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A deeper dive into the Laboratory Component of the Integrated Disease Surveillance Programme (IDSP) in Bihar: A mixed-method study

Abstract

Background: Authentic, reliable and valid laboratory information have become a crucial component of disease surveillance and the base upon which treatment, prevention and control programmes are prioritized. Public health laboratories under the Integrated Disease Surveillance Programme (IDSP) in India perform diagnostic testing for routine surveillance of traditional infectious diseases along with emerging and re-emerging diseases. The primary objectives of this study were to assess the capacity, preparedness and performance of the public health laboratories and individual-level perspectives on IDSP among lab technicians in Bihar.

Methods: A mixed-method approach was used to assess the functionality of the public laboratories reporting to IDSP in Bihar. Initially, the Infectious Disease Surveillance Quality Index was constructed for all 38 districts of Bihar to assess the performance of IDSP. One district from each performance category of good (Begusarai), average (Darbhanga) and poor (Bhojpur) were randomly selected for the current study. For the quantitative part of the study, all 62 public health laboratories in the three districts were assessed using an exhaustive checklist and one consenting laboratory technician involved with IDSP from each laboratory was interviewed using an online/offline synchronized data collection application. In-depth qualitative interviews were also conducted with on-duty 45 consenting laboratory technicians, 15 from each of the three studied districts to gain insights into the specific role and responsibilities of lab technicians during routine surveillance activities, outbreak investigation process, motivation, job-related stress and suggestions to improve the current IDSP and laboratory capacity.

Findings: On an average, the participants were 41 years old and had 4 years of experience in IDSP. The majority were Hindu, a native of Bihar and had completed graduation. About 90% of the respondents were contractual staffs and about 77% reported receiving formal training on IDSP. Quantitative analysis from the majority of the surveyed labs revealed insufficient procedural and documentational readiness, lack of cleanliness and poor condition of equipment, inappropriate bio-safety and bio-medical waste management

process, limited availability of basic resources including consumables, culture media, protective gears, microscopes, freezer, autoclave, ELISA reader and supplies for collection of specimens. Moreover, only 40% of the laboratories had any internal quality control. In-depth interviews with the laboratory technicians reinforced these quantitative findings. Furthermore, participants shared the challenges to reach the affected communities during an outbreak in remote areas. Modification of the IDSP reporting format to include more information, clear and simple display of information regarding tests performed and those done free of cost outside the labs, strengthening infrastructure for preservation of samples/specimen or reagents and regular training on IDSP, particularly the emerging, re-emerging and newer pathogens were some of the possible solutions suggested by the participants. Results indicated that lack of trained human resources, weak infrastructure, inefficient quality control and poor practice among lab personnel had contributed to sub-optimal provision of diagnostic services under infectious disease surveillance in Bihar.

Conclusion: Laboratory-supported surveillance facilitates the early detection of probable cases as well as helps to identify emerging and re-emerging pathogens, critical for prevention of future outbreaks. A strong and efficient public health laboratory network is the need of the hour in the state of Bihar as it is experiencing the crippling burden of communicable diseases endemic to Bihar as well as emerging and re-emerging infections.

Keywords: Laboratory surveillance, IDSP, Mixed method, Bihar, India

Introduction

The preparedness for effective response to communicable disease outbreaks requires an efficient and sensitive nationwide disease surveillance system. Of late, epidemic-prone emerging and re-emerging diseases have alerted the public health setup and surveillance systems all over the world to enhance operational readiness and communication. (1-3) Given that such pandemics could trigger devastating social, economic and health impacts, these should be tackled and contained at the earliest. (4) Therefore, accurate diagnosis through testing forms the backbone of infection control program and rapid outbreak response. (5-8) Initiation of appropriate treatment following early diagnosis prevents avoidable deaths and supports the practice of evidence-based medicine. (9) The role of laboratory surveillance appears critical for effective control of public health threats during an outbreak and emergency response. Laboratory information are important not only for early warning signals, outbreak detection, response and management but for monitoring

disease trend, evaluation and monitoring progress of ongoing control measures. (8)

Against this backdrop and learnings from other developing countries, the Government of India launched the Integrated Disease Surveillance Programme (IDSP) in 2004. IDSP's three-tier administrative structure consists of the National Surveillance Units (NSU), State Surveillance Unit (SSU) and the District Surveillance Units (DSU) comprising surveillance officers and supported by epidemiologists, microbiologists, data entry operators and data managers. (6) The National Centre for Disease Control (NCDC) under the Directorate General of Health Service, Ministry of Health and Family Welfare is the nodal agency for IDSP in India. (6) The IDSP was adopted by the Government of Bihar in 2007 and rolled out in phasic manner to all 38 districts of the state during 2008 and 2009. This was adopted by the state to strengthen district-level surveillance capacities for detecting, confirming and responding to priority diseases that afflict the population. (10) Evidence suggests that strong laboratory support is a pre-requisite for early warning, detection and monitoring of disease trend so that timely public health action could be adopted. (11,12)

The International Health Regulations (IHR, 2005) published by the World Health Organization (WHO) recognised the role of public health laboratory in surveillance and outbreak response and advocated to strengthen national laboratory strategic plans using a standard reporting format having interconnections with regional and sub-regional laboratories. (12,13) Furthermore, laboratory confirmation of epidemic-prone diseases is crucial for an effective national response to infectious disease threat, developing case-specific management guidelines, treatment protocol and control of communicable diseases. (14,15) Therefore, it's the Government's responsibility to ensure functional laboratory with well-trained staff, basic infrastructural support, consumables and equipment so that each country could meet the global objectives and national priorities. (16)

Despite the critical role of laboratory in disease surveillance, investment in enhancing laboratory capacity and maintenance are limited in majority of the developing countries. (17,18) In India, reporting of laboratory confirmed case under the IDSP using a prescribed format known as L form are mandated by the Government of India as a part of routine surveillance. (10) During the early years of surveillance, upgradation of laboratory set-up from the peripheral to the national level and ensuring quality assurance became mandatory for improving diagnostic accuracy across the country. However, due to limited human resources and fund restraints, upgradation of existing laboratories was done in a

phased manner throughout India. As a part of laboratory strengthening, the upgraded laboratories were provided with trained work force and funds for procuring essential equipment, reagents and consumables so that laboratories can run efficiently. A network of referral laboratories was established and they were linked with medical colleges in each state to carry out selective diagnosing testing, an essential step in effective control of infectious disease outbreak. (19)

Despite playing a critical role in disease surveillance, the laboratory component has not received due attention in resource-poor countries including India. (20) Evidence indicated several challenges associated with having a functional laboratory which included insufficient laboratory supplies, lack of essential equipment, limited trained staff, poor quality control, ineffective logistical support, weak laboratory network, lack of laboratory policies and strategies, inadequate monitoring and absence of specific indicators to measure efficiency of laboratory surveillance. (21-23)

Published literature showed limited studies on detailed assessment of laboratory surveillance under the IDSP in the country, especially in less developed states where reporting of suspected cases of infectious diseases appeared to be high. Thus, a comprehensive evaluation of the laboratory component of the ongoing IDSP in Bihar would help to develop insights regarding the gaps in identifying burden of endemic and epidemic-prone diseases, outbreak investigation process, changes in disease aetiology, emergence and re-emergence of new diseases, dissemination of surveillance data and integration with other public health labs at the national level. The current study was conducted to explore functionality and infrastructure of public health laboratories under IDSP in Bihar, one of the backward states in the country. In addition, qualitative interviews were conducted with laboratory technicians to have a better understanding of the specific role and responsibility of lab technicians during routine surveillance activities, outbreak investigation process, motivation, job-related stress and suggestions to improve the current IDSP and laboratory capacity.

Methods

Study Setting

The study was conducted in the state of Bihar which is located in the eastern part of India. A land-locked state between West Bengal in the east and Uttar Pradesh in the west, bounded by Nepal in the north and Jharkhand in the south. The main languages spoken in the state are Hindi, Bhojpuri, Magahi and Maithili. Bihar is currently suffering from a high burden of infectious diseases, challenges of increasing non-communicable diseases and emergence of new pathogens causing epidemics and pandemics. (24)

Out of several disease control initiatives in Bihar, IDSP is the largest surveillance program looking after thirty infectious diseases in the state. This state-surveillance initiative is a decentralised programme focused mainly at the district and block levels. At the ground (sub centre) level, Auxiliary Nurse Midwives (ANM) with the help of key informants like Accredited Social Health Activists (ASHA) undertake data collection through the Form-S (based on syndromic approach) on a weekly basis. Provisional diagnosis via Form-P (presumptive cases) is used by the clinicians at the Health Centre level and Form-L (laboratory cases) for the lab-confirmed cases is reported by the laboratory personnel under the supervision of Medical Officer-in charge. PLS forms collected from all reporting units (sub-centre, Primary Health Centre (PHC) & laboratory) are uploaded onto IDSP portal from each district on Thursday. No data can be incorporated after that as the system freezes. Analysis is conducted at the district level as well as at the state level.

The current laboratory network and capacity in Bihar has improved significantly from the initial stages of IDSP in Bihar. As of 2019, there was one functional District Public Health Lab (DPHL) in Patna Medical College and Hospital (PMCH) and five new DPHL were sanctioned in Jamui, Siwan, Rohtas, East Champaran and Purnea. Other than the DPHL, five referral labs are also housed in the medical colleges of Nalanda Medical College and Hospital (NMCH, Patna), Jawahar Lal Nehru Medical College and Hospital (JLNMCH, Bhagalpur), Darbhanga Medical College and Hospital (DMCH, Darbhanga), Shri Krishna Medical College and Hospital (SKMCH, Muzaffarpur), Anugrah Narayan Magadh Medical College and Hospital (ANMCH, Gaya). Information about laboratory surveillance is filled by Lab Assistants/Technician at PHC/Community Health Centre (CHC) through Medical Officer-in charge (MO-IC) where only Tuberculosis, Typhoid & Malaria tests are undertaken. At the facility level, a register is maintained and the information is uploaded

onto the IDSP portal. After confirmation from MO-IC, line listing for all positive cases is done and documented in both L-Form and lab register. Two copies of the L-Forms are maintained for reporting (Yellow (send to DSU) & Blue (kept at the lab)). During outbreaks, the personnel in the field have a proactive and prompt role to report early warning signals for notifiable diseases.

In general, the source of information for any outbreak generally comes from the Medical Officer-incharge (MOIC) based on presumptive surveillance, Community Health Workers based on syndromic surveillance or the Media. The laboratory surveillance is another important component of disease outbreak detection though very few outbreaks have been notified by laboratory surveillance in Bihar. In case of any outbreak, data is collected in early warning signal (EWS) format filled in by MO-IC at PHC/CHC/Private Hospital/Nursing homes or by ANM at sub-centre and send to the next higher level.

To effectively tackle epidemics and outbreaks, each district in Bihar has a Rapid Response Team (RRT) that comprised clinician, epidemiologist, entomologist, district vector-borne disease control program officer, district immunization officer and respective program officers, laboratory technician and also officers from animal husbandry, public health engineering department, food and safety. The typical outbreak intervention usually consists of the RRT visiting the affected areas and investigating the causal factors and provide treatment while generating community awareness and implementing effective control measures. Laboratory technicians in the RRT collect biological sample and send them to the referral labs for confirmation.

Study design

A mixed method approach (cross-sectional survey followed by in-depth-interview based qualitative deep dive) was employed to assess and understand the implementation gaps of IDSP laboratory component in Bihar.

Timeframe

January and April 2019

Sampling method and selection of participants

All the 38 districts of Bihar were eligible to be included in the study. To have a better understanding of the performance of each district related to IDSP, some standard core indicators as recommended by WHO and CDC, for which complete state-level data were available, had been applied in the current paper. In the current study, the districts' weekly (IDSP) performance was measured by analysing the completeness and timeliness of S-reporting forms (a prescribed reporting format for disease-specific syndrome by ANM) for a period of 52 weeks (July 2017-June 2018) in the state. An infectious disease surveillance Quality Index for Districts (IDSQID) was obtained, validated and measured for all the 38 districts of Bihar based on standard WHO/CDC/GOB-recommended core IDSP indicators through the analyses of secondary data. Accordingly, the districts were categorized into poor (<60%), average (60% and <80%) and good (80%) based on tertile distributions of IDSQI. Among the 38 districts of the state, 14 were identified as poor, and 12 each as average and good performing. One district was randomly selected from each category. Begusarai was selected as good performing, Darbhanga as average performing and Bhojpur as poor performing. Following selection of the districts, all functional reporting units for PLS-Form of the three selected districts were enlisted. In the 3 selected districts, all 62 designated laboratories for IDSP and one consenting on-duty technician involved with IDSP were included (Begusarai=23, Bhojpur=17 & Darbhanga=22) for quantitative data. Qualitative Data was obtained by personal interview of 45 consenting on-duty laboratory technicians working under IDSP (15 from each district) in all the three study districts. Any lab technician not willing to participate or not involved with IDSP reporting and testing was excluded.

Under source of quantitative data

Interviewer-administered personal interview with the help of an online/offline synchronised data collection application was used to collect the information. The assessment employed a structured questionnaire and observation checklists regarding: (a) Current level of preparedness and response towards notifiable infectious diseases covered under the IDSP, (b) Functioning of laboratory surveillance system for infectious diseases including core and support functions, supervision and response activities and

performance of the laboratory staff in carrying out the recommended surveillance functions, (c) Measuring quality of surveillance for specific diseases or public health events, (d) Existing practice of documentation and reporting, (e) Checking documentations available including IDSP register, laboratory test register, facility reporting forms, documentation of suspected outbreaks, supervisory checklists. Special emphasis was given to: 1. Existing list of diseases under surveillance being tested, 2. Availability and implementation of specific protocols/guidelines/standards for the laboratory testing and documentation of infectious diseases identified at the facility and community, 3. Flow of information, feedback mechanism and training, and 4. Performance of the laboratory personnel and their predictors.

Source of qualitative data

Qualitative data were collected through key informant interviews from all the three selected districts in the state of Bihar. Key informants included laboratory technicians involved in IDSP duties and present during the time of visit to the lab facility. Qualitative analysis was done to gain a comprehensive understanding of the individual level gaps in disease surveillance activities and perceptions of surveillance among the laboratory staff. This was important for deciding on priorities and making decisions about strategies and interventions. In general, the length of the interviews ranged between 25 and 45 minutes.

Data Analysis

Quantitative data analysis was done with SAS software version 9.4. All the numerical (continuous) variables were summarized for mean and 95% confidence Interval (CI). Categorical variables were tabulated for frequency percentage and 95% Confidence Interval (CI) of each category. Categories were clubbed logically and systematically if needed for carrying out statistical analysis, based on literature review so that the analysis had sufficient power. Some categorizations for variables were based on percentile distribution upon suitable transformation of the respective values of the basic variable aiming at normalization. A composite index score was constructed for assessing the overall procedural preparedness, general cleanliness, general organization, cleanliness of the incubator, condition of freezers, microscopes, autoclaves and ELISA reader. The tertile distribution of the score was categorized into good, fair and poor, with lowest tertile being the poor. The level of significance is set at 5%.

For qualitative analysis, in-depth interviews, with pre-tested interview guides, were audio-recorded with prior permission of the participants and later transcribed, preferably within 24-hours of the interview. The transcribed documents were imported into ATLAS.ti version 8, and content analysis was done using the Grounded Theory Approach. The transcripts were coded carefully without missing any relevant information. Familiarization with the data subsequently led to the refinement of codes followed by summarization into thematic areas and development of a broader analytical framework. Any discrepancies were resolved after discussion with the larger research team.

Results

Quantitative Data

Socio-demographic characteristics & job-related factors

All together information was obtained from 62 laboratory personnel (Begusarai=23, Darbhanga=22 & Bhojpur=17) from each public health laboratory in the three study districts. The mean age of the respondents was 40.77 (95%CI 39.33-42.22) years. Majority of the respondents were Hindus (80.65% (95%CI 70.53-90.76)) and had completed graduation (61.29 95%CI (48.82-73.76)) in the three studied districts, with Bhojpur having the highest proportion (82.35% (62.15-100.0)) of graduates. More than 90% of the technicians were hired contractually (90.32(82.75-97.89)), a native of Bihar (96.77 95%CI (92.25-100.0)) and had spent on average about 9 years and 10 months (118.13 months (95%CI 104.23-132.02)) on the job. In general, the respondents had been involved with the IDSP for little over four years (mean= 51.19 months (95%CI 42.80-59.59)). Using own vehicle seemed to be the preferred mode for transport to work in Begusarai (60.87 95%CI (39.29-82.45)) and Darbhanga (59.09 95%CI (36.78-81.40)), while majority (64.71 95%CI (39.38-90.03)) travelled by foot in Bhojpur. Also, in Bhojpur 70.59% (95%CI 46.44-94.74) of the technicians had not received any special training related to IDSP. (Table 1)

Presence of key documents

Overall, only 14 of 62 labs received a copy of Standard Operating Procedure (SOP) from the state. None of the laboratories in Bhojpur had a copy of SOP, guideline for budget allocation, reagent kit registers and national vaccination policy for lab workers. Even in districts where special training was given to nearly all, the presence of standard operating

procedure (SOP) (8 of 23 in Begusarai and 6 of 22 in Darbhanga), guideline for budget allocation (1 of 23 in Begusarai and none in Darbhanga) and national vaccination policy for lab workers (2 of 23 in Begusarai and none of the 22 in Darbhanga) were missing. Only 7 of 40 in the other two districts had an annual maintenance contract (AMC) for instruments and none in Darbhanga. Similarly, only 15 of the 40 laboratories in Begusarai and Bhojpur and none in Darbhanga had any record of consumables and reagents purchased.

Though majority of the laboratories visited in the three districts had stock registers (53 of 62), presence of external quality assessment scheme was missing in 83.87% (95%CI 74.45-93.29) of them. In all, 21 of 62 labs had certification and accreditation documents including calibration & validation certificates while 72.73% (95%CI 52.52-92.94) of the labs in Bhojpur did not have maintenance logbook. Logbooks were absent in 45.45% 95%CI (22.86-68.05) and 70.59% 95%CI (46.44-94.74) of the labs in Darbhanga and Bhojpur, respectively. Overall, only 40.32% had a training module for lab workers and 33.87% could document the presence of any policy for waste management and disposal.

National guidelines for specimens packaging was absent in 58 of the 62 labs, while only 19 (of which 12 were in Bhojpur) had the national guideline for the transport of infectious materials. Information on costs and turn-about time for the test results was available to patients in only 22.58% (95%CI 11.88-33.29) of the labs in the three districts. Also, there was no standardized request form for tests in majority of the laboratories (64.52 95%CI (52.27-76.77)) where as for reporting results standardized form were available (62.90 95%CI (50.54-75.27)). Results of internal quality control reports were also unavailable in 40 labs.

Only 12 of the 62 units had a list of hazards associated with proposed lab work, while 35 did not have a list of the notifiable diseases the laboratory must report on to the IDSP. Regarding inventory log book, 91.30% 95%CI (78.85-100.0) of the laboratories in Begusarai lacked them, though 16 of the 32 in the other two districts had them in their possession.

Overall, the laboratories in all the three districts were very poor regarding procedural preparation and documentation (41.94% (95%CI 29.30-54.57)). (Table 2)

Assessment of the laboratory structure

General cleanliness and organization were found to be poor in 10 of the 22 laboratories in Darbhanga. Incubators were not clean in 77.42% (95%CI 66.71-88.12) of all surveyed labs in the three studied districts. Near about 21% (95%CI 10.55-31.39) of the labs had microscopes in a poor condition. Furthermore, the maintenance of autoclave and Eliza reader was also

poor in 57 of the 62 units. Only 3 of the 17 labs in Bhojpur had a clean and working refrigerator, while 27 of 45 labs in the other two districts had a working refrigerator. Of the 30 working refrigerators in the three districts, only 7 had internal thermometers and temperature chart was maintained for only 4 of them.

Blood culture bottles were not available in 38 of the 39 laboratories of Darbhanga and Bhojpur districts and petri dishes were not organized in 60 of the 61 labs in the three districts. Cleanliness of the incubators was poor in 77.42% (95%CI 66.71-88.12) of the visited laboratories. In 40.91% (95%CI 18.60-63.22) of the labs in Darbhanga, the samples collected were not adequately labelled. Availability of personal protection equipment such as lab coats (38.71% (95% CI 26.24-51.18)), gloves (77.42(95%CI 66.71-88.12)), glasses (14.52(95%CI 5.50-23.53)), masks (50.00(95%CI 37.20-62.80)) and protective footwear (none)was inadequate. Provision for disinfection of benches at the end of the work, separate waste (lid-covered) containers for non-contaminated and contaminated wastes and regular clearance of waste were not available in 24, 28 and 13 of the 62 labs in the three studied districts.

Findings indicated that consumables for culture and ELISA were present in 10% and 11% of labs, respectively. In total,48.39% (95%CI 35.59-61.18) of the labs did not have the new L-forms. Even though the inability to confirm malaria and tuberculosis was moderately low in the labs due to the presence of strong vertical programs, inability to confirm Typhoid, Cholera, Shigellosis, Leptospirosis, Meningococcal Meningitis, Japanese Encephalitis, Diphtheria, Hepatitis, Measles, Dengue and Chikungunya was alarmingly high. (Table 3)

Assessment of lab functionality & reporting

Logbooks/lab register were correctly filled for all listed diseases under IDSP in 42 of the 50 laboratories. Line list registers for all laboratory-confirmed positive cases were present in only 36 of the 62 labs, but all filled correctly. Approximately 61% (61.29 95%CI (48.82-73.76)) laboratories uploaded weekly report of L-forms onto IDSP portal. Only 40% (40.32(95%CI 27.76-52.88)) surveyed labs practised some degree of internal quality control mechanism and about 16% (16.13(95%CI 6.71-25.55)) labs could document bio-safety and bio-medical waste management practices. Approximately 34% (33.87(95%CI 21.75-45.99)) lab technicians admitted transport of specimen to the referral lab for confirmation. Perhaps the most concerning fact is that less than 2% (1.61(95%CI 0.00- 4.84)) lab staff received the recommended vaccination. List of referral labs was documented only in 31%

labs (30.65(95%CI 18.84-42.45)). Training on IDSP by district officials was imparted to lab technicians in 49 out of total 62 labs. The majority reported that such training was provided at least once preceding 6-12 months. Interestingly, a trained lab technician was present in all the units of the three districts (Table 3&4).

Logistic regression analysis was conducted to determine the factors associated with the practice of correctly filling "L" forms. In both unadjusted and adjusted models, no significant associations were found between demographic factors (age, education), receiving formal training on IDSP, overall condition of the lab and correctness in filling up the forms. This finding could be attributable to the small sample size and lack of statistical power. (Table 5)

Table 1: Distribution of socio-demographic characteristics and job-related factors of lab technicians, Bihar, 2019 (n=62)

Description	Overall		Begusarai		Darbhanga		Bhojpur	
	N	Mean (95% CI)	N	Mean (95% CI)	N	Mean (95% CI)	N	Mean (95% CI)
Age of the respondent (years)	62	40.77 (39.33-42.22)	23	41.52(39.03-44.01)	22	41.36(38.67-44.05)	17	39.00(36.44-41.56)
Duration in current job (months)	62	118.13 (104.23-132.02)	23	112.78(91.65-133.91)	22	124.73(91.78-157.67)	17	116.82(102.44-131.21)
Duration in IDSP (months)	62	51.19 (42.80-59.59)	23	53.70(43.07-64.33)	22	43.68(26.15-61.21)	17	57.53(40.04-75.02)
	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Employment contact	6	9.68(2.11-17.25)	2	8.70 (0.00-21.15)	4	18.18 (0.68-35.68)	-	-
	56	90.32(82.75-97.89)	21	91.30 (78.85-100.0)	18	81.82 (64.32-99.32)	17	100.0 (100.0-100.0)
Religion	50	80.65(70.53-90.76)	17	73.91 (54.50-93.33)	19	86.36 (70.79-100.0)	14	82.35 (62.15-100.0)
	12	19.35(9.24-29.47)	6	26.09 (6.67-45.50)	3	13.64 (0.00-29.21)	3	17.65 (0.00-37.85)
Education	24	38.71(26.24-51.18)	11	47.83 (25.74-69.91)	10	45.45 (22.86-68.05)	3	17.65 (0.00-37.85)
	38	61.29(48.82-73.76)	12	52.17 (30.09-74.26)	12	54.55 (31.95-77.14)	14	82.35 (62.15-100.0)
Special training	48	77.42(66.71-88.12)	22	95.65 (86.64-100.0)	21	95.45 (86.00-100.0)	5	29.41 (5.26-53.56)
	14	22.58(11.88-33.29)	1	4.35 (0.00-13.36)	1	4.55 (0.00-14.00)	12	70.59 (46.44-94.74)
Residence	60	96.77(92.25-100.0)	22	95.65 (86.64-100.0)	22	100.0 (100.0-100.0)	16	94.12 (81.65-100.0)
	2	3.23(0.00- 7.75)	1	4.35 (0.00-13.36)	-	-	1	5.88 (0.00-18.35)
Mode of transport to work place	22	35.48(23.23-47.73)	2	8.70 (0.00-21.15)	9	40.91 (18.60-63.22)	11	64.71 (39.38-90.03)
	10	16.13(6.71-25.55)	7	30.43 (10.09-50.78)	-	-	3	17.65 (0.00-37.85)
	30	48.39(35.59-61.18)	14	60.87 (39.29-82.45)	13	59.09 (36.78-81.40)	3	17.65 (0.00-37.85)

Table 2: Distribution of key documents in the public health laboratories under IDSP, Bihar, 2019

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Presence of Standard Operating Procedure (SOP)	No	48	77.42(66.71-88.12)	15	65.22 (44.16-86.28)	16	72.73 (52.52-92.94)	17	100.0 (100.0-100.0)
	Yes	14	22.58(11.88-33.29)	8	34.78 (13.72-55.84)	6	27.27 (7.06-47.48)	-	-
Presence of Guideline for budget allocation	No	61	98.39(95.16-100.0)	22	95.65 (86.64-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	1	1.61(0.00- 4.84)	1	4.35 (0.00-13.36)	-	-	-	-
Presence of Reagent Kit Register	No	25	40.32(27.76-52.88)	1	4.35 (0.00-13.36)	13	59.09 (36.78-81.40)	17	100.0 (100.0-100.0)
	Yes	37	59.68(47.12-72.24)	22	95.65 (86.64-100.0)	9	40.91 (18.60-63.22)	0	0 (0.00-0.00)
Presence of Stock Register	No	9	14.52(5.50-23.53)	-	-	6	27.27 (7.06-47.48)	3	17.65 (0.00-37.85)
	Yes	53	85.48(76.47-94.50)	23	100.0 (100.0-100.0)	16	72.73 (52.52-92.94)	14	82.35 (62.15-100.0)
Presence of External Quality Assessment Scheme	No	52	83.87(74.45-93.29)	20	86.96 (72.07-100.0)	17	77.27 (58.25-96.29)	15	88.24 (71.16-100.0)
	Yes	10	16.13(6.71-25.55)	3	13.04 (0.00-27.93)	5	22.73 (3.71-41.75)	2	11.76 (0.00-28.84)
Presence of Certification and accreditation documents including calibration & validation certificates	No	41	66.13(54.01-78.25)	12	52.17 (30.09-74.26)	15	68.18 (47.04-89.32)	14	82.35 (62.15-100.0)
	Yes	21	33.87(21.75-45.99)	11	47.83 (25.74-69.91)	7	31.82 (10.68-52.96)	3	17.65 (0.00-37.85)
Presence of Operation and maintenance of instrument	No	20	32.26(20.29-44.23)	-	-	16	72.73 (52.52-92.94)	4	23.53 (1.05-46.01)
	Yes	42	67.74(55.77-79.71)	23	100.0 (100.0-100.0)	6	27.27 (7.06-47.48)	13	76.47 (53.99-98.95)
Presence of Logbooks or Lab Information System Records	No	25	40.32(27.76-52.88)	3	13.04 (0.00-27.93)	10	45.45 (22.86-68.05)	12	70.59 (46.44-94.74)
	Yes	37	59.68(47.12-72.24)	20	86.96 (72.07-100.0)	12	54.55 (31.95-77.14)	5	29.41 (5.26-53.56)
Presence of Lab worker training module	No	37	59.68(47.12-72.24)	11	47.83 (25.74-69.91)	14	63.64 (41.81-85.47)	12	70.59 (46.44-94.74)
	Yes	25	40.32(27.76-52.88)	12	52.17 (30.09-74.26)	8	36.36 (14.53-58.19)	5	29.41 (5.26-53.56)
Presence of Policy or regulation for waste management and disposal	No	41	66.13(54.01-78.25)	19	82.61 (65.85-99.37)	15	68.18 (47.04-89.32)	7	41.18 (15.09-67.26)
	Yes	21	33.87(21.75-45.99)	4	17.39 (0.63-34.15)	7	31.82 (10.68-52.96)	10	58.82 (32.74-84.91)
Presence of National document for specimens packing	No	58	93.55(87.26-99.84)	22	95.65 (86.64-100.0)	20	90.91 (77.86-100.0)	16	94.12 (81.65-100.0)
	Yes	4	6.45(0.16-12.74)	1	4.35 (0.00-13.36)	2	9.09 (0.00-22.14)	1	5.88 (0.00-18.35)

Table 2 : Distribution of key documents in the public health laboratories under IDSP, Bihar, 2019 (contd.)

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Presence of National regulations for the transport of infectious materials	No	43	69.35(57.55-81.16)	22	95.65 (86.64-100.0)	16	72.73 (52.52-92.94)	5	29.41 (5.26-53.56)
	Yes	19	30.65(18.84-42.45)	1	4.35 (0.00-13.36)	6	27.27 (7.06-47.48)	12	70.59 (46.44-94.74)
Presence of National vaccination policy for lab workers	No	60	96.77(92.25-100.0)	21	91.30 (78.85-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	2	3.23(0.00- 7.75)	2	8.70 (0.00-21.15)	-	-	-	-
Presence of National guidelines in use (Standard Operating Procedure or SOP)	No	50	80.65(70.53-90.76)	15	65.22 (44.16-86.28)	18	81.82 (64.32-99.32)	17	100.0 (100.0-100.0)
	Yes	12	19.35(9.24-29.47)	8	34.78 (13.72-55.84)	4	18.18 (0.68-35.68)	-	-
Presence of Lab own operating documents (Instructions, SOP)	No	45	72.58(61.16-84.00)	13	56.52 (34.60-78.44)	17	77.27 (58.25-96.29)	17	100.0 (100.0-100.0)
	Yes	17	27.42(16.00-38.84)	10	43.48 (21.56-65.40)	5	22.73 (3.71-41.75)	0	0.00 (0.00-0.00)
Information on costs and turnaround time for the test results available to patients	No	48	77.42(66.71-88.12)	18	78.26 (60.02-96.50)	18	81.82 (64.32-99.32)	12	70.59 (46.44-94.74)
	Yes	14	22.58(11.88-33.29)	5	21.74 (3.50-39.98)	4	18.18 (0.68-35.68)	5	29.41 (5.26-53.56)
Copies of any reports for review	No	24	38.71(26.24-51.18)	4	17.39 (0.63-34.15)	12	54.55 (31.95-77.14)	8	47.06 (20.61-73.51)
	Yes	38	61.29(48.82-73.76)	19	82.61 (65.85-99.37)	10	45.45 (22.86-68.05)	9	52.94 (26.49-79.39)
Standardized request form for tests prescribers	No	40	64.52(52.27-76.77)	17	73.91 (54.50-93.33)	16	72.73 (52.52-92.94)	7	41.18 (15.09-67.26)
	Yes	22	35.48(23.23-47.73)	6	26.09 (6.67-45.50)	6	27.27 (7.06-47.48)	10	58.82 (32.74-84.91)
Standardized form for results reporting	No	23	37.10(24.73-49.46)	7	30.43 (10.09-50.78)	12	54.55 (31.95-77.14)	4	23.53 (1.05-46.01)
	Yes	39	62.90(50.54-75.27)	16	69.57 (49.22-89.91)	10	45.45 (22.86-68.05)	13	76.47 (53.99-98.95)
Results of Internal Quality Control	No	40	64.52(52.27-76.77)	17	73.91 (54.50-93.33)	15	68.18 (47.04-89.32)	8	47.06 (20.61-73.51)
	Yes	22	35.48(23.23-47.73)	6	26.09 (6.67-45.50)	7	31.82 (10.68-52.96)	9	52.94 (26.49-79.39)
Record of consumables and reagents purchase	No	47	75.81(64.84-86.77)	12	52.17 (30.09-74.26)	22	100.0 (100.0-100.0)	13	76.47 (53.99-98.95)
	Yes	15	24.19(13.23-35.16)	11	47.83 (25.74-69.91)	-	-	4	23.53 (1.05-46.01)
Record of staff qualifications, training and experience	No	32	51.61(38.82-64.41)	3	13.04 (0.00-27.93)	20	90.91 (77.86-100.0)	9	52.94 (26.49-79.39)
	Yes	30	48.39(35.59-61.18)	20	86.96 (72.07-100.0)	2	9.09 (0.00-22.14)	8	47.06 (20.61-73.51)

Table 2 : Distribution of key documents in the public health laboratories under IDSP, Bihar, 2019 (contd.)

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
List of hazards associated with proposed lab work	No	50	80.65(70.53-90.76)	15	65.22 (44.16-86.28)	21	95.45 (86.00-100.0)	14	82.35 (62.15-100.0)
	Yes	12	19.35(9.24-29.47)	8	34.78 (13.72-55.84)	1	4.55 (0.00-14.00)	3	17.65 (0.00-37.85)
List of the notifiable diseases the lab must report	No	35	56.45(43.76-69.15)	9	39.13 (17.55-60.71)	19	86.36 (70.79-100.0)	7	41.18 (15.09-67.26)
	Yes	27	43.55(30.85-56.24)	14	60.87 (39.29-82.45)	3	13.64 (0.00-29.21)	10	58.82 (32.74-84.91)
Standardized form/document to report notifiable diseases or event	No	29	46.77(34.00-59.55)	10	43.48 (21.56-65.40)	15	68.18 (47.04-89.32)	4	23.53 (1.05-46.01)
	Yes	33	53.23(40.45-66.00)	13	56.52 (34.60-78.44)	7	31.82 (10.68-52.96)	13	76.47 (53.99-98.95)
Inventory Log Book	No	44	70.97(59.35-82.59)	21	91.30 (78.85-100.0)	14	63.64 (41.81-85.47)	9	52.94 (26.49-79.39)
	Yes	18	29.03(17.41-40.65)	2	8.70 (0.00-21.15)	8	36.36 (14.53-58.19)	8	47.06 (20.61-73.51)
Log work sheet for a particular disease	No	26	41.94(29.30-54.57)	14	60.87 (39.29-82.45)	9	40.91 (18.60-63.22)	3	17.65 (0.00-37.85)
	Yes	36	58.06(45.43-70.70)	9	39.13 (17.55-60.71)	13	59.09 (36.78-81.40)	14	82.35 (62.15-100.0)
Annual Maintenance Contract (AMC) for instruments	No	55	88.71(80.61-96.81)	19	82.61 (65.85-99.37)	22	100.0 (100.0-100.0)	14	82.35 (62.15-100.0)
	Yes	7	11.29(3.19-19.39)	4	17.39 (0.63-34.15)	-	-	3	17.65 (0.00-37.85)
Overall procedural preparedness & documentation	Poor	26	41.94(29.30-54.57)	4	17.39 (0.63-34.15)	13	59.09 (36.78-81.40)	9	52.94 (26.49-79.39)
	Average	21	33.87(21.75-45.99)	11	47.83 (25.74-69.91)	5	22.73 (3.71-41.75)	5	29.41 (5.26-53.56)
	Good	15	24.19(13.23-35.16)	8	34.78 (13.72-55.84)	4	18.18 (0.68-35.68)	3	17.65 (0.00-37.85)

Table 3: Distribution of general characteristics and overall conditions of the public health laboratories under IDSP, Bihar, 2019

Description	Overall		Begusarai		Darbhanga		Bhojpur		
	Category	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
General cleanliness	Poor	10	16.13(6.71-25.55)	-	-	10	45.45 (22.86-68.05)	-	-
	Fair	34	54.84(42.10-67.58)	9	39.13 (17.55-60.71)	11	50.00 (27.31-72.69)	14	82.35 (62.15-100.0)
	Good	18	29.03(17.41-40.65)	14	60.87 (39.29-82.45)	1	4.55 (0.00-14.00)	3	17.65 (0.00-37.85)
General organization	Poor	10	16.13(6.71-25.55)	-	-	10	45.45 (22.86-68.05)	-	-
	Fair	39	62.90(50.54-75.27)	11	47.83 (25.74-69.91)	11	50.00 (27.31-72.69)	17	100.0 (100.0-100.0)
	Good	13	20.97(10.55-31.39)	12	52.17 (30.09-74.26)	1	4.55 (0.00-14.00)	-	-
Overall cleanliness of the incubator	Poor	48	77.42(66.71-88.12)	15	65.22 (44.16-86.28)	21	95.45 (86.00-100.0)	12	70.59 (46.44-94.74)
	Fair	6	9.68(2.11-17.25)	-	-	1	4.55 (0.00-14.00)	5	29.41 (5.26-53.56)
	Good	8	12.90(4.32-21.49)	8	34.78 (13.72-55.84)	-	-	-	-
Overall condition of the freezers	Poor	40	64.52(52.27-76.77)	7	30.43 (10.09-50.78)	18	81.82 (64.32-99.32)	15	88.24 (71.16-100.0)
	Fair	11	17.74(7.96-27.52)	7	30.43 (10.09-50.78)	2	9.09 (0.00-22.14)	2	11.76 (0.00-28.84)
	Good	11	17.74(7.96-27.52)	9	39.13 (17.55-60.71)	2	9.09 (0.00-22.14)	-	-
Overall condition of microscopes	Poor	13	20.97(10.55-31.39)	1	4.35 (0.00-13.36)	8	36.36 (14.53-58.19)	4	23.53 (1.05-46.01)
	Fair	30	48.39(35.59-61.18)	8	34.78 (13.72-55.84)	12	54.55 (31.95-77.14)	10	58.82 (32.74-84.91)
	Good	19	30.65(18.84-42.45)	14	60.87 (39.29-82.45)	2	9.09 (0.00-22.14)	3	17.65 (0.00-37.85)
Overall condition of autoclave	Poor	57	91.94(84.96-98.91)	18	78.26 (60.02-96.50)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Fair	1	1.61(0.00-4.84)	1	4.35 (0.00-13.36)	-	-	-	-
	Good	4	6.45(0.16-12.74)	4	17.39 (0.63-34.15)	-	-	-	-
Overall condition of ELISA reader	Poor	57	91.94(84.96-98.91)	19	82.61 (65.85-99.37)	21	95.45 (86.00-100.0)	17	100.0 (100.0-100.0)
	Fair	2	3.23(0.00-7.75)	1	4.35 (0.00-13.36)	1	4.55 (0.00-14.00)	-	-
	Good	3	4.84(0.00-10.33)	3	13.04 (0.00-27.93)	-	-	-	-

Table 3: Distribution of general characteristics and overall conditions of the public health laboratories under IDSP, Bihar, 2019 (contd.)

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Overall condition and organization of stock shelves, expiration dates of reagents on the shelves	Poor	7	11.29(3.19-19.39)	1	4.35 (0.00-13.36)	5	22.73 (3.71-41.75)	1	5.88 (0.00-18.35)
	Fair	26	41.94(29.30-54.57)	3	13.04 (0.00-27.93)	16	72.73 (52.52-92.94)	7	41.18 (15.09-67.26)
	Good	29	46.77(34.00-59.55)	19	82.61 (65.85-99.37)	1	4.55 (0.00-14.00)	9	52.94 (26.49-79.39)
Overall cleanliness & organization	Poor	24	38.71(26.24-51.18)	1	4.35 (0.00-13.36)	18	81.82 (64.32-99.32)	5	29.41 (5.26-53.56)
	Average	19	30.65(18.84-42.45)	5	21.74 (3.50-39.98)	4	18.18 (0.68-35.68)	10	58.82 (32.74-84.91)
	Good	19	30.65(18.84-42.45)	17	73.91 (54.50-93.33)	-	-	2	11.76 (0.00-28.84)
Presence of presence of temperature chart	No	-	-	-	-	-	-	-	-
	Yes	62	100.0(100.0-100.0)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
Presence of refrigerator	No	32	51.61(38.82-64.41)	7	30.43 (10.09-50.78)	11	50.00 (27.31-72.69)	14	82.35 (62.15-100.0)
	Yes	30	48.39(35.59-61.18)	16	69.57 (49.22-89.91)	11	50.00 (27.31-72.69)	3	17.65 (0.00-37.85)
Presence of clean refrigerator	No	33	53.23(40.45-66.00)	8	34.78 (13.72-55.84)	11	50.00 (27.31-72.69)	14	82.35 (62.15-100.0)
	Yes	29	46.77(34.00-59.55)	15	65.22 (44.16-86.28)	11	50.00 (27.31-72.69)	3	17.65 (0.00-37.85)
Presence of presence of internal thermometer	No	55	88.71(80.61-96.81)	18	78.26 (60.02-96.50)	21	95.45 (86.00-100.0)	16	94.12 (81.65-100.0)
	Yes	7	11.29(3.19-19.39)	5	21.74 (3.50-39.98)	1	4.55 (0.00-14.00)	1	5.88 (0.00-18.35)
Presence of presence of temperature chart	No	58	93.55(87.26-99.84)	19	82.61 (65.85-99.37)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	4	6.45(0.16-12.74)	4	17.39 (0.63-34.15)	-	-	-	-
Presence of blood culture bottles	No	48	77.42(66.71-88.12)	10	43.48 (21.56-65.40)	22	100.0 (100.0-100.0)	16	94.12 (81.65-100.0)
	Yes	14	22.58(11.88-33.29)	13	56.52 (34.60-78.44)	-	-	1	5.88 (0.00-18.35)
Organization of the Petri dishes	No	61	98.39(95.16-100.0)	22	95.65 (86.64-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	1	1.61(0.00-4.84)	1	4.35 (0.00-13.36)	-	-	-	-
Samples labelled adequately	No	13	20.97(10.55-31.39)	-	-	9	40.91 (18.60-63.22)	4	23.53 (1.05-46.01)
	Yes	49	79.03(68.61-89.45)	23	100.0 (100.0-100.0)	13	59.09 (36.78-81.40)	13	76.47 (53.99-98.95)

Table 3: Distribution of general characteristics and overall conditions of the public health laboratories under IDSP, Bihar, 2019 (contd.)

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Re-agents labelled adequately	No	6	9.68(2.11-17.25)	-	-	4	18.18 (0.68-35.68)	2	11.76 (0.00-28.84)
	Yes	56	90.32(82.75-97.89)	23	100.0 (100.0-100.0)	18	81.82 (64.32-99.32)	15	88.24 (71.16-100.0)
Personal Protection Equipment available: Lab coats	No	38	61.29(48.82-73.76)	2	8.70 (0.00-21.15)	22	100.0 (100.0-100.0)	14	82.35 (62.15-100.0)
	Yes	24	38.71(26.24-51.18)	21	91.30 (78.85-100.0)	-	-	3	17.65 (0.00-37.85)
Personal Protection Equipment available: Gloves	No	14	22.58(11.88-33.29)	-	-	13	59.09 (36.78-81.40)	1	5.88 (0.00-18.35)
	Yes	48	77.42(66.71-88.12)	23	100.0 (100.0-100.0)	9	40.91 (18.60-63.22)	16	94.12 (81.65-100.0)
Personal Protection Equipment available: Glasses	No	53	85.48(76.47-94.50)	19	82.61 (65.85-99.37)	21	95.45 (86.00-100.0)	13	76.47 (53.99-98.95)
	Yes	9	14.52(5.50-23.53)	4	17.39 (0.63-34.15)	1	4.55 (0.00-14.00)	4	23.53 (1.05-46.01)
Personal Protection Equipment available: Masks	No	31	50.00(37.20-62.80)	6	26.09 (6.67-45.50)	16	72.73 (52.52-92.94)	9	52.94 (26.49-79.39)
	Yes	31	50.00(37.20-62.80)	17	73.91 (54.50-93.33)	6	27.27 (7.06-47.48)	8	47.06 (20.61-73.51)
Personal Protection Equipment available: Any special footwear	No	62	100.0(100.00-100.00)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	-	-	-	-	-	-	-	-
Disinfection of benches at the end of the work	No	24	38.71(26.24-51.18)	2	8.70 (0.00-21.15)	19	86.36 (70.79-100.0)	3	17.65 (0.00-37.85)
	Yes	38	61.29(48.82-73.76)	21	91.30 (78.85-100.0)	3	13.64 (0.00-29.21)	14	82.35 (62.15-100.0)
SOP or any recommended good practice strictly followed	No	41	66.13(54.01-78.25)	12	52.17 (30.09-74.26)	18	81.82 (64.32-99.32)	11	64.71 (39.38-90.03)
	Yes	21	33.87(21.75-45.99)	11	47.83 (25.74-69.91)	4	18.18 (0.68-35.68)	6	35.29 (9.97-60.62)
Regular clearance of waste	No	13	20.97(10.55-31.39)	-	-	9	40.91 (18.60-63.22)	4	23.53 (1.05-46.01)
	Yes	49	79.03(68.61-89.45)	23	100.0 (100.0-100.0)	13	59.09 (36.78-81.40)	13	76.47 (53.99-98.95)
Separate waste (lid-covered) containers for non-contaminated and contaminated wastes	No	28	45.16(32.42-57.90)	5	21.74 (3.50-39.98)	15	68.18 (47.04-89.32)	8	47.06 (20.61-73.51)
	Yes	34	54.84(42.10-67.58)	18	78.26 (60.02-96.50)	7	31.82 (10.68-52.96)	9	52.94 (26.49-79.39)
Special solvent container (any for acids)	No	29	46.77(34.00-59.55)	10	43.48 (21.56-65.40)	15	68.18 (47.04-89.32)	4	23.53 (1.05-46.01)
	Yes	33	53.23(40.45-66.00)	13	56.52 (34.60-78.44)	7	31.82 (10.68-52.96)	13	76.47 (53.99-98.95)

Table 3 : Distribution of general characteristics and overall conditions of the public health laboratories under IDSP, Bihar, 2019 (contd.)

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Logbooks/lab register present	No	12	19.35(9.24-29.47)	-	-	7	31.82 (10.68-52.96)	5	29.41 (5.26-53.56)
	Yes	50	80.65(70.53-90.76)	23	100.0 (100.0-100.0)	15	68.18 (47.04-89.32)	12	70.59 (46.44-94.74)
Logbooks/lab register correctly filled for all diseases	No	8	16.00(5.48-26.52)	-	-	2	13.33 (0.00-32.82)	6	50.00 (16.82-83.18)
	Yes	42	84.00(73.48-94.52)	23	100.0 (100.0-100.0)	13	86.67 (67.18-100.0)	6	50.00 (16.82-83.18)
Line list register present for all laboratory confirmed positive cases	No	26	41.94(29.30-54.57)	6	26.09 (6.67-45.50)	6	27.27 (7.06-47.48)	14	82.35 (62.15-100.0)
	Yes	36	58.06(45.43-70.70)	17	73.91 (54.50-93.33)	16	72.73 (52.52-92.94)	3	17.65 (0.00-37.85)
Logbooks or line list register are filled correctly	No	-	-	-	-	-	-	-	-
	Yes	36	100.00(100.00-100.00)	17	100.0 (100.0-100.0)	16	100.0 (100.0-100.0)	3	100.0 (100.0-100.0)
Summary of the logbooks or lab register done	No	27	43.55(30.85-56.24)	4	17.39 (0.63-34.15)	7	31.82 (10.68-52.96)	16	94.12 (81.65-100.0)
	Yes	35	56.45(43.76-69.15)	19	82.61 (65.85-99.37)	15	68.18 (47.04-89.32)	1	5.88 (0.00-18.35)
Availability of new L forms at lab	No	30	48.39(35.59-61.18)	12	52.17 (30.09-74.26)	16	72.73 (52.52-92.94)	2	11.76 (0.00-28.84)
	Yes	32	51.61(38.82-64.41)	11	47.83 (25.74-69.91)	6	27.27 (7.06-47.48)	15	88.24 (71.16-100.0)
L forms filled correctly	No	34	54.84(42.10-67.58)	12	52.17 (30.09-74.26)	19	86.36 (70.79-100.0)	3	17.65 (0.00-37.85)
	Yes	28	45.16(32.42-57.90)	11	47.83 (25.74-69.91)	3	13.64 (0.00-29.21)	14	82.35 (62.15-100.0)
Availability of consumables for culture	No	56	90.32(82.75-97.89)	20	86.96 (72.07-100.0)	21	95.45 (86.00-100.0)	15	88.24 (71.16-100.0)
	Yes	6	9.68(2.11-17.25)	3	13.04 (0.00-27.93)	1	4.55 (0.00-14.00)	2	11.76 (0.00-28.84)
Availability of consumables for Typhi-dot test	No	59	95.16(89.67-100.0)	22	95.65 (86.64-100.0)	20	90.91 (77.86-100.0)	17	100.0 (100.0-100.0)
	Yes	3	4.84(0.00-10.33)	1	4.35 (0.00-13.36)	2	9.09 (0.00-22.14)	-	-
Availability of consumables for ELISA test	No	55	88.71(80.61-96.81)	20	86.96 (72.07-100.0)	18	81.82 (64.32-99.32)	17	100.0 (100.0-100.0)
	Yes	7	11.29(3.19-19.39)	3	13.04 (0.00-27.93)	4	18.18 (0.68-35.68)	-	-
Ability to confirm Malaria	No	16	25.81(14.60-37.01)	7	30.43 (10.09-50.78)	7	31.82 (10.68-52.96)	2	11.76 (0.00-28.84)
	Yes	46	74.19(62.99-85.40)	16	69.57 (49.22-89.91)	15	68.18 (47.04-89.32)	15	88.24 (71.16-100.0)

Table 3 : Distribution of general characteristics and overall conditions of the public health laboratories under IDSP, Bihar, 2019 (contd.)

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Ability to confirm Typhoid	No	45	72.58(61.16-84.00)	17	73.91 (54.50-93.33)	17	77.27 (58.25-96.29)	11	64.71 (39.38-90.03)
	Yes	17	27.42(16.00-38.84)	6	26.09 (6.67-45.50)	5	22.73 (3.71-41.75)	6	35.29 (9.97-60.62)
Ability to confirm Tuberculosis	No	7	11.29(3.19-19.39)	1	4.35 (0.00-13.36)	2	9.09 (0.00-22.14)	4	23.53 (1.05-46.01)
	Yes	55	88.71(80.61-96.81)	22	95.65 (86.64-100.0)	20	90.91 (77.86-100.0)	13	76.47 (53.99-98.95)
Ability to confirm Cholera	No	61	98.39(95.16-100.0)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	16	94.12 (81.65-100.0)
	Yes	1	1.61(0.00- 4.84)	-	-	-	-	1	5.88 (0.00-18.35)
Ability to confirm Shigellosis	No	61	98.39(95.16-100.0)	23	100.0 (100.0-100.0)	21	95.45 (86.00-100.0)	17	100.0 (100.0-100.0)
	Yes	1	1.61(0.00- 4.84)	-	-	1	4.55 (0.00-14.00)	-	-
Ability to confirm Leptospirosis	No	61	98.39(95.16-100.0)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	16	94.12 (81.65-100.0)
	Yes	1	1.61(0.00- 4.84)	-	-	-	-	1	5.88 (0.00-18.35)
Ability to confirm Meningococcal Meningitis	No	62	100.00(100.00-100.00)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	-	-	-	-	-	-	-	-
Ability to confirm Japanese Encephalitis	No	62	100.00(100.00-100.00)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	-	-	-	-	-	-	-	-
Ability to confirm Diphtheria	No	62	100.00(100.00-100.00)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	-	-	-	-	-	-	-	-
Ability to confirm Hepatitis	No	35	56.45(43.76-69.15)	13	56.52 (34.60-78.44)	14	63.64 (41.81-85.47)	8	47.06 (20.61-73.51)
	Yes	27	43.55(30.85-56.24)	10	43.48 (21.56-65.40)	8	36.36 (14.53-58.19)	9	52.94 (26.49-79.39)
Ability to confirm Measles	No	62	100.00(100.00-100.00)	23	100.0 (100.0-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	-	-	-	-	-	-	-	-
Ability to confirm Dengue	No	57	91.94(84.96-98.91)	20	86.96 (72.07-100.0)	22	100.0 (100.0-100.0)	15	88.24 (71.16-100.0)
	Yes	5	8.06(1.09-15.04)	3	13.04 (0.00-27.93)	-	-	2	11.76 (0.00-28.84)
Ability to confirm Chikungunya	No	59	95.16(89.67-100.0)	21	91.30 (78.85-100.0)	22	100.0 (100.0-100.0)	16	94.12 (81.65-100.0)
	Yes	3	4.84(0.00-10.33)	2	8.70 (0.00-21.15)	-	-	1	5.88 (0.00-18.35)

Table 4 : Distribution of overall functionality of the public health laboratories under IDSP, Bihar, 2019

Description	Overall		Begusarai		Darbhanga		Bhojpur		
	Category	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Uploading weekly report of L forms at IDSP portal	No	24	38.71(26.24-51.18)	8	34.78 (13.72-55.84)	13	59.09 (36.78-81.40)	3	17.65 (0.00-37.85)
	Yes	38	61.29(48.82-73.76)	15	65.22 (44.16-86.28)	9	40.91 (18.60-63.22)	14	82.35 (62.15-100.0)
Presence of any internal quality control for this lab	No	37	59.68(47.12-72.24)	14	60.87 (39.29-82.45)	15	68.18 (47.04-89.32)	8	47.06 (20.61-73.51)
	Yes	25	40.32(27.76-52.88)	9	39.13 (17.55-60.71)	7	31.82 (10.68-52.96)	9	52.94 (26.49-79.39)
Availability of any bio-safety and bio-medical waste management policy	No	52	83.87(74.45-93.29)	23	100.0 (100.0-100.0)	17	77.27 (58.25-96.29)	12	70.59 (46.44-94.74)
	Yes	10	16.13(6.71-25.55)	-	-	5	22.73 (3.71-41.75)	5	29.41 (5.26-53.56)
Transport specimen to the referral lab for confirmation	No	41	66.13(54.01-78.25)	16	69.57 (49.22-89.91)	12	54.55 (31.95-77.14)	13	76.47 (53.99-98.95)
	Yes	21	33.87(21.75-45.99)	7	30.43 (10.09-50.78)	10	45.45 (22.86-68.05)	4	23.53 (1.05-46.01)
Any vaccinations given to the staff	No	61	98.39(95.16-100.0)	22	95.65 (86.64-100.0)	22	100.0 (100.0-100.0)	17	100.0 (100.0-100.0)
	Yes	1	1.61(0.00- 4.84)	1	4.35 (0.00-13.36)	-	-	-	-
Availability of appropriate supplies or set aside for collecting specimens during an urgent situation	No	39	62.90(50.54-75.27)	15	65.22 (44.16-86.28)	18	81.82 (64.32-99.32)	6	35.29 (9.97-60.62)
	Yes	23	37.10(24.73-49.46)	8	34.78 (13.72-55.84)	4	18.18 (0.68-35.68)	11	64.71 (39.38-90.03)
Documented list of referral labs	No	43	69.35(57.55-81.16)	15	65.22 (44.16-86.28)	15	68.18 (47.04-89.32)	13	76.47 (53.99-98.95)
	Yes	19	30.65(18.84-42.45)	8	34.78 (13.72-55.84)	7	31.82 (10.68-52.96)	4	23.53 (1.05-46.01)

Table 4 : Distribution of overall functionality of the public health laboratories under IDSP, Bihar, 2019 (contd.)

Description	Category	Overall		Begusarai		Darbhanga		Bhojpur	
		Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)	Frequency	% (95% CI)
Training on IDSP	No	13	20.97(10.55-31.39)	1	4.35 (0.00-13.36)	7	31.82 (10.68-52.96)	5	29.41 (5.26-53.56)
	Yes	49	79.03(68.61-89.45)	22	95.65 (86.64-100.0)	15	68.18 (47.04-89.32)	12	70.59 (46.44-94.74)
Frequency of training	At least once during preceding 6 months	8	16.33(5.60-27.05)	2	9.09 (0.00-22.14)	5	33.33 (6.31-60.36)	1	8.33 (0.00-26.67)
	At least once during preceding 6-12 months	34	69.39(56.01-82.76)	18	81.82 (64.32-99.32)	7	46.67 (18.07-75.26)	9	75.00 (46.26-100.0)
	None during preceding 12 months	5	10.20(1.42-18.99)	2	9.09 (0.00-22.14)	3	20.00 (0.00-42.93)	.	.
	Other (Specify)	2	4.08(0.00- 9.82)	2	16.67 (0.00-41.40)
Presence of a functional waste management system	No	18	29.03(17.41-40.65)	5	21.74 (3.50-39.98)	5	22.73 (3.71-41.75)	8	47.06 (20.61-73.51)
	Yes	44	70.97(59.35-82.59)	18	78.26 (60.02-96.50)	17	77.27 (58.25-96.29)	9	52.94 (26.49-79.39)

Table 5: Association between age, education, training, presence of key documents, overall condition of the laboratory and correctly filling the L-Form

Description	Categories	Type of OR*	L form correctly filled or not (Reference = No)	
			OR (95% CI)	P-Value
Lab Technician's age	-	UOR	0.93(0.85-1.03)	0.1461
		AOR	0.93(0.85-1.03)	0.1483
Education of the Lab Technician (Reference = Beyond 8th standard but below graduation)	Graduate/ Post-graduation	UOR	1.83(0.62-5.33)	0.2717
		AOR	1.99(0.65-6.10)	0.2271
Received formal training on IDSP (Reference = No)	Yes	UOR	1.42(0.41-4.94)	0.5860
		AOR	1.50(0.39-5.82)	0.5592
Presence of key documents (Reference = Poor) *	Average	UOR	0.88(0.28-2.79)	0.8212
		AOR	0.94(0.28-3.10)	0.9133
Overall condition of the lab (Reference = Poor) *	Good	UOR	1.02(0.29-3.65)	0.9747
		AOR	0.88(0.24-3.28)	0.8453
	Average	UOR	3.34(0.94-11.85)	0.0621
		AOR	3.04(0.83-11.08)	0.0927
	Good	UOR	2.69(0.77-9.51)	0.1223
		AOR	2.91(0.79-10.73)	0.1096

*UOR=Unadjusted Odds Ratio

AOR=Adjusted Odds Ratio after adjusting for age and education

Qualitative Data

Altogether 45 In-Depth Interviews were conducted among laboratory technicians involved with IDSP in the three studied districts (15 from each district). All qualitative data from the interviews were coded with emerging concepts and according to a-priori after which key themes and sub-themes were identified. (Table 6)

Table 6: Key themes and subthemes that emerged from the qualitative analysis

Key themes	Sub-themes	Verbatim
● Routine Investigation	● Collection of biological samples	"we collect samples from anyone who comes to the hospital without any prejudice." - Lab tech # Begusarai District
	● Proportion of suspected cases sent to lab per day	"in general, 10 to 15 patents come for testing every day." -Lab tech #Darbhanga District
	● Record keeping of investigation	"for all tests being conducted in the lab there are different registers, after testing we record in the register." -Lab tech # Bhojpur District
	● Sero-types or anti-biotic resistance patterns tests	"this I don't have any information about" -Lab tech # Darbhanga District
	● Reliable results in a timely manner	"no there is no issues with reliability of this lab. See it is important to maintain the reagents and instruments properly and that will give you correct result and that is why I have not faced any problem with reliability." -Lab tech # Begusarai District
	● Communication of results to appropriate authority	"the patient takes the report to the doctor and sometimes I go with them if they are worried" -Lab tech # Darbhanga District
	● Supply of media, equipment and other related materials	"if there is a shortage of materials we give an indent and if available in the store we get it but if it is not available in the store then we send applications endorsed by the in-charge to the management and it takes a bit of time then but is made available." -- Lab tech # Begusarai District
● Outbreak Investigation	● Detecting and confirming outbreak	"when a patient comes to me and he is tested positive and other patients from the same area also come and are found positive, it indicates an outbreak." -Lab tech # Bhojpur district
	● Action following confirmation of an outbreak	"from the information from the ASHA worker or from what I have, a visit to the field is made. A team is constituted where the doctor is there, lab tech is also present. The team does a survey to identify where and when the disease is spreading and treatment is started on field or transported by ambulance to hospital" -Lab tech # Begusarai district
	● Challenges during specimen collection and transport	"the most difficult part is facing the public and convincing them to give sample for testing. Another issue is then the transportation of the sample to the referral laboratory."-Lab tech # Begusarai district
	● Intersectoral co-ordination	"no, we do not get the support of other agencies such as the PWD or the animal husbandry" -Lab tech # Darbhanga district
● Job responsibilities	● Awareness about IDSP	"yes, I am aware about the idsp" -Lab tech # Begusarai district

	● Knowledge about job responsibility of IDSP	"the main work for IDSP is to fill up the L-Form" -Lab tech # Darbhanga district
	● Analysis of data	"felt the need for analysis but have not done it myself" -Lab tech # Bhojpur district
● Motivation and happiness	● enjoy doing this job	"I feel very happy working" - Lab tech # Darbhanga district
	● motivation of work	"I feel that I am helping the patient and from my test report he will get the correct treatment" - Lab tech # Begusarai district
● Stress management	● work pressure	"there is pressure when 30-40 patients come at the same time and I am the only laboratory technician working. Moreover, every disease has a different register and I have to fill them also beside providing the test results" -Lab tech # Begusarai district
● Suggestions	● improve the existing efficiency of lab	"need more space for laboratory and separate spaces for collection and testing" -Lab tech # Darbhanga district
	● improving IDSP	"daily reporting needs to be undertaken and more diseases should be added to the list" -Lab tech # Darbhanga district
	● improving skills	"what I want is regular information about the tests and special training should be available to improve ourselves" -Lab tech # Bhojpur district

Based on study findings and content analysis, the following major themes and sub-themes emerged.

A. Routine investigation

Collection of biological samples: Almost all of the laboratory technicians responded that they collected biological samples from anyone suspected to be suffering from infectious diseases at their facility without any bias. Most of them also mentioned that samples were collected from those who were advised to undertake laboratory test in the OPD of the same facility only.

"of course, we do sir, from the patients. When the doctor recommends test, they come to us and based on the test we give them labelled and marked containers to give samples in. I put the names into the registers and after they have given the samples, we test it" - Lab tech #, Begusarai

"yes, we collect samples for tuberculosis and HIV" - Lab tech #, Darbhanga

"yes, we collect samples from presumptive cases" - Lab tech #, Begusarai

There were few who pointed out that due to limited number of facilities, they often preferred not to collect enough samples.

"there is no facility for doing laboratory tests, what will we do collecting samples" -Lab tech #, Darbhanga

Proportion of suspected cases sent to lab per day:As reported by the respondents, the proportion of patients who were sent for laboratory confirmation ranged from 8-20 percent of the OPD attendance and varied with seasonality.

“for testing in the laboratory about 8-10% of the patients are sent by prescription” -Lab tech #, Begusarai

“more or less in about 100 patients 10-15 days come for testing or in some cases depending on seasons more patients come” - Lab tech #, Begusarai

“daily about 10-12% of the patients are sent for testing” - Lab tech #, Darbhanga

Record keeping of investigation: Majority of the respondents said that they kept detailed records of the investigations in registers and that the samples are appropriately processed. The different vertical disease programs and the IDSP, all have different registers which necessitate the laboratory technicians to maintain them separately, often leading to duplication of records and is a burden on the personnel.

“test results are reported on the OPD form and also in a register where we register the patients name, investigation, report and OPD form no.” -Lab tech #, Begusarai

“for all the tests that takes place here there are different registers. There is one for malaria, one for kala-azar, one for TB and one for general laboratory tests. After testing we write in the registers according to format and also give reports to the patients by writing on the slips and adding the official seal” - Lab tech #, Bhojpur

Sero-types or antibiotic resistance patterns tests: Most participants had no idea about the sero-typing and the antibiotic sensitivity tests. A few did report undertaking antibiotic sensitivity tests for detecting antibiotic susceptibility of Tuberculosis mycobacterium from sputum samples for a vertical control programme (RNTCP).

“no, I don't know anything about these sero-typing and antibiotic sensitivity tests” -Lab tech #, Darbhanga

“yes we do antibiotic susceptibility test in the RNTCP program for TB patients” -Lab tech #, Bhojpur

An interesting point that came to notice was that respondents working in laboratories of district or sub-divisional hospitals were more aware about the risk factors for emergence of antibiotic resistance and had opinions on dealing with them.

“the target especially set by Govt. of India to eliminate TB is 2022. Other than TB, elimination is also targeted for malaria, kala-azar etc. and the medicines that are provided we understand that it should not be stopped midway and if you have started taking antibiotics

then finish it. We should target the eldest of the family or the head of the family to make them understand and create awareness that the medicines should not be stopped and if the patient is on the verge of stopping medicines or forgets then they must be reminded periodically and the patient should get the full dose of the medicines.” -Lab tech #, Begusarai

Reliable results in a timely manner: There was a consensus among the respondents of the study that there was currently no problem in providing reliable and timely test report from their facility.

“No there are no such problems. We work hard to give reliable and accurate results to the patients and if there are some discrepancies in the report, we undertake retesting. So, there is no problem as we use reagents sourced from different company for retesting.” -Lab tech #, Begusarai

Many of those who reported that there were currently no problems in providing reliable and timely report stated that the situation was different before and has improved now.

“there were some problems before but not now. Previously there was no room and now a new building has been created and all the facilities are present. Now the lab is functioning properly” - Lab tech #, Begusarai

A few did report that there were some problems with reliability and timeliness but that was minuscule compared to the alternate opinion.

Communication of results to appropriate authority: This was a major problem that emerged from the qualitative interviews. There was no set protocol for reporting the test results to the higher authorities other than filling up the L-Form on the IDSP portal and from the laboratory register. Many of the technicians on a personal basis informed the medical officers about the test results but that too was far and few. At present the patients form the key link of reporting test result from the laboratory to the medical officers.

“from the records in the register they come to know” -Lab tech #, Begusarai

“I myself accompany the patients along with the report to the doctor and he gives medicine accordingly” -Lab tech #, Begusarai

“I inform my superiors and then only they give medicines” -Lab tech #, Bhojpur

Supply of media, equipment and other related materials: The respondents were divided on this point, many were of the opinion that though sometimes requisition is a time-taking affair there were no problems with the availability of reagents in general.

“no there is no such problems and if it happens it is very rare. We inform the in charge of the

central store over telephone and the materials is sent over. If it is not available in the central store then we give applications and it is sent there is no problem”-Lab tech #, Begusarai

Others, however, identified that there was a lack of resources to undertake tests and that hindered the delivery of test reports in a timely manner.

“many at times it has happened that materials are not available and there is pressure of patients for testing” -Lab tech #, Bhojpur

“sometimes it happens that reagents are finished then testing is stopped”-Lab tech #, Darbhanga

B. Outbreak Investigation

Detecting and confirming outbreak: Many of the lab technicians were of the opinion that they would be able to detect outbreaks by looking at clustering of the laboratory-confirmed cases.

“If a patient come to me and is tested positive and few other patients comes from the same area and are also tested positive then I suspect an outbreak”-Lab tech #, Bhojpur

There were a further few who could not clearly state that they could detect outbreaks and identified the ASHA, ANM and medical officers as those responsible for detecting and responding to such health events.

“I send my reports to my superior. They identify if there is an outbreak” -Lab tech #, Bhojpur

Also, on the other end, some laboratory personnel could not shed any light on the process of detecting and confirming outbreaks or their role in them.

“don’t know” -Lab tech #, Darbhanga.

Action following confirmation of an outbreak: Almost all of the responding technicians in Begusarai and Darbhanga correctly identified the RRT as the primary outbreak response mechanism in the block. They also mentioned that along with the experts in the RRT they also played a vital role in it.

“there is a team of doctors and ANM is also there who go to the spot and I also go. I collect samples and then treatment is given there or the patients are sent to the hospital” –Lab tech #, Darbhanga

“After detection of an outbreak our medical officer goes there, a team is constituted and visits the affected area...there proper treatment facilities are provided and counselling is provided to prevent further outbreaks” - Lab tech #, Begusarai

Most of the lab technicians were of the opinion that biological samples were obtained regularly for laboratory testing during outbreaks but the main challenges for sample collection and processing were superstitious views of the population, large gatherings during visit, unavailability of facilities in the field, transporting the collected samples to referral labs and maintaining cold chain for transporting samples for testing.

“see the challenges we face is that we have to reach the outbreak area and undertake a camp strategy. Now to reach the camp we face problems with transport. Also, there are several teams facilitated by different agencies like NGOs, hospitals and there is communication gap at times” - Lab tech #, Darbhanga

“yes, during outbreaks we receive samples like sometimes if there is a presumptive AFP case and we receive information of it, we instantaneously send vehicle to collect sample” - Lab tech #, Bhojpur

“as far as biological samples are concerned sometimes, we receive them sometimes, we don't during outbreaks.

Now think if there is a sample, suppose stool sample and for that we need transport and also maintain a cold and we have to travel by own means then we face difficulties but still we collect sample and do test” - Lab tech #, Begusarai

“here few people who are uneducated and superstitious who create problems but we make them understand and work accordingly” – Lab tech #, Darbhanga

“here in the lab everything is organised but in field during outbreak majority are uneducated who come at the same time and demand to be looked at first, other than that there are problems with transportation and organisation, there is no chair, no table and we have to work somehow” -Lab tech #, Bhojpur

Intersectoral co-ordination: Majority responded that they did not get support from other departments, may it be the PWD or the animal and livestock department during outbreak investigation and doing it alone was the norm.

“No, we work on our own, don't get any help from others” Lab tech #, Bhojpur

“No” Lab tech #, Darbhanga

There were very few places though where the respondents informed that they received inter-sectoral co-ordination when required.

“there is the animal hospital besides us. We get help if needed. No problem as such” -Lab Tech #, Darbhanga

“yes, we receive help” - Lab tech #, Bhojpur

C. Job responsibilities

Awareness about IDSP and knowledge about job responsibility: Most of the respondents were aware about the IDSP and identified it with filling up of the L-Form.

“yes, I have heard of IDSP” -Lab tech #, Bhojpur

“In IDSP I have to fill up the reports in L-Form in the week” - Lab tech #, Darbhanga

“Data operator shows me the L-Form and asks to weekly fill it up so I have to report” - Lab tech #, Darbhanga

Analysis of data: Many felt the need of analyzing the reported notifiable diseases, but all of them said they never did such analysis. There were others too who had not thought of analysis of the laboratory data and were unaware of its benefits.

“yes, I have felt the need of analysis” -Lab tech #, Bhojpur

“yes, I have felt the need as every week or every 15 days we have to report. If we do not report weekly then immediately superiors call and asks why reporting has not been done. We are aware and after testing we take the address of the patient and report to my supervisor” – Lab tech #, Begusarai

“I have never done any analysis” -Lab tech #, begusarai

D. Motivation and happiness

Enjoy doing this job: Barring a few, nearly all the respondents enjoyed doing their job and felt very happy with their work.

“yes, I am happy doing my work, I am helping patients” -Lab Tech #, Darbhanga

Motivation of work: It was the fact that they were an essential part of medical diagnosis and that their work helped patients get appropriate treatment was the major motivator that emerged from this study. Surprisingly, financial motivation was one of the least mentioned sub-themes in the analysis.

“I was motivated to work as a lab tech as my father was once hospitalized and then I had to run pillar and post to get laboratory test done. From that day I decided to become a lab tech and help the patients” -Lab Tech #, Darbhanga

“I feel motivated because my work is helping the patients get good treatment and that is a very happy scenario if the patient is cured due to the proper treatment” -Lab tech #, Bhojpur

“I am motivated itself” -Lab Tech #, Darbhanga

E. Stress management

Work pressure: Work pressure was perceived to be the most integral part of the job as a lab technician. The majority also admitted that they were able to effectively tackle the problem of overburdening.

“yes, there happens that I am the only technician and at times there are a lot of patients and I don't get the time, patients also ask for reports fast. I make them understand that I am only person here and i have to fill different registers for different tests like malaria, Tuberculosis and also give report. So that time there is pressure” -Lab Tech #, Begusarai

“I know that I alone have to do the work as there is no one else, so I do it part by part and finish the work” –Lab Tech #, Darbhanga

Economic insecurity was another point that came up during the interviews among few respondents in Bhojpur which led to some stress in the job.

“this work has pressure and salary is less leading to pressure in the family”- Lab tech #, Bhojpur

F. Suggestions

Improve the existing efficiency of lab: There were several suggestions provided for improving the functionality of the public health laboratory. These included provision of more space, quality equipment, availability of reagents and kits, updating knowledge through regular training. The other factors which the respondents found crucial to improving the laboratory efficiency included more manpower and regular servicing of existing equipment.

“this should be an independent laboratory with various new instruments. If any machine or instruments does not work properly there should be center/cell at district level to procure and repair these instruments. With this people can trust on our laboratory in generating correct report”-Lab tech #, Darbhanga

“There should be a proper infrastructure to reach excellence at laboratory and there should a timely updating of all the technology” Lab tech #, Begusarai

“As per the need, there should be a designated medical officer and the duty of every medical officer should be fixed because the doctors are not available every day in hospital daily as per their schedule, which creates problem. The doctors are always involved in their own private clinic. In laboratory, there are some inner link between doctors, health workers and private lab to earn commission or illegal money on the

name of test for which they send the patients to private hospital/laboratories in place of public hospital/laboratories. Therefore, the public does not believe us and devalue to us” - Lab tech #, Darbhanga

Improving IDSP: For improving IDSP, many suggestions were offered which included increasing the frequency of reporting from a weekly format to daily format, increasing the number of diseases reported under the IDSP, increasing the space provided in the IDSP reporting format to add more relevant information and increased monitoring.

“we are working as much as possible but if the superiors engage in regular monitoring and from time to time provide feedback then we will be better able to do work and also we will be able to inform about inefficiencies and corrective actions can be taken accordingly” – Lab Tech #, Begusarai

“add more diseases which are not included in the current IDSP notifiable diseases. there should be place for writing other diseases in the register and a column should be added if necessary” -Lab tech #, Bhojpur

“from the superior level there should be monitoring” - Lab tech #, Darbhanga

Improving skill in the laboratory: The major opinions that emerged for improving laboratory skills were regular training, improved learning through practices.

“studying every day and learning new things” -Lab tech #, Darbhanga

“from training” -Lab tech #, Bhojpur

“read good books, collect new information on current methods or guidelines and study. This will ensure there is no mistake and if there is training anywhere then one should participate and participate with seriousness” - Lab tech #, Darbhanga

“There are some new instruments which were installed to improve the performance of lab. For new laboratory test and also old ones, there is a need to provide training There should be workshops so we can always get new information related to work. There are some problems regarding new instruments (connected with computer application) because engineers come only once to teach us especially at the time of new technology instalment period and we can't learn all the app based application at that time as we are not expert in computer-based application and also did not get any information about computer in our education system. Therefore, engineers should be available all the time to teach us and we should have easy to access the engineers. In training period, our training manual was in hardcopy but now there are online or computer-based systems. Therefore, we are taking time to earn each and every step to conduct all the laboratory test” -Lab tech #, Darbhanga.

Discussion

To the best of our knowledge, this was the first study that assessed the laboratory component of the IDSP in Bihar. Findings identified serious constraints that were hampering routine surveillance activities and outbreak investigation under the said program. Data were collected from all 62 designated laboratories under IDSP in three districts of Bihar-Begusarai, Darbhanga and Bhojpur during January and April, 2019. Results revealed very few labs had good procedural and documentational readiness. Overall preparedness of the surveyed laboratories in terms of basic equipment, consumables, staff, skill-sets, bio-safety and bio-medical waste management, specimen-transportation and recommended protective measures appeared inadequate. These findings corroborated with the previous study. (25, 26) Although major progress had been made in the laboratory surveillance since 2009, still further improvements were needed for creating new public health laboratories and simultaneously strengthening the infrastructure of existing laboratories. Therefore, stabilizing the laboratory components through strategic planning in terms of procedural preparedness and infrastructure support by the national standards at regional, state and local levels will likely yield valid test results, the backbone for appropriate diagnosis, specific management and subsequent control of disease outbreaks.

Results revealed that nearly all of the respondents were hired contractually and had spent on average 10 years in IDSP. Alike other studies, it seemed that permanent position had positive impact on job satisfaction and organisational commitment than contractual employees. (27, 28) Although the concept of short-term employment contract has gained popularity in recent times, such hiring may affect the productivity of staff. Thus, designing some innovative scheme to absorb the temporary workers to permanent ones through on-the-job trainings might enhance the staff morale and performance.

Findings highlighted several major concerns with respect to the availability of key documents in the labs that included standard operating procedure (SOP) and reagent kit registers, which are crucial elements for the functioning of any laboratory. These findings were similar to the prior studies. (29, 30) Formal training in safe handling, disposal of hazardous biologicals and chemicals using specific SOP with proper documentation prior to the beginning of laboratory activities should be a priority in the state as reported elsewhere. (31) Surprisingly, only 11% of the studied public health laboratories had an annual maintenance contract (AMC). However, to ensure high-quality laboratory

services, good maintenance checks are essential. (29) Certification and accreditation documents including calibration & validation certificates were unavailable in 33% of the laboratories surveyed, while only 19% had a list of hazards associated with the work carried out in the laboratories. This was a clear contradiction of biosafety and laboratory management protocols that were globally accepted for healthy and cleaner environments. (32, 33) In order to strengthen the state's laboratory services to respond to infectious diseases, the current findings highlighted the urgent need for establishing standards for operating procedure, procurement system, quality assurance, bio-waste management, data-base management and reporting.

A list of the diseases reported under the IDSP was unavailable in 42% of the visited laboratories and might indicate poor preparedness in terms of system awareness. As reported elsewhere (26, 34-36), majority of public health laboratories were unable to undertake tests to confirm Typhoid, Cholera, Shigellosis, Leptospirosis, Meningococcal Meningitis, Japanese Encephalitis, Diphtheria, Hepatitis, Measles, Dengue and Chikungunya in the state. Poor condition and lack of maintenance of incubators, microscopes, autoclaves, ELISA-readers, refrigerators and blood culture bottles/petri-dishes had culminated into a substantial reduction in the proper functioning of public health labs in the state. Therefore, ensuring supplies, appropriate specimen collection process, diagnostics and equipment at primary health centre level will enable to take diagnostic decision and to monitor disease occurrence/pattern.

During the qualitative interviews, it seemed that the participants were aware about IDSP in general but were more focussed regarding the need of filling up of L-Form on weekly basis.

Similar to previous studies, (30, 37, 38) when asked about how to detect an outbreak in the community, majority of the study subjects said that clustering of similar cases in a community used to alert them. RRT was singled out as the main response setup for controlling outbreaks. The technicians also articulated their role in the RRT and the difficulties they faced during an outbreak investigation process which ranged from inadequate supply of basic stuff (particularly the transport medium), cold-chain maintenance, poor road condition, transport issues, lack of community support to inter-sectoral co-ordination.

Majority of the respondents did not have any knowledge of sero-typing and only a few who were involved in Revised National Tuberculosis Control Program (RNTCP) knew

about antibiotic susceptibility, which has a strong focus on detecting resistance. (39) A significant proportion of the technicians in Bhojpur did not receive any formal training on IDSP. As reported elsewhere, (40, 41) trained personnel were likely to improve the performance of any laboratory. Therefore, planning for an effective training program including how to detect infectious agents, particularly the new emerging pathogens, identify outbreak in the community, learn about antibiotic resistance pattern, proper data management, reporting and alerting the system should be state's priority. Furthermore, provision of regular training on IDSP in general and updating on new testing algorithm appeared essential for lab technicians in Bihar to enable them to diagnose such infections in the early phases.

Direct observation showed that record keeping and documentation in all the laboratories in the three studied districts were inadequate contrary to what respondents stated during the in-depth interviews. This might be related to inadequate knowledge and awareness regarding the procedural readiness in the laboratory among the study subjects, which corroborated with the prior research. (42) During the quantitative analysis it was observed that there was no standardised method of reporting of test results which was substantiated by the qualitative findings. Most of the laboratory technicians wrote the test report on the out-patient department (OPD) card generated at the registration desk by hand only. There appeared no standardized system in place for regular reporting of test results to the treating physicians. Inadequacy was found in uploading weekly report of complete L-forms onto the IDSP portal at the district-level. Thus, there is a need to have a state-specific plan, terms of reference, enforce standards and response requirements and review mechanism so that a well-functioning quality laboratory surveillance system with appropriate technical competence could be ensured.

The majority of the respondents appeared to enjoy their work and were happy to contribute to the medical fraternity and society. From qualitative analysis, results indicated that financial rewards did not motivate the participants. This was in accordance with the previous studies which indicated that social recognition and job content were the major contributors to employee motivation while the financial component had least influence as a motivator for work. (43)

In qualitative analysis, many of the laboratory technicians were of the opinion that changing of the reporting time from weekly to daily basis would improve the IDSP reporting. When asked for suggestions to improve the efficiency of the laboratories as well as increasing their personal skills, the major ideas that emerged were for spacious and

organised working environment, updated and well-functioning equipment, availability of basic reagents along with adequate manpower and regular training.

Limitations

The current study has some limitations. Being cross-sectional by design and inherit temporal ambiguity, the causal interpretation would be misleading. The study was conducted in three districts of Bihar, so generalizability beyond the study area should be done with caution. Given small sample size and lack of statistical power, regression analysis did not show any significant association between individual-system-level factors and the practice of correctly filling the L-forms.

Conclusion

This study aimed to assess the functionality and operational feasibility of surveillance activities of the laboratory under the IDSP in the state of Bihar. Findings indicated that current laboratory facilities at the sub-district levels needed further upgradation with good procedural preparedness and necessary documentation. Perhaps the most concerning fact was the limited availability of basic resources for confirmatory diagnosis of endemic and epidemic-prone diseases in the state. In addition, public health laboratory services and the surveillance component of IDSP in Bihar were jeopardized by inadequate staffing both in terms of number and the skills, limited and late supply of basic laboratory supplies, poor servicing and maintenance of available infrastructures. The gaps identified in the current study would likely guide the Government and IDSP stakeholders in Bihar to streamline and undertake measures which are locally contextual to alleviate some of the existing challenges.

Way forward

The concerns and challenges with respect to the functioning of the public health laboratories indicated in this paper reinforced the urgent need to act decisively on integration of basic services under one standardized platform so that early warning mechanism, detection and response capacities could be effectively implemented. It is imperative for the government to invest in personnel and equipment for the state public health laboratories, develop state-based laboratory strategic plans and policies for upgradation of the existing labs, capacity-building, establish public-private partnerships for increasing accuracy in the diagnostic services, and ensure effective laboratory network and sustainable investing. Some of the recommendations that may be considered for strengthening the laboratory component under IDSP in Bihar:

- To design intervention strategies to increase the state's capacity for diagnostic or confirmatory tests for epidemic (-) and endemic-prone diseases. It should be the quickest and least resource-intensive method to prioritize laboratory responses to endemic infections in the state;
- To establish credible, sustainable and high-performing laboratory networks for timely diagnosis of priority infectious disease outbreaks and epidemiological tracings of infections through appropriate sharing of scientific data and effective collaboration with national and international agencies;
- Regular training to staff, particularly updating on the skills required to detect newer emerging pathogens through short-form videos, online interactive sessions and effective communication will likely enhance the quality of services;
- A multidisciplinary effort is required to ensure quality laboratory services including motivated workforce with appropriate technical competence, external quality assessment scheme, accreditation mechanism, proper infrastructure, laboratory supplies, laboratory standards and policy;
- To establish a credible and viable biomedical waste management system with consensus on standards for safe handling of health-care waste and equipment; and,
- To plan and develop an innovative strategic reward system will keep staff motivated.

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The Centre for Health Policy (CHP) at the Asian Development Research Institute (ADRI) has been set up with support from the Bill & Melinda Gates Foundation to strengthen the health sector in Bihar with a multidimensional and multi-disciplinary approach. Its aim is to engage in rigorous analysis of the health system and inform policy makers to fine-tune interventions for even stronger outcomes.

- Research and Analytical Studies

It constitutes the core of CHP's activities. The areas of research include health infrastructure and delivery with emphasis on equity, health outcomes such as IMR, MMR, TFR and its predictors, health financing, private-public partnerships, regulatory framework and its implementation, and other issues which might emerge.

- Informing Policymakers on Strengthening the Existing Health System

CHP aims to be the trusted partner of the state Government in providing evidence-based inputs in making the health system stronger, resilient and equitable.

- Sustainable Health Solutions

CHP recognizes the need for establishing a strong health system which will be self-sustaining. It means immunity to natural disasters/calamities, financial uncertainties and other unanticipated factors. These pillars may be interrelated; CHP will provide a framework of synergy among actors working on these pillars.

- Collaboration

CHP engages in collaboration with an extensive network of academic and policy research institutions both in India and abroad in health and the broader social sciences.