



## Integrated Disease Surveillance in India: Way Forward

Deepak K. Raut,<sup>1\*</sup> Anil K. Bhola,<sup>2</sup>

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\*Corresponding Author:

[drdeepakraut@gmail.com](mailto:drdeepakraut@gmail.com)

<sup>1</sup> Department of Community Medicine, Vardhaman Mahavir Medical College & Safdarjung Hospital, New Delhi, India

<sup>2</sup> Independent Public Health Consultant, New Delhi, India

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### ABSTRACT

Integrated Disease Surveillance Project (IDSP) with 9 years of its implementation in India has given a positive impetus to integration of surveillance functions primarily for epidemic prone diseases and decentralized symptoms-based detection of early warning signals of outbreaks at primary health care level.

This review is based on systematic literature review through PubMed and Google Scholar databases and published reports of the IDSP from 2005-2013. It attempts to describe the progress and projects future directions for integrated disease surveillance.

District and sub-district level are pivotal to the IDSP. District level epidemiology needs further strengthening with effective use of improved tools of data collection and analysis; and training for analytical and predictive epidemiology. States/UTs should ensure presence of adequate data managers, epidemiologist, microbiologists, entomologists and veterinary specialist for regular and effective monitoring & evaluation of the project activities and generating operational research evidences. The district and regional public health laboratories need up-gradation to shift from sheer clinical testing to detecting and monitoring epidemic threats, and assistance in improving quality of outbreak investigation and reporting. The IDSP should have a technical advisory group to supervise and guide its future progression.

**Keywords:** : Integrated disease surveillance, IDSP, surveillance in India, public health informatics

### INTRODUCTION

Surveillance for diseases is essential for health system for early detection of outbreaks, measuring disease burden, change in morbidity and mortality patterns; and for timely implementation of control and preventive measures. Since for the last few decades, disease surveillance in low and middle-income countries have been fragmented under the disease-specific vertical programmes that although proved effective and efficient in short term outcomes but consumed lots of resources in an already resource constraint settings.<sup>1-5</sup> In 1990s, The World Health Organization (WHO) facilitated and supported evolution of integration of surveillance functions of most of the categorical disease control based on gathered evidences in Asia and Africa.<sup>6</sup>

The Integrated Disease Surveillance and Response Strategy (IDSR) is being implemented in 46 Member States of the WHO's African Regional Office since 1998 and in India since 2004. Integrated disease surveillance is 'a combination of active and passive systems that use a single infrastructure to gather information about multiple diseases or behaviours of interest using similar structures, personnel and processes.'<sup>7</sup>

### Integrated Disease Surveillance Project, India

India has a huge healthcare delivery system (public and private sector) which has grown immensely across different systems of medicines but the disease surveillance did not get much attention till 1997. The



National Surveillance Programme for Communicable Diseases (NSPCD) that was launched by the Government of India in 1997-98 rolled over 101 districts. Every state/UT and all the 101 districts had a trained Rapid Response Team (RRT) to establish and maintain Early Warning and Response System. Under this programme, the states were implementing agencies and the National Centre for Disease Control (NCDC) Delhi was the nodal agency for coordinating the activities. The programme was based on outbreak reporting with weekly reporting of epidemic prone diseases (including nil reporting) directly from districts to the higher Centres. There was a definite improvement in the capacity for an early detection of outbreaks and response in a time bound basis thereby justifying further expansion of the program.<sup>8</sup> However, it was not a case-based reporting and did not give a complete picture of disease burden in the country especially in respect of epidemic prone diseases. Therefore, the Government of India decided to launch the Integrated Diseases Surveillance

Project (IDSP) instead of expanding the NSPCD to all districts of India.

Integrated Disease Surveillance Project was formally launched by the Union Minister of Health and Family Welfare on 8<sup>th</sup> November, 2004 with the aid of World Bank (US \$ 68 million over 5 years). World Bank provided funds for the national Surveillance Unit (NSU) and 9 states (Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttarakhand and West Bengal. Domestic funding was available for rest of the states. Thus, the IDSP was implemented in three phases: Phase I (2004-05)- 9 states, Phase II (2005-06)- 14 states, Phase III (2006-07)- 12 states. Now IDSP is fully Government of India funded program since under the 12<sup>th</sup> Five Year Plan with a domestic budgetary support worth Rupees 6.4 Billion The list of diseases under the surveillance was also expanded (**Table 1**) with inclusion of accidents, snake bites and dog bites.

**Table 1 List of Diseases/syndromes under Integrated Disease Surveillance Project in India**

Communicable	Non communicable disease risks
1. Acute Diarrhoeal Diseases (Cholera, Shigella, Rota virus, Acute Gastroenteritis)	1. Road Traffic Injuries
2. Acute Respiratory Infections (Pneumonia)/Influenza Like Illness (ILI)	2. Snakebite
3. Fever of Unknown Origin (PUO)	3. Dog bite (Rabies)
4. Enteric Fever	4. Cardiovascular Disease Risk Factors
5. Meningitis	
6. Malaria	
7. Dengue/DHF/DSS	
8. Chikungunya	
9. Viral Hepatitis	
10. Acute Flaccid Paralysis (<15 years of age)	
11. Diphtheria	
12. Measles	
13. Pertusis	
14. Chicken Pox	
15. Plague	
16. Japanese encephalitis	
17. Yellow Fever	
18. Leptospirosis	
19. Any other state-specific disease	
20. Unusual syndrome	



IDSP has administrative mechanism in the form of Surveillance committees and surveillance units at district and state level. The District (DSU), State (SSU) and National Surveillance Units (NSU) are the organized structures, headed by a surveillance officer and supported by epidemiologists, microbiologists, data entry operators and data managers. There are 604 DSUs in the country and 35 SSU that report to the NSU based at the National Centre for Disease Control (NCDC), New Delhi.<sup>9</sup>

District level is the focus for integrated disease surveillance system. At sub-centre levels multi-purpose health workers (MPHW), Accredited Social Health Activist (ASHA) and Auxiliary Nurse Midwifery (ANM) are involved in data collection through Form-S (based on syndromic approach) on weekly basis. Form-P (presumptive cases) is used by the clinicians for provisional diagnosis and Form-L (laboratory cases) for the lab-confirmed cases. This approach is based on detection of early warning signals of impending outbreaks and helps initiating an effective response in a timely manner. Through the provision of L, S and P form detection of early warning signals of impending outbreaks and initiation of an effective response in a timely manner is ensured. Computerization of data collection, compilation and reporting were established down to primary health care level with web-enabled databases and connectivity with the district surveillance units. The IDSP integrates both public and private sector by capturing data from private practitioners as well.

With nine years of implementation; the IDSP has been a unique initiative with integrative approaches in surveillance functions. This review paper examines the progress of the IDSP and envisions possible way forwards for further strengthening of integrated disease surveillance in India.

#### METHODOLOGY

A literature search was conducted in PubMed and Google Scholars databases for the period 2005-2013 for articles in English language using the combination of key words, 'IDSP', 'Integrated disease surveillance', 'surveillance in India', and 'public health informatics'. The PubMed showed 16 hits of which 7 were found

relevant and Google Scholars showed 16 hits of which only 5 relevant (including 3 repeats from PubMed). The articles focusing on disease-specific vertical programmes were not considered for the review. The database searches revealed only scant research evidences relevant to the IDSP. The 9 relevant articles were considered for review. In addition, published reports available at the IDSP website were also considered.

#### FINDINGS & DISCUSSION

The Integrated Disease Surveillance Project is a decentralized surveillance system wherein data generation, capturing, compilation, analysis and feedback to actions take place primarily at district level and flow upwards to state and centre level. Hence, quality of data generation and capturing in Form-S, Form-P and Form-L makes the final impact across states and the overall surveillance system in country.

The implementation of Form-S is intended to uncover the burden of infectious diseases and detect early warning signals for outbreaks based on syndromic reporting right from the population level. There has been problems of inconsistency, incompleteness and untimely reporting, thus its implementation needs improvement<sup>10</sup>. The data in Form-P depends on the outdoor patients registers of clinicians or medical officers. The entry about provisional diagnosis in these registers is sometimes either not complete or not even legible in case it is complete. It hints towards need of raising awareness and understanding among the health professionals engaged in medical care about the scope and significance of accurately generating, documenting, compiling and reporting data on health events or diseases. Despite simplified symptom-based case definitions at sub-centre levels, there are instances of confusion about the case definitions.<sup>11</sup>

Although about 90% of the districts report every week (including mandatory Nil reporting) through email or IDSP portal but the quality of data compiled at district levels still need rigorous monitoring and capacity building.<sup>10</sup> Capturing of data from private sector clinicians is still patchy. The epidemiological



data compiled were neither fully analyzed nor utilized at district level for guiding interventions despite presence of epidemiologist but rather were forwarded to higher levels. The processed data and reports should be used to guide public health interventions which is still lacking at state and district levels.

Although the number of outbreaks reported by states have significantly increased from 553 in 2008 to 1964 in 2013 and 655 outbreaks in 2014 (as on 22<sup>nd</sup> June, 2014) but there is urgent need of improving quality of outbreaks reporting and investigations.<sup>10</sup> The weekly reports on outbreaks compiled at the national levels remain unclear in most of reported outbreaks on acute diarrheal diseases, fever of unknown origins, food poisoning and measles. It gives an impression that either majority of the outbreaks are only reported and never investigated or remained inconclusive for want of epidemiological training and acumen. It reflects the poor quality of investigations conducted or time lapsed between outbreaks occurrence and reporting leading to difficulties in tracing etiological of such outbreaks. Besides, the frequency of reporting of early warning signals or outbreaks through portal in 2012 has been poor (<40%) from states/UTs: North eastern states (Meghalaya, Manipur, Mizoram, Nagaland, Tripura), Jharkhand, Jammu & Kashmir, Delhi, Andaman & Nicobar including Lakshadweep that never reported any outbreak since the inception of the programme.<sup>10</sup> The delayed or poor reporting from remote and hilly areas seems self-explanatory especially in situation when EduSat is also not functional for long time. However, the RRTs in states have taken initiative of conducting mock drills in high risk blocks and have also established Epidemic Coordination Committee to improve capacity for outbreak control.

Laboratory confirmation of cases and outbreaks is another important component of the IDSP that feeds in Form-L. It is an achievement that the district level laboratories are being strengthened for diagnosis of epidemic prone diseases. In addition, a reference laboratory network has been established in 9 states (Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttarakhand and West Bengal) by utilizing the existing 65 functional

labs in the medical colleges and various other major centres in the states and linking them with adjoining districts for providing diagnostic services for epidemic prone diseases during outbreaks.<sup>10</sup> Gradually, the lab network will be rolled over to rest of the 26 states/UTs. As of August, 2013, around 44 out of 50 identified district public health laboratories were functional in India.<sup>10</sup> There are 12 laboratories involved in testing clinical samples of Influenza A H1N1 in different regions of the country. In a multi-centric cross-sectional evaluation study<sup>13</sup> conducted in 2012 in Maharashtra, it was found that stool sampling was the deficient at the peripheral level. Availability of transport media, trained staff and rapid diagnostic tests were main challenges at the periphery.<sup>11</sup>

Availability of trained technical human resources at district and state levels is essential to run the surveillance on sustainable basis. As of 30<sup>th</sup> June, 2014; there are 411 epidemiologists against 646 district positions, 108 Microbiologists and 22 Entomologists against.<sup>10</sup> The wide gap on availability of technical professionals at district and state levels indicates towards strengthening and consolidating human resources in the IDSP through regular periodic training and more recruitment.

In order to facilitate speedy communication on outbreaks' alert, sharing information and giving feedback to states/districts, a satellite-based communication and learning network; Education Satellite (EduSat) was established at the NCDC by the Indian Space Research Organization (ISRO). It has connected the 367 of the 400 ICT network site across India. The network operation centre (the principal teaching end) is housed at the NCDC, and the Satellite Interactive terminals (SITs) are located at State Headquarters, District Surveillance Units and Government Medical Colleges and connects all sites in north-eastern states, hilly and island states also. It has also provided high-end video conference equipments at all states and Union Territory headquarters.<sup>12,13</sup> However, non-availability of satellite (ISRO) connectivity for EduSat since September, 2010 (same problem till end of September, 2013) has severely affected the benefits that IDSP could reap from it for building technical



capacity through on-line IT training modules and providing prompt guidance and feedback to state and district rapid response team in wake of outbreak situations.

A Media Scanning and Verification Cell established at the NCDC in July 2008 has really supplemented the integrated surveillance. The cell collects and examines reported unusual health events on infectious diseases within the country and informs the concerned state, district and national level health officials for further investigations and appropriate actions. A total of 2744 media alerts were reported from July 2008 to June, 2014; majority of which were related to food poisoning, measles and vector-borne diseases.<sup>10</sup> A 24x7 call centre had also been established in February, 2008 with a toll free number 1075 (1800-11-4377) to receive disease alerts from any citizen; keeping in mind the exponential increase in access to telephone in general population in India.<sup>9</sup> The call centre has multiple language calling and answering capabilities, and any person speaking one of the major regional languages can call to inform about outbreaks/unusual events. Since its inception to 2010, more than 277, 000 calls were received, and more than 150 were confirmed as health alerts.<sup>9,10,12,13</sup> Media Scanning and Verification Cell at centre level is a positive addition. The event based reporting tools such as early warning signals; media surveillance, toll free number and community based surveillance have proven to be efficient and effective in timely detection of many public health threats in India.<sup>14</sup>

#### WAY FORWARD

Strengthening of the existing surveillance infrastructure, resources and network although appears primary and foremost priority for further consolidation of the IDSP still the following ten ways are suggested here for moving forward:

##### 1. Improved Tools of Data Collection, Data Management, Reporting and Analysis

Functional integration of surveillance components of vertical programmes has been a progressive step that needs to be further consolidated for improving quality and completeness of data capturing, compilation, reporting and analysis. We need to

gradually move from mixed (paper+ electronic) to electronic form of surveillance forms/systems.

The regular re-enforcing of clarifying and practice of accurate case definitions of diseases/symptoms under surveillance should be foremost priority along with improving data capturing. The states/UTs may think of using palmtops (eg. Personal Data Assistant) or smart-phones where ever available resources permit. The use of Personal Digital Assistants (PDAs) by rural health workers in Rajasthan is a successful example. Other examples are of computerized village offices in Andhra Pradesh and Puducherry.<sup>15</sup> Mobile phones can be used for speedy and timely data reporting through short messaging services (SMS).

Electronic Medical Records (EMRs), Hospital Management Information Systems and; Geographical Information System (GIS) are possible solutions for the problem of ineligible or missing information in the outdoor registers of clinicians in hospitals. Electronic Medical Record is the electronic record of the specific health-related event for a person; whilst Electronic Health Record (EHR) is the electronic record for a person of all health related events before birth till death (womb-to-tomb health record!).<sup>16,17</sup> The use of EMR in India is limited to large corporate or public sector tertiary hospitals. This can be gradually made a reality in India in future once the Aadhar card (Unique Identification Card) issued to all and a micro-processing chip may be inserted in these cards that can contain card holders' health information. However, the start-up costs involving both human resources and expensive technology can be substantial.

The epidemiologists at district levels and block medical officers at community health centres levels should have understanding, skills and access to data analyzing softwares like Epi-Info and SPSS.

##### 2. Strengthening Capacities of Public Health Laboratories

Only 44 functional district public health laboratories is too low number for a national level surveillance for a big country like India. Capacity building in terms of personnel and equipment in each district level should be planned consequently through core state budgets



to strengthen the states laboratory infrastructure for both regular and outbreak functions. The network of reference laboratories also needs further expansion. To realize a quality implementation of lab network, a national regulatory body on laboratories accreditation and quality control would become a necessity in future.

The IDSP needs to review and enforce mechanisms of capturing data from laboratories of regional and national research institutes under the Indian Council of Medical Research, and other sectors such as railways health service, employees' states insurance hospitals, armed forces, public and works departmental laboratories on water quality testing, animal husbandry and private laboratories.

### 3. Strengthen Local Epidemiology:

The state and district level surveillance units need to build technical capacities on detection of early signals of outbreaks, data analysis, interpretation and synthesis of information. The general concept of collection of data merely to compile reports should be upgraded with enhancement of epidemiological skills in reference to local contexts. The surveillance staff working at the primary health care level such as ASHA, ANM and MPHWS should be periodically sensitized and briefed about the early warning signals of impending disease outbreaks and symptoms-based case definitions. Even 'Nil' reporting of outbreaks should also be a practice in regular reporting system.

When an epidemiologist at district and state level starts reporting health events and diseases into epidemiological indicators such as attack rate, case fatality rate, cumulative incidence rate, and prevalence rate then it may be considered that the local epidemiology has started trenching roots at district level. Henceforth; while analyzing the trends of outbreaks, district and state epidemiologist should be able to use predictive epidemiology to forecast outbreaks so that pre-emptive control measure can be implemented in time. It will further have add-on progressive changes in states and national level reports.

The IDSP should be able to capture mortality data on selected diseases in the 'P' form. The states/UTs must be consulted before adapting the Form 'P' for capturing data on mortality. The Civil Registration System and Health Management Information System at district level are already collected mortality data. The ways can be explored and implemented to capture and link it with the IDSP by further strengthening local epidemiology.

### 4. Surveillance Logistics

Each district and state needs to ensure availability of all surveillance tools, guidelines, standard operating procedures and requisite technical professionals in place. Lack of surveillance forms, compiling formats and registers may severely compromise the timely data flow and verifications. Therefore, provision of printing standardized forms and registers in states through local contingency funds should be made at health facility level. Even private health practitioners will need regular supply of reporting forms. Data managers and epidemiologists will also need access to computers and analyzing softwares. States also need to ensure sustainable procurement and supply of equipments, reagents, microbiologist and laboratory technicians in public health laboratories.

There is need to train and produce more data managers, epidemiologists, microbiologist, and Entomologists through a Continued Public Health Education Programme (CPHE). Veterinary experts should also be integrated at state level wherever possible for exploring zoonotic diseases. The CPHE programme should be intended to assess training needs, recall surveillance staff for refresher training and sensitize field workers on why do we need data and what may goes wrong if data goes missing or remain incomplete at district, state or national level.

### 5. Expand Collaborations

The share of private sector in total hospitalized treatment has been estimated in 2004 at 58.3% in rural and 61.8% in urban areas.<sup>18</sup> The data from the National Family Health Survey (NFHS) III also confirms that the private medical sector remains the





primary source of health care for the majority of households in urban (70%) as well as rural areas (63%)<sup>19</sup> hence it becomes utmost important to expand surveillance activities to involve private health care providing clinics/hospitals to capture data. The participation of private health practitioner in sharing data with the IDSP is still weak.<sup>20</sup> Hence, linkages and collaboration with private health practitioners, occupational and environmental health specialists, veterinarians; Indian Medical Association, Indian Pediatrician Association should be enhanced at state and district levels.

Every medical college and hospital in states or centre should designate a nodal officer for clinical informatics analysis and sharing surveillance data with the district/state or national surveillance unit. The other opportunities for capturing data through horizontal sharing of information are with the routine immunization information systems, disease specific vertical surveillance programmes (Polio, Measles, Tuberculosis), Mother & Child Tracking System (MCTC) and national vector-borne disease control programme. The collaborations with the national research institutes under the Indian Council of Medical Research (ICMR) should also be proactively sought. Besides, the need of involving sectors providing health services such as defense, railways, travels and hospitality; and the alternative system of Indian medicines (AYUSH) through sensitization, persuasion, training or legislation is not overemphasized in projecting future growth of the integrated disease surveillance system in India.

#### 6. Inclusion of Non-communicable Diseases

The inclusion of surveillance of risk factors for the cardiovascular disease under the IDSP was leveraged by the ICMR based on a systematic literature review on the burden of disease till 2003 on Non-communicable Diseases.<sup>20,21</sup> The meta-analysis of eight studies carried out between 1995 and 2002 in urban areas gave a pooled prevalence rate of hypertension as 164 per 1000 in urban, and 157 per 1000 in rural areas.<sup>22</sup> It facilitated mapping of distribution of risk factors for cardiovascular diseases, appreciation of regional and state-wise difference and guidance in design of control interventions.

Inclusion of any new non-communicable disease/health event can only be considered by state or centre if the severity, disease burden and threat to public health is alarming.

#### 7. Risk Communication, Learning and Networking

State governments need to have state-specific risk communication strategy and training manuals-in-place. Media Scanning Cell at centre level should be capacitated enough to run periodic orientation workshop or trainings to sensitize communication and media professionals to improve the quality of risk communication in situations of outbreak or other public health emergencies.

Media Scanning Cell can also explore google or yahoo disease groups, HealthMap and Biocaster websites for scanning disease outbreaks alerts. IDSP should start voluntary disclosure of suspected outbreak reporting of cases or health related events with the help of mobile based applications or computer based programs for early detection and response.

#### 8. Early Warning and Action

The field teams have to be proactive and prompt in reporting early warning signals and disease outbreaks. The use of mobile or smart phones for sending early signals data, information or even photos to the district rapid response team (DRRT) should be encouraged. The RRT at district or state level should swing into actions promptly for investigation of the reported outbreaks including the collection of biological and environmental samples. The compiled reports at states and national levels should be conclusive on etiological basis of outbreaks at best so that it may assist in implementation of specific control interventions. National RRT should be involved in investigation of events/outbreaks if more than one state is involved and similarly state RRT should swing into action if more than one district is involved.

The IDSP provides strong link with the International Health Regulations (IHR), 2005 but yet to be strengthened at inter-states levels. In situations of inter-state epidemic or beyond national borders,



central government plays a pivotal role in controlling the transmission of infectious disease. In time of serious disease transmission threats from one state/UT to another (Concurrent List entry 29, Constitution of India) coordination among public health administrators and administration officials should be enhanced and if need be appropriate quarantine or isolation measures must be implemented.

The state surveillance officers should find ways to engage and seek support of the domestic airports health officers, naval sea-port officers or land-borders controlling authority for implementing quarantine or isolation measures (Union List entry 28, constitution of India). Travel and trade advisory inside state/country should be released by the state public health department responsible for risk communication. Assessment of high-risk areas near borders, present capacities at the designated airports, sea-ports and ground crossings should be done at least once in a year. The physical infrastructure of quarantine centres at the designated airports, ports and ground crossings should be improved.

#### g. Monitoring 'Operational Research' and Evaluation (M'OR'E)

Monitoring & evaluation system has been weak at district and states levels.<sup>10,11</sup> The state governments needs to ensure that state and district surveillance units get engaged in regular monitoring and there should be at least one external evaluation of the programme every second year. There should be periodic monthly meetings at district and quarterly meeting at state levels in which progress; prevailing difficulties, barriers and facilitators of surveillance activities should be discussed. The surveillance officers' need to ensure availability and implementation of the IDSP guidelines and standard operation procedures. The Central Surveillance Unit at the NCDC should be able to publish annual report.

The collection of research evidences generated from the IDSP can be linked to the National Knowledge Network (NKN) which has been set up to connect

institutions/organization for carrying out research and development.

#### 10. Technical Advisory Group

In order to review the progress of the program, periodic independent external evaluation of the programme and strengthening the integrated disease surveillance in India, it is also suggested there should be constituted a Technical Advisory Group constituting of all important stakeholders in public health surveillance.

#### CHALLENGES

The Integrated Disease Surveillance Project has severe limitations on human resources. It is much needed at district and states levels for lack of which there is often problems of coordination and cooperation between district and state surveillance units. The strong foothold of vertical disease programmes (such as on Universal Immunization Programme, National HIV/AIDS Control Programme, Revised National Tuberculosis Control Programme) and their funding mechanism do also marginalize the integrated disease surveillance programme.

#### CONCLUSION

The Integrated Disease Surveillance Project in India has significantly uncovered the infectious disease burden, improved case and outbreak detection and provided a scope for epidemiology at district levels. It has ample opportunities for building capacity in field epidemiology, public health laboratories, public health informatics, quarantine and isolation measures and operational research. With its expansion and linkages with other surveillance systems, it has potential to revolutionize integrated disease surveillance by timely detection and control measure on impending disease outbreaks.

#### AUTHORS' CONTRIBUTIONS

DKR conceptualized the paper. AKB performed literature review and developed the first draft and revised subsequent drafts. DKR and AKB extensively edited the paper. All the authors contributed in revision of the subsequent drafts and agreed upon the final version of the draft.





## REFERENCES

1. M'ikanatha N, Lynfield R, Julian K, Van Benden C, De Valk H. In: Infectious Diseases Surveillance. M'ikanatha N., Lynfield R., Van Benden C., De Valk H., Malden M.A., editor. Biley-Blackwell; 2007. Chapter 1: Infectious Disease Surveillance: A cornerstone for prevention and control.
2. Mahendradhata Y, Moerman F. Integration and disease control: notes from the Prince Leopold Institute of Tropical Medicine Colloquium 2002. *Trop Med Int Health*. 2004; **13**(6): A5-10. Doi:10.1111/j.1365-3156.2004.01258.x
3. Nsubuga P, Eseko N, Tadesse W, Ndayimirije N, Stella C, McNabb S. Structure and performance of infectious disease surveillance and response, United Republic of Tanzania, 1998. *Bull World Health Organ*. 2002; **13**(3):196–203.
4. Calain P. From the field side of the binoculars: a different view on global public health surveillance. *Health Policy Plan*. 2007; **13**(1):13–20
5. John TJ, Dandona L, Sharma VP, Kakkar M. Continuing challenge of infectious diseases in India. *Lancet*. 2011; **13**(9761):252–269. doi: 10.1016/S0140-6736(10)61265-2
6. WHO. An integrated approach to communicable disease surveillance. *Epidemiological Bulletin, PAHO*. 2000; **13**(1):1–16. Available at [http://www1.paho.org/english/dd/ais/EB\\_v21\\_n1.pdf](http://www1.paho.org/english/dd/ais/EB_v21_n1.pdf).
7. Nsubuga P, White M, Evans E, Jha P., Mills A., Musgrove P., editor. 2006. Chapter 53: Public health surveillance: A tool for targeting and monitoring interventions. Available at <http://files.dcp2.org/pdf/DCP/DCP53.pdf>
8. Thakur J.S. Integrated disease surveillance- A key step to improve public health in India; Editorial, *Indian J. of Community Medicine*; 2006, vol. **31**, No. 4
9. Kant L, Krishnan KS. Information and communication technology in disease surveillance, India: a case study. *J. BMC Public Health*. 2010, **10** (Suppl 1): S11
10. Ministry of Health & Family Welfare, Government of India. Integrated Disease Surveillance Project. Available at: <http://idsp.nic.in>
11. Revati KP, Shukla S, Shardul S, Ashtekar N, Valsa S, Awate P et al. Assessment of the core and support functions of the Integrated Disease Surveillance System in Maharashtra, India. *BMC Public Health*. 2013; **13**: 575
12. Sharma R, Luthra P, Karad A, Dhariwal AC, Ichhpujani RL, Lal S. Role of information, communication technology (ICT) in disease surveillance under Integrated Disease Surveillance Project (IDSP). *J Commun Dis*. 2010, **42**: 101-110
13. Central Surveillance Unit: National Institute of Communicable Diseases, Progress Report Integrated Disease Surveillance Project India. 2009
14. Sharma R, Ratnesh L, Karad AB, Kandpal H, Dhariwal AC, Ichhupujani RL. Communicable disease outbreak detection by using supplementary tools to conventional surveillance methods under Integrated Disease Surveillance Project (IDSP), India. *J. Commun. Dis.*, 2009 Sept; **41** (3): 149-59
15. Athavale AV, Zodpey SP. Public health informatics in India: The potential and the challenges. *Indian J. of Public Health*. 2010; vol **54** (3): 131-136
16. Pagett C. Clarifying the complex world of EHR. *Health-e developments*. 2005; **1**: 1-5
17. Smolij K, Dun K. Patient health information management: Searching for the right model. *Perspective in Health Information Management* [serial on the internet]. 2006; **3**: 10. Available from: [http://www.library.ahima.org/xpedio/groups/public/documents/ahima/bok1\\_032723.html](http://www.library.ahima.org/xpedio/groups/public/documents/ahima/bok1_032723.html) [last cited on 2009 Jan 28].
18. Rao PH. The private health sector in India: a framework for improving quality of care. *ASCI Journal of Management*, 2012; **41** (2): 14-39
19. Ministry of Health and Family Welfare, Government of India. National Family Health Survey (NFHS III): 2005-06. Available at



<http://www.measuredhs.com/pubs/pdf/SR128/SR128.pdf>

20. Indian Council of Medical Research, Ministry of Health & Family Welfare, Government of India. Report of the ICMR – WHO study on assessment of burden of non-communicable diseases, 2006
21. Shah B., Mathur P. Surveillance of cardiovascular disease risk factors in India: The need & scope. Indian J. Med. Res. 2010 November, **132** (5): 634-642
22. Ministry of Health and Family Welfare, Government of India. Burden of disease in India. 2005. Background papers for the National Commission on Macroeconomics