

# MALARIA INNOVATION SYSTEM IN INDIA: A SYSTEM BASED ANALYSIS

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**ABSTRACT:-** This study aims to analyze malaria innovation using system based analysis. It analyses the performances of actors using different indicators of innovation system. Study discusses that scientific innovations are not only sufficient enough to tackle the infectious disease of poverty, like malaria. Study contributes that system base innovation approach for such disease would also analyze social innovations as these innovations become equally important for the control and eradication of the disease because they are necessary for the uptake and delivery of health Interventions. Social innovation is only possible with interdisciplinary learning and integrated delivery with other programmes. In an increasingly interconnected world many factors – social, economic, environment and biology – influence an individual’s health. Investing in health innovations without incorporating the broader determinants of health will not be sufficient to maintain a nation’s health and R&D competitiveness. Therefore, it is concluded that to address infectious diseases of poverty, we need an innovative system with a focus beyond product development. This system needs to be able to respond to changing health needs, translate technological development, deliver useful innovation and, eventually, ensure greater sustainability and equity for the country’s poorest populations..

**KEYWORDS:-** Malaria innovation system, India, Infectious disease, Social innovation.

## 1. INTRODUCTION:-

In a little over a century, knowledge in the fields of microbiology and parasitology, immunology and genetics, public health and medicine has increased exponentially. In combination with economic developments, this has resulted in many positive changes in human health: reductions in infant mortality, improved life expectancy, the near eradication of certain infectious diseases and the effective treatment of others.

More recently, major advances in new fields and technologies, including genomics, proteomics, high throughput screening, robotics, imaging and geographical information systems (GIS) have revolutionized drug discovery and the surveillance, prevention, treatment and control of new and emerging infectious diseases [King DA et al, (2006), Diggle PJ et al, (2007), Thomson MC et al (2006)].

However, getting the right tools to those who need them most is not easy. Although government agencies and research institutes, private organizations, public–private partnerships (PPPs) and community-based organizations have all worked to reduce the burden of infectious diseases, the challenges persist. Lifesaving innovations, including very simple yet effective interventions, still remain out of the reach of many. Many infectious diseases are still under-researched and poorly understood, and the innovations to address them are of limited commercial interest. Malaria disease is one of them; to control malaria is still a great concern and a major challenge for the tropical country like India.

Despite of concerted global efforts after the Second World War for malaria eradication and control, the disease [WHO, (2003)] continues to be prevalent and is a leading cause of morbidity and mortality in many tropical regions of the world. The major elementary problem identified in intervention strategies against malaria is the incidence gap i.e., failure to estimate accurate population at risk [WHO, SEARO, (2010)]. Although there have been advances in terms of new drugs and vaccines, eradication of the disease is still a way off. Worldwide, about 500 million people are estimated to be at risk of infection and the mortality is estimated at 1 million. The most vulnerable sections of the society are those living in poor sanitary conditions, especially drainage, which promotes the breeding of mosquito in stagnant water. [DST, (2009) report].

In India, healthcare system is facing continuous challenges in dealing with increasing burden of Malaria, Indian public healthcare system faces many challenges which are responsible for inappropriateness and weakening of healthcare system of the country [Das et al, (2012)]. Despite of continuous intensive effort from Indian government for malaria control, malaria is still a major challenge to Indian healthcare system. About 1.6 million Malaria cases and 1000 death have been reported in 2010 as per malaria control program in India [WHO, SEARO, (2010)]. Malaria disease control program implemented in India are facing a various obstacles that are hindering in delivering designated results. Major bottlenecks found within these national anti-malarial programmes are, Firstly, considering the vertically organised anti-malaria programmes that were launched before the 1990s, had been conducted largely without reference to the behaviour and the belief systems of the affected populations. Indoor residual insecticides, the hallmark of the eradication era, were applied uniformly across entire country. Although residents frequently denied the government spray teams' entry to their homes and removed the insecticidal sprays from treated walls, their active participation was largely irrelevant to the intervention. Secondly, current antimalarial programmes, however, generally are organised horizontally and depend heavily on resident participation, relies mainly on insecticide impregnated bed nets (ITNs) and combination drug therapy (CT). ITNs must be hung by the people who are to sleep under them and they must be reimpregnated in a timely manner, frequently at the user's expense. Failure to sustain this intervention would result in increased sickness and death due to exposure of relatively non-immune people to new infections. CT requires a standard schedule of drug administration that relies on the cooperation and understanding of each affected person. Failure to adhere to the prescribed regimen would endanger the long-term efficacy of the regimen. Therefore, it is concluded that the major failures of these programmes are the lack of adequate consideration given to target population and their social and behavioural aspects for the disease. These practical reasons drive our current need for a solid understanding of the behavioural and social factors that influence malaria risk and that may inhibit or facilitate particular intervention modalities. [WHO, SEARO, (2010)]

To reduce the burden of infectious disease and broker greater global equity, we need new levels of global commitment and new models of collaboration among stakeholders to bring about innovative solutions and to translate these solutions into effective programmes in settings where the needs are greatest. The challenge is more than the pursuit of technological marvels and "magic bullets". It is about fostering a "culture of innovation". [Global report for research on infectious diseases of Poverty, (2012)]

Innovation is about stimulating the search for novel discoveries; the development of technologies and tools for health interventions; understanding the specific social contexts in which interventions will be delivered; and strong engagement with communities to ensure maximum and sustainable implementation and uptake [Mahoney RT, Morel CM]. Innovation is not just about doing things differently but also about doing things in a more sustainable, effective, safe and equitable manner.

In this study, we take a innovation system approach. We start by (1) discussing how to create an environment of social innovation in low and middle-income countries (LMICs) like India through literature review, (2) Methodology to contribute for the development of social innovation of the study (3) Analysis of malaria innovation system through system based approach using different indicators (4) Social innovations necessary for the uptake and delivery of health interventions: presentation of the case of a National Vector- borne disease control program for Malaria, (5) Concluding remarks

## **2. LITERATURE REVIEW:**

### **Understanding the challenges of health innovation system**

Health innovation systems acknowledge the interrelationship between education, research and development (R&D), manufacture, domestic and export markets, intellectual property and regulatory policies [Morel C et al, (2005)]. These different components must be linked so that overall national and regional systems work efficiently and swiftly to respond to country and global health needs. Research plays a central role in an innovation system, from the inception of ideas to new ways of translation, policy design and regulation [(Matlin S, Samuels G, (2009) , Gardner C, Acharya T, Yach D (2007)].

For high-income countries, health innovation systems include actors from multiple sectors and disciplines. Conventionally, training and basic research are funded by the public sector through universities and government research institutions. Translational research and product development such as prototype productions or small-

scale production are conducted by pharmaceutical or other companies or, depending on the national system, government institutions. In low-income countries, however, the health innovation system is often rudimentary and fragmented. The public sector provides most, if not all, funding and infrastructure for research. Although research is conducted in academic institutions, often there is little applicability to local health problems, due to the lack of capacity to conduct translational research and limited manufacturing capacity. LMICs with some industry and manufacturing experience are usually limited to manufacturing low-technology products, or higher-technology products only under technology transfer agreements, rather than producing “home-grown” innovation for local health needs. The absence of private sector institutions engaging in health innovation also reflects limited expertise in product development, in regulatory and intellectual property management. This is partly due to the consistent drift of scientists to higher income country research institutions, and partly due to lack of access to domestic and global markets. These factors represent major barriers to establishing and strengthening national innovation systems in LMICs. The various steps in the innovation value chain remain disconnected, impeding the progress of innovation in these countries. Thus, unlike high-income countries, most LMICs have only a few areas of research and very limited development capacity. Resources in most other areas of innovations (e.g. intellectual property management and regulation, production and operation standards, and other social research) are also very limited. These scattered clusters of R&D-linked activities need to be connected in order to transform ideas and commitments towards innovative solutions. [Global report for research on infectious diseases of Poverty, (2012)]

Richard Mahoney and Carlos Morel argue that innovation disparity has created three kinds of “health failures” [Mahoney RT, Morel CM, (2006)].

- Science failures: This refers to a lack of knowledge and tools to address health problems. For example, there are still no effective vaccines or drugs for infectious diseases such as dengue, tuberculosis (TB), malaria and trypanosomiasis.
- Market failures: These happen when stock-outs occur due to high demand or when the purchase costs of drugs, vaccines and health interventions prevent the poor from accessing them. Often the new drugs and diagnostics are very expensive to develop and/or require sophisticated technical and health infrastructure for optimal use.

- Public health failures: This refers to the lack of good governance, transparency, effective delivery systems and a clear articulation of health priorities and values. Political and economic instability, cultural and religious barriers and shifts in government priorities can block the uptake and implementation of health innovations.

To overcome these failures and to maximize the potential for innovation, stronger partnerships are needed between countries, through global health initiatives and between the private sector and civil society. The World Health Assembly has called for the global control or elimination of neglected diseases of poverty as a major public health problem by 2020 (8, 9). An innovative and systems-based approach can help realize this goal. New thinking on innovation, access to medicines, and developing capacity in health innovation will allow the stronger translation of basic research, support product development and strengthen and sustain community uptake.

### **3. METHODOLOGY:-**

This study undertook System Based Analysis of Malaria Innovation System in India. The ‘system of innovation’ approach to the production of scientific and technological knowledge has been gaining ground in policy and academic circles over the last two decades. It has, for example, already been endorsed by an array of international and national bodies, including the Organization of Economic Co-Operation and Development (OECD), the Inter-American Development Bank (IDB), the World Bank, as well as non-governmental organisations and governments in both developed and developing countries. As a result, those responsible for funding and supporting research, technological development and innovation in developing countries are increasingly likely to come under pressure to adopt the innovation system approach as a guide to decision making. The approach represents a major change in the way that the production of knowledge is viewed and thus supported. It shifts attention away from the research and the supply of science and technology, towards the whole process of innovation, in which research is only one element. (Dantas, 2005).

To analyse innovation system of malaria in India, the main indicators of system of innovation that have been studied are as follows: (i) Funding, (ii) Priority settings

for R&D, (iii) Interactive Learning, (iv) Public private partnership (v) Social innovations (vi) Capacity building. Thus, multiple data sources are used to serve the purpose. Basically, our approach consists of retrieving a wide range of activities using a variety of sources related to the development and diffusion innovation. Firstly, archival data were collected from multiple sources. Academic publications related to MDs in India were extracted from the Thomson Reuters' Web of Science database. Publications related to MDs between 1991 and 2016 were searched. Information on extramural research projects (EMR) has been collected from the database of the Department of National Science and Technology Management Information System (NSTMIS) for the period 2000 to 2015 available at Department of Science and Technology (DST) website. Patents granted to Indian Applicants in recent decades in the United States Patent and Trademark Office. Patents related to Malaria were extracted from 2005-2016.

Secondly, information were also collected from the annual reports and websites of the different innovation actors selected for study as on December 2016.

Third, a case study approach has been used to study National Vector borne disease control program for malaria in India as a facilitator of social innovation.

### 3. Analysis of Malaria Innovation System in India

#### 3.1 Funding for innovation

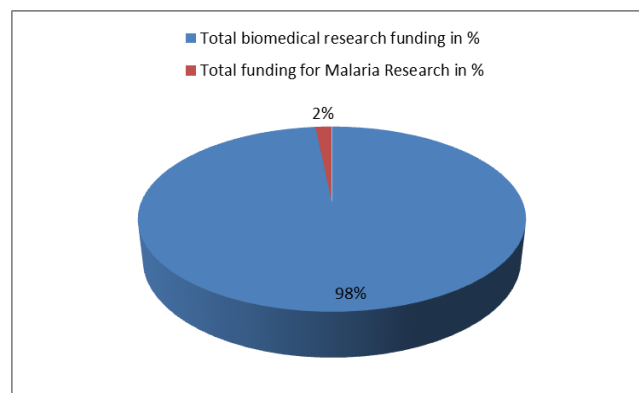
*The Global Strategy and Plan of Action on Public Health, Innovation and Intellectual Property* (GSPOA), published by WHO in 2008, called for the need to promote new thinking on innovation and access to medicines and to develop capacity in relation to health innovation as an essential response to public health needs(16). Below we analyse the pattern of funding for malaria R&D in India, this is done through the analysis of- (i) *amount of Extramural research funding allocated by the government for malaria R&D in India*, (ii) *Promotion of research and development for malaria research under Governmental Schemes*, (iii) *International funding supporting malaria research in India*:

#### (i) Extramural Funding in Malaria Research (EMR) Year-wise EMR funding for Malaria research (2000-2015)

Analysis of pattern of EMR funding from 2000-2015 shows that Malaria research was not given much priority in terms of EMR funding allocation. Out of total EMR funding (Rs 85639184066) released during 2000-15 for

biomedical research, malaria research has received only (Rs 1425760493) which contributes to only 2% of total funding. (See Figure: 1)

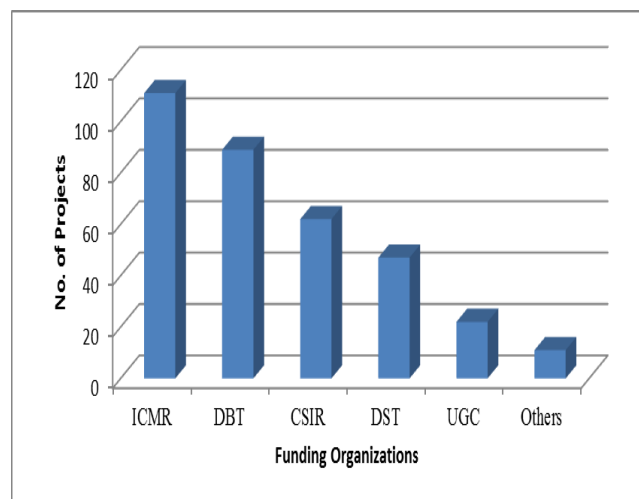
**Fig:—1. Comparison of EMR funding released for malaria R&D with total biomedical R&D (2000-15):**



Source: Data collected from NSTMIS Database of DST  
*Funding organization wise EMR funding allocated for malaria research (No. of projects funded) (2000-2015):*

Analysis of funding organization wise EMR funding for malaria research projects illustrates that over the period of 2000-15 there are only 342 projects funded for diagnostic research by different funding organizations and amongst them ICMR, DBT and CSIR are leading agencies for diagnostic research followed by DST and UGC. These five funding bodies contribute to 95% of the total funding given to malaria research during 2000-15. (See Figure: 2)

**Fig: 2. Number of Projects funded by different funding organisations**



Source: Data collected from NSTMIS Database of DST

*Promotion of malaria R&D through various Government funding Schemes*

This section undertook the analysis of malaria project funded by the government promotional funding schemes which are constituted to promote public private partnership and for promotion of research in private sector. NMITLI of Council of Scientific and Industrial Research (CSIR), Drugs and Pharmaceuticals Research Programme (DPRP), Technology Development Board (TDB) of Department of Science and Technology (DST), Biotechnology Industry Partnership Programme (BIPP) of Department of Biotechnology, Small Business Innovation Research Initiative (SBIRI) of Department of Biotechnology (DBT), are the different funding schemes promoted by the Indian government.

Analysis of project funded under these schemes for malaria research indicates that very few projects are funded till date. SBIRI and BIPP of DBT and NMITLI of CSIR have mainly supported the malaria R&D. (See **Table: 1**)

**Table: 1. — Projects Funded by different government promotional funding schemes from the period 2002 onwards**

<b>Funding Schemes</b>	<b>No. of Projects funded for Malaria R&amp;D</b>
NMITLI	5
SBIRI	4
BIPP	7
TDB	1
DPRP	0
Total	17

Source-Compiled by the authors on the basis of information available at CSIR, DBT, DST

***International Donor and funding organizations supporting malaria research in India***

International donor and funding organizations started supporting research oriented for poor related diseases affecting majority of population in developing countries, these initiatives have been taken to reduce 10/90 gap prevailing in research and development for poverty related diseases and led significant development over the past decade benefiting poor populations. **Table: 2** present some of the major international funding and donor organization in India promoting malaria research.

**Table:2 —Malaria project funded by these international funding and donor organization in India**

<b>Organizations</b>	<b>Disease Area</b>
Drugs for Neglected Diseases Initiative (DNDi)	DNDi supports the implementation of the various R&D projects. It closely works on raising awareness and advocating for increased public responsibilities and a more enabling environment for neglected disease R&D. DNDi supports the implementation of the various R&D projects. It closely works on raising awareness and advocating for increased public responsibilities and a more enabling environment for neglected disease R&D.
MMV (Medicine for Malaria Venture)	MMV has provided funds to various institutes in India to foster the development of effective alternative to current frontline antimalarial drugs for the treatment of uncomplicated P. falciparum malaria, artemisinin-based combination therapies (ACTs), which are under threat of resistance.
Bill & Melinda Gates Foundation	Funding to support R&D on a malaria vaccine, new drugs, and improved mosquito control methods.
World Bank	The World Bank has been assisting the Government of India in developing effective services for the control of malaria for over a decade

Source-Compiled by the authors from various sources

From the above analysis on funding for malaria it can be concluded that there are various funding mechanism to support malaria innovation in India, but at present these are not sufficient enough to combat the disease burden. Funding has increased over the period but still national innovation system is lacking to address the challenges associated with the disease.

**3.2 Priority setting for R&D –**

To invest effectively and strategically in R&D, funding agencies need to move away from disease- specific approaches, and think more broadly and systemically. The development of tools for disease prevention and control must take into account the changing global health context including the epidemiology and economics of disease, the increasing impact of climate change, and demographic changes including migration on disease distribution. Changing health systems and structures, and

the values that underpin these, need to be accommodated.

Priority needs to be given to develop tools which are effective and affordable, have high benefit–cost ratio, are sustainable and carry low risks. They need also to be culturally appropriate and acceptable. LMICs must be involved in setting and implementing the agenda for action in the response to, and control of, infectious diseases. The governments of some developing countries have already become important contributors of financial and technical resources in the global health landscape. This section of the study analyses the performances of innovation actors active in malaria R&D in India, this has been analysed through various indicators discussed below in terms of knowledge production to address the priority needs:

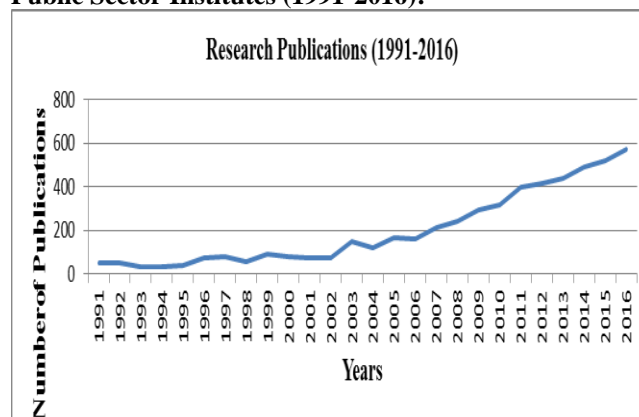
***Knowledge production (R&D) through publication activities Publication activities by public sector research institutes (1991-2016)***

Publication activities in India are mostly done by public sector research institutes. Analysis of publications indicates that publication activities by public sector research institutes have increased over the period (fig: 3) particularly after 2005 i.e., during 11<sup>th</sup> and 12<sup>th</sup> five year plan as during this phase healthcare R&D is being given a major priority and government has set an objective to foster disease oriented research in order to reduce the increasing disease burden in the country. The major public sector research laboratories contributed for malaria R&D in India are National Institute of Malaria Research (NIMR), National Institute of Communicable Disease (NICD), National Institute Immunology (NII), Vector Control Research Centre (VCRC), National Centre for Genetic Engineering and Biotechnology (ICGEB), Centre for Research in Medical Entomology (CRME), National Centre for Disease Control (NCDC).

These research laboratories have contributed and fostered malaria R&D towards various disciplines like Parasitology, Entomology, Vector biology, Genetics of Vectors, Epidemiology, Drug development, Diagnostics, and Vaccines (fig:4). The efforts from the research laboratories are remarkable and significant to deal with the challenges associated with malaria control and management.

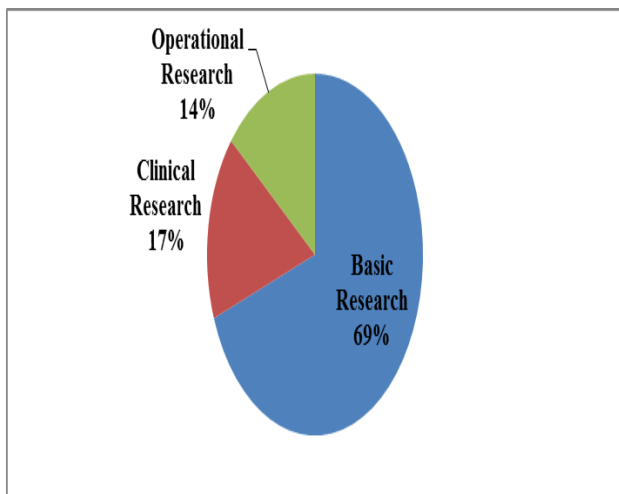
Coming to the issue of priority setting for focused R&D for malaria, publication activities have been classified using G-finder classification which revealed that at present out of the total research publications during 1991-2016, 69% are in basic research and only 17% and 14% have focused on clinical research and operational research respectively (Fig:5). This picture confirms that at the moment healthcare system lacks priority setting for focused malaria R&D. In case of infectious disease like malaria clinical and operational research are very important to deal with the complexities of the issues like spreading of disease, drug resistance, early diagnosis etc. Priority setting for malaria R&D in addition to basic research also needs research activities towards clinical research and operational research through the performances of public sector research laboratories in order to address the challenges involved with the disease control and management.

**Figure: 3— Publication activities on Malaria R&D by Public Sector Institutes (1991-2016):**



Source: Data collected from Web of Science Database

**Figure: 5 — G-finder classification on publication activities (1991-2016):**

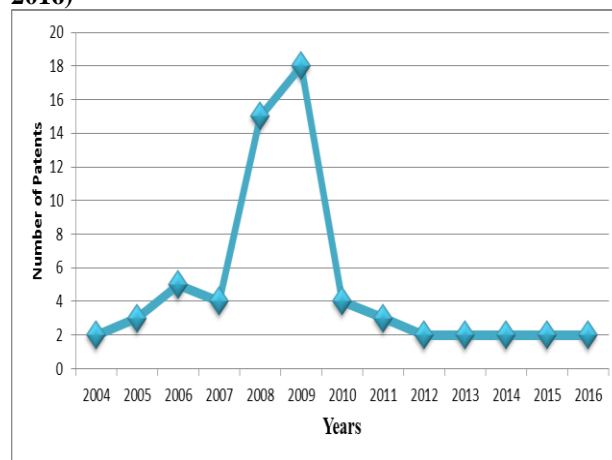


Source: Data collected from Web of Science Database  
*Knowledge production through Patenting Activities (2005-2016)*

As far as patenting activities are concerned we would expect the involvement of private firms as well. Therefore, the analysis in this section consists of the patenting activities (granted patents) by both public sector research institutes and private firms during the period of 2005-2016). Analysis of patenting activities (granted patents) through Indian Patent Office database (IPO) database in the area of malaria research shows that patenting activities has increased between the period 2005-2009 specially there was considerable increase in granted patent in 2009, but after 2009 number of granted patent has declined (**figure: 6**), one of the reason responsible for this change is the dramatic shift in government funding from communicable disease to non-communicable disease segment (Visalakshi, 2014). Further, analysis of nature of patenting activities reveals that both public sector research institutes and private firms in India in-house technological capabilities for development of product patents (drugs, diagnostics, vaccines for malaria), there are mostly processes patents (analogue molecules, new forms of substances, dosages

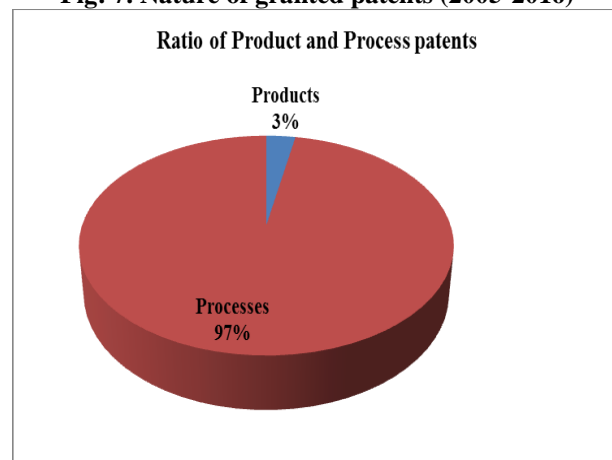
and formulations) (**figure: 7**). Nature of claims analysed for granted patents shows that most of the patents are claimed for therapeutics and research tools, however claims are lacking in the area of diagnostics and vaccines (fig: ), which is the major loophole in malaria R&D because at present the major challenge associated with malaria disease is development of vaccine and accurate diagnosis.

**Figure: 6. Trend in granted patents in Malaria (2005-2016)**



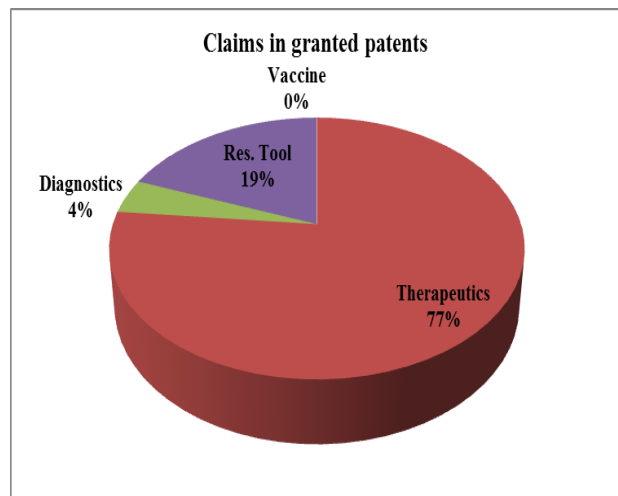
Source: Data collected from USPTO Database

**Fig: 7. Nature of granted patents (2005-2016)**



Source: Data collected from USPTO Database

**Fig: 8. Ratio of nature of claims in granted patents (2005-2016)**



Source: Data collected from USPTO Database

Coming to the ownership pattern of granted patents the type of institutions involved in the patenting activities comprised universities, public research institutions, research units in private companies and individuals/other type of organisations (non-profit/non-governmental organisations) in India and abroad. Private companies have fewer patents than Research Institutions. Applicants from Indian Universities were not granted any patents. **Table 3** gives details of data on this aspect, which shows that malaria research has only been given priority by public sector research laboratories.

**Table: 3. Institution-wise Distribution of Granted Patents related to Malaria**

Nature of Institution					Total
Indian Universities	Indian Research Institutes	Pvt. Cos (Domestic Firms)	Others	Foreign Firms	
0	18	5	5	19	47

Source: Data collected from USPTO Database

From the above analysis one is able to conclude although malaria healthcare system in India in terms of patenting activities is very weak for addressing the needs. So far very less number of institutes have come up with the patents. Patents in the area of potential target products for disease control like vaccines and diagnostics are still lacking. Thus, it can be concluded that malaria healthcare system has failed to set the priority R&D as far as patenting activities are concerned.

### 3.4 Interactive learning

Interactive learning is the key for the development of innovation system; it plays a very vital role in the development and diffusion of the knowledge, particularly for the developing country. The interaction between development and learning has largely been recognized by innovation system research and innovation has become the centre of analysis and debate around upgrading in developing countries (Lundvall et al 2006; Giuliani and Bell, 2005; Lee and von Tunzelmann, 2004; van Dijk and Sandee, 2002). Scholars in the innovation system tradition highlight that innovation is the result of interactive learning taking place between organizations located in a specific national, regional or sectoral institutional system (Edquist and Hommen, 2008; Balaguer, 2008, Lim, 2008, Ernst, 2007, Lundvall et al, 2006, Orozco, 2005).

This section of the study highlights that how and what type of interactive learning has been developed by different innovation actors for the development of system for malaria R&D in India. This is done through the analysis of collaborative publication activities (1991-2016)

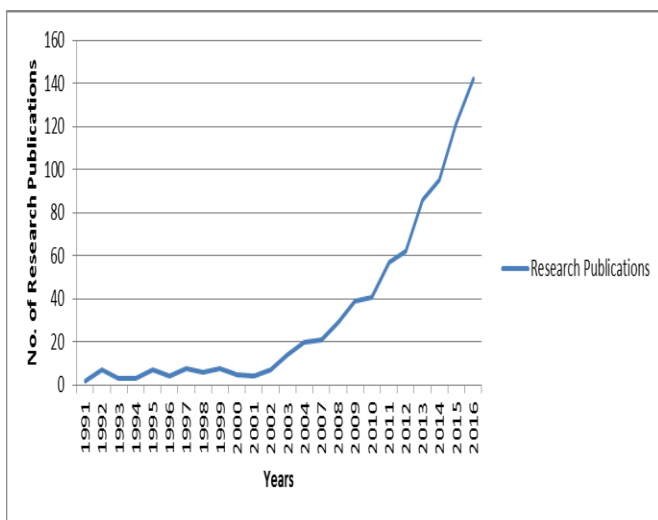
#### *Collaborative research activities*

Analysis shows that collaborative research publications has increased over the period, which is very encouraging and significant sign as it shows that researchers have increased their involvements in interactive learning and sharing their knowledge (**figure: 9**). Nature of collaborations through publication activities by public sector institutions and private sector pharmaceutical companies in malaria research illustrates that within public sector institutions at national level both intra-institutional and inter-institutional collaborative activities have evolved over the period, although still inter-institutional collaborations are less than intra-institutional collaborations which reflects the loophole in the system as inter-institutional collaborations are more important as its diversifies and expand the learning. Analysis of collaborative research pattern within the pharmaceutical shows that at present very few industries



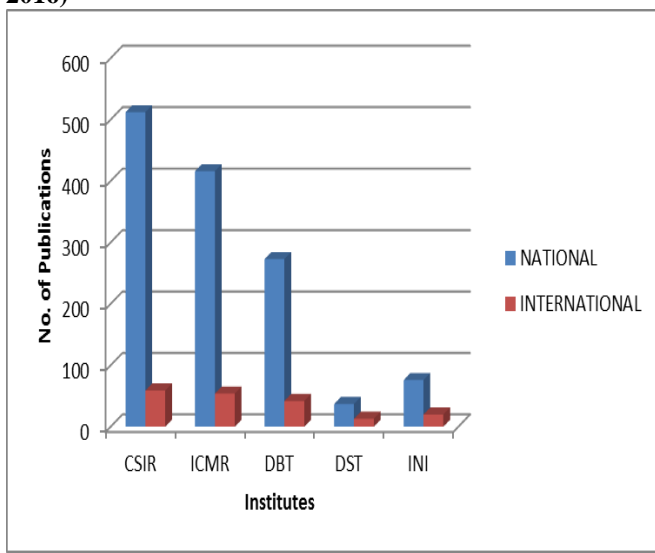
are involved in interactive learning like Biocon, Ranbaxy, Ipca laboratories, and these firms shows some significant collaborative activities in this disease area. International collaborations are very less within both public sector research institutions and pharmaceuticals which clears out learning and competence building through international collaborations are lacking within the actors active in malaria research. (figures: 10 &11 )

**Fig. 9. Trend in Collaborative Research Publications (1991-2006)**



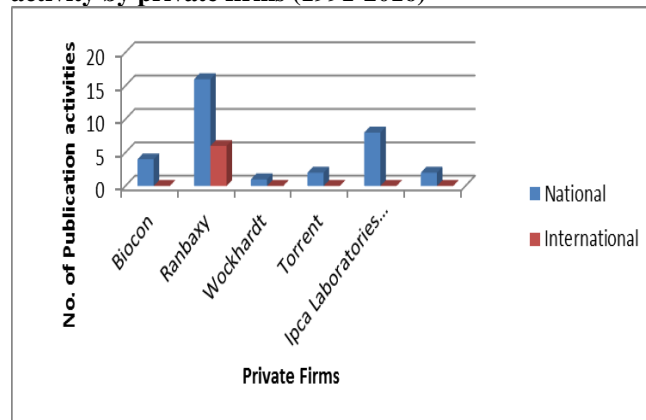
Source: Data collected from Web of Science Database

**Table: 10 — Pattern of collaborative publication activities by Public sector Research Institutes (1991-2016)**



Source: Data collected from Web of Science Database

**Table: 11 — Pattern of collaboration publications activity by private firms (1991-2016)**



Source: Data collected from Web of Science Database

### 3.5 Performance of private firms

In India till now various policy environment have supported firms to flourish in India<sup>1</sup>. These policy environments have created local private sectors in health R&D, provided incentives for Public Private Partnerships (PPPs) and encouraged technology transfers. They have designed innovative intellectual property management strategies through humanitarian licensing agreements, which have allowed for the manufacture of licensed products to promote the access of health technology in other developing countries. In spite of this very few firms at the moment in India are involved in the development of malaria innovation

<sup>1</sup>In India, the original Patents Act (1970) restricted patents on food, chemicals and drugs and discouraged the presence of multinational drug companies. This allowed local companies to build expertise in generic drug manufacturing and to sell drugs at low cost (37). On joining the World Trade Organization in 1995, India was required to comply with TRIP s. This could have reduced India’s generic drug manufacturing capacity and the availability of affordable essential medicines (38, 39). However, TRIP s was implemented judiciously and the Patents (Amendment) Act (2005) contained stringent intellectual property measures, opposition measures for challenging frivolous patents, limited patentability exceptions and detailed criteria for provisions relating to compulsory licensing and parallel importation (37). These legislative measures helped Indian companies to expand into foreign markets in the United States of America and Europe, and to offer the United States of America’s Food and Drug Administration approved facilities for drug R &D, including clinical trials, in India (37).

system, tables: 4 and 5 presents the involvements of Private firms in malaria publication and patent activities. This confirms that private firms are more market driven and do not want to invest in the disease of poor where there is scope for revenue generation.

**Table: 4 — Involvement of private firm for research publication on malaria (1991-2016)**

Companies	Total
Ranbaxy	13
Biocon	6
Torrent	3
Wockhardt	2
IPCA	2
Nicholas piramal	2
Pfizer	3
Total	30

Source: Data collected from web of science

**Table: 5— Patenting activities in Malaria research by Private firms (2005-2016)**

Name of Companies	Malaria
*Ranabaxy Laboratories	3
Cipla Ltd	3
Wockhardt Ltd	1
*Nicholas Piramal	3
Ipca Laboratories	1
Grand total	11

Source: Data collected from Indian Patent Office Database

### 3.6 Public –private partnerships (PPPs) and Product development partnerships (PDPs)

Both PPPs and PDPs aim to accelerate R&D, through establishment of mechanisms to redistribute funds and pool expertise and, importantly, to share benefits and risks of investments in health R&D. To foster malaria R&D in India some of the significant PPPs and PDPs have been established (See table: 6).

**Table: 6. Public Private Partnership (PPP) and Product Development Partnerships (PDPs) for Malaria Research and Development in India**

Organizations	Partnering with	Purpose of Collaboration	Years
DNDi	Sanofi-aventis	(ASAQ)-Fixed-dose combination of artesunate (AS) and amodiaquine (AQ), Launched in 2007, was the first drug to be made available by dndi in an innovative Partnership with sanofi-aventis.	2007
	Cipla	Cipla serves as dndi's Indian pharmaceutical development and manufacturing partner for ASMQ, facilitating the drug's availability across Southeast Asia	2007
	National Institute of Malaria Research (NIMR)	NIMR assists in conducting dndi's ASAQ and ASMQ clinical trials in India.	2007
	Indian Medical Research Council (ICMR), Delhi; Kala-Azar Medical Research Centre (KAMRC), Muzaffarpur; Rajendra Memorial Research Institute of Medical Sciences (RMRIMS), Patna, GVK BIO, India	For combinations therapies Partnering This combination involves has three clinical (active) projects: One examining combination treatments (ambisome®, paromomycin, miltefosine) Project Phase III start: December 2006 • Project Phase III end: January 2010 • Project Pilot Implementation:	2011
	ICMR, India; GVK BIO, India;	ASMQ, fixed-dose Artesunate/Mefloquine combination therapy , Phase IV post-registration	2002

		monitoring and access	
	Alkem, India;	Lscreening of promising Chemical classes- Target diseases- HAT, Chagas, and VL	2005
MMV (Medicine for Malaria Venture)	NIMR	Overcoming the challenge of conducting clinical trial in India	-
	Astrazeneca	To identify novel candidate drugs for the treatment of malaria	2010
Bill & Melinda Gates Foundation	International Centre for Genetic Engineering and Biotechnology (\$2,950,000)	To establish a core management structure that will plan, coordinate and execute the Indian Malaria Vaccine Program whose goal is to advance the development of safe, affordable and efficacious vaccines against Plasmodium falciparum & P. Vivax to protect children.	2008
MMV Geneva	Ranbaxy Laboratories Limited (RLL) Gurgaon, Haryana, India	(RBX11160) Arterolane Antimalaria combination drug on going	
CDRI-CSIR	Nicholas Piramal	Ablaquin, anti-malarial drug developed	1994
	Kembiotic Collaborators, Bombay	Primaquin Antimalarial	1980
	Themis Chemical Ltd., Mumbai	Arteether Antimalaria	1994
	Nicholas Piramal India Ltd., Mumbai	Primaquin Antimalarial	1994
	IDL Chemicals Ltd., Hyderabad	Primaquin Antimalarial	1994
	Themis Medicare Ltd.	Arteether	1995
	IPCA Labs Ltd.	Artemether	1995
	Wockhard Lt., Aurangabad	Mefloquin	1997
	IPCA Labs Ltd.	Compound 97/78	2004
	IPCA Labs Ltd.	Compound 99/411	2007
	Nicholas Piramal Ind. ltd.	Elubaquine (Compound 80/53) Antirelapse antimalarial	1999
ICGEB New Delhi	-	Malaria recombinant vaccine development	-
	Bharat Biotech Hyderabad (BBIL) & Malaria Research Centre	Malaria vaccine molecule against P vivax & P falciparum	2001
Ranbaxy laboratories Ltd	Sun pharmaceuticals Ltd.	Arterolane Maleate “Synriam TM” for the treatment of uncomplicated Plasmodium falciparum malaria, in adults.	NCE Molecule 2012 approved by DCGI
ICGEB New Delhi			
Sanofi Aventis	DNDI	Fix dose combination of artisunate – amodiaquine for children	2005
Sun Pharma	ICMR , MOHFW GoI and jointly with the NVBDCP New Delhi	For malaria Eradication in three to five years	2016
GlaxoSmithKline Pharma	MMV Geneva	Developing a vaccine candidate molecule	
	MMV Geneva	Anti-malarial whole cell inhibitors	

Source: data collected from various sources as on April 2017

The above analysis clears that PPPs & PDPs are very few in the area of malar and if one can there are no such partnerships after 2010-11, which presents a major

loophole in the system progressiveness. Most of the partnerships mentioned above are for the development of combination therapies and technology transfers but there

are only one or two partnerships for the development of novel anti-malarial compound or malaria vaccines. At present there is no effective malaria vaccine, the major challenges of development of malaria vaccine are discussed in next section. Also, public-private are required for the development of more basic research in the laboratory and the delivery of sustainable innovative products into the field.

### **3.7 Development of Malaria Vaccines**

According to Department of Science and Technology (DST) Report (2009), The malaria vaccine initiative at present in India is directed only against the erythrocyte stage of the parasite. However, global experiences in the vaccine development, which included multi-antigenic combination vaccine aimed at the sporozoite stage of the parasites as well, are more likely to be successful. Research on pre-erythrocyte stage vaccine would require special expertise and infrastructure for in-vitro culturing of the sporozoites in liver cells.

Such a challenging initiative for identification of promising antigens from different stages of the parasite and for verifying approaches for development of successful combination vaccine will be best undertaken jointly by partnering of institutes and possibly an industry pooling together their expertise in different aspects of the project. In India, presently no institute other than ICGEB is working in this area. The biopharmaceutical industry is in nascent stage and is in the process of developing expertise in handling complex antigen.

Another constraint is that the adjuvant AS02 found to be effective in inducing good immune response with malaria vaccine leads selected by ICGEB was developed and has already been patented by GSK. However, the patents for antigens cloned by ICGEB are with the scientist working in the area.

There is inadequate experience in conducting clinical trials for the vaccine, which is also a major constraint in expeditious development. The phase III trials have to be conducted in areas endemic for the disease.

### **3.8 Development of New Malaria Policy: New Approach to Malaria Control**

In 2009, under the Government of India's (GOI) new national malaria control policy, malaria prevention was strengthened by the adoption of Long Lasting Insecticide-treated Nets (LLINs), and case management expanded through the mobilization of voluntary community workers (called ASHA, recruited under NRHM) who were trained in the use of Rapid Diagnostic

Kits (RDKs), and then administration of Artemisinin-based Combination Therapy (ACT).

Although ideally, all fever patients should be tested for malaria before any treatment is administered, the distance from laboratory facilities had earlier led to a practice whereby all such patients were administered chloroquine on the presumption that they had the disease. This had however resulted in the malaria parasite's growing resistance to chloroquine treatment, and arises in the share of falciparum malaria cases in the country.

The Government of India has now taken a policy decision to discontinue this presumptive treatment for malaria. It states that all suspected malaria patients should have their blood tested before any medication is prescribed. Whenever result can be delivered within 24 hours, testing should be done in a quality controlled laboratory through a microscope. If not, Rapid Diagnostic Kits should be used for testing, and health care providers should be trained for this purpose.

For all confirmed uncomplicated falciparum cases, ACT should be used as first-line of treatment. The exception is pregnant women in their first trimester, who are treated with quinine.

As many patients seek private medical care, it is important to ensure that for-profit and non-profit private sectors are involved in the implementation of the national program. Effective oversight mechanism, possibly combined with strategies like franchising or social marketing, are also needed to ensure that private healthcare providers (including pharmacies, drug vendors and non-licensed medical practitioners) who may lack the necessary training, and who do not for the most part have access to laboratory facilities, follow the national treatment guidelines. In keeping with this, last year the GOI banned mono-therapies with Artemisinin to prevent the development of resistance to the drug.

Recently, The National Framework for Malaria Elimination (NFME) 2016-2030 has been developed through an extensive consultative process by the National Vector Borne Disease Control Program (NVBDCP) of the Ministry of Health and Family Welfare in India.

## **4. Social Innovations – science on its own is not enough**

From the above analysis it is found that all the indicators used above to study malaria innovation system in India are found inadequate in their performances. So, the question arises why is it so? What are the factors

hindering the performance of innovation system?. At the moment there are various challenges persist within Malaria system in India therefore malaria is still a major problem in India. Every year it kills number of peoples because of failures in the performances of different innovation actors of the system. Disease of poor like malaria can not only be controlled and eradicated by the scientific development, apart from it there are various issues which are persisting in the innovation system, which are needed to be tackled and solved. Initiatives to strengthen health innovation systems must account for the complex challenges of health infrastructure, economics, social and cultural factors that inhibit people from accessing new and life-saving innovations. Innovation must include R&D and delivery. Social Innovations strengthened the innovation system as it deals the issues associated with the effective delivery of the innovations. Social innovation comprises of following features:

- It is crucial to understand local contexts, engage communities and incorporate the wisdoms of local knowledge. Partnerships between private, civic and public sectors should be strengthened to enhance access to essential drugs.
- **Overcoming social and cultural barriers – getting communities involved:** to expand access to health innovation, we must also factor in social and cultural barriers to prevention and care. These are associated with social norms, sex and gender biases, stigma and taboo behaviours. Too often interventions and innovations are not taken up because local communities are not consulted. To overcome such barriers, we need to find innovative methods to translate and customize health interventions and products to local settings. In other words, we need to find new ways of engaging communities so that these initiatives are sustainable in the long term and not simply imported interventions, the effects of which will fade once the programme has ceased.
- **Building capacity:** Capacity building is crucial if developing countries are to become active participants in innovation and research. Areas of research such as the social sciences, epidemiology, and health systems research require significant local involvement in capacity training. This is because the effective implementation and adoption of health solutions require understanding of local contexts and the participation of the local partners.

#### ***4.1 Case study of National Vector-borne Disease Control Program for Malaria in India: An effective attempt towards Social Innovation for the delivery of innovation for malaria control***

#### **National Vector Borne Disease Control Programme (NVBDCP)**

The National Vector Borne Disease Control Programme (NVBDCP) is the agency responsible for the prevention and control of six vector borne diseases namely Malaria, Dengue, Chikungunya, Japanese Encephalitis (JE), Lymphatic Filariasis and Kala-azar. It is one of the technical departments of the Directorate General of Health Services under the Ministry of Health and Family Welfare and is responsible for framing technical guidelines and policies, and monitoring implementation through regular reports on malaria control. The NVBDCP goals are to develop a well-informed and self-sustained health care system in India with equitable access to quality health care and to ensure that the program activities are in accord with the Millennium Development Goal of halting and reversing the incidence of malaria and other vector-borne diseases by the year 2015 and beyond. The major strategies being pursued by the NVBDCP to help achieve its objectives are: (i) disease management through early case detection and complete treatment, (ii) integrated vector management (IVM) to reduce the risk of vector-borne transmission; and (iii) supportive interventions which include communicating behavior change, capacity building and monitoring and evaluation of programs. To facilitate disease management, fever treatment depots (FTDs) exist at the village level. The FTDs are diagnostic stations for the collection of blood slides from febrile patients, with an Annual Blood Examination Rate (ABER) target set by NVBDCP at  $\geq 10\%$  for screening the Indian population.

#### ***Initiatives towards promotion of Social Innovation***

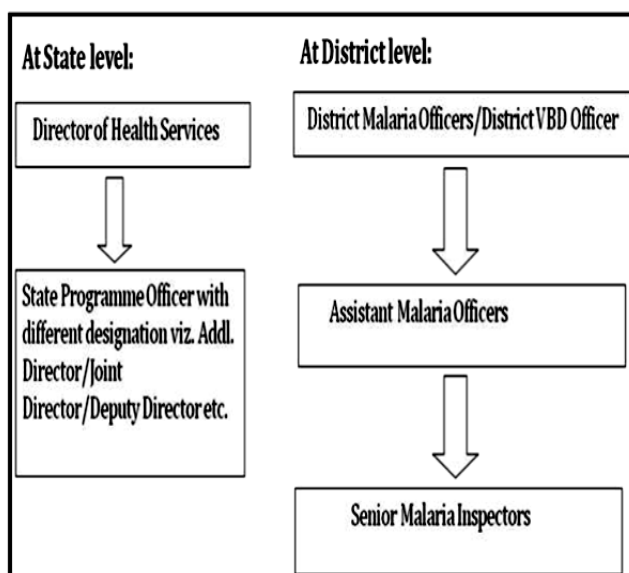
1. An important initiative introduced by the National Rural Health Mission (NRHM) is the provision of village-based Accredited Social and Health Activists (ASHAs), personnel that have been trained in malaria diagnosis by rapid diagnostic tests (RDTs) and anti-malarial drug administration. The main aim of NRHM is to provide accessible, affordable, accountable, effective and reliable primary health care facilities, especially, to the poor and vulnerable sections of the populations. It also aims at bridging the gap in rural health care services through creation of a cadre of female community volunteers known as Accredited Social Health Activists (ASHAs) and improved hospital care, decentralization of programme to district level to improve intra- and intersectoral convergence and effective utilization of resources.
2. The NVBDCP has introduced the use of Rapid Diagnostic Tests (RDTs) to help facilitate early detection and also the deployment of insecticide-treated bed nets in high-risk regions for prevention.

The NVBDCP achieves evaluation of its programs in collaboration with the National Institute of Malaria Research (NIMR), one of the permanent institutes of the Indian Council of Medical Research (ICMR; under the Department of Health Research, Ministry of Health and Family Welfare, Government of India). While the NVBDCP undertakes the fortnightly domiciliary operational surveillance of malaria across India, NIMR provides technical support to the national program for the control of malaria. Thus NIMR, through its ten field stations, evaluates new insecticides and diagnostic kits, conducts clinical trials, and monitors resistance to insecticides among vectors and drug therapy among parasites. The institute has also established quality assurance of malaria RDTs for NVBDCP.

**Organizational Structure of NVBDCP**

The Directorate of NVBDCP, under the Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India, is the national level government agency for the programme. As such, it is responsible for formulating policies and guidelines, monitoring, and carrying out evaluations. It also provides financial and commodity assistance to states for programme activities as per approved pattern. The implementation part of the programme is the responsibility of states. The Directorate of NVBDCP, initially designed for malaria control, has now been looking after six vector borne diseases, hence the work allocation with officers keep on changing. The present working organogram is depicted in a chart (Figure: 13)

**Figure: 13. Actors responsible for the delivery of innovation at state and district level**



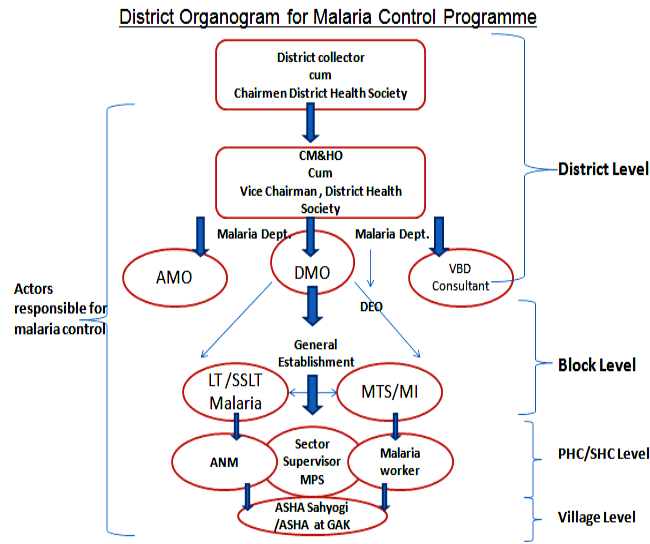
Source: Adopted from NVBDCP

Government of India also has 19 Regional Offices for Health and Family Welfare (ROH&FW), located in 19 States. One or more states are covered under the jurisdiction of each ROHFW. They perform a vital role in monitoring of NVBDCP activities in the states. Besides conducting entomological studies (in collaboration with the States), these Regional Offices also perform therapeutic efficacy studies, cross-checking of blood slides for quality control, capacity building at the state level along with monitoring and supervision of Vector Borne Diseases (VBDs).

The states are responsible for implementing the programme activities including monitoring in accordance with central guidelines. Every state has a Vector Borne Disease Control Unit under its Department of Health and Family Welfare. It is headed by the State Programme Officer, who is responsible for day-to-day management. Each state has State Health Society at state level and District Health Society at district level through which the funds are released. They also play a role in district planning and in monitoring of programme activities within districts.

At the district level, the vector borne disease control programme is managed by the erstwhile District Malaria Officer (DMO), however the states have been requested to redesignate this post as District Vector Borne Disease Officer in order to synchronize the prevention and control activities for all the six vector borne diseases covered under the programme. The district level officers are under the control of District Health Officer which also has different designations in different states like Chief Medical Officer (CMO), Deputy Director Health Services, District Medical Officers, Civil Surgeons, Chief Medical & Health Officers, Joint Director of Health Services etc. The programme is also monitored under NRHM through the District Health Societies under the chairmanship of respective District Collectors. Within the district the staff under primary health care system is involved in implementation at block level (CHC), at PHC, sub centre and village level. The institutions created under NHM like Village Health & Sanitation Committees, ASHAs etc. are involved at the grass root level. Figure: represent the actors responsible for delivery of innovation at district, block, PHC/SHC and village level. (Figure: 14)

**Figure: 14. Actors responsible for delivery of innovations at various levels**



Source: Adopted from NVBDCP

**Functions of NVBDCP Programme**

The policy under NVBDCP for prevention, control and elimination of vector borne diseases has been displayed on the website of National Vector Borne Disease Control Programme. However, the general strategies and pattern of assistance under the programme have been outlined below:

- I. **Disease Management** (for reducing the load of Morbidity & Mortality) including early case detection and complete treatment, strengthening of referral services, epidemic preparedness and rapid response, and preventive measures like vaccination (for JE) and Annual Mass Drug Administration (for LF)
- II. **Integrated Vector Management** (For Transmission Risk Reduction) including Indoor Residual Spraying in selected high risk areas, use of Insecticide treated bed nets (ITN/LLINs), use of larvivorous fish, anti-larval measures in urban areas like source reduction and minor environmental engineering
- III. **Supportive Interventions** (for strengthening technical & social inputs) including Behaviour Change Communication (BCC), Public Private Partnership, Inter-sectoral convergence, Human Resource Development through capacity building, Operational research including studies on drug resistance and insecticide susceptibility, monitoring and evaluation through periodic reviews/field visits and web based Management Information System.

The existing strategies for prevention and control of vector borne diseases focus on surveillance, including early detection and prompt treatment, human resource

development, behaviour change communication, supervision and monitoring, quality assurance and quality control of diagnostics, drugs and operational research. In brief, the strategies for malaria diseases:

- Focused interventions in high malaria endemic areas.
- Early diagnosis and Complete treatment (EDCT)
- Strengthening of human resources for surveillance and laboratory support
- Use and scale up of Rapid Diagnostic Test (RDT)
- Introduction and scale up of Artemisinin-based Combination Therapy (ACT) for Pf cases
- Up-scaling use of Long Lasting Insecticidal Nets (LLINs)
- Indoor Residual Spray (IRS)
- Intensive monitoring & supervision
- Intensified Information, Education and Communication (IEC) and Behaviour Change Communication (BCC) activities involving community.

**Role of different Actors of involved in innovation delivery**

The health care infrastructure in rural areas has been developed as a three-tier system, i.e., Sub-centre, Primary Health Centre and Community Health Centre. Sub-Centre is the most peripheral and first contact point between the primary health care system and the community. Each sub-centre is staffed by one Multipurpose male and female health worker / Auxiliary Nurse Midwife (ANM) and one Multipurpose Health Worker - Male (MPHW-M). Similarly The PHC is the first contact point between village community and the Medical Officer. The PHCs provide integrated curative and preventive health care to the rural population with emphasis on preventive and promotive aspects of health care.

At the block level the Community Health Centre (CHC) serves as a referral centre for primary health centers (PHCs) and also provides facilities for obstetric care, communicable and non-communicable diagnosis and treatment facility and specialist consultations. It has 30 beds, one operation theatre, X-ray, Labour room and laboratory facilities.

Rural health infrastructure under the National Rural Health Mission is being strengthened. The main aim of NRHM is to provide accessible, affordable, accountable, effective and reliable primary health care, especially to poor and vulnerable sections of the population. It aims to achieve this aim through creation of a cadre of Accredited Social Health Activists (ASHAs), improved hospital care, decentralization of programme to district level to improve intra and inter-sectoral convergence and

effective utilization of resources. The mission further seeks to build greater ownership of the programme among the community through involvement of Panchayati Raj institutions, NGOs and other stakeholders at National, State, District and Sub-district levels. Important role of actors to strengthen health programme from village level to national level as follows:

**ASHAs:**

Accredited Social Health Activist (ASHA) chosen by and accountable to the panchayat, to act as the interface between the community and the public health system. ASHA acts as a bridge between the ANM and the village and be accountable to the Panchayat. She is an honorary volunteer, receiving performance-based compensation/incentive for promoting universal immunization, referral and escort services for RCH, surveillance activities of national healthcare delivery programmes like TB, malaria, leprosy blindness etc. ASHAs have been recognized as very important components for field surveillance, EDCT, Indoor residual spray, Behaviour change communication (BCC), Recording and reporting. Presently ASHAs are involved in the diagnosis and treatment of malaria cases to the health facilities. ASHAs perform rapid diagnostics test, prepare slides and give treatment to malaria positive cases. ASHAs are given incentive for each of these activities like Rs. 15 per RDT or slide preparation, Rs. 50 per complete treatment for *Pf* cases and Rs. 75 for radical treatment of *Pv* malaria. Presently, as per the norms of national health mission. NVBDCP is giving such incentive to ASHAs in identified high risk districts which mainly comprise of the World Bank and Global Fund supported project areas.

**ANM-**

ANMs are posted at sub-centers level. She is over all in charge of the sub centre in respect of all the man power posted at the sub centre level including the community health guides working within the geographical area of the sub centre. ANMs are responsible for various national health programmes like family welfare, routine immunization, TB, Malaria, leprosy, blindness etc. She is also responsible for the coordinating with the working staff MPW, HA, link workers and ward boy. She is responsible for maintenance of records and registers related to SHC / villages and submission of all the reports and returns to the higher level. She reports to the higher level in case of any disease outbreak. ANM directly report to the Health Supervisor posted at the Gram Panchayat level under whose jurisdiction the sub centre falls. She will be responsible for financial management, maintenance of Stock ledger of different family welfare materials and other articles at the sub

centre. The NRHM seeks to provide minimum two ANMs (against one at present) at each Sub-Centre, as one ANM at a sub-centre has not been found adequate to attend to the complete needs of maternal and child care in any village. The Government of India would support the second ANM for appointment on contract basis and apart from fulfilling the other criteria she must be a resident of a village falling under the jurisdiction of the Sub-Centre. The intention is to improve accountability at the local level.

**MPW (female):** MPWs are responsible for collecting blood smears from all antenatal and post natal cases under her care as well as from infants. She will, therefore, carry out the following functions such as early diagnosis and complete treatment, larval and vector control activities, Indoor residual spray, Behavior change communication (BCC), Recording and reporting.

**MPW (male)** MPWs are essential for the malaria control programme as they are the health workers (besides ASHA) who are responsible for field surveillance, constitute an integral part of EDCT as per treatment guidelines, Indoor residual spray, larval and vector control activities, Behavior change communication (BCC), integrated vector control, Recording and reporting.

**Laboratory Technicians:**

As microscopy is still gold standard for Malaria diagnosis and crucial for EDCT, therefore the programme has provided additional support of LTs in high malaria endemic states through external assistance. Programme also proposes to recruit LTs to intensify the diagnosis of malaria.

**Malaria Technical Supervisors (MTS): /Malaria inspectors at block level**

Under the programme each district was having with Malaria inspector / supervisors mostly one per block but now there is huge vacancy of this category. To bridge the gap, NVBDCP has supported Malaria and other vector borne diseases technical supervisors in the high endemic areas in the state. This has paid rich dividends as these Technical Supervisors have been proved as a very effective tool for supervision, monitoring and evaluation. MTSs are responsible to strengthen supportive supervision and micro-monitoring for malaria prevention and control at sub district level in malaria-endemic districts. Other than this to maintain the availability of essential medicines, inspection of laboratory works and records throughout the village level and to send the weekly and monthly report to district headquarter. MTS will see the facility centres (sub centre), Providers (ASHA, health worker), At



community level. Each MTS will be covering population of 2, 50,000. Vehicle has been also supplied to MTS for monitoring and supervision as per the Checklist provided by the NVBDCP. MTS are also liable to Maintain monitoring register, tour diary, Vehicle log Book and route maps.

**District VBD Consultants:** Like the MTS in the high endemic blocks, Vector borne disease consultants have been appointed in high endemic districts of Madhya Pradesh under the supported project of World Bank for strengthening and implementation of the malaria control programme. These consultants accountability has been fixed under which to assist in all technical components of programme formulation and programme implementation. These are liable to consolidate and analyses reports/data received from the subcentres and block level on weekly/fortnightly and monthly basis and to ensure timely data analysis, presentation and interpretation. By the consultants conduct regular field visits for ensuring quality implementation of the programme and provide technical support to the block and sub centres health facility including ongoing on-the-job training and supportive supervision.

#### **CM&HO/ DMO**

Chief Medical Officer is the overall in charge of the general administration and discipline of the Medical Department. He works under the administrative and technical control of the District collector. He does exercise technical supervision over NVBDCP in the entire District with District malaria officer.

#### **SPO/State Level Consultants:**

SPO is mostly looking after many works which affect the monitoring of programme, hence, at state level, consultants are provided under World Bank /GFATM supported projects. However, considering the importance it is proposed to provide one M&E consultant (Medical graduates with Public Health qualification), one VBD consultant (preferably entomologist) and one finance and one logistics consultant. They will be provided mobility and operational support. Like the District VBD consultant, they will assist the state programme officers at the state level. Each state will have one M&E consultant (medical graduates with public health specialization). The project states already have such consultants working and the plan is to further extend the staffing to cover all States. In addition to this, one data entry operator shall also be provided at each state HQ to facilitate the recording and reporting of the programme data.

NVBDCP is working significantly for development of malaria innovation system through its contribution

towards social innovation in terms of delivery of healthcare for malaria control and eradication. However various studies like Sundarajan et.al., (2013) & Das et.al., (2011) have significantly pointed out the barriers hindering the performance of NVBDCP. These studies have noted that geographic, cultural and social factors create barrier to malaria control program in delivering better healthcare. They suggested that improving community level about malaria using culturally appropriate health education materials; making traditional healers, partners in malaria control; promoting rapid diagnosis and treatment in village; Increasing ITN distribution and promoting their use as potential strategies to decrease infection rates in the communities. These insights may be used to shape malaria control program more progressively. Dr G.S. Sonal,(2007) and Dr Neeru Singh (2010) have reported inadequate reporting system resultant to inadequate health facilities, shortage of health care personnel, poor access to healthcare, poor quality of slides/microscopy, constraints in data flow, etc. in NVBDCP.

#### **5. CONCLUDING REMARKS:-**

This study analyses the malaria innovation system in India. It finds that innovation system for infectious disease of poverty like malaria includes both scientific and social innovations to tackle the challenges associated with the disease control, management and eradication. Study through its analysis concludes that at the moment in India, malaria innovation system is facing challenges and failures at both the scientific and social innovations levels. There is a gap of ten upon ninety which refers to high burden and low efforts in terms of product development (drugs diagnostic and vaccines) through scientific innovations. There is hardly any research for malaria conducted in private sectors except a few under public sector organisations. The study also found that in spite of many developments and funding for health research for Malaria being poured in, the environment for steering and coordination, manage, appraise are still absent from the scene. Therefore it is suggested that in order to deal with the system level challenges persisting in malaria innovation system it is required to adopt challenged base approach which starts which stimulates research in the direction of needs and demands of the country, that could lead to about doing things in a more sustainable, effective, and equitable manner.

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