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REVIEW

Challenges with the implementation of an Integrated Disease Surveillance and Response (IDSR) system: systematic review of the lessons learned

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Introduction Despite a realistic strategy and availability of resources, multiple challenges still overwhelm countries grappling with the challenges of communicable disease surveillance. The Integrated Disease Surveillance and Response (IDSR) strategy is by far the most pragmatic strategy in resource-poor settings. The objective of this study was to systematically review and document the lessons learned and the challenges identified with the implementation of the IDSR in low- and middle-income countries and to identify the main barriers that contribute to its sub-optimal functioning.

Methods A systematic review of literature published in English using Web of Knowledge, PubMed, and databases of the World Health Organization (WHO) and the Centers for Disease Control (CDC) between 1998 and 2012 was undertaken. Additionally, manual reference and grey literature searches were conducted. Citations describing core and support functions or the quality attributes of the IDSR as described by WHO and CDC were included in the review.

Results Thirty-three assessment studies met the inclusion criteria. IDSR strategy has been best adopted and implemented in the WHO–AFRO region. Although significant progress is made in overcoming the challenges identified with vertical disease surveillance strategies, gaps still exist. Mixed challenges with core and support IDSR functions were observed across countries. Main issues identified include non-sustainable financial resources, lack of co-ordination, inadequate training and turnover of peripheral staff, erratic feedback, inadequate supervision from the next level, weak laboratory capacities coupled with unavailability of job aids (case definitions/reporting formats), and poor availability of communication and transport systems particularly at the periphery. Best outcomes in core functions and system attributes were reported when support surveillance functions performed optimally. Apart from technical and technological issues, human resources and the health care system structures that receive the IDSR determine its output.

Conclusions The challenges identified with IDSR implementation are largely 'systemic'. IDSR will best benefit from skill-based training of personnel and strengthening of the support surveillance functions alongside health care infrastructures at the district level.

Keywords Assessment, challenges, lessons learned, Integrated Disease Surveillance and Response (IDSR), implementation

KEY MESSAGES

- IDSR strategy is best implemented when funded by core state budgets and as part of existing district health system infrastructures.
- Laboratory capacities, communication systems, supervision, logistics and availability of sufficient cadre of trained surveillance personnel are major systemic hindrances in the successful IDSR implementation.
- Support surveillance functions determine success of core surveillance functions and hence the quality attributes of the IDSR system and should be targeted for interventions.

Introduction

Public health surveillance is 'the on-going, systematic collection, analysis, interpretation and dissemination of health data (disease occurrence and disease potential) to help guide efficient and effective public health decision making and action' (Buehler *et al.* 2004). Surveillance forms the backbone of the health care system and is an essential indicator of the performance of service provision. Today, communicable disease surveillance attains importance more than ever due to stark reductions in travel time and improved communication systems that essentially catalyse the rapid spread of pathogens (MOH Nigeria 2010). The International Health Regulations (IHR, 2005) amongst others is a landmark legislation and testament to the renewed initiative of countries to collaboratively reduce the burden of communicable diseases.

Traditionally, surveillance was interpreted and implemented as a vertical activity in most low- and middle-income countries. To date, several challenges have been identified with vertical, single disease surveillance strategies. The main drawback is that most vertical programmes are designed to merely provide data to central levels with little or no co-ordination between those collecting it, analysing it or those using it for decision-making (Franco *et al.* 2006). There is also a generalized lack of resources coupled with non-prioritization of surveillance in terms of budget allocation (Lukwago *et al.* 2012).

Present day challenges to conducting effective disease surveillance arise not only from disease pathogens and the dynamics with their hosts but also from the surveillance systems themselves. First, individual country capabilities to conduct surveillance vary and range from good to practically none (Nsubuga *et al.* 2010b). Second, the majority of the surveillance efforts in low- and middle-income countries (where most disease-specific challenges emerge) are limited to humans, when over 60% of the emerging diseases detected between 1940 and 2004 were caused by zoonotic pathogens (Jones *et al.* 2008). Third, surveillance systems in low- and middle-income countries tend to adopt passive approaches to conducting regular surveillance. Given the limited resources, this may be pragmatic, but a lack of co-ordination between the national and sub-national levels often delays both case and outbreak detection, defeating the very purpose of conducting regular surveillance (Todd 2006). Other unresolved issues in the surveillance efforts in low- and middle-income countries include weak health infrastructures; use of obsolete methods and concepts to operate surveillance systems; dearth of human, technical and financial resources; alongside unco-ordinated policies at different levels of the systems (Hitchcock *et al.* 2007).

To overcome some of these challenges, the World Health Organization (WHO) advocated the Integrated Disease Surveillance and Response (IDSR) approach in 1998 (WHO 2000). Integrated disease surveillance is 'a combination of active and passive systems using a single infrastructure that gathers information about multiple diseases or behaviours of interest' (Nsubuga *et al.* 2006). The strategy aims to 'strengthen surveillance and response at each level of the health system by building local capacities; leveraging strengths and expertise through partnerships and co-ordination; training personnel at all levels; developing and implementing plans of action; mobilizing resources; integrating multiple surveillance systems to ensure efficient use of resources; improve the use and flow of surveillance information; strengthen laboratory capacity and involvement; emphasize community and clinician participation; use data thresholds to trigger alerts' (Centers for Disease Control [CDC] 2012b). Forty-six member states of the WHO–AFRO have implemented the IDSR to date (CDC 2012a). Although the WHO–SEARO adopted the strategy in 2002 so far only Thailand, Sri Lanka and Indonesia had attempted integration of disease surveillance in the region and India is by far the most advanced in terms of nationwide IDSR implementation (Phalkey *et al.* 2013; Sathyanarayana 2010).

Fourteen years after WHO–AFRO endorsed and implemented the IDSR and the WHO–SEARO region following suit (WHO SEARO 2003b), communicable diseases continue to challenge these and other regions of the world. Despite the will and adequate resources made available, multiple challenges still overwhelm countries grappling with the challenges of spread and surveillance of communicable diseases—reasons for which remain complex and manifold.

Although integrated surveillance is by far—undoubtedly—the most practical disease surveillance strategy in resource limited settings, empirical evidence for its performance is still lacking (Somda *et al.* 2009). The need to generate evidence is urgent not

only to understand the associated problems but also to guide necessary amendments to the approach. As a first step in this direction, the main objective of this study is to systematically review and document the experiences, lessons learned and the challenges identified with the implementation of the IDSR systems in low- and lower middle-income countries. The study aims to identify the main barriers that contribute to sub-optimal functioning of the IDSR.

Materials and Methods

A systematic search was done by two independent researchers (R.P. and S.Y.) using Web of Science, PubMed, the WHO library database (WHOLIS) and the CDC, Atlanta document databases (Figure 1). The pre-identified search terms included MEdical Subject Heading (MESH) terms and free text phrases used in various combinations. The terms 'Programme Evaluation'; 'Project Evaluation'; 'Health Care Evaluation Mechanisms'; 'Evaluation/Assessment Studies as Topic'; 'Self-Evaluation Programmes'; 'Evaluation Studies' [Publication Type]; 'Health Services Research'; 'Process Assessment (Health Care)'; 'State Health Plans'; 'Costs and Cost Analysis'; 'Task Performance and Analysis'; 'Systems Analysis'; 'Benchmarking'; 'Lessons learned'; AND 'Communicable Diseases'; 'Communicable Diseases, Emerging'; 'Communicable Disease Control'; 'Disease Outbreaks'; AND 'Sentinel Surveillance'; 'Population Surveillance'; 'epidemiology' [Subheading]; 'Disease Eradication'; 'Infection Control'; AND 'Integrated Disease Surveillance and Response' 'Integrated Advanced Information Management Systems'; 'Information Systems'; 'Hospital Information Systems' were used in various combinations.

Inclusion criteria were set at full text citations published in English dated 1998 to June 2012 that assessed the lessons learned from the implementation of the WHO IDSR strategy in low- or lower middle-income countries (as classified by the World Bank). Studies that assessed any of the IDSR system's core and support functions, as defined by the WHO protocol for the assessment of communicable disease surveillance and response systems (WHO 2001) or the systems quality attributes as identified by the CDC updated guidelines for the assessment of communicable disease surveillance systems, were included in the review (CDC 2001). **Core functions** included case detection; case confirmation; case registration; case reporting; data management; data analysis; outbreak preparedness; outbreak response; and feedback. S**upport functions** included guidelines, laboratory capacity; supervision; training; resources (financial, human, material/equipment) and co-ordination. S**ystem attributes** included usefulness; simplicity; flexibility; representativeness; timeliness; completeness; consistency; sensitivity; specificity; positive predictive value; data accuracy; acceptability and stability. Excluded literature included abstracts, letters to editors, conference papers, studies concerning upper middle-income or high-income countries and citations dealing

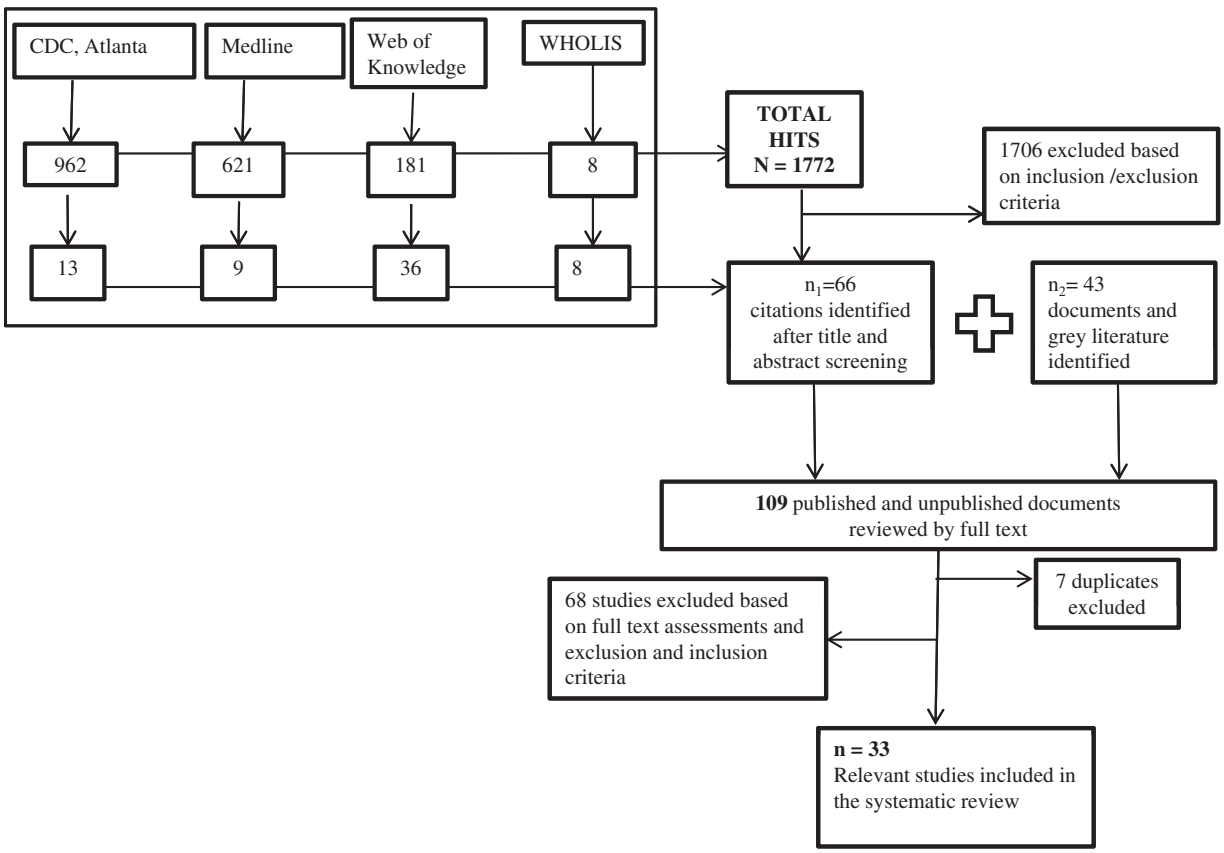

Figure 1 Assessment studies identified and included in the review.

with single disease surveillance systems or single diseases addressed within the integrated disease surveillance system.

Each country assessment was independently reviewed by the researchers. Further published and unpublished grey literature was identified through a snowball approach. In this way, national assessment reports along with secondary references were also obtained and included in the review. Additionally, the WHO–AFRO and SEARO offices, East African Surveillance Network office and individual authors of reports/theses were contacted to obtain copies of unpublished grey literature. Unpublished complete national assessment reports were preferred over short reports.

Data extraction and synthesis of findings

All documents and papers were manually reviewed, duplicates identified and excluded. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement checklist for systematic reviews was referred for the review process (Moher *et al.* 2009). Data were extracted and the information documented in a matrix based on the WHO framework (nine core surveillance functions and six support functions) and the CDC updated guidelines for the assessment of surveillance systems (13 system attributes). In the case of discrepancies between the two reviewers, disagreements were discussed and resolved by consensus.

Limitations of the study

Documents only in English language were included in the review, which may have led to a degree of selection bias. Second, it was discovered that several internal individual country reports existed but could not be included in the review due to our inability to access them. Nonetheless, the results of the review suggest similar findings across the 33 identified assessment studies and are nonetheless valuable in terms of corroborating evidence.

Results

Assessment studies included

The search yielded a total of **33 references** that included 15 grey literature documents and 18 published documents (Table 1). Experiences from 18 countries (Burkina Faso, Cape Verde, Eritrea, Ethiopia, Ghana, Guinea Bissau, India, Iraq, Lesotho, Malawi, Mali, Mozambique, Nigeria, South Sudan, Tanzania, The Gambia, Uganda, Zimbabwe) mainly in the WHO–AFRO region were documented.

Six of the assessment studies presented multi-country experiences. The average time taken to conduct the IDSR assessments was 6 years (range 2–12 years) after the adoption of the IDSR strategy. Systems covered between 7 and 24 diseases and syndromes under weekly and monthly surveillance. The assessments ranged from 2003 to 2012 with the majority of them from 2003. Table 2 below gives an overview of the total number of studies that report problems with performing activities within each of the functions assessed. Not all countries assessed each of the surveillance functions and most mentioned it only when there was a problem. Therefore, assessing the denominators for each surveillance function was difficult. Individual findings from the 27 single-country and 6 multi-country assessments are presented in Annex 1 (Supplementary data).

Core functions

Case detection

Standard case definitions (SCD) were often developed and distributed in the initial years of project implementation. Availability varied depending on the disease and level of surveillance as reported in Nigeria, Tanzania and Ghana (Abubakar 2010; Franco *et al.* 2003; Quality Health Partners and Ghana Health Service 2005). Printed SCDs were rarely available at the periphery in Tanzania, Uganda and Eritrea as the time elapses because personnel moved with the copies when transferred (Franco *et al.* 2006; MOH Eritrea 2004; MOH Uganda 2004; Rumisha *et al.* 2007). Use of SCDs, even when available, was low partly because staff rely heavily on previous knowledge and training and because the definitions were complex and often unavailable in local languages in Sudan (Mghamba *et al.* 2004; Pond *et al.* 2011). Syndromic surveillance was limited and data capture from communities was often poor, hampering effective case detection.

Case registration

Although IDSR standardized registers were rare, inconsistent and incomplete filling of regular in and out-patient facility registers, lack of patient referral data, misclassification of diagnostic categories and illegible handwriting were some of the challenges identified with data compilation and reporting within IDSR (Gueye *et al.* 2005b; MOH Nigeria 2010).

Case confirmation

The majority of the assessments reported weak diagnostic capabilities at facilities in confirming diseases, particularly at the peripheral level. In general, diagnostics for malaria and tuberculosis were better than meningitis in most countries due to the lack of competent staff and resources for the collection and transport of cerebrospinal fluid (CSF) (MOH Eritrea 2004; MOH Uganda 2004). Inadequate financial resources, lack of equipment and reagents, lack of training in sample collection and limited storage and transport compounded by inadequate lab technicians delayed case and outbreak confirmation in Ethiopia, Tanzania and Sudan (Franco *et al.* 2003; MOH Ethiopia 2005; Nsubuga *et al.* 2010b).

Case notification

Maintaining adequate reporting forms at all levels was a major challenge for case notification, often leading to inadequate record keeping at source and unstandardized or non-reporting of data (Dairo *et al.* 2010; Gueye *et al.* 2005b; MOH Ethiopia 2005). Reporting deadlines were poorly understood and varied by states, districts and even facilities within a district leading to over- or under-reporting, thus masking the real epidemiological distribution of health conditions in Tanzania, Uganda and Sudan (Alfred 2005; Gueye *et al.* 2006, 2005b; Pond *et al.* 2011; Rumisha *et al.* 2007). Frequent changes in reporting formats were challenges faced by most evolving systems. The availability of reporting formats along with other job aids such as activity charts, reporting deadlines and case definitions were

Table 1 List of country assessments included in the review

	Country	Year adopted	Year evaluated	Author	Sample size
1	Burkina Faso	1998	2002	SARA (2003)	NA
2	Eritrea	2000	2004	MOH Eritrea (2004)	9 Zobas from each of the 3 zones and 26 health facilities
3	Ethiopia	1998	2005	MOH Ethiopia (2005)	59 Waderas, 64 facilities and 22 labs.
4	Ethiopia	1998	2002	SARA (2003)	NA
5	Ghana	1998/2002	2004	Quality Health Partners and Ghana Health Service (2005)	100.0% of regional hospitals and 94.9% of other hospitals. 171 facilities excluding private clinics and facilities below the health center level
6	Ghana	1998/2002	2002	SARA (2003)	NA
7	India	2002/2004	2010	Sathyanarayana (2010)	Bellary district of Karnataka state
8	Iraq	NA	2004–2005	Al-Jawadi and Al-Neami (2008)	33 facilities
9	Lesotho	1998/2002	2004	MOH Lesotho (2004)	6 districts, 11 focus group discussions and 20 key informant interviews
10	Malawi	1998/2002	2006	MOH Malawi (2006)	8 districts, 30 facilities and 13 labs
11	Mali	1998	2002	SARA (2003)	NA
12	Mozambique	1998	2006	MOH Mozambique (2006)	37 facilities
13	Nigeria	1998	2010	Abubakar (2010)	3 Local Government Areas (LGAs) one each from 3 Zones; 15 Primary Health Care centres and 3 private facilities.
14	Nigeria	1998	2007	Abubakar *et al.* (2010)	49 facilities including 29 public and 20 private
15	Nigeria	1998	2006	Dairo *et al.* (2010)	Total sampling, 42 Disease Surveillance and Notification officers (DSN) officers surveyed,
16	South Sudan**	2006/2007	2011	Pond *et al.* (2011)	38 health facilities, including seven hospitals, 16 Primary Health Care Centers, and 15 Primary Health Care Units.
17	South Sudan	2000	2002	SARA (2003)	NA
18	Tanzania	1998/2002	2002–2003	Mghamba *et al.* (2004)	54 facilities (36 facilities in Babati; 13 of 72 in Dodoma; 5 facilities in Mbulu and Mpwapwa).
19	Tanzania	1998/2002	2004	Rumisha *et al.* (2007)	109 health facilities that included 12 hospitals, 24 health centres and 74 dispensaries
20	Tanzania	1998/2002	2003	Gueye *et al.* (2005a)	104 facilities
21	Tanzania	1998/2002	NA	Mboera *et al.* (2005)	81 Facilities
22	Tanzania	1998/2002	2002	Franco *et al.* (2003)	8 facilities in Babati and 13 facilities in Dodoma rural
23	Uganda	1998	2001–2002	Alfred (2005)	7 Health Sub Districts, 21 health Units, 384 reports assessed.
24	Uganda	1998	2002	CDC (2003)	NA
25	Uganda	1998	2004	MOH Uganda (2004)	20 districts, 40 Health Sub Districts (HSDs) and 217 Health Facilities.
26	Uganda	1998	2000, 2004 and 2012	Lukwago *et al.* (2012)	20 districts, 40 HSDs and 217 Health Facilities.
27	Uganda	1998		SARA (2003)	NA
Multiple countries					
28	East Africa	1998	2002	WHO *et al.* (2003)	Burkina Faso, Ethiopia, Ghana, Mali and Uganda
29	Malawi	1998	2006	Sow *et al.* (2010)	
	Cape Verde	1998	2007		
	Eritrea	1998	2004		
	Ethiopia	1998	2005		
	The Gambia	1998	2004		
	Guinea Bissau	1998	2007		
	Lesotho	1998	2004		
	Uganda	1998	2004		

(continued)

Table 1 Continued

	Country	Year adopted	Year evaluated	Author	Sample size
30	Multiple	NA	NA	Somda *et al.* (2009)	Eritrea, Mali and Burkina Faso
31	Ghana, Tanzania Uganda, Zimbabwe	1998	2005	Nsubuga *et al.* (2010a)	
32	West Africa	1998	2010	MOH Nigeria (2010)	West Africa (Nigeria, Uganda, Togo, Senegal, Mali, Burkina Faso, Mauritania, Ghana and Cote D'Ivoire)
33	Multiple	1998/2002	2004 and 2005	Franco *et al.* (2006)	Ghana and Tanzania

Table 2 Number of assessments that reported issues in each assessed surveillance aspect

Surveillance function assessed	Activity	Total Assessments reporting problems
Core functions	Case detection	22
	Case confirmation	13
	Case registration and notification	19
	Data management	18
	Data analysis	26
	Outbreak preparedness	18
	Outbreak response	20
	Feedback	21
Support functions	Laboratory structure	19
	Supervision	18
	Training	24
	Human, logistic, and equipment resources	22
	Co-ordination	12
System attributes	Data accuracy	11
	Acceptability	2
	Representativeness	2
	Timeliness	21
	Completeness	24

deemed essential in guiding peripheral health staff and ensuring appropriate reporting.

Data management

Complicated and time consuming multiple reporting formats overburdened peripheral staff in Eritrea and Lesotho (MOH Eritrea 2004; MOH Lesotho 2004). Incomplete data filing and inadequate organization was identified as an inherent shortcoming at all levels of IDSR and led to poor institutional learning, given that staff turnover was often high in Tanzania (Rumisha *et al.* 2007). Lack of clear policy on the flow of reports within the system led to problems in the reporting chain in Nigeria (Alfred 2005). In Uganda, district hospitals bypassed facilities and directly reported to the districts, interrupting information flows due to hierarchal structures of the system (MOH Uganda 2004). Harmonization of case definitions/reporting protocols across programmes was identified as a necessary step towards improving IDSR reporting.

The majority of the IDSR systems relied on hard copies particularly at the periphery. Where computers were available, a lack of computer-literate staff prevented their use (Abubakar 2010). In Tanzania, multiple programmes shared computers compromising availability (Gueye *et al.* 2006). In South Sudan, mutually incompatible weekly and monthly reporting forms and use of Excel sheets for data entry and processing complicated data compilation. Errors in data transcription and formulae limited automatic report generation (Pond *et al.* 2011). Limited means of communication reportedly compromised data transmission and processing at all levels in Ethiopia (MOH Ethiopia 2005). Use of alternate reporting channels like high frequency radios and satellite phones in hard to reach areas with no mobile connectivity facilitated data transmission and improved completeness in Sudan and rural Tanzania (Franco *et al.* 2003; Pond *et al.* 2011). Provision of bicycles, motorcycles and report drop box at public bus terminals improved reporting in Tanzania and is recommended for similar settings (Mboera *et al.* 2005).

Data analysis

There was limited or no evidence of routine data analysis at sub-national levels (particularly at facilities) in the majority of the countries mainly due to lack of clear guidelines on how and when to analyse data (Abubakar 2010; Gueye *et al.* 2005b; Lukwago *et al.* 2012; Mghamba *et al.* 2004; MOH Lesotho 2004; Quality Health Partners and Ghana Health Service 2005; Rumisha *et al.* 2007; Sathyanarayana 2005, 2010). Development of generic data analysis guides improved data analysis in Zimbabwe (Nsubuga *et al.* 2010b). In most cases, analysis for age, gender and place were missing due to the unavailability of appropriate denominators (Al-Jawadi and Al-Neami 2008; Franco *et al.* 2003). Some of the reasons identified for limited data analysis included lack of skilled personnel, poor understanding of the use of surveillance data in planning together with shortages of basic equipment such as calculators, computers and respective software (MOH Lesotho 2004; MOH Nigeria 2010). Appropriate analysis was significantly associated with the in-service training of surveillance staff in Mozambique (MOH Mozambique 2006). Trend analysis varied depending on the disease but was more frequently available for malaria in Ghana amongst other countries (Gueye *et al.* 2005a; Nsubuga *et al.* 2010a; Quality Health Partners and Ghana Health Service 2005).

Outbreak preparedness

The general tendency was to react rather than prepare. Sub-optimal coverage and inactivity of outbreak response teams at sub-national levels, poor co-ordination between the Epidemic Management Committees (EMC) and a generalized lack of written preparedness plans was observed in Ghana, Tanzania, Uganda and Zimbabwe (Gueye *et al.* 2005b; Nsubuga *et al.* 2010a). Evidence for meetings of EMC was available in less than 10% of the districts in Ethiopia (MOH Ethiopia 2005).

Outbreak detection

Limited use of outbreak/rumour registers, inadequate data analysis at district and facility levels and weak knowledge of disease thresholds restricted the early identification of outbreaks in Mozambique and Eritrea (MOH Eritrea 2004; MOH Mozambique 2006). Knowledge of disease thresholds was weakest at the periphery, varied by disease and was rather informed by experience than training in Ethiopia, Tanzania and India (Sathyanarayana 2010). Less than 20% of staff in Mozambique correctly identified disease outbreak thresholds, a finding similar to Tanzania and Iraq (Al-Jawadi and Al-Neami 2008; Franco *et al.* 2006; MOH Mozambique 2006).

Outbreak response

Delays in outbreak detection, confirmation and response were reflected in poor case fatality rates in Ethiopia, Uganda and Tanzania (Franco *et al.* 2006; Lukwago *et al.* 2012; MOH Ethiopia 2005). Outbreak response was mainly affected by poor technical expertise, weak laboratory infrastructures, limited transport capacities, and a lack of pre-positioned emergency stock supplies in Nigeria (MOH Nigeria 2010). Limited access to budgets for epidemic response (even when available) were noted in Ethiopia, Eritrea, Malawi, Lesotho, Southern Sudan and Nigeria (Abubakar 2010; MOH Eritrea 2004; MOH Ethiopia 2005; MOH Lesotho 2004; Pond *et al.* 2011). Response was guided by ad hoc emergency committees, which delayed action significantly. Absent or incomplete documentation of outbreak management limited evaluations and led to poor institutional learning (Abubakar *et al.* 2010; Franco *et al.* 2003; Nsubuga *et al.* 2010a; Pond *et al.* 2011).

Feedback

Regular feedback was missing at lower levels (Mghamba *et al.* 2004; MOH Mozambique 2006; Nsubuga *et al.* 2010a), 63% of facilities in Ethiopia, 40% of facilities in Tanzania and 100% of facilities in Mozambique did not receive feedback in any form in the 12 months prior to the assessments. Limited evidence of written feedback was available at any level (MOH Ethiopia 2005; MOH Mozambique 2006; Rumisha *et al.* 2007). In Nigeria, 13% of the facilities received feedback. However, the Local Government Authority or state did not receive any feedback from higher levels (Abubakar 2010). Feedback was not mandatory and rarely incorporated in implementation plans in Tanzania (Franco *et al.* 2003). Lack of formal mechanisms and generic guidelines left feedback components open to interpretation with regard to content and frequency of implementation in Tanzania (Mghamba *et al.* 2004). Funding for feedback activities was often not budgeted as reported from Nigeria (MOH Nigeria 2010). In Uganda, weekly morbidity and mortality data were published in a national daily, which provided much needed feedback to staff, communities and also attracted political commitment for the programme (MOH Uganda 2004). Feedback and supervision were seen as major determinants of staff motivation.

Support functions

Supervision

Implementing supervisory visits and holding regular IDSR review meetings was a challenge at district levels due to poor co-ordination (Gueye *et al.* 2005b). Supervisory visits were conducted more frequently at district and state levels than at facility levels in most countries. The percentage of facility visits ranged between 70% in Eritrea, 55% in Ethiopia and Mozambique to 18% in Iraq (Al-Jawadi and Al-Neami 2008; MOH Eritrea 2004; MOH Ethiopia 2005; MOH Malawi 2006; MOH Mozambique 2006; Pond *et al.* 2011; Rumisha *et al.* 2007). Written reports were seldom available in Mozambique and Nigeria (MOH Mozambique 2006; Nsubuga *et al.* 2010b). Supervision was conducted only as a problem-solving measure, generally after outbreaks in Sudan (Pond *et al.* 2011). Supportive supervision with checklists along with well-defined schedules at each level was recommended to improve IDSR performance and staff motivation by majority of the assessments (Gueye *et al.* 2006; Quality Health Partners and Ghana Health Service 2005; Sathyanarayana 2010).

Training

Training improved IDSR data collection, compilation. analysis and interpretation in Tanzania, Ethiopia, Lesotho, South Sudan, Nigeria, Mozambique, Uganda and Burkina Faso (Gueye *et al.* 2006; MOH Ethiopia 2005; MOH Lesotho 2004; MOH Mozambique 2006; MOH Nigeria 2010; Pond *et al.* 2011). The number of trained personnel was directly proportional to improvements in reporting quality, timeliness, consistency, completeness as well as supervision and feedback at all levels in Cape Verde, Eritrea, Ethiopia, Guinea Bissau, The Gambia, Uganda, and Malawi (Sow *et al.* 2010). The percentage of trained surveillance staff varied and ranged from 87% in Malawi to 5% in Nigeria. District and state focal persons were better and more frequently trained as compared with facility staff in most countries (Abubakar 2010; Al-Jawadi and Al-Neami 2008; MOH Ethiopia 2005; MOH Malawi 2006; MOH Nigeria 2010). Surveillance training of lab staff was limited. High attrition and the transfer of trained staff without replacement hampered programme continuity in Ethiopia and Lesotho (CDC 2003; MOH Ethiopia 2005; MOH Lesotho 2004). The absence of updated databases made it difficult to assess the exact number of trained staff in positions in Eritrea and South Sudan (MOH Eritrea 2004; Pond *et al.* 2011).

Achieving balance between adequate training and the time staff spend away from their duty stations was a challenge but single day training strategies were deemed inadequate (MOH Lesotho 2004). In-service training conducted at a site was considered the best strategy (Nsubuga *et al.* 2010b). Although resource and time intensive, automated data processing was recommended in majority of the assessments and incorporating computer skills in IDSR training was considered essential (Mboera *et al.* 2005).

Collaboration with public health schools helped institutionalize IDSR training in the basic academic curricula of paramedical and medical programmes in Ghana, ensuring its sustainability (CDC 2003). In the absence of formal or special training, the availability of job aids like SCD, tips on filling out forms and flow charts assisted peripheral staff in improving their performance and was advocated (CDC 2003; Gueye *et al.* 2006; Mghamba *et al.* 2004; MOH Mozambique 2006; WHO *et al.* 2003).

Laboratory function

Weak lab structures at the periphery and lack of functional networks compromised facilities' ability to confirm priority diseases, microbial resistance and outbreaks (Quality Health Partners and Ghana Health Service 2005). Capacities for specimen handling, storage, processing and transport (especially CSF) affected specimen quality. The availability of reagents also varied significantly. Rapid diagnostic tests were not widely available in majority of the countries (MOH Malawi 2006; Nsubuga *et al.* 2010b). Incomplete and inadequate laboratory data compilations made it difficult to link them to surveillance data (CDC 2003). Lack of Standard Operating Procedures and inadequate resources affected the optimal participation of labs in regular surveillance and outbreak investigations (MOH Mozambique 2006). Poor technical support and lack of trained lab staff were the chief impediments in Uganda and Eritrea, Malawi and Lesotho (MOH Eritrea 2004; MOH Uganda 2004). In South Sudan, no lab could confirm all priority diseases and samples were shipped to Nairobi, delaying results by over 22 days significantly affecting surveillance functions (Pond *et al.* 2011).

Resources (financial, human, logistical and equipment)

Delays in receiving allocated budgets hampered IDSR implementation in most countries (Alfred 2005; CDC 2003; Dairo *et al.* 2010; Somda *et al.* 2009). Start-up costs and mean annual personnel costs were the highest for IDSR implementation. Routine surveillance activities (e.g. detection, report and analysis) absorbed more resources than support activities (e.g. evaluation and monitoring) (Somda *et al.* 2009). Satyanarayana (2010) reports administrative difficulties in obtaining allotted funds from the center and recommend financial autonomy for districts. Lack of specific IDSR budgets at any level directly affected logistics (vehicles, transport facilities, etc.) and equipment (stationary, calculators, computers, printers, Information Education and Communication (IEC) materials, job aids, etc.) availability and hence IDSR performance (Abubakar *et al.* 2010; MOH Lesotho 2004). Generalized lack and frequent turnover of staff resulted in multiple responsibilities for focal persons and hampered work quality in the majority of countries (MOH Nigeria 2010; WHO SEARO 2003a). This is an inherent gap in health systems structures of most developing countries.

Co-ordination

Co-ordination of IDSR with other sectors and surveillance components of other national vertical programmes are the main determinants of its successful integration (Support for Analysis and Research in Africa (SARA) 2003). National IDSR Task Forces were successfully established in most countries but their functioning was ad hoc. Partial adoption of IDSR technical guidelines restricted optimal results. Successful co-ordination was demonstrated in Mozambique, Ghana, and Uganda by channelling all surveillance budgets and activities through central epidemiologic/surveillance units (MOH Mozambique 2006; MOH Uganda 2004; SARA 2003).

Lack of clear operational mechanisms was identified as a chief limiting factor for effective co-ordination in Lesotho (MOH Lesotho 2004). In Tanzania, sharing data and co-ordinating with other sectors such as livestock, combining vehicle and human resources particularly to respond to outbreaks was noted (Gueye *et al.* 2006). Mboera *et al.* (2005) observed that linking IDSR with other stakeholders such as public transport systems improved timeliness and completeness of reporting. In South Sudan, successful co-ordination was reported with the guinea worm eradication programme but limited progress with the acute flaccid paralysis surveillance system indicating inter-programmatic variances (Pond *et al.* 2011). Regular meetings with accurate documentation were identified as weak points in successful co-ordination at all levels in Uganda, Lesotho and South Sudan (MOH Lesotho 2004; MOH Uganda 2004; Pond *et al.* 2011).

System quality attributes

Data accuracy, timeliness and completeness were the most frequently assessed quality attributes of IDSR systems. The ease of reporting formats and time required to perform surveillance activities determined the acceptability of IDSR in Ethiopia and Iraq (Al-Jawadi and Al-Neami 2008; MOH Ethiopia 2005). A significant number of patients in Tanzania, Ghana and India did not seek care at public health care facilities and therefore the exclusion of traditional/alternate medicine and private practitioners together with under 50% reporting completeness of public facilities significantly compromised representativeness of the system (Franco *et al.* 2003; Sathyanarayana 2010).

Data accuracy

Average reporting accuracy varied by facility, by level and by disease. The tendency of both over- and under-reporting was observed. Accuracy ranged from 63% in Malawi to 58% in Tanzania and 29% in Uganda (Gueye *et al.* 2005b, 2006; MOH Malawi 2006; MOH Uganda 2004). Data for deaths agreed better than that of cases but varied by disease. Data agreement was problematic, particularly at larger hospitals due to the volume of cases, clerical errors and extreme number of Out Patient Department (OPD) approximations in Mozambique (MOH Mozambique 2006). Incomplete and non-standardized registers with missing variables were frequent in OPDs. When no diagnosis was recorded, the record assistant relied on treatment to backtrack diagnosis, jeopardizing data reliability in Uganda, Ghana and India (MOH Uganda 2004; Quality Health Partners and Ghana Health Service 2005; Sathyanarayana 2010). Duplication of cases in outpatient, inpatient and lab registers were common due to a lack of unique identifiers. Data were more accurate where separate registers were maintained in Uganda (MOH Uganda 2004).

Further, unreported cases were often found in registers as a result of differences in reporting deadlines followed (Rumisha *et al.* 2007). As a result, data were added to the next reporting

cycle leading to under reporting in current cycle and over reporting in the next, in the case of delayed reports. Meaningful and correct reports were rare and in some cases missing registers and loss of submitted reports made it difficult to validate data (Alfred 2005; MOH Lesotho 2004). The importance of 'zero reporting' in IDSR was poorly understood by peripheral staff (Gueye *et al.* 2005a). Tally sheets were rarely observed. Systems for quality control were rarely incorporated in the programme, making it a structural incapacity (Sathyanarayana 2010).

Timeliness

Use of hand-delivered, paper-based systems delayed reporting in most countries. Use of telephones was considered an alternative; however, inadequate documentation of verbal reporting compromised data completeness and quality. Training and sensitization, in addition to the implementation of negative incentive mechanisms, helped improve reporting timeliness in Iraq and Tanzania (Al-Jawadi and Al-Neami 2008; Franco *et al.* 2003). Timeliness was better at district levels compared with facilities and for monthly compared with weekly reporting in a majority of the countries (Gueye *et al.* 2006; Mboera *et al.* 2005; MOH Eritrea 2004; MOH Uganda 2004; Pond *et al.* 2011; Rumisha *et al.* 2007). In Tanzania, overall reporting was 24% for monthly and 8% for weekly reporting, which significantly declined with the absence of a focal person or during holiday periods (Rumisha *et al.* 2007).

Ineffective transport and communication systems delayed timeliness significantly, making it an infrastructural and resources problem (Mboera *et al.* 2005). Other issues included multiple responsibilities at the periphery, shortage of budgets, delivery of reporting forms to inaccurate destinations and competing activities (Alfred 2005; MOH Lesotho 2004; MOH Mozambique 2006). In Malawi and South Sudan, timeliness could not be determined due to the unavailability of adequate 'date' documentation (MOH Malawi 2006; Pond *et al.* 2011). Timeliness of outbreak detection (an identified IDSR indicator) was poorly tracked due to inaccurate recording of dates of onset and responses in the majority of assessments.

Completeness

Reporting completeness improved with training, sensitization of staff, multiple communication channels and adequate technical support (Lukwago *et al.* 2012; Pond *et al.* 2011). Mean completeness was better at district levels compared with facility levels and for monthly reporting over weekly in the majority of the countries (Abubakar 2010; Gueye *et al.* 2006; MOH Eritrea 2004; MOH Mozambique 2006; MOH Nigeria 2010; MOH Uganda 2004; Rumisha *et al.* 2007). National level completeness was rarely reflected at lower levels. Districts and facilities rarely met the identified targets (MOH Uganda 2004). Written reminders and supportive supervision with negative incentive mechanisms improved completeness in Tanzania (Gueye *et al.* 2006). The exclusion of the private sector from reporting systems was the main structural flaw in most countries with compromised reporting completeness and hence representativeness (Abubakar 2010; CDC 2003; Gueye *et al.* 2006; Nsubuga *et al.* 2010b).

Discussion

Significant progress has been made in core and support surveillance functions and surveillance quality in a majority of the countries that adopted the IDSR; however, a few gaps remain. The quality of surveillance is still evolving and few IDSR—implementing countries have moved from 'input and process' to 'output and outcome' variable assessments (Table 2). Given the advanced stages of IDSR implementation in most countries, the change in focus to surveillance quality assessments should be envisaged (Sahal *et al.* 2009).

The shortcomings of the vertical disease surveillance strategies have not all equally been successfully overcome by IDSR, as observed in the review. Numerous systems with unique reporting requirements still persist and true integration remains a distant reality. Only partial adoption of the technical guidelines has been achieved. The lack of clearly identified operational mechanisms for co-ordination at all levels is the main reasons for this result (MOH Lesotho 2004). Recent introduction of approaches to strengthen the Health Information Management Systems (HIMS) in some of the countries is an important milestone with mutual benefits. Synergies between IDSR reporting and district HIMS have now become most pertinent (John *et al.* 2011; Nsubuga *et al.* 2010b).

Issues with SCD for priority diseases have improved with the mandatory development of IDSR technical guidelines in most countries. However, the distribution of these guidelines and their availability in local languages at the periphery marred its success (Pond *et al.* 2011; Rumisha *et al.* 2007). As a result, staff tended to rely more on their academic training and skills. Weak participation of the private sector along with poor community-based surveillance components remain essential gaps in the IDSR as with other surveillance strategies (Abubakar 2010; CDC 2003; Franco *et al.* 2006). Unstructured and irregular supervision, lack of sustainable training strategies and little or no bottom-up approach feedback leads to an overburdened, under-compensated and demoralized peripheral staff that affects surveillance quality within the IDSR as demonstrated in most assessments (Gueye *et al.* 2006). Formal mechanisms with clear guidelines on frequency and content of supervision and feedback should therefore be developed in project implementation plans.

Under-utilization of IDSR data at all levels was reported as a result of poor data management and analysis skills. The culture of analysis was lacking and the relevance of surveillance data for decision making at district levels was grossly underestimated. Training of personnel has led to significant advances in overcoming these issues. However, in most cases, training is treated as a one-time strategy and often occurs at the launch of the programme (Sow *et al.* 2010). High attrition of personnel along with frequent turnover negated the training effect. Hence, regular training of staff is mandated and should be specified in project implementation plans. One of the best strategies is to institutionalize IDSR training in regular public health curricula (CDC 2003).

Factors such as weak laboratory infrastructures, particularly at the periphery; absence of established networks; lack of standard specimen collection, transport and processing guidelines; and inadequate lab personnel have been the old elephant

in surveillance issues in most developing countries (CDC 2003; Gueye *et al.* 2006; Nsubuga *et al.* 2010b; Pond *et al.* 2011). Although IDSR envisaged capacity building and lab strengthening at peripheral levels, and progress has been made in most countries, further consolidation efforts are necessary. Poor participation of labs in regular and outbreak surveillance leads to sub-optimal use of lab data to inform surveillance systems. Additionally, dysfunctional epidemic committees and low preparedness compromises outbreak response. Inclusion and training of lab staff specifically in surveillance activities at all levels is therefore necessary (Buckeridge 2006).

Inadequate and uneven resources (financial, human, medical supplies, communication and transport) affect all core and support functions and hence the system's attributes. Availability and access to sustainable funds are major concerns. Funding for most IDSR programme has been sought externally and this compromises sustainability (Somda *et al.* 2009). Although smooth transitions from external funding to state funding have been documented (Lukwago *et al.* 2012; Sow *et al.* 2010), the process itself is demanding and should best be avoided. Core IDSR funding should be obtained or channelled through central budgets right at the start of programmes to avoid unnecessary delays in implementation and progress.

To date, most efforts to strengthen IDSR systems have been focused on technical aspects, such as the provision of data processing equipment, logistics and laboratory structures. Limited progress has been made on all fronts. Use of modern information technology for data collection, analysis and interpretation is still lacking. Poor inclusion of the private sector in IDSR systems is a major drawback given that a significant part of health care in most low- and middle-income countries is provided by private and alternate medicine practitioners (Abubakar 2010; CDC 2003; Franco *et al.* 2006; Sathyanarayana 2010). Exclusion of non-communicable diseases (NCDs) from current integrated surveillance systems is indefensible given that most of these countries are in transition and bear the double burden of both communicable and NCDs. One may argue that the current systems are not ready to absorb additional surveillance burden given their fragility and sub-optimal performance. Nonetheless, once the existing systems are operating smoothly, inclusion of NCDs should be considered. The revised IDSR technical guidelines (2010) address

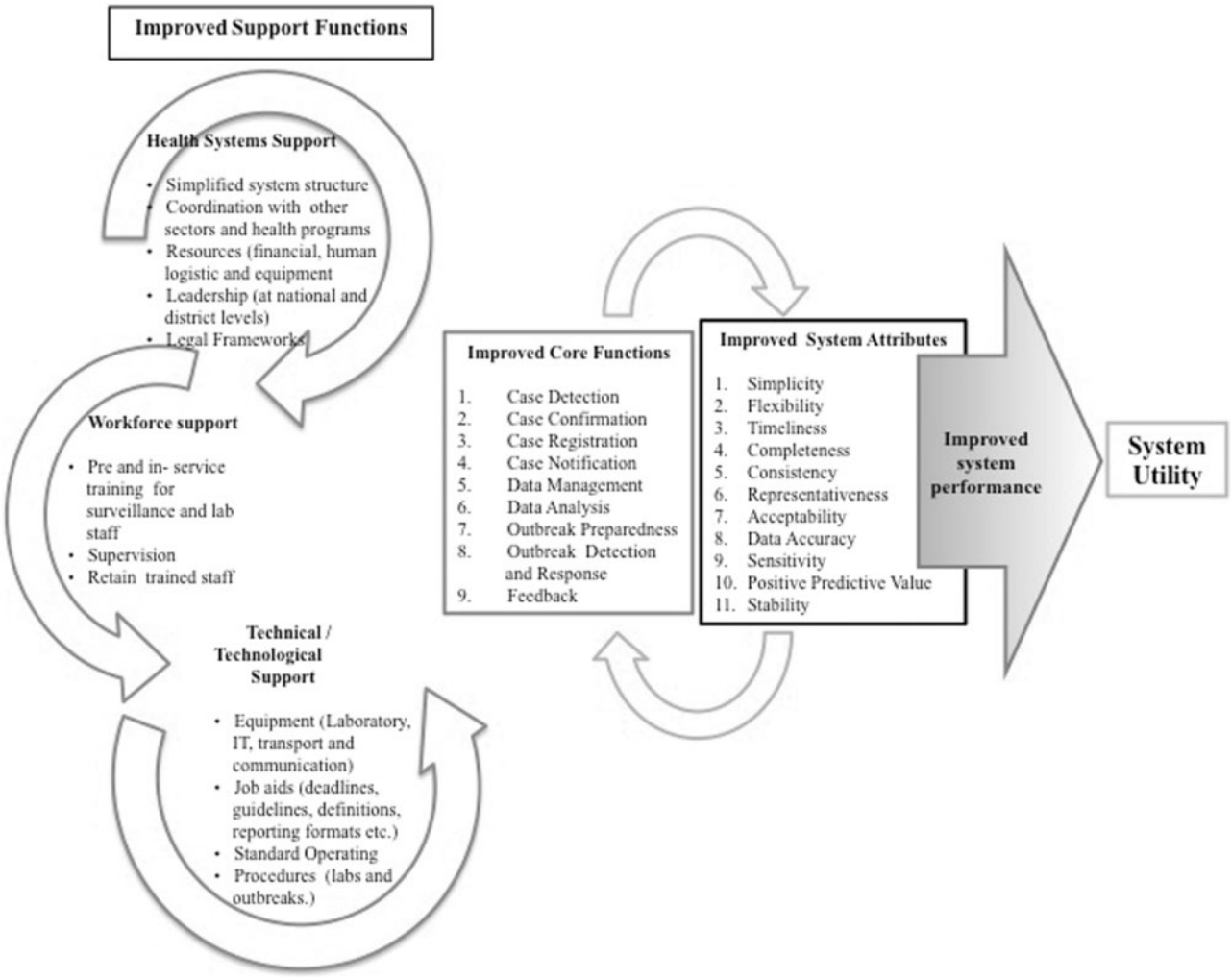

Figure 2 Support; core surveillance functions and systems attributes: symbiotic associations.

this issue but it will be a while before it is incorporated within the country systems (Kasolo *et al.* 2010). Additionally, realigning existing systems to include NCDs will help test the flexibility of current systems.

It is important to recognize that human resources and health care system support structures where the IDSR 'sits' are equally important in strengthening the overall output of the system, in addition to the technical and technological aspects (Franco *et al.* 2006). Efforts to strengthen isolated aspects lead to sub-optimal functioning. Substantial focus should be laid on the collateral consolidation of infrastructures at district levels. Quality attributes such as data accuracy, timeliness, consistency, etc. heavily depend on the core and support functions of the system (Figure 2).

Leadership at central and peripheral levels is most important to nourish ownership of the programme and partnerships within the health care sector and others hold the key (Mboera *et al.* 2005; Nsubuga *et al.* 2010a). Recent health system reforms and decentralization efforts in terms of distributed data processing in most low- and middle-income countries, including that from the IDSR, calls for a skills-based approach (Mghamba *et al.* 2004; Nsubuga *et al.* 2010b). IDSR should snugly fit into the district health information systems and mutual co-benefits should be optimally reaped. Nsubuga *et al.* (2010b) summarized the complex challenges countries face as 'to date, the challenge for most countries remain how to design integrated disease control programmes that provide maximum benefits to health service systems and how to re-design health service systems that are flexible, efficient, effective and responsive to integrated disease surveillance systems without compromising service delivery'.

Conclusion

In conclusion, the IDSR strategy has been most widely implemented in the WHO–AFRO region. Mixed challenges are reported across countries. The main challenges include non-sustainable financial resource strategies, inadequate training and turnover of peripheral staff, erratic feedback, lack of supervision from higher authorities and weak laboratory capacities coupled with scarce job aids such as case definitions, reporting formats and poor communication and transport systems. Best outcomes in core surveillance functions and quality attributes were seen when support functions [laboratory capacity, supervision, training, resources (financial, human, material/equipment) and co-ordination] perform optimally. All of the weaknesses identified in IDSR implementation were 'systemic' in nature. IDSR will best benefit from skill-based training of personnel and strengthening health care system infrastructures alongside support surveillance functions at the district levels.

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Author contribution

R.K.P conceptualized and designed the study; analysed and interpreted of the data; wrote first draft of the manuscript and revised the manuscript. S.Y. analysed and interpreted the data; and revised it for content and for English language. P.A. and M.M. participated in the conception and design of the study and provided comments for revision of the manuscript.

Conflict of interest

None declared.

Supplementary Data

Supplementary data are available at *Health Policy and Planning* online.

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