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その他資料

（１）Protecting AII Pregnant Women and Children Under Five Years
Living in Malaria Endemic Area in Africa
With Insecticide Treated Mosquito Nets
(WHO 資料より)

（２）Community Based Strategies for Malaria Prevention and Treatment
(WHO 資料より)

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Protecting All Pregnant Women and Children Under Five Years Living in Malaria Endemic Areas in Africa With Insecticide Treated Mosquito Nets

Working Paper

Prepared for

Global Malaria Programme
World Health Organization

by

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Summary

This working paper was originally prepared for a High Level meeting on scaling-up insecticide treated net coverage convened by the United Nations Foundation (UNF) in Paris on 7 September 2005 as a follow-up to an initial meeting convened by UNF and the Canadian International Development Agency (CIDA)in Geneva, on 23 June, 2005. The purpose of the meeting (Minutes attached, see Annex 1) was to discuss the feasibility of a rapid scale-up ("quick win") to protect all pregnant women and children under five years by 2010 with insecticide treated nets (ITNs) with an emphasis on long lasting insecticidal nets (LLINs). This document aims to provide a basis for planning for such a scale-up by evaluating the future commodity and operational costs associated with providing universal coverage with ITNs for pregnant women and children under five years in malaria endemic areas of Africa. Following the recommendations of the meeting on 7 September 2005, the working paper has been revised based on comments from participants in that meeting, members of the Roll Back Malaria Partnership Working Group on Insecticide-treated Nets (WIN), WHO and UNICEF staff working on malaria control and vector control as well as other partners. It is now published on the web so as to provide benchmark figures on commodity needs and funding needs, against which actual implementation can be gauged.

The advantages and disadvantages of alternative delivery channels are explored. Technical and epidemiological rationale are used to conclude that the best way to achieve universal coverage is to build universal provision through routine services, antenatal clinics (ANC) and the Expanded Programme on Immunization (EPI), as the primary method of delivery. Whilst these routine health system-based delivery channels will cover the majority, it is recognized that they should be complemented by other channels, EPI outreach, community based systems and/or Child Health Days/Weeks (CHD/W), with which to reach those who do not access these routine ANC and EPI services. The combination of these systems provides a 'keep-up' of sustained delivery of ITNs.

Combined delivery of ITNs with immunization campaigns has recently provided an exciting opportunity for rapid scale-up of equitable ITN coverage as shown in a number of countries. Whilst recognizing the advantages of this channel as a quick-fix 'catch-up' delivery system, the disadvantages of the 'transient' coverage achieved are outlined as the reason that such campaigns are most useful as a complement to routine systems. In countries where routine systems are very weak, such as those in complex emergencies, campaigns may be the best way to deliver ITNs in the longer term, until health systems become stronger.

(Re) treatment campaigns are proposed as a way of rapidly scaling-up coverage of ITNs in countries where there is relatively good coverage with mosquito nets.

Donors considering investing in one or other of these systems should consider giving long-term support for routine services, which are better able to address the challenge of providing continuous coverage to pregnant women and children under five years with ITNs. This kind of support may help substantially in the long-time priority of strengthening health systems.

The numbers of ITNs needed to cover the target population of pregnant women (25.6 million) and children under five years (109.7 million) at risk of malaria in Africa are calculated, using a mix of delivery channels. Cost data from previous studies on ITN programmes are used to estimate the funds needed to deliver this number of ITNs over a five year period. These

estimates are simplistic and much more detailed costing is required to gain more accurate figures.

However, using the methods and assumptions outlined in the report and taking into account the simplistic nature of our methods, we estimate that 312.3 million ITNs are required to deliver to the target group over a five year period through ANC, EPI and planned measles campaigns, at a cost of US$ 2.27 billion.

This paper, commissioned by WHO, has been prepared by scientists of the London School of Hygiene and Tropical Medicine with inputs from staff from a number of organizations, institutions and partners, including Centers for Disease Control and Prevention, Atlanta, USA, UNICEF, WHO, the Roll Back Malaria Partnership Secretariat and the Roll Back Malaria Working Group on Insecticide-Treated Nets. The views expressed in the paper do not necessarily reflect the policies of WHO and statements regarding countries, their borders and populations do not imply the expression of any opinion on the part of WHO. This document represents "work in progress" and should not be quoted or disseminated without the agreement of WHO. Queries should be addressed to Dr M. K. Cham, Global Malaria Programme (chamm@who.int).

Acronyms

ACSD	Accelerated Child Survival and Development
ANC	Antenatal Clinic
b	Billion
CBO	Community Based Organization
CHD	Child Health Day
CHW	Child Health Week
CIDA	Canadian International Development Agency
DHS	Demographic and Health Survey
DTP	Diphtheria-Tetanus-Pertussis
EPI	Expanded Programme on Immunization
GFATM	Global Fund for AIDS, TB and Malaria
GIVS	Global Immunization Vision and Strategy
HIV/AIDS	Human Immunodeficiency Virus/Autoimmune Deficiency Syndrome
IMCI	Integrated Management of Childhood Illness
ITP	Intermittent Preventive Treatment [for pregnant women]
ITN	Insecticide Treated Net
LLIN	Long Lasting Insecticidal Net
m	Million
M&E	Monitoring and Evaluation
MERG	Monitoring and Evaluation Reference Group
MICS	Multiple Indicator Cluster Survey
NGO	Non-governmental Organization
NID	National Immunization Day
OPV	Oral Polio Vaccine
PCA	Principal Components Analysis
PSI	Population Services International
PW	Pregnant Women
RED	Reaching Every District
RBM	Roll Back Malaria
SIA	Supplementary Immunization Activity
SNID	Sub-National Immunization Days
SSA	Sub-Saharan Africa
UNF	United Nations Foundation
UNICEF	United Nations International Children's Fund
US$	United States Dollar -
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Scheme

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1. Introduction

In 2000, African Heads of State and Government agreed to seek to achieve that "at least 60% of those at risk of malaria, particularly pregnant women and children under five years, benefit from the most suitable combination of personal and community protective measures such as insecticide treated mosquito nets" by 2005.[1] It became clear already in 2004 that with baseline coverage rates for insecticide treated nets (ITNs) as low as 2-3% in most African countries measured between 1997 and 2001[2], it would not be possible to meet the target, mainly as a result of insufficient funding, but also on the background of inadequate planning and organization. Increased international attention to Roll Back Malaria and the emergence of huge production of inexpensive LLINs, which could make ITN operations easier to manage and maintain and more cost-effective created an environment, where the rapid scale-up of ITN coverage was seen as the most realistic "quick-win" for the Roll Back Malaria movement, which could save lives and restore confidence. After various initial contacts, The United Nations Foundation (UNF) and the Canadian International Development Agency (CIDA) convened a 'High Level' meeting in Geneva, June 23, 2005, which was followed by a second meeting convened by UNF in Paris on 7 September 2005. The purpose of the meetings was to discuss the feasibility of and requirements for a rapid scale-up to protect all pregnant women and children under five years by 2010 with ITNs with an emphasis on LLINs. The Minutes of the second meeting are attached (Annex 1). Following the recommendations of the meeting on 7 September, the working paper has been revised based on comments from participants in that meeting, members of the Roll Back Malaria Partnership Working Group on Insecticide-treated Nets (WIN), WHO and UNICEF staff working on malaria control and vector control as well as other partners.

Achieving universal coverage is an ambitious goal as only a few African countries (Eritrea and Togo) have thus far achieved the Abuja target, although a number of others, especially in East Africa, have made excellent progress also. Broadly speaking, coverage successes were attained using a number of different strategies and delivery systems, highlighting the need for adaptation of a mix of strategies to local circumstances. The lessons learnt now need to be put into practice on a much larger scale, supported by stronger donor commitment to sustained investment and supplemented by emerging new strategies to expand coverage across geographic and economic strata.

This document aims to provide a basis for strategic planning by evaluating the future commodity and operational costs associated with providing universal coverage with ITNs for pregnant women and children under five years in malaria endemic areas of Africa. This document also reviews the advantages of a number of delivery models, particularly ANC, EPI, and immunization campaigns. To date, the choice between models has been constrained by a shortage of ITNs (and funding for ITNs), and influenced by preferences for short-term funding and quick results within defined geographic areas. A subsidiary aim of the document therefore, is to consider how the public health benefits of donor funding can be maximized.

Donor interest in ITN scaling-up has recently been invigorated by pilot campaigns in which ITN distribution is combined with vaccination programmes, especially measles campaigns. As many country ITN distribution programmes have marked geographical and socio-economic inequities in ITN coverage, campaign-based distribution of ITNs is one of several options that may help redress these inequities. These intensive short-term campaigns may prove more attractive to some donor groups than supporting routine service delivery of ITNs. The relative advantages and costs associated with campaign delivery of ITNs and routine public health service ITN delivery such as ante-natal care (ANC) and immunization (EPI) will also be presented. It is hoped that new initiatives in ITN scaling-up will provide universal sustained coverage to pregnant women and children under five years.

It is therefore concluded that a mix of delivery systems will be needed to achieve complete and sustained coverage, with no one single delivery system achieving complete coverage on its own. Each distribution system can reach segments of the target groups not reached by the others. An integrated approach to ITN distribution should build on and strengthen existing local distribution and supply systems, including the commercial and public health channels. Ghana, Kenya, Nigeria and United Republic of Tanzania are all planning to combine more than one method of delivering free and/or highly subsidized ITNs, with various types and degrees of commercial sector involvement. The balance of this mix will certainly vary between countries, and may also vary from one province to another within a country, and may change over time.

For this initial stage of planning, this document first reviews the types of mosquito nets available including the process by which LLINs are tested and evaluated. Then, the strengths and weaknesses of the various distribution systems are outlined and how these can be combined, taking into account prospects for new technology, likely constraints in supply, and the opportunities offered by local net suppliers and distributors.

The approach presented for costing is admittedly simplistic and provisional. Previous attempts to estimate the expected cost of scaling-up ITN coverage in Africa used a wide variety of approaches and assumptions, and the resulting estimates range between US$258 million to US$1.66 billion. This review builds on these previous estimates and suggestions are offered as to the recurrent funding needed to maintain full coverage, and the catch-up funding that will be needed to reach this target at an accelerated pace. For present purposes, very simple and general assumptions are made about how routine and campaign delivery systems are to be combined, but it is emphasized that more detailed plans will have to take account of country-specific overlaps and complementarities in order to maximize coverage. This paper aims to provide a simplified analysis as a basis for a feasible strategy to protect all pregnant women and children under five years at risk from malaria.

2. Technical issues

This analysis is limited to consideration of the costs and benefits of distribution systems for ITNs to pregnant women and children under five years in Africa. Before considering the costs associated with distribution systems, a brief overview of ITNs and LLINs is presented. This includes (re)treatment of conventional nets and the process by which a new insecticide treated net is recommended for public health use. Two parameters having key impact on the costs of distribution systems are the life of the net fabric and the effective life of the insecticide with which the net is treated.

2.1 Effective life of the net fabric

There is a paucity of detailed data on how long nets last. However, there is a growing body of evidence that the lifespan of conventional nets made of 75 or 100 denier multifilament knitted polyester varies widely from place to place and from house to house, and that 2 or 3 years is probably a realistic estimate of the average life of the net fabric. Nets made of polyethylene, such as the Olyset™ net, are likely to have a longer structural life. This has important implications for planning and cost estimates. Traditional nets, made from a variety of fabrics, are commonly used in rural areas in West Africa and Madagascar. These nets are estimated to last 6 years on average[3].

2.2. LLIN Products:

There are two currently-available WHOPES-recommended LLINs. They differ from one another in both their physical properties and the technology used to extend the effective life of the insecticide. The Olyset™ LLIN is a more wide-mesh net made of a monofilament of

polyethylene with permethrin incorporated into the body of the fibre. The PermaNet™, by contrast, is a conventional knitted spun polyester fibre net coated with a special deltamethrin resin. One significant difference between these two LLINs is the need for regeneration (diffusion of the insecticide to the surface that is temperature dependent) after washing by the Olyset™ net in order to benefit from full insecticidal properties. Differences in their performance are emerging as they are evaluated under a wide range of conditions. Costs for the available sizes of LLINs are given on the RBM website with "family-sized" nets costing around US$5.10 (Olyset®) and US$4.00 (PermaNet®). Both companies are currently increasing sharply their LLIN production capacity.

The technology of LLINs is rapidly evolving. The large developing market for new LLINs will encourage market entry by new products. Strict quality control standards are necessary to ensure both safety for the user and efficacy as a public health tool in both the recommendation process by the World Health Organization Pesticide Evaluation Scheme (WHOPES) and in the subsequent quality assurance processes. The WHOPES evaluation process of a new LLIN and its requirements is reviewed below.

2.3. WHOPES Recommendation and Importation of LLINs

WHOPES is the only international programme that promotes and coordinates the testing and evaluation of pesticides for public health use[4]. These steps are necessary to ensure both the safety and efficacy of the product to the user as well as the confidentiality of the manufacturing process for the producer. An important aspect is that the procedure and requirements by which a product receives a WHOPES recommendation is developed in consultation and agreement with industry together with national disease control programmes, pesticide regulatory authorities and other international and regional organizations and institutions.

The WHOPES four-phase testing and evaluation of LLINs can be summarized as follows. Phase 1 entails determination of efficacy and wash resistance of a LLIN and study of dynamics of the insecticide on the fibre. It also includes an evaluation with the WHO Programme on Chemical Safety on safety for humans and the environment. Phase 2 involves small-scale field studies under well controlled conditions to determine efficacy of LLIN in terms of blood-feeding inhibition, deterrence, induced exophily and mortality as well as recording perceived side-effects of LLIN among users. Phase 3 involves assessment of the efficacy, longevity and fabric integrity as well as community acceptance of a LLIN. During Phase 4 specifications for the product are established and subsequently updated as needed (see WHO specifications for pesticides at http://www.who.int/whopes/quality/en/).

In view of the long-term studies that may be required to fully test or evaluate a LLIN product, *interim recommendations* on its use may be given subject to the following: use of WHO-recommended insecticides in making the LLIN; satisfactory completion of laboratory and small-scale field testing; and confirmation that after at least 20 standard WHO washes the LLIN performs equal to or better than a conventionally treated net washed until just before exhaustion. A LLIN is given a full recommendation when it meets Phase III criteria. The PermaNet™ has an interim recommendation while the Olyset™ net has a full recommendation. The criteria are outlined at the following website:
http://whqlibdoc.who.int/hq/2005/WHO_CDS_WHOPES_GCDPP_2005.11.pdf

In order for the product to be used, the product should first be registered by the country. The registration process will vary by country. The national registration authority is responsible for ensuring that pesticide use conforms to national standards. WHOPES recommendation will

often facilitate the country registration of a product and should minimize or eliminate the need for local product testing prior to registration. WHO specifications and pesticide quality standards are part of the International Code of Conduct on the Distribution and Use of Pesticides. WHO recommendations on the use of pesticides in public health are valid ONLY if linked to WHO specifications for their quality control.

2.4. Prospects for new products

Additional long lasting insecticidal products are being developed. One approach being explored is the production of a long lasting yarn (with insecticide coated or incorporated) that can then be knitted into nets using existing machinery currently used to produce polyester nets. A promising approach to LLINs is the prospect of a single-dose long-lasting insecticide treatment that can turn any net into a LLIN, and that can be applied in the field to a wide variety of fabrics. Such a product will be especially important in countries with significant coverage levels of untreated nets. For example in Mali, net coverage rates are more than 50% overall. Manufacturers of mosquito nets are also likely to be interested in this product with which they will have the option of converting their nets to LLINs at source before they reach the market. One product targeting polyester netting material has recently been submitted to WHOPES for testing and evaluation.

When new products are ready for wide-scale field use, current concerns about supply constraints will be alleviated and reductions in procurement and costs would be expected.

3. Delivery channels for covering the majority

All pregnant women and children under five years will not be fully reached by any one public health delivery system/channel. Therefore a combination of systems is needed for ITN delivery in order to reach the full complement of malaria target groups. In this section, the options for distributing ITNs are described which aim to "catch-up" (rapid scale-up), "keep-up" (maintain consistent availability of ITNs), and reach vulnerable groups in emergency situations.

Distribution of adequate numbers of ITNs by itself is necessary but not sufficient, since provision will not immediately translate into correct and consistent use. Comprehensive communication needs to accompany distribution systems. While not all ITNs distributed for use by a child or pregnant woman are used by them, surveys across 6 countries[5] consistently show that a greater proportion of children under five years old sleep under a net than other age-groups. Net use rates were also above average in women aged between 14 and 49 years, while adult men were the least likely sub-group to use nets.

The terms 'catch-up' and 'keep-up' are borrowed from EPI; however, these terms have different implications for ITNs compared with childhood vaccines.

Catch-up
EPI this term is used for campaigns where the aim is to vaccinate all children aged nine months to fifteen years in order to reduce the numbers of susceptible persons in the population (those never vaccinated and those in whom the primary vaccination failed). These campaigns need to interrupt transmission and therefore need to be conducted over a period of a few days. Routine systems are not used for 'catch-up' in EPI.
ITNs The aim is to achieve a rapid increase in the proportion of pregnant women and children under five years who are sleeping under an ITN. There is not a need for this rapid increase to occur within just a few days. Routine systems can also be used to catch-up on coverage to deliver the intervention, and are necessary as campaigns do not cover the complete target group. Where resources are available delivery of ITNs through routine systems will initially need to cover the whole population of children up to five years, and all pregnant women, whereas in later maintenance phases those newly pregnant and under one year olds will be mainly targeted for delivery. This represents a 'catch-up' phase.

Keep-up
EPI The aim is to maintain high coverage through routine activities during inter-campaign periods.
ITNs the aim is to ensure that ITNs are available to all pregnant women and all children under five years at all times. Keep-up aims not only to maintain high levels of household ownership of ITNs but also to ensure that they are used regularly and in the most appropriate manner by the target group for maximum effectiveness. Where ITNs are not long-lasting this includes ensuring that nets are retreated.

3.1 Catch-up

As coverage across countries of sub-Saharan Africa (SSA) is currently low, a 'catch-up' period of rapid scale-up is suggested as a complement to a more sustained 'keep-up' set of strategies. Strategies suggested for a rapid scale-up are combined measles campaigns, national polio immunization days (NIDs), child health days/weeks and (re)treatment of nets currently in households.

3.1.1 Combined measles campaigns

The main target group for measles campaigns, known as Supplementary Immunization Activities (SIAs) is children 9 to 59 months, or in some cases children 9 months to 15 years. There are two categories of measles SIAs: catch-up campaigns and follow-up campaigns. Catch-up campaigns aim to vaccinate all children aged 9 months to 15 years, in order to reduce the number of susceptible persons in the population including both those who were never vaccinated and those in whom the primary vaccination failed. Follow-up campaigns target children 9 to 59 months with the aim of reducing the number of susceptible persons born since the last SIA. Children below 9 months are therefore normally excluded from these campaigns. Occasionally, if a significant proportion of measles cases occur in children between 6 and 9 months, usually in emergency or refugee populations, then this group may be included. A significant advantage of these campaigns is that they can be used as vehicles to rapidly deliver ITNs to large numbers of vulnerable people. It should be noted, however, that although such campaigns involve delivery over just a few days, the period of planning and preparation for distribution is necessarily extensive. Depending on the measles epidemiology and the performance of the routine EPI programme, these campaigns which may occur at 3 or 4-year intervals also have the important advantage that the resulting ITN coverage is equitable, reaching children who do not attend ANC or EPI services, who are often the poorest and most distant from health services.

This approach has a disadvantage in that coverage achieved in a campaign is complete only for the population present at the time of the campaign. Children born after the campaign will not be protected for the first five years of their lives unless ITNs are available by additional routes, or they happen to share a sleeping place with an older sibling who received an ITN. For example, if a campaign giving ITNs to all children under five is repeated every four years, then only 25% of children will be given a new ITN during their first year of life. The majority of children will be conceived and born and reach their first birthday during the inter-campaign interval, and will be given a net only when the period of greatest vulnerability to malaria is over.

> The health benefits of ITN coverage during the first two years of life will normally be far greater than those of coverage during the subsequent three years. Therefore, not all children under five years are equally at risk. The risk of malaria in Africa is strongly concentrated in the youngest children, and in many settings, half of all under five deaths happen in the first year of life.

Compared to other delivery systems, therefore, campaigns are relatively good at achieving both socioeconomic and geographical equity (i.e. they reach the poor and remote communities), and they will often be the only way of reaching people in areas where routine services have broken down, due to conflict or disasters. On the other hand, campaigns are inefficient for achieving "timing equity", as children born shortly before a campaign will enjoy far better health benefits than children born later in the in the inter-campaign interval.

3.1. 2 (Re)treatment campaigns: converting conventional nets to ITNs

According to the Africa Malaria Report [2], about 80% of the nets in household use in Africa are untreated, and the great majority of these nets are presumably purchased from local unsubsidized commercial sources. Untreated nets in good condition offer approximately half as much protection as ITNs [6-12].

In many African countries, untreated nets are relatively equitably distributed across socio-economic groups, and in some places, poor rural households are more likely to have an untreated net than rich urban households. Almost everywhere, untreated nets are far more equitably distributed across socio-economic groups, than ITNs. So these untreated nets, and the systems that distribute them, have considerable public health value.

This situation offers an important opportunity: by treating these nets with insecticide, through campaigns or other means, we could very rapidly bring about a massive increase in the number of ITNs in Africa. One advantage of this idea is that the insecticide is relatively cheap compared to the price of a net (US$ 0.35 versus US$ 2.50 at bulk prices); another is that there are no supply constraints on insecticide and prompt delivery can usually be arranged. Retreatment campaigns in Cameroon and Uganda have demonstrated that campaigns can readily be organized, and can produce substantial and very rapid increases in ITN coverage[13,14].

Economic argument and experience also favour the policy of insecticide treatment free of charge. Modelling the cost-effectiveness of ITNs compared to insecticide treatment of existing nets found the range for ITNs of US$ 19-85 per Disability Adjusted Life Year (DALY) averted improved to US$ 4-10 if only insecticide was required[15]. The addition of the insecticide to an untreated net converts it from a private good into something that produces substantial external benefits for the community as a whole, and this gives theoretical justification to the idea that

the insecticide in particular should be publicly funded. In practice, moreover, programmes have found that treatment coverage levels fell dramatically when the insecticide started to be sold where previously it had been given free of charge [16].

Treatment of existing nets can effectively be combined with the ITN and LLIN distribution discussed elsewhere in this document, including through campaigns. (Re)treatment will remain a necessary element in ITN distribution plans for at least as long as the supply of LLINs remain limited. The availability of products enabling the conversion of any kind of net to an LLIN in the field is imminent, and holds the promise of converting all nets to LLINs through treatment campaigns.

3.1.3 National Immunization Days (NIDs)

The eradication of polio is now a global public health goal, and NIDs are therefore a time-limited intervention. Polio NIDs aim to interrupt poliovirus transmission through giving oral polio vaccine (OPV) to all children in a large geographic area over a short period of time. Therefore special efforts are needed to reach children who are missed by routine immunization services. During NIDs doses of OPV are given to children within a defined age group, which is usually 0 to 59 months of age, regardless of their vaccination history. These are considered to be additional doses and do not replace those received through routine EPI. The aim is to provide these vaccinations during each round of NIDs in as short a period of time as possible, and preferably within two days. NIDs are conducted in two rounds and the second round should take place four to six weeks after the first. NIDs are expected to be conducted annually for 3 years after which time polio should be reduced to focal transmission and NIDs will be replaced by mopping-up campaigns and sub-national immunization days (SNIDs) as appropriate.

Polio NIDs usually involve door-to-door vaccinations together with vaccinations within the community more generally. Every opportunity is taken to vaccinate a child. This has several implications for integrating delivery with ITNs. The first of which is the transportation of the heavy, bulky nets by volunteers. The second is that children are frequently vaccinated in the absence of an adult; this is a strategy which is not conducive with a policy of providing one ITN per caretaker and there is a broader question to be asked on giving the ITN directly to an unaccompanied child.

The number of countries in which NIDs are conducted, and their frequency within countries, will decrease. There are eight countries in SSA planning NIDs in 2006. Although combined delivery of ITNs with NIDs was carried out in Central Region, Ghana, in October 2004, and again almost at a national scale in Niger in December 2005 (whole country except Niamey)there has been less focus on the delivery of ITN through NIDs than through measles campaigns.

> The best way to achieve universal coverage is to build universal provision through routine services (such as ANC and EPI), as the primary method of delivery, supported by delivery through extended outreach and community-based systems. Campaigns are very useful in the short-term for achieving rapid and equitable scale-up
>
> Donors considering investing in one or other of these systems are encouraged to give commitment to long-term support for routine services.

3.2 Keep-up

In this section, delivery choices for maintaining constant access to ITNs are discussed.

3.2.1 Antenatal clinics (ANC) and Expanded Programme on Immunization (EPI)

ANCs offer a good opportunity for targeting pregnant women with the delivery of ITNs. The aim of delivering an ITN through this channel is that the recipient will use the ITN while pregnant and share the ITN with the newborn child for at least one year. In this way, ANCs provide a delivery channel for ITNs to both pregnant women and young children during their most vulnerable period.

Delivery of ITNs to children concurrent with EPI presents an opportunity for reaching children under one year. The proportion of children under one year reached with the various EPI vaccines is officially reported by countries to WHO/UNICEF in the annual joint reporting form and WHO/UNICEF estimates of immunization coverage are calculated on this basis. DTP1 may be used as a proxy indicator of the proportion of children that attend any vaccination. As measles is the final vaccination at 9 months of age, measles vaccination can be a proxy indicator of the proportion of children under one year who complete routine EPI.

In addition to free distribution of ITNs through ANC/EPI, both ANC and EPI also provide ITNs through subsidies by: 1) giving a subsidized ITN (i.e., direct product) or 2) giving a discount voucher (of varying values including 100% discount) which can be exchanged for an ITN at a commercial or other pre-identified outlet. In general the use of vouchers in the immediate term is more appropriate where commercial distribution is relatively well developed. The voucher system may, however, help promote a commercial market for ITNs and penetration of ITNs into more rural areas. Vouchers have the added advantage of avoiding the bulk storage facilities needed for continuous supply of ITNs to ANC and EPI, which may be a significant problem in more remote rural areas. Some countries, such as Zambia, have segmented delivery of ITNs through ANC using direct delivery in rural areas and vouchers in urban areas.

ANC and EPI systems are equitable in terms of timing, that is, aside from stock-outs, ITNs should always be available to pregnant women and young children. This contrasts with campaigns where if you enter the target age group just after a campaign you are excluded. Moreover, in much of Africa, ANC and EPI systems achieve high levels of coverage. However, these services can be variable in service delivery, failing in some countries to reach the poorest families. ANC and EPI can be especially weak in remote, sparsely populated areas with poor infrastructures. They also tend to break down in conflict and emergency situations.

There are differences between ANC and EPI-based delivery of ITNs. ANC coverage tends to be slightly higher than EPI coverage (ANC: 26.8 - 98.8%, median 83.8%; DTP3: 20.3 - 88.4%, median 63.8%)[1] . Provision of ITNs through ANC allows women to use the ITN during pregnancies, and the child to be protected by the ITN from birth. Provision of ITNs through EPI loses the benefits of pregnancy coverage, but means that the ITN will remain intact until the child is a little older. Nevertheless, the second contact at EPI provides an opportunity to deliver a new ITN, retreat an old net or replace a damaged ITN. In this way, the two systems should complement each other very well.

[1] Analysis by the authors of data from Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) surveys across 29 countries

We expect *a priori* that the majority of those women who attend ANC are the same women who take their children for at least the initial EPI visits. In many countries (but not all) EPI coverage and ANC coverage varies together, that is, where one is low the other is also low. This supports the hypothesis that most mothers either attend both ANC and EPI, or they attend neither, and only some attend one but not the other. Data is needed on this association. If ANC and EPI acted as independent systems in terms of who is reached, we would expect one system to reach most of the people missed by the other, and therefore delivering ITNs through both would greatly improve coverage. However, if the overlap between attendances through both of the systems is complete, then delivering ITNs through both systems would mean that those who attend get two ITNs and those who do not attend get none. Thus, depending on the strength of the association, the combination of ANC and EPI can help to produce much more equitable coverage, but in other conditions it can also reinforce existing differentials.

Another point to consider is that delivery of ITNs through ANC and/or EPI may increase attendance. There is some evidence from the UNICEF supported Accelerated Child Survival and Development (ACSD) projects in Mali and Senegal that this is the case, with delivery of highly subsidized ITNs through ANC increasing attendance[17].

3.2.2 The commercial sector

Surveys indicate that the majority of the nets currently in use in African households are untreated, and these were presumably delivered through the commercial sector[18]. The commercial sector includes manufacturers, importers, wholesalers, retailers, and various itinerant traders, working within the formal or informal commercial sectors. To date, public-private partnerships in the delivery of ITNs have tended to focus on the formal private sector with distribution generally through factory-based manufacturers of mosquito nets and ITNs, distribution by agricultural and pharmaceutical distribution companies and retailing through relatively fixed and formal outlets such as pharmacies and petrol stations. Many of these partnerships with the formal commercial sector have achieved better distribution of ITNs in urban areas than in rural areas.

Partnerships with the informal private sector, including manufacturers of locally stitched mosquito nets and traders in open markets, have so far not been developed. These informal distribution systems, operating through very small businesses, provide the channels through which many goods, including clothes and textiles, are distributed into remote rural areas. They have been shown to be much better than more fixed and formal distribution systems at delivering nets to the poor in some countries, particularly those with longstanding net cultures and particularly in West Africa [5,18].

Although the commercial sector does not specifically target pregnant women and children under five years, there is evidence that they have achieved good coverage of these groups with untreated nets in some countries. Collated data from 11 household surveys, commissioned by NetMark in 8 countries[5] www.netmark.org, shows that a substantially larger proportion of nets in households were delivered through the commercial sector than through non-commercial sources (Table 1).

Table 1: Proportion of nets in households delivered through commercial sources

	2000			2004		
	Household ownership[1]	Total number of nets recorded[3]	% nets from a commercial source[2]	Household ownership[1]	Total number of nets recorded[3]	% nets from a commercial source[2]
Ethiopia				25.3	313	57.5
Ghana				38.1	769	59.7
Mali				72.8[4]	1,244[4]	74.3[4]
Mozambique	26.5	403	78.8			
Nigeria	12.0	159	92.4	26.7	155	69.0
Senegal	33.6	598	69.9	56.1	2,309	27.3
Uganda	34.0	586	86.8			
Zambia	26.5	363	51.4	50.0	318	58.2
MEDIAN	26.6	403	78.8	44.1	543.5	59.0

[1] Proportion of households with at least 1 mosquito net
[2] Includes: market, kiosk, street vendor, general shop, textile shop, wholesaler, pharmacy, drug store, supermarket, mini-mart, hawker/moving kiosk, petrol station, tailor
Excludes: project, health facility, school, gift, employer, bought from relative/neighbour, don't know
[3] Excludes missing responses
[4] 2003

In the more recent 2004 NetMark surveys, a median of 59% of nets were purchased from a commercial source (ranging from 27% in Senegal to 74% in Mali). This represents a decrease compared to the median of the 2000 surveys (79%), which is probably due to an increase in the rate of ITN output from NGO and government programmes, rather than a reduction in commercial sales.

3.3. Delivery channels for the inaccessible and most disadvantaged

While there are many gaps in our knowledge on the delivery of ITNs aimed at covering the majority populations through routine health systems, these gaps are relatively small in comparison with the problem of reaching the most remote and/or disadvantaged populations. Three strategies are now outlined for delivery of ITNs to the geographically dispersed and most socio-economically disadvantaged pregnant women and children under five years.

3.3.1 EPI outreach

EPI has developed strategies for addressing delivery of immunizations to populations in the most inaccessible geographic areas: the Reaching Every District (RED) strategy and Global Immunization Vision and Strategy (GIVS). RED was the name given to a strategy of district capacity building with the aim of increasing immunization coverage, and has been adopted by many countries Africa since 2002. A recent evaluation found that coverage of DTP3 increased in 4 of 5 countries where assessments were conducted[19]. GIVS was developed by WHO and UNICEF and launched in 2005 at the World Health Assembly. GIVS has three main aims: to immunize more people against more diseases; to introduce a range of newly available vaccines and technologies; and to provide a number of critical health interventions with immunization (www.who.int.vaccines/givs). The focus on reaching geographically remote population through EPI outreach offers the possibility of increased coverage with ITNs by integration with delivery systems that have been strengthened through RED and GIVS strategies.

3.3.2 Community-based delivery

Community-based delivery systems promote the expansion of health care systems within communities, independent of health professionals and for those out of reach of the health systems. Community-based systems are built on the principle that the most effective and efficient way to promote health care is to ensure that it is locally determined, and guided by a thorough knowledge of the needs of economically disadvantaged people. Community-based systems are particularly useful in areas with strong networks of trained community health workers or community-based organizations (CBOs) and well established non-governmental organizations (NGOs).

3.3.3 Child Health Weeks (CHWs)

CHWs can be used to intensify delivery of a minimum package of services together with health education on preventive care, to children aged 0 to 59 months. The goal of CHW is both to increase coverage with child survival interventions and to encourage increased use of routine services for these interventions by creating awareness and demand. ITN delivery and education is consistent with CHW goals.

CHWs (and Child Health Days) are not campaigns; they are 'expanded routine'. They generally involve variable packages of child survival interventions such as EPI vaccines, Vitamin A supplementation, growth monitoring, and ITN (re)treatment. Other services have included education of caregivers on home management of fevers, promotion of use of iodized salts, awareness creation on HIV/AIDS and promotion of male and female condoms, family planning services, distribution of iron tablets, distribution of de-worming tablets and birth registration. A major difference between CHW and campaigns is that during campaigns children of the target age are vaccinated regardless of their immunization status whilst during CHW immunizations are conducted according to health cards. To-date CHWs have been used more for the delivery of (re)treatment than of ITNs, for example in Ghana and Zambia.

Summary of rationale

The action plan presented is based upon:
1) **Universal and sustained provision** ensuring that all children under five years and pregnant women have access to an ITN, and that this provision can be sustained in the long-term.
2) **Catch-up** aimed at accelerated scale-up of coverage through integrated immunization campaigns and (re)treatment of the nets currently in households.
3) **Keep-up** of coverage through routine systems (ANC and EPI) which are emphasized as the primary method for longer term delivery of ITNs to target groups. These are supported by outreach services and community-based distribution.
4) **Covering the majority** through both ANC and EPI, thus effectively delivering two ITNs per household. Where funds are sufficient for one ITN only, children under one year and therefore ANC should be prioritized over children 1-4 years and EPI.
5) **Reaching the minority** who are out of reach of routine health services through outreach and community-based systems. Accessing this minority of pregnant women and children under one year is a priority.
6) **Special situations** exist in countries with very weak health systems such as those with a history of complex emergencies. In these countries, campaigns may be the best way to achieve and maintain coverage.

4. Scaling-up: estimates of the number of ITNs needed over the next five years

The total number of ITNs needed for delivery to the target population for the next five years may be calculated using a number of different delivery system scenarios and assumptions. We calculated the target population, that is, total number of pregnant women and children under five years across 42 countries of sub-Saharan Africa. We then estimated the number of ITNs needed over the next five years under three scenarios. In Scenario 1 we assume that 100% of the target population are fully covered for the full extent of the five years; under this scenario we do not specify delivery systems. In Scenario 2 we estimate the number of ITNs needed if they are delivered to pregnant women through ANC and to children 9 to 59 months through planned[2] measles campaigns (at the time of writing campaigns were planned between 2006 and 2007). In Scenario 3 we estimate the number of ITNs needed if they are delivered to pregnant women through ANC, to children 9 to 59 months through measles campaigns, and to children under one through EPI. In Scenarios 2 and 3 we assume 100% attendance at ANC by pregnant women and at EPI by children under one year.

4.1 Data sources

All population data was derived from World Population Prospects Population Databases. Total populations and number of children under five years were taken directly from the 2002 Revision[20] database; numbers of children under one were taken from the 2004 Revision (Annex 2 Table I). Numbers of pregnant women were calculated from number of live births plus the number of maternal deaths during pregnancy [20]. Figures used for the purpose of this report are

[2] campaigns planned as of August 2005.

population projections for 2004, except for costing estimates which used projections for the years 2006-2010 (courtesy of John Miller, WHO).

Estimates of populations living in areas at risk of malaria transmission were calculated from the Mapping Malaria Risk in Africa project[21], multiplying target population figures by the percentage at any risk of malaria transmission (i.e. epidemic and endemic).

4.2. The target group

The total population in 42 countries of sub-Saharan Africa living at risk of malaria, including both endemic and epidemic areas, is almost 615 million (Annex Table i). Of these living at risk of malaria, around one fifth can be classified as biologically 'vulnerable', including 109.7 million children under five years and 25.6 million pregnant women. Total numbers of at risk vulnerable populations vary greatly between individual countries, with Nigeria alone accounting for 20% of those living in the 42 endemic countries.

4.3 100% of target groups covered within the first year and coverage maintained for five years (delivery system unspecified)

We can make initial calculations of the number of nets needed to meet and maintain 100% coverage of the target group of pregnant women and children under five where no delivery channel or mix of channels are specified. These calculations are based on the population estimates of these groups by year. For the first year (2006) numbers will be equivalent to the total population estimates of these groups; for subsequent years 100% coverage will be maintained by giving one ITN to every pregnant woman (the new cohort of children one year old will be covered by the nets of their mothers received during pregnancy). Assuming that each ITN lasts exactly 3 years, then for each year from 2009, it would also be necessary to provide new ITNs to those still under five and no longer covered (in addition to covering pregnant women). In 2006 this is equal to 135.3m ITNs followed by 26.2m-71.4m ITNs during subsequent years (Annex Table II). The assumption here is that we will be able to deliver this number of ITNs to the target population within the first year of resources becoming available and to then continue at the same scale. Using this scenario 312.3m ITNs are needed over the next five years (Table 2).

Table 2: Estimated number of ITNs needed and their costs assuming 100% attendance at ANC and EPI

	No. NETS NEEDED			COST (at US$7.28/ITN)		
YEAR	SCENARIO 1 100% coverage of vulnerable population	SCENARIO 2 ANC & measles campaigns	SCENARIO 3 ANC, EPI & measles campaigns	SCENARIO 1 100% coverage of vulnerable population	SCENARIO 2 ANC & measles campaigns	SCENARIO 3 ANC, EPI & measles campaigns
2006	135,262,874	69,515,656	79,932,941	984,713,723	506,073,974	581,911,813
2007	26,205,756	33,581,586	44,170,023	190,777,904	244,473,946	321,557,766
2008	26,840,334	26,840,334	37,594,960	195,397,632	195,397,632	273,691,307
2009	71,356,796	27,483,724	38,398,303	519,477,478	200,081,511	279,539,649
2010	52,591,156	28,135,957	39,202,769	382,863,616	204,829,767	285,396,158
TOTAL	**312,256,916**	**185,557,257**	**239,298,996**	**2,273,230,351**	**1,350,856,829**	**1,742,096,692**

4.4 Delivery through ANC and measles campaigns, assuming 100% attendance

If ITNs are delivered to all pregnant women through routine ANC, assuming that 100% of pregnant women attend ANC and that they will all be given one ITN when they do so then 25.6m-28.1m ITNs are needed every year (accounting for increases in projected populations of pregnant women - Annex 2 Table II).

Using available information on planned measles campaigns during 2006 and 2007 and assuming that delivery of ITNs could be combined in all of the campaigns to all children under five we calculate that 53.3m ITNs could be delivered during 2006 and 9.4m during 2007. This includes delivery of ITNs in 26 countries scheduled for measles campaigns in 2006-2007. Thus, across the 42 countries 62.8m ITNs could be delivered. (Annex Table III).

The total number of ITNs delivered using both ANC (assuming 100% coverage) and planned measles campaigns would then be 197.0m over 2006-2010 (Table 2).

4.5 Delivery through ANC, EPI and measles campaigns, assuming 100% attendance

If we add delivery of an extra ITN through EPI vaccination (children aged 9 months), again assuming 100% national measles coverage, we dramatically increase the number of ITNs needed from 197.0m to 316.4m over 2006-2010 (Table 2).

5. Costs of reaching 100% coverage of target groups

Estimating the costs of scaling-up coverage with ITNs to 100% of target groups is a complex challenge which can be approached from a number of perspectives. We review previous estimates and discuss the limited evidence upon which further estimates may be based.

5.1 Review of previous estimates of the cost of scaling-up ITN coverage in Africa

A number of recent estimates of the number of ITNs needed to meet the Abuja and/or MDG targets have been made, and some of these have included estimates of the expected costs. Although it is difficult to compare these studies since they all had slightly different objectives and methods, three of the most prominent reports are summarized below (see also Annex 2 Table IV):

1) Miller *et al* [22] calculate that between 92.3m-169.3m ITNs are needed to reach the Abuja 60% coverage of pregnant women and children under five by 2005. Using a highly conservative cost per net of US$ 2.80, this equates to a funding need of US$ 258m-474m.
2) Kiszewski *et al* [23] have the more ambitious objective of calculating the costs needed to support the basic malaria control interventions for the achievement of the 2010 RBM and WHO targets of minimum 80% coverage and 2015 malaria MDG. For ITN coverage in Africa alone, based on distribution of LLINs, this is estimated to require a total of US$ 1.6b over the next 10 years.
3) A detailed national plan for scaled-up malaria control in Ethiopia [24] estimates that to reach and maintain 100% ITN coverage of the vulnerable target population (cumulative 76.9m over 10 years) to 2015 will cost US$ 274m.

On a smaller scale, several studies have estimated the cost per ITN delivered, and these estimates have varied widely, this is not surprising as they have worked at different scales, used different delivery channels and worked within different contexts. The one study that has provided cost per ITN delivered at national scale was for a programme which scaled-up from one district to the national level over a period of five years and delivered 83,353 to 951,789 per year[25]. However, the design of some of these studies makes comparisons difficult. They have

used different perspectives for the costing exercise - including costs to the provider only, or costs to users, the community and the provider. Some studies have focussed on financial costs, others on economic costs, or both financial and economic. Some have involved costs to the point of delivery only, while only a few included delivery to the end-user. Studies taking place during different time periods and using different products also make comparisons difficult as the costs of ITNs (and different types of these) fluctuate on the international market.

Economic evaluation is based upon the balance between costs and consequences. Here we are concerned with the costs in terms of increasing coverage. It is sometimes assumed that economies of scale can be taken for granted, that is, that unit costs can be expected to decline as scale increases. This is not necessarily so. Scaling-up may reduce the unit costs in more densely populated, homogenous and accessible areas, but operational costs of reaching the distant, smaller communities are likely to be higher. Diseconomies of scale are therefore also likely. This adds considerably to the uncertainties inherent in the estimates discussed here.

There is a lack of evidence within the health sector as a whole on the costs of scaling-up interventions: a recent review found only three studies containing cost data from programmes in the health sector that had already scaled-up[26]. Where average costs vary depending on scale (i.e., where there are economies and/or diseconomies of scale) it is misleading to transfer cost data from a smaller to a larger programme or vice versa [27]. We need to take account of the spatial aspects of scaling-up. Broad areas where economies or diseconomies of scale exist in delivering health interventions include: geography and transportation; fixed costs of establishing a health infrastructure; human resources; and management transition costs[27]. A study on the costs and effects of an ITN programme in Malawi [25] showed economies of scale as the programme scaled-up from district to national level, with the cost per ITN delivered decreasing from US$5.04 to US$1.92.

Scaling-up may realize economies of scope by piggy-backing on current under-utilized capacity. It therefore follows that the cost of adding an intervention where there is an already established system and where there is unused capacity will be much less than where a system has to be expanded or newly established. It is unclear whether in those countries with lower ANC/EPI coverage this is due to an existing system being under-utilized or whether there is a breakdown in the system itself.

As already noted, the initial estimates make very simplistic assumptions about costs, and are therefore approximate and subject to change as scaling-up proceeds. Future efforts to develop more realistic estimates should consider the four factors which Johns *et al*[26] suggested for inclusion in calculations of the cost of scaling-up interventions:
1) Calculate separate unit costs for urban and rural populations;
2) Identify economies and diseconomies of scale, and separate the fixed and variable components of the costs;
3) Assess availability and capacity of health human resources;
4) Include administrative costs, which can constitute a significant proportion of scale-up costs in the short run.

5.2 A simplistic method for defining cost per ITN delivered

In addition to the purchase price of the ITN itself, there are many operational and administrative costs involved in the various elements of delivery, including all transport, storage and human resource costs. Other operational costs include promotion, training, supervision, monitoring and evaluation. In order to calculate costs of providing the number of

ITNs needed, we have assumed a single universal 'cost per ITN' figure ignoring the fact that costs are likely to vary widely including over time.

Various estimates of delivery costs are suggested by the costing studies mentioned above. For example, Miller *et al*[22] use the figure of US$ 1.00 per ITN, based on figures from a rural Kenyan ITN programme[28] which includes wages, allowances, administration and four wheel drive transportation. No promotional, training or M&E costs are included. The Ethiopia estimates[24] use US$ 2.00 per ITN to include handling, storage and distribution. Costs of IEC materials, staff training and M&E are estimated in separate detailed calculations and not given on a 'per ITN' basis.

Thus, as outlined above we have published data on the cost of delivering ITNs at the national scale in one country only [25]. In order to try to quantify a realistic 'cost per ITN' for our calculations, detailed cost breakdowns for a number of smaller-scale ITN distributions were therefore also consulted (Table 3). We also have preliminary data from the economic analysis of the combined measles campaign in Togo. The Togo cost data is not yet published and the data cannot therefore be presented in Table 3. The cost per net delivered including the cost of the ITN itself was US$5.97, and the cost of the delivery alone was US$1.64 [29] in Togo. The median cost for delivering an ITN across these six studies was US$2.73.

Table 3: Cost calculations for individual programmes

		Kenya 1[30]	*Kenya 2*[31]	*Tanzania*[32]	*Ghana*[33]	*Malawi*[25]
Delivery channel		ANC	Employer/ community based	Social marketing	Measles campaign	ANC/social marketing
Scale		35 districts	2 regions	2 districts	1 district	national
Capital costs	ITNs*	5,040,000	281,047	151,906	49,400	2,147,400
	Vehicles		76,723	10,703		50,228
	Furniture/ equipment		10,256	6,100		15,468
Recurring costs	Insecticide			33,033		191,555
	Delivery to country	151,920			1,745	
	Delivery to district	143,424				
	Delivery to facilities	172,800				
	Fuel/ maintenance		10,009			339,346
	Brand creation			5,164		146,801
	Sensitisation	70,000	27,937		450	
	IEC materials	80,784		33,658		272,646
	M&E	100,000	12,190			
	Staff	0	283,731	165,674	0	357,204
	Training		31,645		2,355	
	Office expenses		28,608			45,672
	Supplies					
	Other			192,492		
	TOTAL	5,758,928	730,943	598,729	53,950	3,878,287
Number of ITNs delivered		70,000˘	39,131	65,111	14,600	1,471,941
Cost per ITN delivered in US$(including the net)		**[7.31]**	**[15.8]**	**9.19**	**[3.74]**	**2.63**
Cost per ITN delivered in US$ (excluding the net)		**[3.81]˘**	**[11.50]**	**6.86**[ð]	**[0.32]^**	**1.18**

* cost of pre-treated ITNs, or cost of mosquito net + insecticide
˘ delivered to district level and financial
[ ] = financial costs
^ incremental only, all joint measles and ITN costs are apportioned to measles
[ð] authors calculations

We then estimated the cost of an ITN from the average of family-sized Olyset ® and PermaNet ® listed on the RBM website. The average was US$ 4.55 per LLIN. If we then assume that the cost for each LLIN delivered is the average cost of a LLIN plus the median cost of delivering a net, then the cost for each LLIN delivered is US$ 4.55 + US$ 2.73 = USD$ 7.28.

5.3 Cost estimate for 100% of target groups covered within the first year and coverage maintained for five years (delivery system unspecified)

The simplest calculation of cost is to take this cost per LLIN delivered and multiply by the target population estimates for each year. Using our calculations of number of ITNs required by this approach (312.3m over 2006-2010) and a cost of US$ 7.28 per ITN, this amounts to a total of US$ 2.27 billion for the five year period 2006-2010.

5.4 Cost estimate for delivery through ANC and measles campaigns, assuming 100% attendance

If the delivery strategy of ANC and measles campaigns is employed, this requires an estimated 185.6m ITNs, costing US$ 1.3 billion or an average of US$260m per year.

5.5 Cost estimate for delivery through ANC, EPI and measles campaigns, assuming 100% attendance

If the delivery strategy of ANC, EPI and combined measles campaigns is employed, this requires an estimated 239.3m ITNs, costing US$ 1.74 billion for the same period.

5.6 (Re) treatment campaigns

Considering these calculations of ITN numbers needed to cover the target population over the next five years alone and the current manufacturing capacity of the two companies producing LLINs (projected at a maximum of 50m per year by the end of 2005), conventional ITNs still have an important role to play. (Re) treating the nets currently in households is one way in which to achieve rapid scale-up with ITNs. Miller et al[22] estimated the number of nets currently in households in Africa to be around 28.1 million, with around 4.7 million of these being ITNs. A rough estimate for the costs of retreating all of these existing nets can be made using the value of US$ 1 per net for the insecticide [34]. This amounts to US$ 28.1 million per year. Over five years the cost of (re)treating the estimated 28.1 million mosquito nets in households in Africa will therefore be US$ 140.5 million.

6. Current coverage with interventions and access to delivery systems by the target groups

Estimates of the number of ITNs needed to cover the target population and the costs of procuring and delivering these ITNs were made above, assuming that ANC, EPI and measles campaigns cover 100% of their target groups. That is, we assumed that all amongst the target groups may be reached through these channels. However, target groups not met through these channels are likely to be the most vulnerable amongst the population and finding ways to reach out to them should be a priority.

We can use existing ANC and EPI coverage data to estimate what numbers and proportions of the targets are likely to receive ITNs through these systems and therefore those excluded, assuming that these systems are independent of each other. This then provides an estimate of the numbers and proportions who need to receive ITNs through alternative systems such as extended EPI outreach, community-based distribution and CHWs.

6.1 Data sources

The principal sources of data on ANC attendance, coverage levels of mosquito nets, ITNs, and EPI vaccinations were the nationally-representative Multiple Indicator Cluster Surveys (MICS)[35] and the Demographic and Health Surveys (DHS)[36]. National estimates of DTP1 and DTP3 were also provided by WHO/UNICEF (section 6.6). Twenty MICS surveys were available with data collected between1999-2001; 28 DHS surveys were consulted with study years ranging from 1994 to 2004. Those older than available MICS surveys, however, were only used in the absence of any other data (as was often the case for ANC attendance). In the absence of MICS or DHS data: mosquito net/ITN coverage figures for Ethiopia and Mali were taken from NetMark surveys (not nationally-representative), and for Malawi from a national MoH malaria study[37]; ANC attendance was taken from a recent WHO/UNICEF antenatal care report [38]. Other missing figures were estimated using median values from those countries where data was available.

The possibility that ANC and EPI reach and fail to reach the same target sub-groups is discussed in section 3.1.1, together with the consequences of this association. For present purposes, we have avoided these questions by estimating only the expected number of contacts given existing coverage rates of each channel, and from this the total number of ITNs that would be given away, if one ITN is given at each contact.

6.2 Delivery through ANC and measles campaigns, at current coverage estimates, with or without EPI

Table 4 takes the figures calculated in Table 2 (above) and adjusts them to take account of available coverage data. As before the first column represents the number of ITNs needed for 100% coverage of the target groups. The second column presents the numbers actually expected to be distributed given actual ANC attendance rates from survey data (adjusted for population growth), and the measles campaigns planned for 2006-7. Note, the campaigns are assumed to achieve 100% coverage of children under five in the countries where they occur, but no supplementary distributions to replace worn out nets for older children are included.

Table 4: Estimated number of ITNs that could be delivered through existing systems at current and planned coverage levels

	No. NETS COULD BE DELIVERED			% COVERAGE OF VULNERABLE POPULATIONS		
YEAR	100% coverage of vulnerable population	ANC & measles campaigns	ANC, EPI & measles campaigns	100% coverage of vulnerable population	ANC & measles campaigns	ANC, EPI & measles campaigns
2006	135,262,874	61,218,509	71,635,794	100.0	52.2	59.9
2007	26,205,756	25,067,969	35,656,406	100.0	63.2	78.5
2008	26,840,334	18,107,270	28,861,896	100.0	53.8	76.5
2009	71,356,796	18,528,002	29,442,581	100.0	29.7	52.3
2010	52,591,156	18,954,185	30,020,997	100.0	25.9	48.5
TOTAL	**312,256,916**	**141,875,935**	**195,617,674**	100.0		

If ITNs are delivered to pregnant women through ANC (assuming that the most recent national coverage figures remain constant over the next five years), then 70.6m ITNs will be delivered over the five year period varying from 18.1-27.1m ITNs per year (accounting for increases in projected populations of pregnant women). The total number of ITNs delivered using both ANC coverage and planned measles campaigns (assuming these achieve 100% target coverage) would then be 178.2m over 2006-2010.

If there is additional delivery of an extra ITN through DTP1, DTP3 or EPI measles vaccination, again assuming most recent national measles coverage remains constant, we dramatically increase the number of ITNs delivered from 178.2m to 297.6m over 2006-2010.

This is a substantial increase, but is nevertheless still much smaller than the 312.3m over five years needed, according to Table 2, to cover 100% of children under five and 100% of pregnant women. It is important to observe from Table 4 that 100% of the target population will not be covered through routine systems alone (see also Annex 2 Tables V & VI). Outreach, community-based delivery and other strategies are needed to achieve full coverage and as such the figure of 312.3m ITNs represents the true need if 100% of the target population are to be covered (delivery system unspecified).

There is evidence (section 3.1.1) that delivery of ITNs through routine ANC and EPI services may increase attendance, thereby creating a positive impact upon not only ITN coverage, but also on the coverage of other maternal and child interventions. In order to estimate numbers of ITNs that may be delivered through ANC we have used current coverage levels. If coverage was to increase then the number of ITNs delivered through these channels would increase correspondingly.

6.3 Combined measles campaigns

Combined delivery through measles campaigns is useful as a rapid scale-up and achieves relatively equitable, but not universal coverage. We currently have data on ITN ownership among households with children under five years immediately following combined measles campaigns in three countries: 89.5%[3] in one district of Ghana[33], 86.9% across 5 districts of Zambia[39] and 62.5% at the national level in Togo [40]. These findings offer an indication that the achievements through this method of delivery may decrease with increasing scale. Although in all these campaigns, coverage was surprisingly equitable across socio-economic quintiles (equity ratios of 0.92, 0.88 rural 1.19 urban, and 1.02 in Ghana, Zambia and Togo respectively). However, as already explained, the completeness of coverage is only temporary. Occasional campaigns are likely to be inequitable between children born in different years: those born just before a campaign will gain substantially more benefit than those born just after it, and this timing is important because the risk of malaria is highly concentrated in the youngest children.

All but five (Comoros, Guinea-Bissau, Madagascar, Mali, and Togo) of the 42 sub-Saharan countries included in this study report planned measles campaigns between 2005 and 2008 (Annex 2 Table III). Plans are already in development for combining delivery of ITNs in 11 of these countries.

6.4 Antenatal clinics

The proportion of pregnant women who attend ANC at least once during a pregnancy varies across countries from 21.1% in Sudan (southern) to 94.4% in Malawi (Annex 2 Table VII). The

[3] Proportion of caretakers who reported they had received an ITN during the campaign, rather than the proportion of households who own at least one net.

impact of distribution through ANC on equity of coverage depends upon the socio-economic status of those attending ANC, and possibly upon the cost of the ITN, for example, whether it is free or subsidized. The ratio of attendance in the poorest compared to the least poor socio-economic groups varies between 0.17 in Chad to 0.92 in Kenya with a mean of 0.66 across the 21 countries for which we were able to access data. Coverage in the poorest quintile varies between 12.0% in Chad to 91.0% in Zambia, with a median of 67.0% across the 21 countries.

6.5 Expanded Programme on Immunization (EPI)

Using survey data, the national average for proportion of children one year old covered with DTP1 (by immunization card or mothers report) varies from 42.6% in Nigeria to 95.9% in Malawi (Annex 2 Table VII). The national average for proportion of children one year old covered with DTP3 (by immunization card or mothers report) varies from 20.7% in Ethiopia to 85.9% in the United Republic of Tanzania (Annex 2 Table VII). Using the most recent WHO/UNICEF estimates[4] from 2004 (Annex 2 Table VII), the national DTP1 coverage across countries at risk of endemic or epidemic malaria in Africa ranges from 43% in Nigeria to 99.0% in Benin and Burkina Faso. Estimates of DTP3 coverage are typically lower than DTP1 (indicating drop-outs) and range from 25% in Nigeria to 95% in the United Republic of Tanzania.

Coverage of childhood vaccinations varies not only between countries but within countries with some provinces having relatively high coverage and others relatively low. At the district level ranges may be even wider. Surveys indicate that Nigeria has one of the wider variations in coverage of DTP1 by province (20.0% to 83.7%; median 64.2%), and the variation is even wider for DTP3 (5.8% to 67.8%; median 28.2%). This contrasts with Burundi where coverage of DTP1 ranges between only 83.8% to 89.7%; median 85.7% and DTP3 71.6% to 79.8%, median 75%.

Equity of coverage with EPI across socio-economic quintiles increases with increasing coverage[18]: countries with higher coverage also have more equitable coverage. The strong socio-economic differentials seen in some countries may be largely a reflection of geographic differences in access to services. The ratio of attendance (using DTP1 coverage) in the poorest compared to the least poor socio-economic groups varies from 0.25 in Nigeria to 1.00 in Rwanda with a mean of 0.73 across the 24 countries where data was available. Coverage of DTP1 in the poorest quintile varies between 21.9% in Nigeria to 92.6% in Swaziland, with a median of 68.5% across the 24 countries. DTP3 coverage in the poorest quintile varies between 7.1% in Nigeria to 81.5% in Eritrea, with a median of 45.3% across the 24 countries.

It is clear from the above that both geographic and socio-economic inequities need addressing in delivering ITNs through the systems we are proposing. The scale of these inequities, and therefore the emphasis needed on outreach and other systems to reach the minority, varies accordingly.

7. Current funding levels

From information available from GFATM and DFID, a total of US$ 989m has so far been allocated to malaria control, rising to US$ 1.44b when accounting for GFATM maximum five year funds (see Annex 2 Table VIII). Mosquito nets are increasingly becoming a central component of most funded national malaria control programmes with a total of almost 19m nets having been sold or distributed since 2000 (see Annex 2 Table IX; WMR 2005).

[4] Based on data reported to WHO and UNICEF by national authorities and immunization coverage surveys, consideration of potential biases, and contributions from local experts, WHO and UNICEF annually provide and publish official estimates of the most likely true levels of immunization coverage.

However, as the calculations in this report and elsewhere show, to deliver ITNs to the full target groups through routine ANC and EPI and complementary catch-up with combined measles campaigns 316.4m ITNs are needed costing an estimated US$ 2.50 billion over the next 5 years.

8. Relative costs of different distribution strategies

We have used a single estimate for delivery of ITNs which is not based upon specific delivery channels; the reason for this is that there simply is no data upon which to base more refined estimates. These delivery costs may be over-estimates for some of the routine services and campaign delivery that are a) open to economies of scale and b) piggy-backing onto established services. The priority emphasized throughout this document is to provide ITNs to all children under five years and pregnant women living in areas at risk of malaria in Africa. It has been shown with EPI programmes that the cost per vaccine delivered increases where high levels of population coverage are achieved [41,42]. It is likely that reaching out to the geographically and economically disadvantaged is a major factor in this increased cost. Therefore, whilst possibly being over-estimates for covering the majority, our delivery costs should allow for the priority of reaching the most vulnerable.

9. Mix of strategies for different country infrastructures

A complex variety of factors influences the most appropriate set of delivery channels for ITNs at the country level. These are best assessed country-by-country. However, in order to provide a simplified guide to selecting between the major channels of delivery outlined in this document we have constructed a decision matrix.