Global malaria burden and achieving universal coverage of interventions: a glimpse on progress and impact

*Rajni Kant**

Malaria continues to remain a serious public health problem in many tropical and sub-tropical countries of the World with around 225 million cases and near one million deaths every year causing serious economic and man-day losses, and trapping countries in the vicious cycle of ill health and poverty. With early success of Global Malaria Eradication Programme of 1950–60s, malaria resurged back in 1970s due to drug and insecticide resistance and other operational constraints leading to change and re-organization of control programmes, which helped in bringing the situation under control. With re-energized efforts of global community and implementation of Roll Back Malaria Program of WHO in 1998, malaria got global recognition and many more initiatives were launched which have helped in increasing the funding for malaria control and implementation of key interventions such as insecticide treated nets, indoor residual spray, artemisinin-based combination therapy, etc. in many endemic countries and they have shown promising results as indicated by the decline in the number of malaria positive cases and number of deaths all over the globe as reported in World Malaria Report (2010). However, the challenge lies in new emerging problems such as insecticide and drug resistance, new strains, climate change-related factors and achieving the universal coverage of interventions. The momentum gained is needed to be sustained to achieve the final success.

Keywords: Disease-burden, impact-assessment, key interventions, malaria, universal coverage, World Malaria Day.

AN update on the global malaria situation and impact of current interventions on lowering the burden of malaria in many endemic countries was reported by de Silva and Wickremasinghe[1] on the occasion of World Malaria Day (WMD) last year, including the malaria situation in the authors' own country, Sri Lanka, where malaria cases declined drastically and the plan was to switch over from control to elimination stage. The WMD theme for this year is 'Achieving Progress and Impact'[2]. The importance of WMD becomes more significant this year keeping in view that the deadline of the target of achieving universal coverage of interventions ended in December 2010 (refs 3 and 4). Hence, it is appropriate to have a glimpse of the global malaria situation, impact of ongoing interventions and challenges lying ahead in an attempt to bring the disease down to a manageable limit.

Here it is also pertinent to highlight the genesis of WMD, which goes back to 2000, when on 25 April in Abuja, Nigeria, the Heads of 44 malaria endemic countries of Africa gathered and discussed the problem and committed to halve the malaria burden by 2010 and further halve the disease burden by 2015, and interim targets were decided to be achieved by 2005 (refs. 1 and 5). Since then, 25 April was being celebrated as Africa Malaria Day (AMD) and every year specific themes were selected on each AMD (Box 1). In May 2007, in the 60th meeting of the World Health Assembly attended by delegations from all the 192 member states of the World Health Organization (WHO), latest malaria reports were considered. It was observed that global awareness of malaria remains low despite a high death toll and cost of the disease. The World Health Assembly thus resolved that WMD shall be commemorated annually in place of AMD to provide education and understanding of malaria and spread information on year-long intensified implementation of national malaria control strategies, including community-based activities for malaria prevention and treatment in endemic areas. WMD is thus an opportunity for all countries to learn about the devastating consequences of the disease and share the stories of triumph and struggles. WMD has thus replaced the AMD, which has been commemorated since 2001, and is aimed at promoting a greater awareness of the disease. It also ensures

Rajni Kant is in the Indian Council of Medical Research, Ansari Nagar, New Delhi 110 029, India. *e-mail: kantr2001@yahoo.co.in

Box 1. African Summit 2000

Themes for Africa Malaria Day (AMD)/World Malaria Day (WMD)

AMD 2001	The first Africa Malaria Day.
AMD 2002	Mobilizing communities to roll back malaria (RBM).
AMD 2003	RBM, Protect women and children.
AMD 2004	A malaria-free future: children for children to RBM.
AMD 2005	Unite against malaria: together we can beat malaria.
AMD 2006	Get your ACT together, universal access to effective malaria treatment is a human right.
AMD 2007	Free Africa from malaria now (RBM), the slogan – leadership and partnership for results.
WMD 2008	Malaria – a disease without borders.
WMD 2009	Counting malaria out.
WMD 2010	
WMD 2011	Achieving progress and impact.

that most locally and epidemiologically appropriate strategies are effectively implemented and the target population is reached.

In 2008, WHO's Roll Back Malaria (RBM) Partnership unveiled the Global Malaria Action Plan (GMAP), which is a global framework and clearly describes what needs to be done to meet short, medium and long-term goals of malaria control, elimination and eventual eradication. The plan comprises a three-part strategy, viz. (i) aggressive control in the malaria heartland to achieve low transmission and mortality in around 61 tropical countries with highest burden of the disease; (ii) progressive elimination from endemic margins inward to shrink the malaria map and (iii) research to find a vaccine and better drugs, diagnostics, insecticides and other tools for better management and control of malaria[6,7].

The theme 'Counting malaria out' was selected for 2009 and 2010 so as to ensure and realize the commitment of the global malaria community to speed up control efforts to achieve the 2010 targets. The 'counting malaria out' campaign enforced malaria endemic countries, RBM partners and donors to put extra efforts into comprehensively tracking progress along the way to universal coverage by 2010, near-zero deaths by 2015, and thereafter gradual elimination of malaria. Counting malaria out also requires a robust health information system to ascertain the real picture of the disease prevalence.

In fact, despite earlier neglect, re-energized efforts to improve the malaria situation globally started with a series of meetings in the 1990s such as Ministerial Conference on Malaria in Amsterdam (1992) and the Dakar Conference (1997), which led to the formation of multilateral initiatives on malaria focusing on increasing malaria control activities in Africa, the epicentre of global malaria burden. Under the auspices of WHO, the RBM Partnership was established in 1998 and the Abuja Declaration in 2000 set internationally recognized targets, including halving of malaria deaths in Africa's people by 2010 (ref. 5). Malaria was increasingly acknowledged as a cause of global poverty and was included among UN's Millennium Development Goals (MDGs). Although MDG6 calls specifically for halting and reversal of the malaria burden by 2015, malaria also affects most of the other MDGs as well and six out of eight MDGs can only be achieved when malaria control activities are in place. Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) was formed in 2002, creating a means to finance essential commodities for malaria control with additional mechanisms through the United States President Malaria Initiatives (USPMI) in operation since 2006 in 15 high-burden African countries; the World Bank is providing additional funds in more recent years[3]. In April 2008, the UN Secretary General called for universal coverage by the end of 2010 to halt malaria deaths (Box 2).

There has been significant improvement in malaria situation and control interventions worldwide with these combined initiatives[8], including in the malaria heartland, Africa (Figure 1). The World Malaria Report (WMR 2009)[9] shows that in 2008, of the 108 malaria endemic countries, 68 had a policy of free distribution of bed nets, while 52 had adopted the WHO recommendation to provide bed nets to all age groups at risk of malaria, and 45 used indoor residual spraying (IRS) as the primary vector-control intervention. Thirty-seven countries had adopted intermittent preventive treatment (IPT) for pregnant women by 2008. Seventy-one countries had a policy that recommended parasitological confirmation of infection prior to treatment and 77 countries recommended artemisinin-based combination therapies (ACTs) for treatment of *falciparum* malaria. However, 44 countries had banned the use of artemisinin monotherapies. Overall, 61 countries are now engaged in sustained control of malaria, whereas 39 are embarked upon elimination of the disease. The report[9] notes that on comparison of the number of malaria cases and deaths in 2000 and 2008, there was a decline of over 50% in 38 countries (9 in Africa and 29 outside) in 2008, whereas there was limited evidence of decrease in case load and deaths in 55 countries (33 in

Box 2. Global malaria control

Pre-1899	Control through change in social conditions and agricultural practices.
1950–1955	Focused attempt at malaria control in specific situations.
1955–1969	GMEP – Global Malaria Eradication Programme-based on the use of DDT and chloroquine.
1969–1990	Control through treatment of clinical cases of malaria.
1992	GMCS – beginning of renewed interest in malaria control – EDPT, selective and sustainable vector control, building local capacity, prevention of epidemics.
1998	RBM – brought malaria on the global agenda, stimulated increased financial investment and with a focus on Africa till 2006 when the WHO Global Malaria Programme was launched.
2007	Bill and Melinda Gates – Eradication was resurrected.
2008	GMAP – Road map to malaria control. Plan to promote the use of key interventions (ITN, LLIN, IRS, IPT, ACTs).
	Target is to achieve universal coverage by 2010.
	Reduce deaths by 50% from the 2000 level and to near-zero by 2015.
	Eliminate malaria by maintaining zero death.
	UN Millennium Declaration set a target to halt and begin to reverse the global incidence of malaria by 2015.

EDPT, Early Diagnosis and Prompt Treatment.

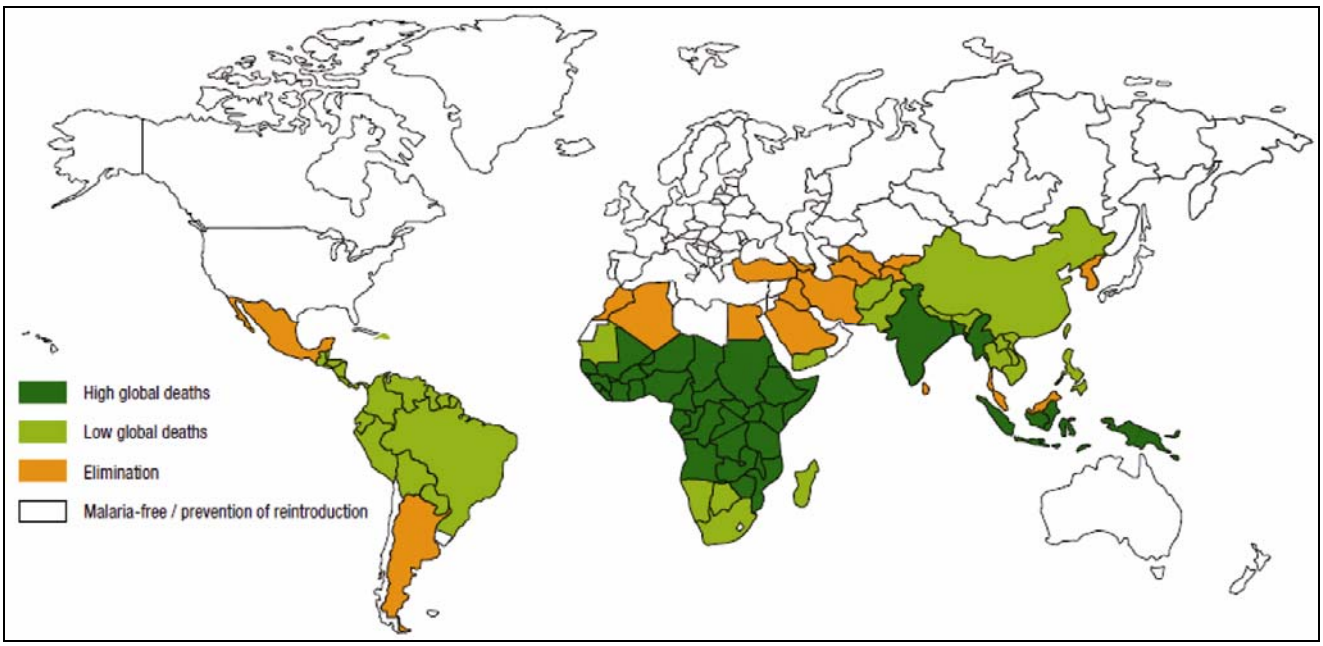

Figure 1. World malaria map (source: World Malaria Report 2008)[3].

Africa and 22 outside) in 2008. Reduction of over 25% was seen in another five countries all outside of Africa. As of 2009, eight countries were in the pre-elimination stage, ten in the elimination, nine working towards prevention of re-introduction and one was certified malaria-free with no ongoing transmission for over a decade. RBM programme of WHO in 1998 focused firmly on Africa for several years until 2006, when the new WHO Global Malaria Programme (GMP) was launched with much broader perspectives[10].

The attempts consolidated further as is evident in the recently released WMR (2010)[11]; the funding to control malaria increased from less than US$ 200 million in 2004 to US$ 1.8 billion in 2010, though still falling short of the required amount of US$ 6 billion. The increased funding has resulted in positive impact in accelerating the implementation of malaria control interventions, particularly increase in the use of insecticide-treated bed nets (ITNs) and people covered with IRS. By 2010, 289 million ITNs were distributed in Africa, 42% of the households in Africa owned a net and about 35% children slept under ITNs in mid-2010. IRS also expanded from 13 million in 2005 to 75 million in 2009, in terms of the number of people protected by IRS. WHO recommends all suspected

malaria cases to be confirmed by a diagnostic test. Malaria control interventions also had significant impact on case reduction. Morocco and Turmenistan were certified by WHO in 2009 as having eliminated malaria. In 2009 the European region did not report any case of *falciparum* malaria for the first time. The report[11] also highlights the reduction in malaria cases from 244 million in 2005 to 225 million in 2009, and number of deaths from 985,000 in 2000 to 781,000 in 2009. The 4th WMD marks a critical moment in time as the Abuja targets adopted in April 2000 should have been reached by now and universal coverage with all malaria control interventions attained. This is the year to assess the significant progress made so far to prepare a road map towards achieving near-zero death by 2015. However, the report[11] also indicates the fragility of the gains as was evident in a rise in cases in three African countries that have recorded the most impressive progress, viz. Rwanda, Zambia, and São Tomé and Principe. The reason may be the old nets which need to be replaced or retreated. Malaria also makes a come back in Sri Lanka after initial success, which is believed to be due to climate change-related factors.

Malaria Eradication Research Agenda (MalEra) has been recently launched, thus developing a comprehensive research agenda to ensure that we have the technologies to free the planet of malaria[6]. 'Malaria no more' has already raised over US$ 37 million and aims to create a US$ 100 million malaria fund[6]. Most endemic African countries have developed national plans for achieving the universal coverage targets, including monthly distribution plans of ITNs. Since malaria is a disease of poverty, its control will help reduce the gap between the poorest and least poor households. Regular use of ITNs has been shown to reduce child mortality by around 20%. According to the joint report by UNICEF and RBM Partnership entitled 'The World Malaria Day 2010: Africa update'[4] showed that global production of ITNs has increased five-fold since 2004, rising from 30 million to 150 million in 2009. UNICEF, the largest global procurer of ITNs purchased more than 40 times more nets in 2009 than in 2000. From 2000 through 2009, UNICEF purchased a total of 141 million nets for malaria endemic countries[4]. Use of ITNs by children rose from 2% in 2000 to 22% in 2008. Of nearly 350 million ITNs needed to achieve universal coverage, nearly 200 million were delivered to African countries by manufacturers during 2007–2009, and are available for use[4]. Results from USPMI, which support National Malaria Control Programme IRS activities in its focus countries indicate that in 2008 alone, nearly 25 million people were protected as a result of these efforts. There has been a recent and rapid rise in ACT procurement since 2009 from 0.5 million in 2001 to 160 million in 2009 (refs 4, 12). Affordable Medicines Facility for Malaria (AMFm) managed by Global Fund has been launched to scale up access to ACT. The AMFm will support countries with the monitoring of drug resistance and pharmaco-vigilance; the first phase of AMFm will be rolled out in 11 endemic countries. Worldwide Anti-Malaria Resistance Network (WARN) is a global collaboration generating quality assured and timely information to track the emergence and spread of resistance.

Outside Africa, it is the thickly populated South East Asia where 30% of the global population is estimated to be at risk of malaria, of which India contributes most cases (80%). In the Asia-Pacific region, malaria is present in 20 countries/territories, including five in South Asia, viz. Bangladesh, Bhutan, India, Nepal and Sri Lanka. Ten out of 11 countries of WHO South East Asia region are endemic for malaria, but vast majority of the cases occurs in India and Bangladesh. While Bhutan, Nepal and Sri Lanka reported a reduction of more than 50% cases between 2000 and 2008, the reported reduction in India was greater than 25% but less than 50%. In 2006, the WHO Regional Office for SE Asia published a revised strategy for malaria control which focuses on local specific measures based on ecological, environmental and behavioural determinants prevalent in the area and the inter-sectoral response to malaria with full engagements of government ministries, NGOs, civil society and private sector[10].

India has the largest population in the world at risk of malaria, with 85% people living in malarious zones[13]. The National Vector Borne Disease Control Programme (NVBDCP) is an umbrella programme for the prevention and control of vector borne diseases, including malaria and is an integral part of India's National Rural Health Mission (NRHM). The activities of NVBDCP are in tandem with National Health Policy (2000) and NRHM goals as well as to focus on MDGs of halting and reversing the incidence of malaria by 2015 (ref. 14). The programme has also been supported by the World Bank and GFATM in highly endemic areas (Box 3).

In India, about 65% of all malaria cases are reported from Orissa, Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal and states of the North East. High burden populations are ethnic tribes living in difficult, inaccessible forested pockets of the above-mentioned states, with 20% of the population contributing 80% of the cases[15]. There has been significant improvement in malaria situation over the years. The number of malaria cases declined from 2.08 million to 1.56 million during 2001–2009 and *Plasmodium falciparum* (*Pf*) cases from 1.00 million to 0.84 million. Annual Parasite Incidence (API) has consistently came down from 2.12 per thousand to 1.36 per thousand in 2009. The number of districts with API > 2 continuously decreased from the year 1995 to 2009. The country Slide Positivity Rate (SPR) has declined from 2.31 to 1.51 and Slide *falciparum* Rate (Sfr) from 1.11 in 2001 to 0.81 in 2009. However, the number of deaths has been fluctuating around 1000 (ref. 16). In Sonapur PHC, Assam, a declining trend in *Pf* from 70% in 1991 to 44%

Box 3. Chronology of malaria control in India

Before 1940s	No organized National Malaria Control Programme (NMCP).
1945	Insecticide properties of DDT were identified.
Before 1953	Estimated malaria cases in India – 75 million and deaths, 0.8 million.
1953	Launcing of the NMCP.
1958	Launching of the National Malaria Eradication Programme.
1966	Cases reduced to 0.1 million.
Early 1970s	Resurgence of malaria.
1976	Malaria cases reached 6.46 million and deaths also increased (highest in post-DDT era, the reason thought to be the development of resistance in vectors).
1977	Modified Plan of Operation (MPO) implemented.
1984–1998	Annual reported incidence 2–3 million.
1994	Resurgence of malaria in some states.
1997	World Bank-assisted Enhanced Malaria Control Project.
2005	Global Fund-assisted Intensified Malaria Control Project (IMCP) – 100 million population in 106 districts in 10 states being covered from 2005 to 2010.
2006	ACT introduced in areas showing chloroquine-resistant *Pf* malaria.
2008	ACT extended to high-risk *Pf* districts covering about 80–90% infection.
2010	As per revised drug policy (2010), 1st line treatment for all confirmed *Pf* cases is ACT.

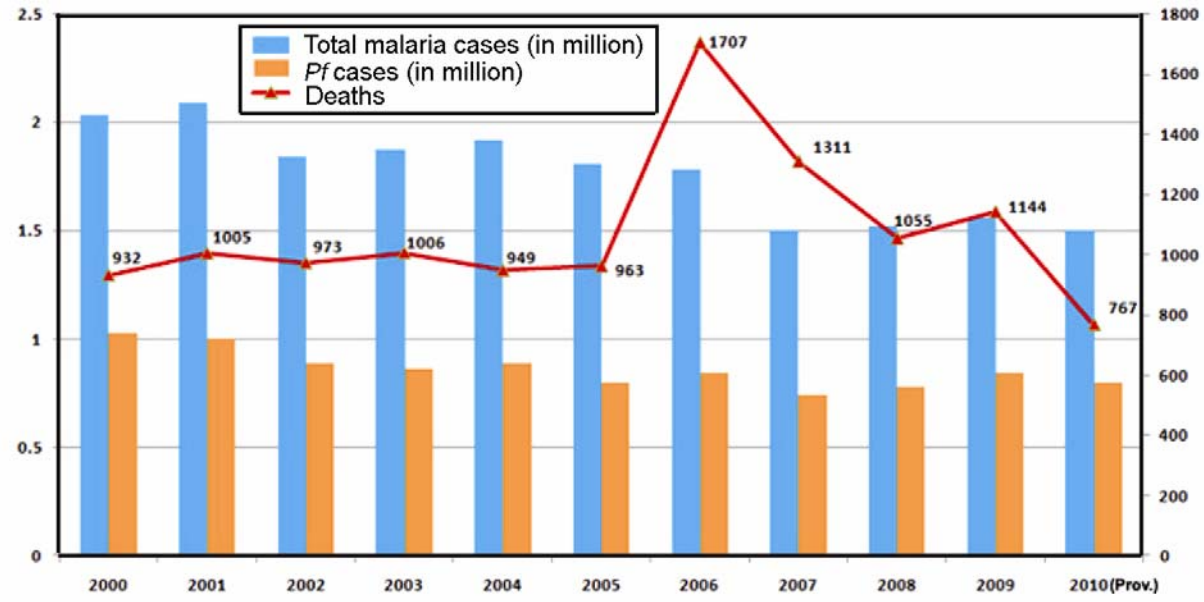

Figure 2. Trend of malaria cases and deaths 2001–2010 (Source: National Vector Borne Disease Control Programme; http://www.nvbdcp.gov.in). (Figure shows that the malaria cases have consistently declined from 2.08 to 1.49 million during 2001–2010. Similarly, *Plasmodium falciparum* (*Pf*) cases have declined from 1.0 to 0.77 million during the same period. Less than 2000 deaths were reported during all the years within this period with a peak in 2006, when an epidemic was reported in the NE states.)

in 2007 was observed due to evidence-based interventions such as ACT, ITN (in BPL families), rapid diagnostic test (RDT), community compliance and Health Education and Behavioural Change Communication (BCC) strategies implemented in the study areas[17] (Figure 2).

Achieving universal coverage has focused on ITN, IRS and prevention during pregnancy. RDT kits for detection of *Pf* cases were introduced in the programme in 2004–2005. Currently, around 8 million RDT kits are being procured mainly to be used in high *Pf* predominant districts of 15 states, including the NE states, Andhra Pradesh (AP), Chhattisgarh, Jharkhand, Gujarat, Madhya Pradesh (MP), Maharashtra, Orissa and West Bengal. Recently, bivalent RDT (for *P. vivax* and *Pf*) are also being made. IRS with DDT, synthetic pyrethroids and malathion is carried out in identified villages and about 70 million people are protected with IRS. During the last few years, 10 million nets have been procured and distributed in the community where there is difficulty to use IRS. From 2009, Long Lasting Insecticide-treated Nets

(LLINs) have also been introduced in high-risk areas. These nets are more effective as they have insecticide incorporated into the fabric during the manufacturing process, they do not require frequent reapplication and possess long efficacy of at least 4–5 years[3]. Artesunate plus sulphadoxine Pyremethamine combination was initially rolled out in 67 *Pf*-predominant district of the NE states and 50 predominant districts of AP, MP, Chhattisgarh, Jharkhand and Orissa apart from chloroquine-resistant foci in the country. Now according to the Revised Drug Policy (2010), the first line of treatment for all confirmed *Pf* cases is ACT. Apart from these interventions, other measures such as source reduction, use of larvivorous fishes and community awareness are also being attempted in feasible areas. GFATM-assisted intensified Malaria Control Project has been implemented from 2005 to 2010 in 10 high endemic states covering a population of 100 million in 106 districts. The results have been quite encouraging[16,18,19].

Malaria control has always been a challenging and daunting task, and new challenges make its control a difficult enterprise. The development of insecticide resistance in mosquito vectors and drug resistance in malaria parasite are known problems and the focus has been on the development of an effective and safe insecticide, and new drugs. The pyrethroids were developed in the 1970s and remain the only insecticide recommended for use in mosquito nets[20]. Pyrethroid resistance clearly threatens the control and elimination initiatives. The development of new insecticides is thus a priority. Innovative Vector Control Consortium (IVCC)[3] funded by the Bill and Melinda Gates Foundation is an opportunity to work in this area. Artemisinin resistance in *falciparum* malaria has emerged in the Thai–Cambodia border. This is the same area where chloroquine resistance arose 50 years ago and spread to Africa and caused havoc. If artemisinin resistance spreads widely, it will derail the current ongoing initiatives[21]. Artemisinin monotherapy, counterfeit and substandard artesunate have been found to be used in many African countries, which also needs to be stopped. Poor quality and counterfeit medicines not only jeopardize the lives of the patients, but also have the potential to fuel drug resistance[20]. Alternative approaches such as ITNs, environment-friendly control methods like the use of larvivorous fishes, source reduction, health education, community involvement and use of new combination drugs like ACTs have shown promising results and should be used judiciously. The challenge in the development of malaria vaccine lies in the complexity of the *Plasmodium* parasite. *Pf* has about 6000 genes; hence it is difficult to induce a protective immune response. However, there is some glimmer of hope and RTS, S plus adjuvant AS01 vaccine developed by GlaxoSmith Kline Pharmaceuticals Ltd with support from the Malaria Vaccine Initiative is a first-generation pre-erythrocytic stage vaccine with modest and time-bound limited efficacy. It entered phase-3 clinical trials in 16,000 children in 11 African countries in May 2010 (refs 3, 22). Malaria vaccine technology road map launched in 2006 provides a coherent framework for aligning resources, facilitating partnerships and identifying pathways to a viable malaria vaccine. Malaria Atlas Project, a collaboration between Kenya Medical Research Institute and the University of Oxford, and funded by Welcome Trust, is involved in the production of a map of global burden of malaria and its risk to help rationalize control operations. The infection of *P. knowlesi* in humans in Kapit Division of Sarawak, Malaysian Borneo is also posing a new challenge[23] and recently, the identification of a new species of *Anopheles gambiae* which is more susceptible to malaria parasite is likely to pose a new problem. *P. vivax* has started showing complications at some places, and malaria during pregnancy also needs special attention. Research is progressing in the area of genetically modified mosquitoes and the role of fungus in mosquito control. The efforts to control malaria in the recent past have been exemplary.

The deadline of 2010 targets and attaining universal coverage is already over and the UN decade to RBM has also ended. The 2015 deadline to meet MDG is fast approaching and requires concrete steps to reach somewhere close to the targets. Recent findings suggest that initiatives towards combating malaria have been effective; there is awareness about malaria worldwide and many donors have come forward to put in extra efforts, which have helped in initiating all-round assault on malaria. Now the challenge is to reduce the malaria burden further and besides attaining the 2015 targets, it is also important to accelerate and sustain the momentum already gained to win the final battle. WMD reconfirms this commitment.

1. de Silva, N. and Wickremasinghe, R., Counting malaria out – what progress? *Indian J. Med. Res.*, 2010, **131**, 475–477.
2. World Malaria Day, 2011; http://www.rollbackmalaria.org/WMD/index.html
3. The control of malaria 2005–2015: Progress and priorities towards eradication. In The 6th Report of the All-party Parliamentary Group on Malaria and Neglected Tropical Diseases, 2010; http:www.appmg-malaria.org.uk
4. Roll back malaria progress and impact series no. 2. World Malaria Day 2010: Africa Update UNICEF/PATH, April 2010.
5. Anon., The Abuja Declaration and the plan of action. An extract from the African Summit on roll back malaria, Abuja (WHO/CDS/RBM/2000.17), 25 April 2000; http://www.rollback-malaria.org./doc/Abuja_declaration.pdf
6. Feachan, R. G. A. and Phillips, A. A., Malaria: 2 years in the fast lane. *Lancet*, 2009, **373**, 1409–1410.
7. Roll Back Malaria (RBM) Partnership. Global Malaria Action Plan. RBM Partnership Secretariat, Geneva, 2008; http://www.rollbackmalaria.org/gmap
8. O'Meara, W. P., Mangeni, J. N., Steketee, R. and Greenwood, B., Changes in the burden of malaria in Sub-Saharan Africa. *Lancet Infect. Dis.*, 2010, **10**, 545–555.
9. World Health Organization, World Malaria Report 2009, WHO; Geneva, 2009, p. 66.

10. Narain, J. P., Malaria in the south-east region: myth and the reality. *Indian J. Med. Res.*, 2008, **128**, 1–3.
11. World Health Organization, World Malaria Report 2010, WHO, Geneva, 2010.
12. Snow, R. W. and Marsh, K., Malaria in Africa: progress and prospects in the decade since the Abuja Declaration. *Lancet*, 2010, **376**, 137–139.
13. Shah, N. K., Dhillan, G. P. S., Dash, A. P., Arora, U., Meshnick, S. R. and Valecha, N., Antimalaria drug resistance of *Plasmodium falciparum* in India: changes over time and space. *Lancet Infect. Dis.*, 2011, **11**, 57–64.
14. Directorate of National Vector Borne Disease Control Programme. Corporate guidelines to combat malaria. *J. Indian Med. Assoc*., 2010, **108**, 837–839.
15. Dash, A. P., Valecha, N., Anvikar, A. R. and Kumar, A., Malaria in India: challenges and opportunities. *J. Biosci.*, 2008, **33**, 583–592.
16. Sonal, G. S., Thakor, H. G., Joshi, C., Arora, P., Das Gupta, R. K. and Dhariwal, A. C., Epidemiological status of malaria and scaling up of interventions in India. *J. Indian Med. Assoc.*, 2010, **108**, 840–843.
17. Dev, V., Doley, G. C. and Dash, A. P., Rolling back malaria is possible. *Indian J. Med. Res.*, 2008, **128**, 82–83.
18. Arora, P., Sonal, G. S., Thakor, H. G. and Dhariwal, A. C., A success story: sharing experiences of implementing the Global Fund supported intensified malaria control Project (IMCP). *J. Indian Med. Assoc*., 2010, **108**, 846–848.
19. Thakor, G. H., Sonal, G. S., Dhariwal, A. C., Arora, P. and Das-Gupta, R. K., Challenges and role of private sector in the control of malaria in India. *J. Indian Med. Assoc.*, 2010, **108**, 849–853.
20. Newman, R. D., Malaria control beyond 2010. *BMJ*, 2010, **340**, 2714–2718.
21. Dondorp, A. M. *et al.*, Artemisinin resistance in *Plasmodium falciparum* malaria. *N. Engl. J. Med.*, 2009, **361**, 455–467.
22. Editorial, Malaria 2010: more ambition and accountability please. *Lancet*, 2010, **375**, 1407.
23. Lee, K. S. *et al.*, *Plasmodium knowlesi*: reservoir host and tracking the emergence in human and macaques. *PLoS Pathogens*, 2011, **7**, 1–11.

Received 12 May 2011; accepted 31 May 2011