Trade-off on Public Health and Indian Public Health System: Analytics through Healthcare Information

Sakhi John, N Ravichandran

Assistant Professor, Associate professor

Jamia Hamdard

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Abstract

National Health Mission focuses on improving accessibility and availability of healthcare services while strengthening accountability through healthcare informatics system. This lead to challenges in performance intervention in terms of quality – sensitivity, specificity ,, validity, reliability,- that are known to be safe, that are affordable to society , and have ability to produce impact on morbidity , mortality, disability and malnutrition. The present study provides a starting -point for public healthcare informatics system with the outlook of changing social responsibility in fulfilling its sustainable development goals. This calls for architectural redefinition and reassessment of healthcare informatics theories and models while looking at changing the nature of the relationship and responsibilities of the mission. This article advocates for a strong contextual and research base for improving quality beyond a trade-off between flow and disaggregated data on population and health. This is a notable and promising side-effect of phenomenological approach through exploratory research design, at least from a health management point of view. This article adopted phenomenological approach in addressing strengths and weakness of the healthcare informatics initiatives to date with their wide-range of contextual understanding and empirical details , with reference to Indian Public healthcare system. Nonetheless , the paper also examines the issues connected to effectiveness , efficiency , optimality , acceptability , legitimacy and equity through unique identification number to strengthen surveillance system in addressing population and health; and the need to build opportunities for providing more valuable relationships between healthcare informatics and 'users' particularly , is the need of the hour.

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*Sakhi John, assistant professor , department of Health and Hospital Management, School of Management and Business Studies, Jamia Hamdard, New Delhi – 110062
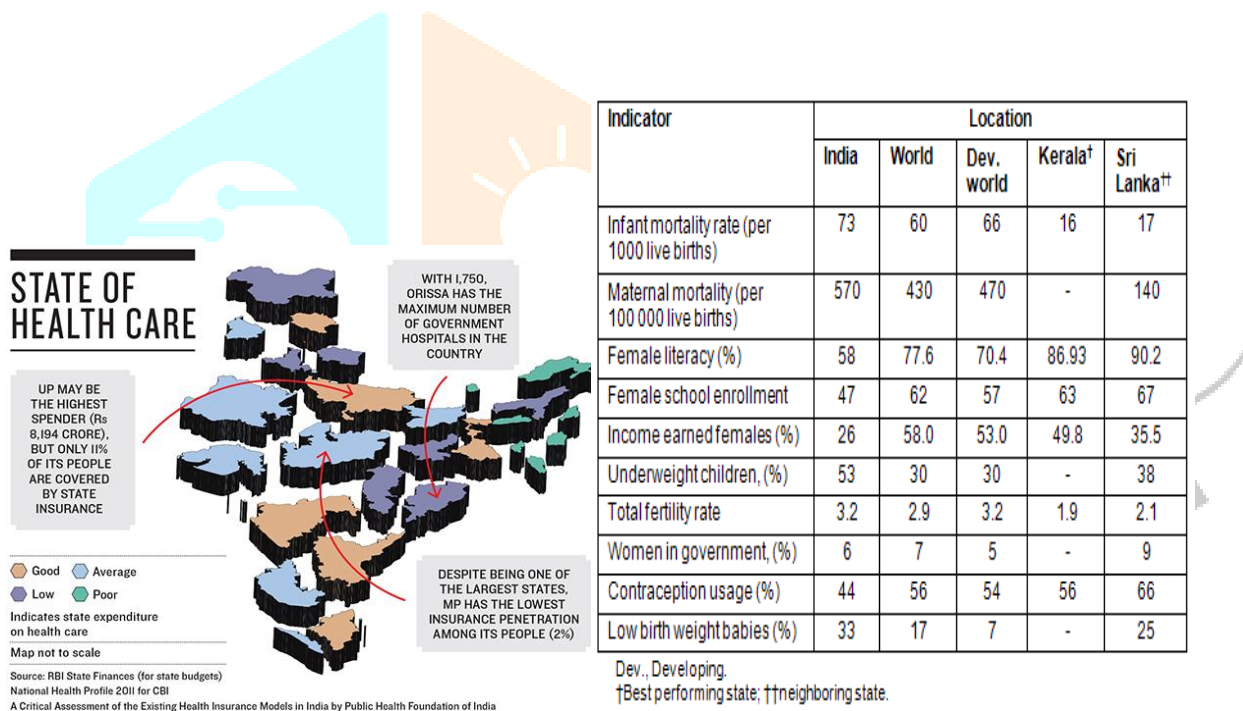
** Dr. N .Ravichandran, Associate professor , department of Health and Hospital Management, School of Management and Business Studies, Jamia Hamdard, New Delhi – 110062 ,

Keyword

Health Information , Data Quality, Registers , Indicators

Background

National Health Mission (NHM)- Improvingaccessibility and availability of healthcare and its relational services delivery while strengthening accountability through healthcare informatics system expected to provide health status of the population, ensuring quality, and, reduce public expenditure on healthcare and health inequitieswith greater efficiency and responsiveness. Thus, healthcare informatics is essential management tool that is expected to guide planning and intact the standards of delivery; assist administration in better implementation and warrant community participation[i].Candidly, there was no focus on healthcare informatics system in millennium development goals, but in SDG expected to do so. With these focus, the present study conducted an empirical assessment in India and calls for changing outlook in changing social responsibility in achieving sustainable development goals.

STATE OF HEALTH CARE

UP MAY BE THE HIGHEST SPENDER (Rs 8,194 CRORE), BUT ONLY 11% OF ITS PEOPLE ARE COVERED BY STATE INSURANCE

WITH 1,750, ORISSA HAS THE MAXIMUM NUMBER OF GOVERNMENT HOSPITALS IN THE COUNTRY

DESPITE BEING ONE OF THE LARGEST STATES, MP HAS THE LOWEST INSURANCE PENETRATION AMONG ITS PEOPLE (2%)

● Good ● Average ● Low ● Poor
Indicates state expenditure on health care
Map not to scale

Source: RBI State Finances (for state budgets)
National Health Profile 2011 for CBI
A Critical Assessment of the Existing Health Insurance Models in India by Public Health Foundation of India

Indicator	Location				
	India	World	Dev. world	Kerala[†]	Sri Lanka[††]
Infant mortality rate (per 1000 live births)	73	60	66	16	17
Maternal mortality (per 100 000 live births)	570	430	470	-	140
Female literacy (%)	58	77.6	70.4	86.93	90.2
Female school enrollment	47	62	57	63	67
Income earned females (%)	26	58.0	53.0	49.8	35.5
Underweight children, (%)	53	30	30	-	38
Total fertility rate	3.2	2.9	3.2	1.9	2.1
Women in government, (%)	6	7	5	-	9
Contraception usage (%)	44	56	54	56	66
Low birth weight babies (%)	33	17	7	-	25

Dev., Developing.
†Best performing state; ††neighboring state.

The present study developed a framework using phenomenological approach through exploratory research design at least from health management point of view. The present study chose one of the minerals rich state – Bihar and currently undergoing third stage of demographic transition with low death rate (7.2 /1000 population) and high birth rate of 28.5 (REFFF). The fluctuated economic criteria such as per capita income Rs. 9702 and below poverty level recorded as high as 42.6, and which is the above national average. (RHS Bulletin ,   profile of Bihar, MO Health & FW, NRHM)[ii].
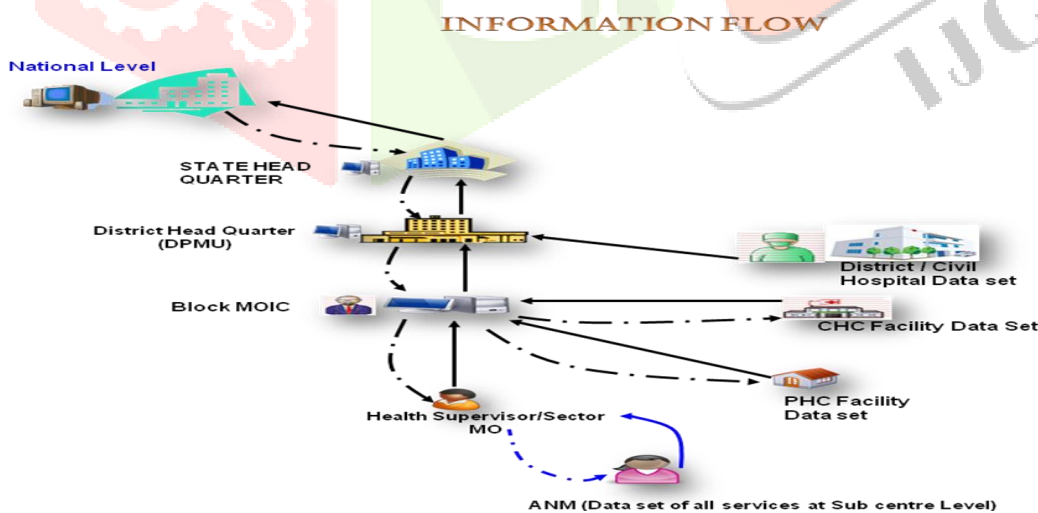
Activities Across India

- Health Education
- Mobile Medical Vans
- Medical Commodities
- Disaster Preparedness
- Disaster Relief

Census of India 2011
Provisional Population Totals

Population and decadal growth rate by residence - Persons

No.	State/UT Name	Population			Percentage to Total		Decadal Growth		
		Total	Rural	Urban	Rural	Urban	Total	Rural	Urban
1	2	3	4	5	4'	5'	6	7	8
	INDIA	1,210,193,422	833,087,662	377,105,760	68.84	31.16	17.64	12.18	31.80
01	Andaman & Nicobar Islands*	379,944	244,411	135,533	64.33	35.67	6.68	1.86	16.64
02	Andhra Pradesh	84,665,533	56,311,788	28,353,745	66.51	33.49	11.10	1.64	36.26
03	Arunachal Pradesh	1,382,611	1,069,165	313,446	77.33	22.67	25.92	22.88	37.55
04	Assam	31,169,272	26,780,516	4,388,756	85.92	14.08	16.93	15.35	27.61
05	Bihar	103,804,637	92,075,028	11,729,609	88.70	11.30	25.07	23.90	35.11
06	Chandigarh *	1,054,686	29,004	1,025,682	2.75	97.25	17.10	-68.51	26.86
07	Chhattisgarh	25,540,196	19,603,658	5,936,538	76.76	23.24	22.59	17.75	41.83
08	Dadra & Nagar Haveli *	342,853	183,024	159,829	53.38	46.62	55.50	7.64	216.73
09	Daman & Diu*	242,911	60,331	182,580	24.84	75.16	53.54	-40.18	218.37
10	Goa	1,457,723	551,414	906,309	37.83	62.17	8.17	-18.56	35.15
11	Gujarat	60,383,628	34,670,817	25,712,811	57.42	42.58	19.17	9.23	35.83
12	Haryana	25,353,081	16,531,493	8,821,588	65.21	34.79	19.90	10.00	44.25
13	Himachal Pradesh	6,856,509	6,167,805	688,704	89.96	10.04	12.81	12.50	15.64
14	Jammu & Kashmir	12,548,926	9,134,820	3,414,106	72.79	27.21	23.71	19.77	35.66
15	Jharkhand	32,966,238	25,036,946	7,929,292	75.95	24.05	22.34	19.50	32.29

Reporting –There is only HMIS reporting, there is no parallel reporting happening in the district, all the report which is compiled and send from SC level to block then block to district level. This report is facility wise service report. But sometimes some SC they don't have ANMs to depute for health camp reporting.

Data and Information Flow

INFORMATION FLOW

National Level

STATE HEAD QUARTER

District Head Quarter (DPMU)

District / Civil Hospital Data set

Block MOIC

CHC Facility Data Set

PHC Facility Data set

Health Supervisor/Sector MO

ANM (Data set of all services at Sub centre Level)

Aggregation and data entry pointsPaper-based reports – All the sub-centers are submitting their paper based report to respective blocks and blocks are entering facility wise reports in the DHIS-2. As Bihar is doing facility wise service reporting and aggregation is done at Block level .Data entry is done at block level. and block send it to district through mail. There are number of Problems with AMM Reporting/ ANM reporting Register, they are not provided

with any specific format or ANM has to visit many villages and would therefore need something very portable- a single book- not a set of 18 registers- to carry to each place. Normally she enters it in a diary and then comes back to center and enters it into appropriate registers.Since the diary is not formatted- she would miss out on many data elements and then try to fill it up from memory.Cross –posting could be difficult- since there are no reference numbers and providing numbers itself could be a challenge.And entering directly into the tracking register is impossible too-

Quality of the Data and Duplication

Data quality refers to the extent to which data measures what they intend to measure, dimensions of data quality is Completeness, Timeliness and Reliability/Accuracy. *The key to data quality is the use of information. the more regularly it is used, the more the seriousness with which data is entered and problems in flow and analysis are sorted out!!*[iii]Duplication is occurring very less at some facilities as all ANM's are not trained or intimated about facility wise service reporting. And some regular ANMs are not competent to do report in HMIS format correctly.[iv]Data duplication leads to false higher coverage of services and inaccurate decision making. For example, if a pregnant women delivers in the CHC, or any private sector health sector ANM is not suppose to report the same to higher set up but the same time she can record this delivery in her register because the pregnant woman should be registered with her for monitoring and tracking purpose. But knowingly or unknowingly, It is happening in our health sector where the duplication is an worrying factor.

Timeliness

Timeliness is very important component of data quality. Timely processing and reporting of data facilitates timely availability of data for decision making.During monthly review meetings, if out of 10 sub-Centers 5 do not submit report on time it will be difficult for the MO to assess the performance and develop a plan for PHC in particular and of sub-Centers in general.We have to restrict on date of reporting for every facility and find out when all facilities report in your district.

Accuracy and Reliability

Accuracy refers to the correctness of data collected in terms of actual number of services provided or health events organized. Inaccurate data will yield incorrect conclusions during analyses and interpretation.[v] Small errors at facility level will cumulate into bigger mistakes since data from various providers/facilities are aggregated.

The Zero Problem: How to reported non-existent vs. Non utilized services

This is the another challenge we are facing in public health sector reporting, Zero reporting always not be a real value zero.[vi]Example: Haemoglobinometer is not available; HSC report says there are 'pregnancy anemia' cases; ANM reports ANC anemia based on clinical examination. What problem you can face by this?it adversely affects data accuracy because ANM may overestimate or underestimate anemia cases. Only Solution for this problem is follow data collection and reporting guidelines of Health information management and always suggest these are reported as zero and no difference be made between zeros and blanks.[vii]

Understanding MIS

District Hospital and Sub Divisional Health centre level facilities are less prone to errors as they are maintaining and compiling records properly. Errors are mainly occurring at the lower level like Primary Health Centre and Sub Centre). ANM's are not able to understand the data elements, for example in most of the SC, ANM's reporting, Number of IFA tablets given in the place of No of women given IFA tablets. Also ANM's are not able to compile their own records from registers (In most of the SC they are using MCTS registers (maternal Child Tracking System Register) for recording which are very difficult to compile, and it leads to errors. All ANM's or Grass root level workers should be given user friendly printed registers for recording and ANM's should prepare summary of the services given at the end of the month. In Bihar, Hariyana, Andrapradesh , Punjab states trying to implemented same.

ACCURACY AND RELIABILITY..

Poor data accuracy/reliability could be due to following four factors

Ambiguity aboutt | Data entry errors
Systemic errors | Dishonesty in reporting

Common Validation Rules

	Data Validation Rules
1	**ANTENATAL CARE**
I	ANC registration should be equal or greater than TT1
II	Early ANC registration must be ≤ to ANC registration
2	**BLINDNESS CONTROL**
I	Eyes collected should be more or equal to eyes utilized
II	Patients operated for cataract should be more than or equal to number of IOL implanted
3	**DELIVERIES**
I	Deliveries caesarean must be ≤ to deliveries institution
II	Deliveries discharged under 48 hours ≤ deliveries at facility
III	Institutional deliveries should be ≤ BCG given
IV	Institutional deliveries should be ≤ OPV0 given
V	Total deliveries should be equal to live births + still births
4	**IMMUNISATION**
I	BCG should be ≤ to live births
II	Immunisation sessions planned should be greater than or equal to sessions held
III	Measles dose given should be greater than or equal to full immunization
IV	OPV Booster should be equal to DPT Booster
V	OPV1 should be equal to DPT1
VI	OPV2 should be equal to DPT2
VII	OPV3 should be equal to DPT3
VII	Vitamin A dose should be equal to measles dose

Data Authentication and Error management protocol

There is clear rules and regulation about the making the reports and its reporting , Reports should be duly signed by the authorized persons, but in ground level reality, they are not reviewing it properly before reporting to higher authority.Error management protocols are not defined by the state. There is no well-established system to rectify data entry errors, non-reporting, validation and outlier issues. But there is supportive software which is using by district and block but some times over populated Primary Health centres/Community Health Centres cannot run validation,which causes error.

Confirmation and Error Management Procedures

No clear delegation of powers for approving or confirming data.Especially, needed for late reporting facilities, non-reporting facilities, cumulative data coming in, error management etc.

Example: If data are entered at Block as 'Block consolidated report' and few facilities have not reported, what actions Data Manager should take?

Make block report based on available data and exclude data for facilities that did not report.

Input previous month's data

Input data of same month but of previous year

Estimate data/values based on numbers reported in neighboring locality.

Reporting responsibility

There are designated person for reporting in hospitals and CHCs. State has assigned official responsibility to collect data from different departments, compile and report. There should be a team at each level for reviewing data before uploading.[viii] Team should ensure checking validation and outliers. If any error occurs at any facility, team will talk to the person at the facility and ask for the reason. If there is an error then only it will be corrected. At District and state level before commuting data will be distributed to different departments for ex Family Planning, RCH, and Medical care for ensuring validity of the data. It is important to note that violation of a validation rule does not always indicate error.

Violations can be due to-

- – Management issues like availability of vaccines or medicines in stock,
- – Disease outbreak
- – Actual improvement due to a good BCC program.

Violation of validation rule prompts you to enquire and check/verify data until satisfactory answer is not found.

Systemic errors are those which are embedded in the system and due to these data quality always remains poor.

Data collection issues

Registers and reporting format mismatch

HMIS formats are in used at all levels and most of the facilities reports on HMIS formats. But some places the printed registers are not available, which causes the errors in preliminary level data collection and its quality.

Primary register issues – Printed registers are not available at all facilities. Only few facilities have all registers. Registers are going to distributed uniformly at SC level. In CHC/PHC level there are no printed registers. Recording were done in Hand made registers. A data element is a record of health event or health related event, Data Elements are recorded in a primary register (recording formats) by the service provider and Similar events for the month are aggregated and reported in specified reporting formats.

Data element required to report in the form are not there and gets missed-out while reporting and Data element present- but cannot be computed easily or prone to recording errors and Multiple registers.

Solutions- Primary registers should be made keep in mind the requirement of HMIS formats and should be easy to carry in field visit. Also registers should be user friendly so that the ANM's easily compile monthly data. Registers should be distributed to all the facilities including CHC/PHC's ANM. Timeline of the reporting should be mentioned in the registers clearly. **And it should be follow very strictly**. Rationalization of Primary Registers. – keeping the service delivery recording function, the tracking function and the computing function, distinct and visible- checking to see all data required is present in the record and lends itself to computation. Capacity building programme for HMIS training has been given to district and block teams by the state officials, The main focus of training was to train in software application, Data definition, indicators, data quality, use of information sections. Service providers are not trained in formats and data definition. Training to service providers are still lacking for collecting, recording,

compiling and reporting data. There are- Gap between recording and reporting figures ,Confusion in reporting the data under particular data element. Inconsistency in data collection , Misunderstanding of data element /Lack of knowledge on Data element Definitions ,Data duplication, Confusion in area wise and Institution wise reporting due to MCTS workload, and Data Entry Errors like Typing errors: wrong numbers entered in computer, Wrong box entry: data entered in wrong box e.g., 'ANC registration' data entered in 'Registration in first trimester', Calculation errors: during data entry basic computation happens if formulae are incorrect than errors can happen. It is advisable to organize a training program on Competency to State and Districts teams, ANMs and other service providers.

Use of information and Feed back

Data analysis and using indicators– Data analysis is not done at every level but some district are doing and it should be done at every level whether data comparison and triangulation done at state level and presented at monthly district review meeting. There is no feedback process in a District in Bihar division, Even if it is feedback is given, that is not in documented format. A regular feedback mechanism needs to be introduced. Data should be analysed at every level and feedback should be given to every facility for improvement.

Infrastructure and Human resource Availability

Infrastructure availability – Computers are adequately available up to Block level and internet connectivity is available up to the Block level. (Except 20% Blocks having poor internet connectivity).[ix]Human resource availability – Human resource is adequate number in state level. But data entry operators are required at District and Block level as per requirement. In **State level -** State M & E Manager, Regional M & E Coordinator, **District Level**- District M & E and data entry operator ,**Block Level**- Block data entry operator and Health manager available.

Software trouble – state is entering data on its own Software (DHIS), and all district Monitoring & Evaluation team is familiar with the software and its operations.[x] Since facility-wise data entry hasnot started in Web Portal, currently Web Portal has slow down considerably which makes task more difficult. Additionally MCTS (Mother and child Track service) entry has started and which requires huge amount of time for data entry.it is very difficult to add up the data across hundreds of facilities- especially manually, disaggregated, need software applications.

Indicator - An indicator is a data element placed in a given context so that it becomes information that can be used for program monitoring, management, and action. Indicators help us assess our performance/progress across time and across places. Indicators also serve as a yardstick for comparison with external sources. There are method to convert data element into indicator, first step is toIdentify a data element as the numerator, and divide it by another data element which represents the context- the denominator, multiply it by a factor to make it easily readable.Indicators help us assess our performance/progress across time and across places. Indicators also serve as a yardstick for comparison with external sources.

For Example:

Indicator: Percentage of registered pregnant women who had an institutional delivery=50%

- **Data elements**: Number of institutional deliveries conducted last year in the PHC=234 and Total number of registered pregnant women=468
- Medical Officer/Supervisor can assess…
  - Did all deliveries happen in the institution?
  - Are delivery services in the PHC utilized well?
  - How is ASHA program working in the District? Is ASHA working properly to motivate mothers to come for institutional delivery? Where are the gaps in the program?

There are number mistake can happen with choosing the of wrong Indicators / denominators, this refers to a common problem where data element itself is correct but denominator chosen is appropriate. Example- When estimating the population of a district one has to extrapolate the population from 2001 census data to the mid-year population of the corresponding year then from this number derive expected population for different age groups and categories. Failure to extrapolate will lead to higher rates or we may be counting the numerator only from public health facilities whereas the denominator may included all patients seen by both public and private facilities e.g. while calculating Caesarean section rate against expected pregnancies this too could lead to misinterpretation. In some districts migration could affect denominator.**Inability to create indicators- or too many data elements for one indicator**which is not a problem of data quality- but because of failure to use data- there is no scrutiny of data element.**Each data element must contribute to 1 to 1.5 indicators**. Need to identify and remove data elements that are not used. Some like couple protection rate- need far to many data elements to compute- high degree of inaccuracy results.

Death Reporting Issues

In grass root level there are problems with understanding the Line listing or they have very little understanding about Line listing and its reporting[xi]. If applications/data entry operators cannot handle line lists- manual conversion to tables must be made available at the facility level. This **is** area reporting- but here also duplication avoidance rules need to be created and areas which are under-reporting deaths need to be identified and worked upon for better reporting.There are many Categories of "cause not known"- and rules regarding aggregation of these poorly appreciated.
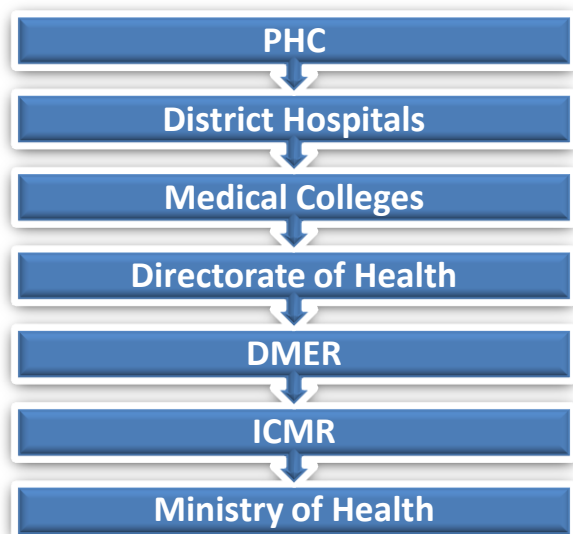
Other Reasons

Non-reporting/inconsistent reporting are also happens due to Form Problems, Shortage of pre printed forms , lack of standardization of forms, poor Quality photocopy, traveling time to submit report etc.

This is the data related to a malaria control programme in a village? What is the action we need to take?

UID & Public Health

Health and health related development schemes could offer a killer application for the UID. Public health in India is seeing a revolution both in terms of (1) Greater commitment towards government financing of public and primary healthcare (2) Pressure to meet the MDG goals (3) Consequent creation of large supply platforms at national levels such as, the NRHM/ NHM, RSBY and complementary state level initiatives. In health there is a cumulative historic

gap both in terms of demand and supply. The UID could further help catalyse a revolution in India's health outcomes.[xii]

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┌─────────────────────────────────┐
│              PHC                │
└─────────────────────────────────┘
              ↓
┌─────────────────────────────────┐
│        District Hospitals       │
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Public health associated payoff through the application of the UID:-

Major challenges in public health today include (1) lack of detailed denominator (i.e. target population to be covered) focussed services delivery by the government's rural and urban healthcare systems at district and sub-district levels (2) Poor tracking of health conditions by for example, the ICD-10 disease classification system, and (3) Lack of ability to roll out at scale, expansion of ambitious national health insurance schemes like the RSBY.

The first problem is related to poor denominator tracking at the lowest level of the government's public health system by frontline health workers, the second additionally also poses a challenge of appropriately administering such demand side incentive schemes such as the JSY to increase institutional births. Thirdly, Routine health information systems (including vital registration, cause of death identification, disease reporting) that capture and track the morbidity and mortality due to various disease conditions are critical to improving public health outcomes including life expectancy.[xiii] Currently infrequent national or state surveys are the major mode of capturing data on infectious disease conditions. Fourthly, chronic or lifestyle diseases are not captured in any meaningful way even through surveys. These pose new challenges for an already strained public health system. Last not the least, which is considered as ultimate objectives of any health management information system, An integrated routine health information system that can capture all name based health record information and track population level disease conditions by linking citizen ID's with hospital or other medical facility records generated through facility visits can (1) inform the public health system of the prevalence of various routine disease conditions (2) help prepare the health system to respond to unforeseen epidemics.

Utility of UID in Healthcare:

- Name based Electronic Health Record
- Epidemiological Database
- Disease Prevalence
- Data mining
- Preventive measures
- Improvement in immunization
- Health of the Nation

UID Should be issued at birth & Death: Health related issues start from birth of a individual & continues till death, so issuing of UID at birth will serve many purpose for lifelong of individual. Healthcare provider registers birth under confinement number. Birth & death related information essential for national statistics will be enrolled in UID.

UID in case of Medical Emergency: Attending physicians will be able to access medical record of any patient so as to save his / her life in case of emergency at any time generating record from UID.

– Treatment of unidentified victims of accidents

– Natural calamity

– Immunization is given to child even if born at home

– Patients will take treatment from healthcare provider at least once in two/three years

– Patients not having UID can be issued one

– Reduce burden off government agencies

Healthcare Provider must Record UID: As UID will help in

    – Patient registration

    – OPD treatment

    – IPD treatment

    – Laboratory tests

    – Radiological tests

    – Pharmacy

Integration with Lifetime EHR: Integration of UID with EHR will reduce a lot of burden of healthcare providers. They will be able to generate any type of patient's data in seconds so making healthcare delivery effective & efficient.

➢ More than one healthcare provider can communicate & share patient's information especially on critical cases so increasing efficacy of healthcare system in India.
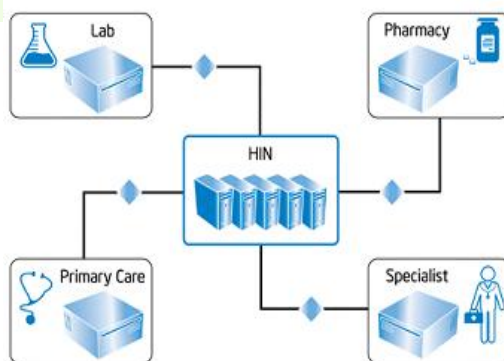
➢ **Transfer of medical information:** There will be an easy mode of transfer of information from One doctor to another doctor, One hospital to another hospital, One city to another city, One State to another state, One software to another software

➢ **Health Information Network:**
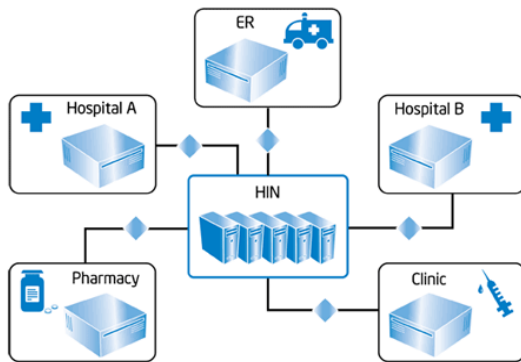
Medical Tourism: UID will help a lot in medical tourism. It will ensure security for citizens of India as well as outsiders, by having a unique number as their identity. Also help in generating revenue for ministry of tourism.

Conclusion

India will be the first developing country to implement a biometric-based unique ID system for its residents on such a large scale. The Unique Identification Number will serve as a universal proof of identity, allowing residents to prove their identity anywhere in the country.[xiv] It will give the government a clear view of India's population, enabling it to target and deliver services effectively, achieve greater returns on social investments, and monitor money and resource flows across the country. The timing of this initiative is encouraging – the creation of the UIDAI coincides with growing social investment in India, a shift in focus to direct benefits, and with the spread of IT and mobile phones, which has made the public receptive to technology-based solutions. The UIDAI is committed to making this project a success. An initiative of this magnitude will also require the active participation of central, state and local governments, as well as public and private sector agencies across the country. With their support, the project will help realize a larger vision of inclusion and development for India.Stakeholders like , Healthcare providers, Insurance companies, Government healthcare organizations, NGOs, Research Institutes, Drug Distribution in Healthcare System can be connected through UID.

[i]Reeve, Bryce B., et al. "Psychometric evaluation and calibration of health-related quality of life item banks: plans for the Patient-Reported Outcomes Measurement Information System (PROMIS)." *Medical care* 45.5 (2007): S22-S31.

[ii]Ladusingh, Laishram, and M. R. Narayana. "7. Demographic dividends for India: evidence and implications based on National Transfer Accounts." *Aging, Economic Growth, and Old-Age Security in Asia* (2012): 203.

[iv]Bhojani, U., et al. "2nd conference on bringing evidence into public health policy (EPHP) 2012: strengthening health systems to achieve universal health coverage, Bangalore, India, 5-6 October 2012." (2012).

[v]Chen, Hong, et al. "A review of data quality assessment methods for public health information systems." *International journal of environmental research and public health* 11.5 (2014): 5170-5207.

[vi]World Health Organization. *The world health report 2000: health systems: improving performance*. World Health Organization, 2000.

[vii]Sequist, Thomas D., et al. "Trends in quality of care and barriers to improvement in the Indian Health Service." *Journal of general internal medicine* 26.5 (2011): 480-486.

[viii]Ramani, K. V., and Dileep V. Mavalankar. "Management Capacity Assessment for national health programs: a study of RCH program in Gujarat State." (2007).

[ix]Dossani, Rafiq, D. C. Misra, and Roma Jhaveri. "Enabling ICT for rural India." *Asia-Pacific Research Center, Stanford University, memo* (2005).

[x]Lungo, Juma H. *Data Flows in Health Information Systems: An action research study of reporting routine health delivery services and implementation of computer databases in health information systems*. MS thesis. 2003.

[xi]Madon, Shirin. "Computer-based information systems for decentralized rural development administration: A case study in India." *Journal of Information Technology* 7.1 (1992): 20-29.

[xii]Kautzky, Keegan, and Stephen M. Tollman. "A perspective on Primary Health Care in South Africa: Primary Health Care: in context." *South African health review* 2008.1 (2008): 17-30.
[xiii]Sharma, Shweta Agrawal Subhashis Banerjee Subodh. "Privacy and Security of Aadhaar: A Computer Science Perspective."

[xiv]Gelb, Alan, and Caroline Decker. "Cash at your fingertips: Biometric technology for transfers in developing countries." *Review of Policy Research* 29.1 (2012): 91-117.