaken at the end of this period.

At the end of the malaria transmission season 1247 children aged 1–9 years resident in zones 3 and 5 were screened for malaria. These two zones were chosen because during the previous year treated bednets were effective at reducing mortality in zone 3 but not effective in zone 5. Children were selected randomly from the same villages used in morbidity surveys during the previous year (D’Alessandro et al. 1995). Each child was examined by a paediatrician, their axillary temperature recorded, their spleen palpated and a finger-prick blood sample obtained for preparation of a thick blood film and determination of the packed cell volume (PCV).

**Statistical methods**

All-cause mortality rates in children aged 1–9 years were compared between villages where charges were made for insecticide and villages where insecticide was provided free of charge. For the overall comparison between the two groups of villages a rate ratio was calculated using Poisson regression with adjustments for zone, age, predominant ethnic group, percentage bednet use, distance of residence from water and pre-intervention mortality. In order to test for a significant difference between groups that took into account randomization by village, a Poisson model was fitted which included covariates but excluded the variable of whether or not a charge for insecticide had been made. The expected number of deaths in each village provided by this model was obtained and used to determine the ratio of observed to expected deaths for each village. A paired ‘t’ test was used to compare ratios for villages charged for insecticide with those in which insecticide was provided free. Confidence limits were calculated for rate ratios using test based methods (Rothman 1986).

The prevalences of parasitaemia, high parasitaemia and splenomegaly were analyzed by logistic regression to give a ratio of observed to expected cases, which was adjusted for zone, age, sex, and ethnic group, for each village. Comparisons were then made between the two groups of villages using ‘t’ tests. Mean PCVs for each village were compared using ‘t’ tests.

**Results**

**Mode of payment**

Direct payment at the time of treatment proved to be much more popular than pre-payment – only 8000 dalasis ($840) were collected by pre-payment whilst 41 000 dalasis ($4400) were collected at the time of treatment. Vouchers for treatment of 90 nets, about 1% of all treated nets, were purchased by the Peace Corps.

**Coverage with impregnated nets**

The results of the national survey showed that in PHC villages where households were charged for insecticide, only 14% of beds were protected by a treated bednet (Table 1). Some regional variation was observed, particularly poor coverage being found in Lower River Division due in part to a perception that treatment of nets should be the responsibility of the Ministry of Health. In contrast, when insecticide was provided free, high levels of coverage (average 77%) were obtained in all divisions, including Lower River Division. Some treated bednets were found in non-PHC villages.

**Table 1.** Coverage achieved by the NIBP in villages in which insecticide was provided free and in those in which a charge for net treatment was made. Results are expressed by Health Division as a percentage of the nets present which had been treated.

<table>
<thead>
<tr>
<th>Health Division</th>
<th>Payment not required</th>
<th>Payment required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western</td>
<td>78</td>
<td>20</td>
</tr>
<tr>
<td>Lower River</td>
<td>82</td>
<td>4</td>
</tr>
<tr>
<td>North Bank West</td>
<td>74</td>
<td>20</td>
</tr>
<tr>
<td>North Bank East</td>
<td>76</td>
<td>12</td>
</tr>
<tr>
<td>MacCarthy Island</td>
<td>81</td>
<td>15</td>
</tr>
<tr>
<td>Upper River</td>
<td>73</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>77</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>

**Recovery of charges**

Table 2 indicates the estimated number of nets treated in each division, based on the results of the cluster survey, the sum that should have been collected on the basis of these numbers, the sum deposited in an NIBP account and the percentage recovery of charges made. Overall, 94% of money collected was recovered. Spot checks in markets suggested that some dilution of insecticide may have taken place with subsequent sale on the open market allowing additional, unofficial revenue to be collected by village health workers.

**Mortality**

Mortality during a seven-month period after permethrin was made available for treating bednets is shown by zone in Table 3. In four of the five study zones, mortality was higher in villages where charges...
Table 2. Recovery of charges by health division

<table>
<thead>
<tr>
<th>Division</th>
<th>Bednets</th>
<th>Bed with impregnated net</th>
<th>Sum anticipated</th>
<th>Sum obtained</th>
<th>% recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western</td>
<td>9 528</td>
<td>1 916</td>
<td>D 9 580</td>
<td>D 9 035</td>
<td>94.3</td>
</tr>
<tr>
<td>Lower River</td>
<td>17 336</td>
<td>726</td>
<td>D 3 630</td>
<td>D 3 580</td>
<td>98.6</td>
</tr>
<tr>
<td>MacCarthy Island</td>
<td>20 702</td>
<td>3 170</td>
<td>D15 850</td>
<td>D12 645</td>
<td>79.8</td>
</tr>
<tr>
<td>Upper River</td>
<td>10 335</td>
<td>1 905</td>
<td>D 9 525</td>
<td>D 9 300</td>
<td>97.6</td>
</tr>
<tr>
<td>North Bank</td>
<td>20 189</td>
<td>2 958</td>
<td>D14 790</td>
<td>D15 370</td>
<td>103.9</td>
</tr>
<tr>
<td>Total</td>
<td>78 090</td>
<td>10 675</td>
<td>D53 375</td>
<td>D49 930</td>
<td>93.6</td>
</tr>
</tbody>
</table>

1 The number of bednets in villages where charges were made was determined by a bednet census conducted in April/May 1993.
2 Estimates based on a cluster sample undertaken in September 1993.

Table 3. Mortality rates in children aged 1–9 years in villages where charges were made for insecticide and in those where insecticide was provided free. Numbers of deaths and child-years at risk are shown in parentheses

<table>
<thead>
<tr>
<th>Zone</th>
<th>Rate per 1000 child years</th>
<th>RR&lt;sup&gt;1&lt;/sup&gt;</th>
<th>p&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Payment for insecticide</td>
<td>Free insecticide</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8.3 (11/1330)</td>
<td>6.2 (8/1283)</td>
<td>1.34</td>
</tr>
<tr>
<td>2</td>
<td>19.4 (34/1756)</td>
<td>16.2 (28/1731)</td>
<td>1.20</td>
</tr>
<tr>
<td>3</td>
<td>12.9 (30/2321)</td>
<td>17.0 (36/2117)</td>
<td>0.76</td>
</tr>
<tr>
<td>4</td>
<td>31.9 (77/2412)</td>
<td>26.8 (58/2160)</td>
<td>1.19</td>
</tr>
<tr>
<td>5</td>
<td>23.7 (93/3925)</td>
<td>21.3 (132/6185)</td>
<td>1.11</td>
</tr>
<tr>
<td>Combined</td>
<td>20.9 (245/11 744)</td>
<td>19.4 (262/13 476)</td>
<td>1.10&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

1 Villages where payment was requested/villages where insecticide was provided free.
2 Taking into account randomization by village and pairing.
3 Taking into account randomization by village, pairing and covariates.

Table 4. Malarometric findings in children aged 1–9 years resident in villages where charges were made for insecticides and in villages where insecticide was provided free

<table>
<thead>
<tr>
<th>No. of children</th>
<th>% with splenomegaly</th>
<th>% with parasitaemia ≥5000/μl</th>
<th>Mean packed cell volume (PCV) ± sem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charges made</td>
<td>280</td>
<td>1.8%</td>
<td>20.7%</td>
</tr>
<tr>
<td>Free insecticide</td>
<td>307</td>
<td>5.5%</td>
<td>30.3%</td>
</tr>
<tr>
<td>Zone 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charges made</td>
<td>307</td>
<td>34.2%</td>
<td>77.2%</td>
</tr>
<tr>
<td>Free insecticide</td>
<td>353</td>
<td>20.4%</td>
<td>54.4%</td>
</tr>
<tr>
<td>OR&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.95</td>
<td>1.57</td>
<td>1.11</td>
</tr>
<tr>
<td>P-value&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.85</td>
<td>0.92</td>
<td>0.50</td>
</tr>
</tbody>
</table>

1 Combining zones and adjusting for covariates: villages charged for insecticide/villages with free insecticide.
2 Taking into account covariates and cluster randomization by village.
were made for insecticide than in those where free insecticide was provided but, using an analysis which took into account covariates pairing and randomization by village, the overall difference in mortality rates between the two groups was not statistically significant. The rate ratio, for mortality in villages where charges were made compared with those where they were not was 1.1 [95% CI 0.76, 1.58] (p=0.61). Rate ratios adjusted for covariates were higher in older than in younger children: 1.30 [95% CI 0.55, 3.06] for children aged 5–9 years, 1.36 [95% CI 0.67,2.76] for those aged 3–4 years and 1.03 [95% CI 0.82,1.28] for those aged 1–2 years, but the difference between age groups was not significantly different.

**Morbidity**

Clinical findings in children resident in 12 villages where insecticide was provided free and in 14 villages where charges were made are shown in Table 4. Combining data from the two zones, overall differences between groups were not statistically significant.

**Discussion**

Pilot studies, a large randomized controlled trial and finally a national programme have demonstrated convincingly that insecticide-treated bednets are an effective way of preventing death from malaria among Gambian children. Because malaria is the major cause of death and severe morbidity among Gambian children, the impact of the NIBP on overall child mortality in The Gambia has been striking (D’Alessandro et al. 1995). Treated bednets now offer the most promising approach to malaria control in The Gambia.

Two economic evaluations of treated bednet trials have been undertaken in The Gambia; the first of a carefully controlled trial (Picard et al. 1993), the second of the NIBP (Akins 1995). In the first study, it was calculated that the cost of each death prevented by the use of treated bednets was $188 and that of each clinical attack prevented was $28. Figures for the NIBP were higher at $600 and $34 respectively, largely because fewer deaths and cases were prevented during the NIBP. These figures take account of the costs of insecticide and of implementing the programme, but not the cost of bednets, as the Gambian NIBP did not provide bednets but relied upon users to provide them. These costs would be substantially higher if the cost of purchasing nets was also included. Both surveys indicate that, in The Gambia, treated bednets represent a highly cost-effective public health measure.

It is estimated that in The Gambia, with a population of about 1 million, around 240 000 bed nets are in regular use, usage being higher in rural than in urban areas. The cost of a bednet in The Gambia is approximately $10, with a useful life of 5–10 years, and a further cost of $0.5 is required for each annual treatment. The Gambia is unusual in that compared to many other countries in Africa, bednets are a highly valued domestic item, especially in areas with high mosquito biting rates (Thomson et al. 1994), so that the NIBP has not been faced with the problem of financing bednets, as would be the case in many other parts of Africa where bednets are used less frequently. However, the annual cost of treating all bednets in The Gambia with permethrin would be in the order of US$120 000 per year.

How might this sum be covered? Possibilities include payment from central government funds, external aid or payment by users. The Ministry of Health, with a total annual budget of 33.5 dalasis per capita ($3.4), has not felt able to meet this need. Support from international donors remains a possibility, as is the case for the expanded programme on immunization which is heavily subsidized by the international community. Some NGOs working in The Gambia have provided villages in which they have a special interest with insecticide for bednet treatment. However, aid is fickle and, in the long term, some form of cost recovery may be the best option for financing the NIBP.

When Gambian villagers were asked to pay to have their bednets treated with insecticide few did so. This was despite knowledge of the benefit of treated bednets, a knowledge reinforced before the treatment exercise by an intensive advertising campaign using radio, posters and local meetings which was directed equally at villages where charges were made and at those where they were not. High coverage rates were obtained when insecticide was provided free, demonstrating the effectiveness of this campaign and of the delivery system, although there was some reduction in the level of coverage in villages where insecticide was provided free in 1993 compared with the previous year (77% compared with 85%), perhaps due to the lack of novelty that had been associated with the first year of the programme. Evidence was found of distribution of insecticide outside the official delivery channels.
Lack of funds was cited by heads of households during a post-treatment survey (Muller et al., submitted) as the main reason why they could not produce the cash needed ($2.0–2.5) to treat the four or five bednets for which they were responsible. During a previous small-scale survey (Mills et al. 1994) most key informants suggested that households would be prepared to pay something (median $0.5–1.0) to have the nets in their compound treated but few stated that they would be prepared to pay as much as the $2–3 that was frequently required to treat all their nets. In this case, a willingness to pay survey, despite the limitations of this method (Russell et al. 1995), did give an indication of what might have been expected to happen when charges were put in place. An economic survey (Zimicki et al., unpublished) suggested that the weekly cash payment for an average household was only about $3.00 on staple items and $0.70 on luxury items such as tobacco, tea etc. so that requests for a cash payment of the $2–3 required to impregnate all bednets in a large household represents a substantial outlay for a family with little disposable income. Gambian villagers remain to be convinced that this is a sound investment. Pre-purchase of vouchers, at a time when cash is generally more readily available, was not effective, perhaps because of the novelty of the scheme and lack of trust that insecticide would be forthcoming.

Following the disappointing results of the first attempt at the introduction of fees for insecticide described in this paper, various ways in which coverage might be improved were investigated the following year (1994). These included increasing education on the benefits of treated bednets through radio, leaflets and letters and introduction of alternative delivery systems to the Ministry of Health’s PHC system including shops and MCH clinics. Using these approaches a higher coverage was achieved but the results were still disappointing (Müller et al. 1997).

It is possible that a reduction in costs might have a substantial effect on coverage. This could be achieved if a cheaper insecticide could be used. In 1994, Luo-Dopeng et al. reported that bednets treated with alphacypermethrin at a cost of $0.06 per net were as effective as those treated with permethrin. Thus, in 1995 a pilot, village trial of this insecticide was carried out in one village in The Gambia (Jawara et al., submitted). Bednets treated with alphacypermethrin at a concentration of 40 mg/m² proved as effective at preventing bites by mosquitoes and as acceptable to their owners as bednets treated with permethrin at a concentration of 500 mg/m² or lambdacyhalothrin at a concentration of 10mg/m². A further larger trial of this insecticide with morbidity from malaria as an end-point will be undertaken in Tanzania in 1997.

It could be argued that, in the long term, it would have been better if charges had been made for insecticide at the beginning of the programme rather than after one year. This would have avoided raising expectations that could not be satisfied and creating attitudes such as those expressed in Western Region that treatment of nets was a responsibility of the ‘government’. On the other hand, it is uncertain how many people would have been prepared to pay substantial amounts of cash on trust for an intervention of which they had no personal experience. For the latter reason, a decision was made to make insecticide available free to everyone on one occasion so that they would have personal experience of what they would subsequently be asked to buy, a technique used frequently in the commercial world. Perhaps some compromise would have been best in which subsidized insecticide was provided initially followed by a gradual increase in cost. The transition from free to expensive insecticide that took place during the NIBP was too abrupt.

In the first year of the NIBP children resident in villages where insecticide for the treatment of nets was provided free had a significantly lower overall mortality and prevalence of malaria than children resident in the villages that initially acted as controls (D’Alessandro et al. 1995). When insecticide was provided free to the latter group of villages but charges for insecticide were made in the first, the pattern of mortality reversed between village groups suggesting strongly that the effect observed during the first year of the NIBP was due to the introduction of insecticides and not due to some underlying imbalance in mortality rates between the two sets of villages. During the second year of intervention, differences in mortality rates between the two sets of villages were smaller, which is what would be expected as the impact of different levels of coverage with insecticide treatment of bednets was being compared rather than a comparison of users of treated bednets and controls. In addition, the size of the groups for comparison was less. It is also possible that differences in mortality between the two groups of villages may have been reduced by a carry-over effect of insecticide previously provided free in villages where charges were made during the second year of the programme but
this was not investigated directly. Another factor that could have affected the difference between the two sets of villages is that the treatment had lost some of its protective effect because of changes in mosquito behaviour but this was not studied.

The experience of The Gambia with treated bednets has recently been reinforced by the results of studies from elsewhere in Africa; significant reductions in childhood mortality have been obtained during large-scale trials conducted in Kenya and in Ghana (Neville et al. 1996; Binka et al. 1996). Many other trials have shown a reduction in the prevalence of malaria. Thus, insecticide-treated bednets currently represent the most promising method for malaria control in tropical Africa. However, in most studies undertaken so far, bednets and/or insecticide have been provided free. Experience from The Gambia indicates that, if treated bednets are to be used widely in the future, innovative ways of funding bednet programmes will be required which may involve either aid in some form or self-financing programmes.

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Biographies

Mohammadou Kabir Cham trained as a physician with a postgraduate degree in International Community Health and is a fellow of the West African College of Physicians. He has worked as a Regional Medical Officer, Medical Officer of Health, assistant Director of Preventive Services and Deputy Director of Health Services in the Ministry of Health, The Gambia. Dr Cham was Manager of the National Impregnated Bednet Programme (NIBP). He is currently working as a Health Adviser in a Technical Cooperation Programme supported by the Government of Germany.

Benjamin Olaeye graduated from the University of Ibadan Medical School in 1981. On completing his pre-registration and National Youth Service Scheme (1981-83), he worked in General Practice for two years. He then trained in Paediatrics at the University College Hospital, Ibadan, Nigeria, and obtained his post-graduate qualification (FWACP) of the West African College of Physicians in 1992. He was a research clinician at the MRC (UK) Laboratories in The Gambia (1992–94) and was involved in the evaluation of the NIBP. He is currently undertaking further training in paediatrics in the UK.
Umberto D’Alessandro obtained his medical degree in 1982 at the University of Pisa, Italy. He then worked as a medical officer for two Italian NGOs in a rural health centre in Benin (1982–84) and a rural hospital in Kenya (1986–89). In 1986 he obtained the Diploma of Tropical Medicine from the Prince Leopold Institute of Tropical Medicine in Antwerp and in 1990 an MSc in Community Health in Developing Countries from the London School of Hygiene and Tropical Medicine (LSHTM). He then worked as a clinical epidemiologist for the MRC UK in The Gambia where he carried out an epidemiological evaluation of the NIBP and a malaria vaccine (SPf66) trial. He is now working at the Department of Parasitology in the Prince Leopold Institute.

Moses K Aitkins, DLSHTM (Public Health & Policy), PhD (Health Economics), is a consultant with JSA Consultants Ltd, Accra, Ghana, working in the area of health policy and planning and population research studies.

Baboucar A Cham is a Public Health Officer by profession and trained as a health inspector. He holds a Royal Society of Health (RSH) Diploma and a Certificate in the Control of Malaria and its Vectors. He has worked as a District Health Inspector in various parts of The Gambia, and was officer in charge of the Vector Control Unit of the Ministry of Health. Currently, he is the Malaria Control Programme Coordinator in The Gambia.

Nick Maine is a statistician who worked in The Gambia for the International Agency for Research on Cancer. Before that he worked in leprosy research at the London School of Hygiene and Tropical Medicine, and for the British Government. He is now working in London.

L A Williams graduated in 1981 in statistics and since then has worked as a statistician in agriculture and rural development as well as health. She is currently employed as a lecturer in medical statistics at the LSHTM. Her main research is on intervention trials to reduce anaemia in women of reproductive age in Africa, and the epidemiology of STDs/HIV in Africa and South Asia.

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Brian Greenwood was Director of the MRC Laboratories in The Gambia at the time this study was undertaken, and the principal investigator of a large bednet trial supported by WHO and the Medical Research Council UK. He is now based at the LSHTM where he is Professor in Communicable Diseases.

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