Monitoring Data Quality in Syndromic Surveillance: Learnings from a Resource Limited Setting

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ABSTRACT

Background: India is in the process of integrating all disease surveillance systems with the support of a World Bank funded program called the Integrated Disease Surveillance System. In this context the objective of the study was to evaluate the components of the Orissa Multi Disease Surveillance System. **Materials and Methods:** Multistage sampling was carried out, starting with four districts, followed by sequentially sampling two blocks; and in each block, two sectors and two health sub-centers were selected, all based on the best and worst performances. Two study instruments were developed for data validation, for assessing the components of the surveillance and diagnostic algorithm. The Organizational Ethics Group reviewed and approved the study. **Results:** In all 178 study subjects participated in the survey. The case definition of suspected meningitis in disease surveillance was found to be difficult, with only 29.94%, could correctly identify. Syndromic diagnosis following the diagnostic algorithm was difficult for suspected malaria (28.1%), 'unusual syndrome' (28.1%), and simple diarrhea (62%). Only 17% could correctly answer questions on follow-up cases, and only 50% prioritized diseases. Our study showed that 54% cross-checked the data before compilation. Many (22%) faltered on timeliness even during emergencies. The constraints identified were logistics (56%) and telecommunication (41%). The reason for participation in surveillance was job responsibility (34.83%). **Conclusions:** Most of the deficiencies arose from human errors when carrying out day-to-day processes of surveillance activities, hence, should be improved by retraining. Enhanced laboratory support and electronic transmission would improve data quality and timeliness. Validity of some of the case definitions need to be rechecked. Training Programs should focus on motivating the surveillance personnel.

Key words: Data quality, Evaluation, Infectious disease surveillance

INTRODUCTION

Syndromic surveillance has been defined as the ongoing systematic collection, analysis, interpretation, and application of real-time (or near-real-time) indicators of diseases and outbreaks that allow for their detection, before public health authorities would otherwise note them.[1] It has also been defined as "...surveillance using health-related data that precede diagnosis and signal a sufficient probability of a case or an outbreak to warrant further public health response".[2] Syndromic approach complements the disease-specific approach, with a precise definition for each syndrome, and was pilot-tested in 21 countries. Development and field testing of syndromic reporting initially identified five syndromes of potential public health importance. After the interim review, the World Health Organization (WHO) concluded that syndromic reporting could be useful. The uniqueness of syndromic surveillance lay in its ability to detect outbreaks of diseases that do not fall into the current WHO case classifications, which is particularly important for emerging diseases, such as Severe acute respiratory syndrome (SARS).[3]

There is a demand for increased surveillance under international regulation with increasing risk of international pandemics, hence, it is important to evaluate and implement new surveillance systems to increase the probability of success.[4]

A five country evaluation of data structures supporting healthcare systems in developing countries, across four continents, identified a number of structural impediments

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(timeliness, accuracy, simplicity, flexibility, acceptability, and usefulness) to an effective health information system.[5]

It was important that surveillance systems avoided unnecessary duplication, and hence, evaluation of such systems should emphasize on improving the quality and efficiency of outbreak detection.[6] Statistical methods for disease surveillance focused mainly on the performance of outbreak detection algorithms and did not pay sufficient attention to the data quality and representativeness, two factors that were especially important in developing countries.[7]

Inadequate data quality may impair our understanding of the true disease epidemiology, compromise the core program functions, and undermine our ability to meet the disease control objectives.[8] The probability of outbreak detection is adversely affected if the data generated from the surveillance system is of inferior quality, therefore, it is extremely important to continuously monitor and evaluate surveillance systems, to ensure a good performance and efficient use of resources.[6]

The orissa multi disease surveillance system

The Government of Orissa had set up the Orissa Multi Disease Surveillance System (OMDSS) in 1999 [Box 1]. The reporting units are the existing government health units. Reporting is carried out weekly on 12 syndromes.[9] OMDSS has been merged with the Integrated Disease Surveillance Program of the Government of India, since 2006, which is a system that draws its origins and learning from successful models such as the OMDSS.

Objective of the study

The objective of our study was to evaluate the components of the OMDSS surveillance system, like accuracy of case detection, data recording, data compilation, and data transmission, and look into the related determinants that have a bearing on the data quality.

Study setting

Orissa is one of the least urbanized states in India, with the rate of urbanization being only 14.97% (2001 census).[10] The health indicators are poor, as compared to the other states of the country with poor infrastructure, lesser health staff, and fewer resources. The healthcare system in the state is operational through the primary healthcare approach, in all the 30 districts. The proportion of tribal population in the state is 22%,[11] and is the highest in the entire country.

MATERIALS AND METHODS

Development of study tools

Two study instruments were developed to evaluate OMDSS, keeping in mind its unique characteristics. The first one focused on the components of disease surveillance, like case detection, data recording, data compilation, and data transmission. The second tool, a diagnostic algorithm, assessed the ability of the study subject in identifying cases through a syndromic approach.

Data collection

The study was conducted during the period of May – June 2005. Four qualified researchers, with a past experience in conducting field research in the health sector, were recruited for the field survey. They were extensively trained to be familiar with the existing surveillance system and use of tools for the field survey.

Study design and sampling

A sample was selected using the multistage sampling method. First, four districts were purposively selected for representing four diverse geographical regions of the state, with the representative demographical and epidemiological features chosen. In the second stage, two blocks were sampled from each district to obtain a contrast sample of two blocks that were considered to exemplify 'good' and 'poor' reporting based on the review of the reporting statistics during the year 2004. Similarly, in the third and fourth stages, in each block two sectors and in each sector two health sub-centers were selected, keeping reporting performance as the criteria.

RESULTS

In all 178 study subjects participated in the survey. Health workers represented the most (52.8%), followed by medical officers (14.6%) [Table1].

Table 1: Designation of the study subjects (*n* = 178)

Designation	Name of the District				Total
	Mayurbhanj	Bolangir	Cuttack	Rayagada	
	No. (%)	No. (%)	No. (%)	No. (%)	
Health workers (F)	31 (66.0)	21 (44.7)	19 (39.6)	23 (63.9)	94
Health workers (M)	3 (6.4)	6 (12.8)	1 (2.1)	2 (5.6)	12
Health supervisors (F)	4 (8.5)	3 (6.4)	5 (10.4)	3 (8.3)	15
Health supervisors (M)	1(2.1)	0 (0.0)	1 (2.1)	1 (2.8)	3
S.A. / BEE	3 (6.4)	2 (4.3)	5 (10.4)	1 (2.8)	11
Pharmacist	4 (8.5)	5 (10.6)	5 (10.4)	3 (8.3)	17
Medical officer	1 (2.1)	10 (21.3)	12 (25.0)	3 (8.3)	26
Total	47 (100)	47 (100)	48 (100)	36 (100)	178

BOX: 1

Unique Features of Orissa Multi Disease Surveillance System (OMDSS)

Population under surveillance

OMDSS covered the entire Eastern Indian State of Orissa with nearly 37 million population under surveillance.

Time period of data collection

Initially, in 1999, the OMDSS covered 12 costal districts worst affected by the super cyclone. Eventually by July 2001, the OMDSS was expanded to the entire state with all the 30 districts under surveillance.

Type of information collected

Syndromic information on morbidity and mortality of 12 diseases under surveillance with age (< 5 and > 5 years) and sex (Male and female) desegregation.

Surveillance information provider and the source of data

Male and female health workers provide suspected syndromic diagnosis. Medical officers provide probable diagnosis. The data source for surveillance information mainly comes from reports that are generated from all the 30 districts, with a public health infrastructure comprising of 5927 health sub-centers (managed by a health worker), 1162 primary health centers (PHC) (first point of contact with a doctor), 314 block PHC / Community Health Centers (CHC) (first level of referral), and 53 district or sub-divisional hospitals (second level of referral).

Mechanism of information transfer

Information is transferred manually from the Health Sub-centers to the PHC. From the PHC to the Blocks to the District and finally to the state headquarters. The information is transferred electronically using the fax, telephone, internet, and so on. Reporting is done weekly on 12 syndromes with a fixed period for reporting (Saturday to Friday), and fixed deadlines at each level. Reports reach the PHC by Saturday, the block level health center by Monday, the district headquarters by Wednesday, and the State Disease Surveillance Cell by Friday.

Method of information storage

OMDSS data is stored in a computerized system using an oracle-based software- with an SQL server.

Responsibility of data analysis

The final analysis is carried out by the state disease surveillance cell, with a dedicated surveillance medical officer and his data team, especially appointed to enter and analyze the OMDSS Surveillance data.

Method of data analysis, and frequency

Data is analysed using Epi info, 6.04, on weekly basis.

Preliminary basic analysis

Tabulation, graphs and charts are prepared weekly. Annual reports are prepared every year.

Frequency of reports dissemination

Weekly, Monthly and Yearly.

Recipient of reports

State health authorities, Central government health authorities, UN agencies, and Non Governmental agencies.

Method of report distribution

Manually as well as electronically.

Case detection

A majority (93.41%) were trained on principles of disease surveillance. All the study subjects were aware of the weekly reporting pattern under OMDSS and that the reporting week was from saturday to friday. Of them 93.6% agreed that they followed the standard case definitions; 86.6% of the subjects were able to enlist more than 10 disease categories out of the 12 under surveillance. The case definition of suspected meningitis was reported to be most difficult (29.94%), followed by the unusual syndrome (26.34%) and neonatal tetanus (8.98%) [Table 2]. Syndromic diagnosis following the diagnostic algorithm [Table 3] was difficult for suspected malaria and the unusual syndrome, with only 28.1% of the correct diagnosis and was followed by 62% of the correct diagnosis for simple diarrhea. The survey revealed that 93.5% of the subjects were aware of the fact that deaths were captured in the system.

Data recording

The participants were asked, how they prioritized the recording of a disease, when a patient presented with two or more diseases. Only 17% could correctly answer the question on how to record a case as old or new, when a patient presented with fever and returned back with the investigation reports after two days [Table 4]. Only 50% could correctly decide the priority disease to be recorded, when given an instance of a case of measles with diarrhea, but no dehydration.

Data compilation

Close to 76% were aware of tallying. However, only 53.37% of them could explain the process of tallying. Fifty-four percent agreed that they cross-checked the data before compilation. In the four weeks preceding the survey, the number of errors that were identified by the subjects was analyzed. A score of one was given to each valid error. The results revealed that among the medical officers, five (19.23%) scored one, seven (26.92%) scored two, two (7.69%) scored three, and only one (3.84%) scored four. The non-response rate was 42%. However, among the other staff, the score was either one (34.86%) or two (48.02%). Only 10 subjects (6.57 %) had scored three.

Data transmission

A majority (82.58%) of the subjects were aware of all the three emergency instances requiring immediate reporting to a higher authority. However, a substantial proportion, close to 17%, were aware of only one of the three instances, and waited till they received reports from all the units before sending it to the higher authority [Table 5].

Human and logistics factors

The constraints found were, non-availability of tally sheets and reporting formats (56%), and second, lack of communication equipments like phone/fax/internet (41%) [Table 6]. The reasons given for participating in OMDSS were job responsibility (34.83%), usefulness to the Health System (25.28%), and that it helps epidemiologically (0.56%) [Tables 6 and 7].

Table 2: Disease categories with case definitions difficult to understand (n = 167)

Disease category	No.	Percent	Disease category	No.	Percent
Simple diarrhea	0	0	Suspected measles	0	0
Severe diarrhoea	0	0	Neonatal tetanus	15	8.98
Bloody diarrhea	1	0.59	Suspected meningitis	50	29.94
Acute jaundice syndrom	4	2.39	Unusual syndrome	44	26.34
Suspected malaria	2	1.19	Heat stroke	3	1.79
Acute respiratory infection	2	1.19	Others	3	1.79

Table 3: Syndromic diagnosis (n = 167)

Disease	Right	Percent	Disease	Right	Percent
Simple diarrhea	104	62.27	Suspected measles	166	99.40
Severe diarrhea	147	88.02	Neonatal tetanus	151	90.41
Bloody diarrhea	156	93.41	Suspected meningitis	125	74.85
Acute jaundice syndrome	164	98.20	Unusual syndrome	47	28.14
Suspected Malaria	47	28.14	Others	113	67.66
Ac Resp. infection	163	97.60	Heat stroke	Not evaluated	

Table 4: Recording of correct diagnosis following the thumb rules of case detection (n = 178)

Question	Total responses	Correct responses		Correct reasoning	
		n	%	*n*	%
Patient reports with more than one disease	167	121	72.45	54	44.62
A case of scabies with severe diarrhea	167	126	75.45	76	60.31
A case of measles with diarrhea, but no dehydration	167	85	50.89	48	56.47
A case of severe diarrhea with runny nose	167	105	62.87	69	65.71
A case of fever seen two days back, now reports to you with investigation results	167	46	17.54	27	58.69
In a week there are no cases / deaths under a particular disease category, the corresponding space to be filled with	174	168	96.55	Not asked	

Table 5: Knowledge of the instances requiring immediate reporting to the higher authorities (n = 178)

Immediate reporting to the administration without waiting for the routine weekly reporting process is carried out in which of the following situations	No. (%)
When a case of an epidemic prone disease is detected	18 (10.11)
When a case of a disease in eradication mode is detected	03 (1.68)
Unusual clustering of cases / unusual clinical presentations causing deaths in a short span of time is noted	10 (5.61)
All of the above	147 (82.58)

DISCUSSION

Disease surveillance systems all over the world use three levels of data types, namely, preclinical data, clinical pre-diagnostic data, and diagnostic data. Preclinical and clinical pre-diagnostic data are generally used by syndromic surveillance, whereas, traditional surveillance mainly relies on diagnostic data.[12]

Table 6: Constraints faced by the health personnel in executing DS activities (*n* = 178)

Constraint	No.	%
No forms–tally sheets, reporting formats	100	56.17
No phone / internet connectivity	73	41.01
CDMO office not getting hard copies of the reports	8	4.49
Disease surveillance vehicle not functioning	1	0.56
No computer assistant / lack of man power	3	1.68
No quarter / electricity	5	2.81
No communication facility	1	0.56

DS: Disease Surveillance

Table 7: Reason for accepting OMDSS (*n* = 178)

Reason	No.	%
It is the job responsibility	62	34.83
It is useful for the health system	45	25.28
It creates interest	2	1.12
All of the above	65	36.51
Helps epidemiologically	1	0.56

OMDSS: Orissa multi disease surveillance system

Case detection

In our study, we had a higher number of paramedical staff as compared to medical officers, as OMDSS is a syndromic surveillance system; hence, an overwhelming workload is shared by the paramedical staff. Our study found that a case definition for meningitis was the most difficult for case detection (29.94%). Other studies have also reported similar problems with case definition and diagnosis of meningitis affecting the positive predictive value of meningitis.[13] It was disconcerting to note that only 28% of our study subjects could accurately diagnose suspected malaria and the unusual syndrome. Malaria being a highly endemic disease in Orissa, we recommended repeated training and reinforcement at regular intervals, to familiarize with the case definitions and syndromic diagnosis for malaria. It has been proven beyond doubt that syndromic surveillance has time and again demonstrated to be an effective mechanism for early detection of the malaria epidemic, from the experience of the African continent. The case in point is Ethiopia, where weekly percentile cutoffs proved to be an efficient tool for the detection of a malarial outbreak, and hence, there was no need to always rely on complicated algorithms.[14]

The standard method for characterizing data quality, measures the sensitivity and specificity with which the data can accurately classify patients relative to a criterion determination (gold standard).[15] The importance of regular training of surveillance personnel cannot be overemphasized as it helps not only in enhancing the sensitivity of the surveillance system, but also betters case detection and disease reporting indicators.[16]

Data recording

In OMDSS, training was given on the process of recording a priority disease, when a patient came in with multiple diseases, with logical reasoning, by following the thumb rules of case detection. Yet 17% of the respondents committed errors in recording cases as new or old. A majority, 50%, of the participants could not prioritize the disease for surveillance recording nor give any logical reasoning when a patient presented with two or more diseases. Accurate, complete, and timely information improves the quality of surveillance data and supports public health decision-making.

Measurements of disease frequencies get distorted when there are serious diagnostic misclassifications taking place in the surveillance system, and errors in data recording are rampant.[17,18] One of the ways to improve data quality in a surveillance program is to boost up the laboratory back-up and switch over to the electronic reporting mechanisms.[19,20] Reporting errors can also be brought down considerably by imparting regular refresher training to personnel involved in surveillance.[21,22]

Data compilation

Our study shows that 54% cross-checked the data before compilation. Several other studies have pointed out errors in data. Deficiency in reports gathered in public health systems has been noted across the world. Studies from South Africa have shown that there have been serious defects in their death notification systems.[23] Errors have been found in nearly all death notification forms (91%), with a major error detected in 43% of the instances, resulting in documentation of an illogical sequence or cause of death.[24]

The quality of data is influenced by the clarity of surveillance forms, the quality of training, supervision of persons who completed the surveillance ms, and the care exercised in data management. A review of these facets of a surveillance system provides an indirect measure of the quality of data. Examining the percentage of unknown or blank responses to items on the surveillance forms or questionnaires is straightforward. Assessing the reliability and validity of responses would require special studies such as chart reviews or re-interviews of respondents.[6] In conducting a public health investigation, the first task is to differentiate natural (statistical) variability from 'pseudo-outbreaks' due to data entry or coding errors from a true increase in an infectious illness.[25] This is one of the reasons why many experts question the capacity of syndromic surveillance to provide an early outbreak detection, as there is a lack of precision in the data it generates.[26] Therefore, a potential data source should be judged by the combination of its data quality and timeliness, as well as, knowledge of the cost of false alarms versus the cost of delays in triggering true alarms for a specific disease threat.[25]

Data transmission

In our study, a substantial proportion, 22% of the subjects, waited till they received reports from all the units before sending it to the higher authority, even when the event needed emergency notification.

New strategies need to be evolved, especially those aimed at reporting personnel, as they remain the most important component of the disease surveillance systems.[19] Syndromic surveillance does not need to be highly computerized or technical; its tools can be simple, using few technological or human resources, and can complement the existing surveillance programs.[3]Many researchers have already proven that rather than the conventional methods of morbidity reporting, electronic transmission of reports lead to a 2.3-fold increase in case reports, therefore, every attempt should be made to upgrade the method to automated data transmission.[16] Electronic tools such as the phone and internet have been seen to be efficient modes of data transmission.[27]

Timeliness

In OMDSS only 69% of the reporting units had sent the weekly diseases surveillance report on time. Our study findings were very similar to other studies reporting timeliness.[28] It had been observed that timeliness had been area of concern in the entire disease surveillance program across the world.

The pertinence of timeliness in public health surveillance systems was also underlined by several authors. The importance of a regular evaluation of timeliness has been stressed time and again, as it is the crucial component of the disease surveillance system.[29,30] Timeliness becomes all the more crucial if data from surveillance system are to be used in achieving the objectives of public health, namely, disease control and disease prevention.

Studies have shown that timeliness of reporting is identified as the system attribute most amenable to improvement.[13] In an effort to improve the efficiency of the disease surveillance system, many electronic and automated innovations have been tried.[31,32] Among all the strategies, a simple act of reminding the surveillance personnel through phone calls has proved to be the most tactical way of improving timeliness.[28] The other assured method of improving timeliness has been the adoption of the electronic transmission of reports, as it results in the speedy arrival of reports. The implementation of electronic-based platforms, improves timeliness, and facilitates access to the epidemiological data allowing more rapid analysis and response.[19]

Completeness of data

In the OMDSS the flow of information in the system has been very efficient with more than 90% of the 358 reporting units (blocks and hospitals) sending reports every week, since April 2002 onwards.

Some measure of reporting completeness is necessary to accurately interpret disease incidence or to make national and international comparisons among public health jurisdictions.[16] Routine notifiable disease surveillance often suffers from incomplete reporting. It has been reported that completeness of notifiable infectious disease reporting in the United States varies from 9 to 99%.[33] It has been observed that surveillance systems that have not upgraded to an automated system of disease monitoring and reporting and still carry on with the conventional methods, invariably experience a delay in notification of vital events.[34,35]

Many researchers have tried to improve the completeness of the surveillance system through the Capture–Recapture method, also referred to as the underascertainment corrected method. Whether this corrected method results in a more accurate estimate of reporting the completeness depends on how these methods are applied and the individual characteristics of the data sources being used.[16]

Data analysis and alarm thresholds

The very purpose of the disease surveillance system is early detection of epidemics and the response. This can only be achieved if the surveillance program has good data management and analysis systems, to enable identifying of the threshold level, to serve as alarms.[36,37] Since the 1990s, syndromic surveillance has proven its utility as a reliable instrument in the early detection of outbreak.[38] The utility of syndromic surveillance is dependent on the alarm thresholds. The WHO has advocated alerts when weekly cases exceed 75% of the baseline?[3] Some methods used are CPEG, commonly used by both the military systems, and currently coded 0 if the observed data are not outside the historical limits ('normal' situation), + if the observed data are outside the historical limits by more than two standard deviations ('pre-alarm'), and ++ if by more than three standard deviations, compared to the expected data ('alarm'). It is important to be aware that syndromic surveillance is associated with an increased risk of false alarms,[39] hence, we need to be extremely cautious in the interpretation of epidemic alerts, because investigation of false signals places a significant burden on the staff resources. Therefore, alarm thresholds should be set based on explicit utility considerations that attempt to optimize the tradeoff between the cost of false alarms and the expected benefits of earlier detection.[25]

Surveillance manpower

Human resource is a vital component of the surveillance system. In our study many constraints were found affecting the efficiency of the surveillance activity, namely, nonavailability of tally sheets, reporting formats (56%), and lack of communication equipments like phone/fax/internet (41%).

Lack of required skills among the surveillance personnel was reported by many studies, and it was found that there was multitasking done by health workers, who were given the additional role of surveillance activity. They were otherwise not directly involved in the primary healthcare activities, and this has been the primary reason for the inefficiency.[28]

In our study, we also looked at motivation for the study participants to be part of surveillance activity. The reasons given for participating in the OMDSS were job responsibility (34.83%) and usefulness for the health system (25.28%). Many researchers have highlighted the paramount importance of having highly motivated reporting personnel in the surveillance programs, as it has a direct bearing on the data quality and timeliness. If health workers are involved in the surveillance program merely as an additional job responsibility, then they will invariably display poor commitment.[40] The notification rates can be improved significantly by improved coordination between the health personnel involved in the clinical and public healthcare activities.[35] Reporting activities can be considerably improved if health workers are regularly visited and motivated.[41]

This analysis supports the recommendations of the WHO, who argue for simplified data collection tools, a minimal common set of key indicators, reduced numbers of registers, and allocation of dedicated, trained personnel at the local level, to maintain patient records and reports.[24]

CONCLUSIONS

The personnel involved in surveillance activities need to be given refresher training and monitored regularly for quality checks. The manual nature of the surveillance activity increases human error. Laboratory support at all levels and automation of data transmission will improve data quality and timeliness. Some of the case definitions, especially malaria, need to be reviewed. The motivation of surveillance personnel need to be boosted.

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RS conceptualized the study. DTM and AA helped in executing the study. EVR coordinated the study. RRP prepared the manuscript. All authors were involved in various stages of data collection and analysis. All authors contributed toward finalizing the manuscript.

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