

Chapter 16

Public Health Laboratories

Riki Merrick, Steven H. Hinrichs, and Michelle Meigs

Abstract This chapter will review the multiple functions of Public Health Laboratories (PHLs), including their differences to commercial clinical laboratories. For example, the types of samples submitted to PHLs differ from those submitted to commercial clinical laboratories. PHLs are critically important to population based healthcare; playing an essential role in the detection of disease outbreaks.

This chapter will describe the hierarchical organization of the PHL system in the United States, as well as the networks that have been created to support diverse PHL functions such as food safety testing and emergency response to terrorism or natural disaster. It will briefly describe the standards used by PHLs and how the implementation of standards should further improve patient safety as a whole.

In this chapter the reader will be introduced to PHL informatics in the context of the laboratories operational workflow – from test ordering, interfacing with diagnostic instruments, quality control and result reporting and analysis. The reader will also understand the impact of PHL informatics collaboration efforts and its effect on ongoing policy development.

R. Merrick, MPH (✉)

Public Health Informatics, Consultant, 2541, Carmichael, CA 95609-2541, USA
e-mail: rikimerrick@ucdavis-alumni.com

S.H. Hinrichs, MD

Department of Pathology and Microbiology, University of Nebraska Medical Center,
Omaha, NE 68198-5900, USA
e-mail: shinrich@unmc.edu

M. Meigs

Informatics Program, Association of Public Health Laboratories, 8515 Georgia Ave.,
Suite 700, Silver Spring, MD 20910, USA
e-mail: michelle.meigs@aphl.org

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Learning Objectives

1. Illustrate how Public Health Laboratory (PHL) functions differ from clinical labs, either at hospitals or national commercial laboratories.
2. Examine the full environment of the PH informatics domain; from the long term sustainability of an enterprise Laboratory Information Management System (LIMS) to the universe of data exchange partners and networks.
3. Demonstrate how the evolution of informatics has enhanced the PHL workplace and its practice.

Overview

This chapter will review the multiple functions of Public Health Laboratories (PHLs), including their differences to commercial clinical laboratories. For example, the types of samples submitted to PHLs differ from those submitted to commercial clinical laboratories. PHLs are critically important to population based healthcare; playing an essential role in the detection of disease outbreaks.

This chapter will describe the hierarchical organization of the PHL system in the United States, as well as the networks that have been created to support diverse PHL functions such as food safety testing and emergency response to terrorism or natural disaster. It will briefly describe the standards used by PHLs and how the implementation of standards should further improve patient safety as a whole.

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Functions of a Public Health Laboratory

Public Health Laboratories (PHLs) play a vital role in protecting the public from health hazards. PHLs offer diagnostic testing for humans and animals as well as testing of environmental samples and products. These laboratories also provide laboratory confirmation for special organisms, and are part of public health's (PH) disease surveillance enterprise, conferring accurate, timely identification of infectious organisms or toxins during disease outbreaks. They are also critical components in disaster response and bioterrorism preparedness. PHLs often perform tests that are not commonly available

elsewhere. The catalog of available tests at a PHL varies almost as much as their organizational structures. Some PHLs are multi-branch operations; others are university-affiliated laboratories, while others are an integrated part of a Public Health Department [1].

The Association of State and Territorial Health Officials (ASTHO) and the Association of Public Health Laboratories (APHL), in their publication “A Practical Guide to Public Health Laboratories for State Health Officials,” summarize these 11 core functions of the PHL [2]:

1. *Enable disease prevention, control and surveillance* by providing diagnostic and analytical services to assess and monitor infectious, communicable, genetic, and chronic diseases as well as exposure to environmental toxicants.
2. *Provide integrated data management* to capture, maintain, and communicate data essential to public health analysis and decision-making.
3. *Deliver reference and specialized testing* to identify unusual pathogens, confirm atypical or uncommon laboratory results, verify results of other laboratory tests, and perform tests not typically performed by private sector laboratories.
4. *Support environmental health and protection*, including analysis of environmental samples and biological specimens, to identify and monitor potential threats. Part of the monitoring also ensures regulatory compliance.
5. *Deliver testing for food safety assurance* by analyzing specimens from people, food or beverages implicated in foodborne illnesses. Monitor for radioactive contamination of foods and water.
6. *Promote and enforce laboratory improvement and regulation*, including training and quality assurance.
7. *Assist in policy development*, including developing standards and providing leadership.
8. *Ensure emergency preparedness and response* by making rapid, high-volume laboratory support available as part of state and national disaster preparedness programs.
9. *Encourage public health related research* to improve the practice of laboratory science and foster development of new testing methods.
10. *Champion training and education* for laboratory staff in the private and public sectors in the US and abroad.
11. *Foster partnerships and communication* with public health colleagues at all levels, and with managed care organizations, academia, private industry, legislators, public safety officials, and others, to participate in state policy planning and to support the aforementioned core functions.

Levels of PHLs

PHLs exist at all levels of government – from local to state to federal, and even internationally. There are approximately 300 public health laboratories in the US [3]. Local PHLs are an intrinsic part of the safety network in underserved populations – they are highly integrated with Public Health Departments (PHDs) clinics to provide routine diagnostic testing as well as screening tests for disease prevention. Lead

abatement programs and monitoring of sexually transmitted diseases are other examples of community support functions of a local PHL. Local PHLs may serve metropolitan areas, counties, or regions within a state. In 2012, 40 local PHLs are listed as members of the Association of Public Health Laboratories (APHL).

There are 54 State PHLs [4]; they are found in every US state and territory as well as the District of Columbia. State PHLs often offer and perform tests that no other labs perform – be it for clinical practice (e.g., a regional reference lab for *Salmonella* serotyping) or environmental surveillance (e.g., well water testing). Their work informs public health officials in state government, allowing for targeted disease surveillance, quicker response to disease outbreak and provides population based data that may lead to new guidelines or policies to protect their residents. Where local PHLs are not available, the state PHL supports locally-needed public health activities. State PHLs also have the power to regulate private medical laboratories [5] and operate quality assurance programs (e.g., air quality or clean water act). During surveillance activities, the state PHL takes a leadership role through active collaboration with federal agencies, state epidemiologists, first responders, and environmental professionals.

Within the US, the federal government operates several PHLs that act as reference labs for their state and local counterparts; they manage centers for public health program areas, and are liaisons to international organizations like the World Health Organization (WHO). These federal reference laboratories are located at the Centers for Disease Control and Prevention (CDC), the United States Department of Agriculture (USDA), the Food and Drug Administration (FDA), and the Environmental Protection Agency (EPA). Just like their state counterparts, they provide the federal government with information to help protect Americans everywhere, and through global outreach they ensure laboratory capacity around the world [6].

Differences Between PHLs and Clinical and Commercial Laboratories

At the typical clinical lab, human biological samples are sent in for routine testing, such as blood sugar level, presence of bacteria, or screening for cancers. At a PHL, in addition to human samples, PHLs also perform testing on non-human samples and even inanimate objects. Animal samples are received at the PHL for a number of reasons including: rabies testing, West Nile virus surveillance, as well as ensuring the safety of our food animals through feed testing. Water samples are also tested at the PHL for a variety of reasons, but most importantly the PHL monitors both well water and public water systems. Food, be it peanut butter or spinach, is tested on a daily basis to detect pathogenic bacteria. Our soil, building materials and even cups and plates are tested to protect citizens from high levels of toxic chemicals such as lead. And finally; our PHLs work closely with first responders and the federal government to test for agents of bioterrorism; these samples can range from “white powder” to human based samples.

PHLs also perform regularly scheduled tests on samples collected from designated sentinel (guard) sites. Samples come from animals that are more susceptible to a disease, are living in close proximity to people and are being tested regularly to gauge when a

new disease can be expected. The monthly testing of samples from a chicken population for West Nile Virus is one example. Chickens are more susceptible to West Nile Virus infections than people. When West Nile Virus is detected in the chicken population, it is a good indicator that human cases can be expected soon in the same area.

While commercial laboratories do report the detection of certain infectious diseases to their respective public health departments, it is the PHLs that are at the frontline when an infectious disease outbreak occurs. PHLs provide support to the public health department in identifying the cause of the latest foodborne outbreak that may have been first detected at a clinical laboratory. PHLs also spend a significant amount of time developing new test procedures for emerging new diseases; such as the detection of the newest influenza virus strain that may cause the next epidemic or even a pandemic, as we experienced in 2009. Because of their efficacy, some of these newly developed tests are adopted by commercial laboratories and offered to their customers at a later point in time.

Not all human samples arriving at a PHL come from sick people. For example, every newborn is screened for a panel of genetic disorders to ensure early detection of issues that can sometimes save a child's life. These tests are almost exclusively performed at the PHLs [5]. Clinical labs perform mostly diagnostic testing, but they also offer some screening tests for example the pap smear testing to screen for cervical cancer.

PHLs have *surge capacity* agreements with partner laboratories to cover the increase in testing volumes during outbreaks: if one PHL is overwhelmed by the volume of samples received during an outbreak, they can send some of the samples to a neighboring PHL with whom they have such an agreement. These surge capacity partners will have to have identical, or at least similar, testing capabilities, hence they are mainly other PHLs. Because PHLs are critical to the health of a population, they also have *continuity of care* agreements to ensure that, in the event one PHL is affected by a natural disaster, the other partner will perform their duties. Hurricane Katrina put these agreements to the test, especially in the areas of newborn screening, where test requests were successfully transferred to partner PHLs, because babies don't wait to be born because of a disaster (Fig. 16.1).

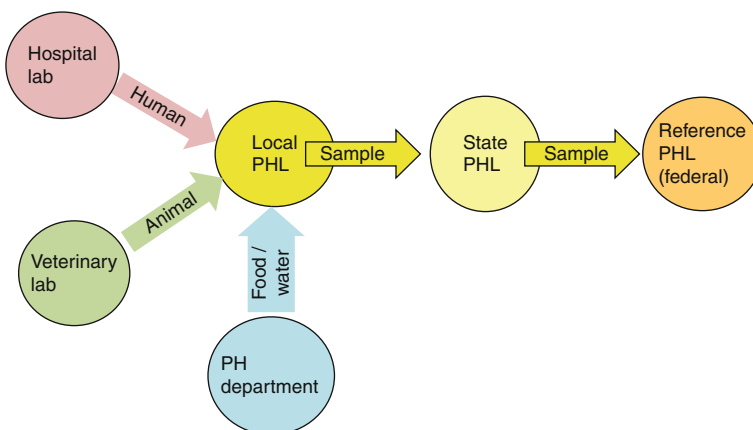


Fig. 16.1 Levels of PHLs in the US and their sample flow

Informatics in the Public Health Lab

Since the advent of computers, the laboratory, with its capacity to produce and manage important data, has been at the forefront of health informatics. What initially began as a database for local results, over time developed into a Laboratory Information Management System (LIMS) that provides capacity for improved workflow management, inventory tracking, and most importantly, patient management. Testing is often performed on stand-alone instruments. These results need to be incorporated into the LIMS, in order to be included in the final result sent to the submitter. In the beginning the LIMS was capturing only those results that needed to be printed to be sent back to the submitter. With the improvement of informatics knowledge in the PHLs more and more of the instruments are being interfaced, using industry developed standards, improving the quality of data and making the workflow more efficient. Informatics practice certainly has transformed several laboratory workflows as organizations migrate from paper-based to electronic system-based tracking. Being able to draw data from a database in an electronic format facilitates secondary use of this information for forecasting or event detection. This information can then be shared with partners in the Public Health Laboratory system (e.g., the public health department, a regional taskforce, preparedness coordinators, policy makers and federal agencies). The capability of the laboratory and its public health partners to share data in the same format, through an electronic data interchange (EDI), can greatly reduce communication delays between partners; resulting in faster, better outcomes for both patient and population based responses. All these functions are covered by informatics principles – from database design to queries as well as application of format and content standards. Table 16.1 illustrates examples of laboratory data at the center of public health events. Figure 16.2 depicts other situations in which the PHL needs to exchange data with a partner as part of normal PHL operations, used with permission from Zarcone et al. [1].

The LIMS Functional Requirement Document [8], developed by APHL and the Public Health Informatics Institute (PHII), lists 16 core business processes for every Laboratory Information system:

1. Laboratory test processing – this business process includes four segments:
 - (a) Test request and sample receiving
 - (b) Test preparation
 - (c) Testing, result recording and result verification
 - (d) Test result report preparation and exchange
2. Test scheduling – includes assignment of resources and prioritizing of the order of testing
3. Sample collection logistics and workload projections – this includes distribution of sample collection kits and order forms to partners
4. Chain of custody tracking for samples
5. Manufacturing of media, reagents and other test related supplies

Table 16.1 Events where critical PHL data enabled response [7]

Disease outbreak	Year	Natural disaster/bioterrorism
Severs Acute Respiratory Syndrome (SARS)	2001	Anthrax letters
West Nile Virus		
Several foodborne outbreaks	2002	
Worst Hepatitis A outbreak in US	2003	
	2004	
	2005	Hurricane Katrina
		Hurricane Rita
E coli outbreak in spinach	2006	
several foodborne outbreaks	2007	
Salmonella in salsa	2008	Floods in IA
Pandemic Influenza (H1N1)	2009	
Salmonella in eggs	2010	Tornado in Joplin, MO
Multiple foodborne outbreaks including the second deadliest on record due to Listeriosis in cantaloupe	2011	
Salmonella outbreak in Salmon	2012	Hurricane Sandy

Use case	Diagram	Business need	Example
Unsolicited laboratory results	<pre> graph LR PHL((PHL)) -- Result --> PHDEpi((PHD-Epi)) PHL -- Result --> CDC_Epi((CDC-Epi)) </pre>	Laboratory surveillance	Reportable condition to PHD influenza positive test results to CDC influenza division
PHL to PHL; PHL to CDC; clinical lab to PHL	<pre> graph LR PHL1((PHL1)) -- Order --> PHL2((PHL2)) PHL2 -- Result --> PHL1 PHL((PHL)) -- Order --> CDC_Lab((CDC-Lab)) CDC_Lab -- Result --> PHL Clin_lab((Clin. lab)) -- Order --> PHL PHL -- Result --> Clin_lab </pre>	Service requests	Routine testing such as measles IgM; salmonella PFGE; hantavirus PCR
PHL to PHL	<pre> graph LR PHL1((PHL1)) -- Order --> PHL2((PHL2)) PHL2 -- Result --> PHL1 </pre>	Surge capacity	West Nile virus outbreak – state must divert sample surge to neighboring state
PHL to PHL	<pre> graph LR PHL1((PHL1)) -- Order --> PHL2((PHL2)) PHL2 -- Result --> PHL1 </pre>	Continuity of operations	State declares "state of emergency" i.e. Louisiana post Katrina

Fig. 16.2 Public health laboratories: data exchange scenarios (use cases) (Originally published in Public Health Reports, Copyright 2010 Association of Schools of Public Health)

6. Inventory and forms management
7. General Laboratory Reporting – is part of the general systems requirements – all electronic data management systems need to be able to create reports
8. Statistical analysis and surveillance – provides value added to the test results to both the submitters of the sample as well as public health partners
9. Billing for services
10. Contract and Grant management – unlike clinical laboratories, PHLs often are funded through grants to provide services free of charge to the submitter of the sample, so tracking funding amounts and requirements is important
11. Training, education and resource management – to comply with regulations and to document capacity of laboratory personnel and equipment
12. Lab certifications and licensing – PHLs, mostly at the state level, are responsible to ensure compliance in laboratories operating in their jurisdiction, which includes inspections of those laboratories
13. Customer feedback tracking
14. Quality Control (QC) and Quality Assurance (QA) management – both involve audit functionality about the tests performed – QC tracks the parameters for each method and instrument at the test level and allows for over time analysis of the control parameters, while QA defines specific measures across all the tests performed to ensure accurate testing
15. Laboratory safety and accident investigation
16. Laboratory mutual assistance and disaster recovery to support surge capacity and continuity of care operations

Not all business processes apply to every lab, but across the spectrum of laboratories all of these business processes are relevant. This document describes interdependencies between the lab and outside partners and following informatics protocol decomposes each of the core business processes into their individual steps with related functional requirements for the system, based on detailed laboratory workflow analysis [8]. The publication of this requirements document has created a functional standard vendors can utilize to build more useful systems that are conformant with these requirements. Although much variability between information systems still exists, this requirement document has provided a solid basis to better identify and pin-point these variations.

The PHLs use several kinds of codes in their daily operations: codes for the tests they offer and perform, codes for pre-defined results, and codes for patient demographics. In order to make data comparable across locations, the PHLs map their local codes to national data standards. These data standards include the Logical Identifiers Names and Codes (LOINC[®]) [9] for the tests they perform, Systematized Nomenclature of Medicine (SNOMED[®]) [10] to identify organisms and ordinal results, and codes from Health Level Seven (HL7[®]) [11] for patient demographics like gender, race, and ethnicity. To exchange standardized data between PHLs and their partners, the order and format of the data to be exchanged needs to be defined. For individual point to point exchanges, simpler formats can be agreed upon; for example, comma-separated files (CSV) or excel spreadsheets can be exchanged, but in order to accommodate larger scale data exchange with multiple partners across

multiple information systems standards such as HL7® messages (in version 2.x) or the XML-based clinical document architecture (CDA) formats should always be considered as part of the normal business process. In addition to utilizing these standards, transport mechanisms need to be defined and agreed upon by electronic data interchange (EDI) partners [12].

In order to support these critical public health functions, PHLs create support networks among themselves. These networks help group laboratories together that perform the same kinds of tests and exchange results within the same networks, usually under the guidance of a federal program. Utilization of the requirements document among PHLs has advanced the application of informatics in the PHL realm, and has made several of these networks quite successful. Examples of functional PHL networks in the US are summarized in Table 16.2.

Unfortunately, at this stage each of these networks is using different data exchange methods. LRN and NAHLN use HL7® v2.x messages as data exchange standard, FERN and ERLN use XML-based Electronic Data Deliverables (EDDs). This forces the PHL to support a variety of formats and vocabularies in order to properly report to the respective partners during an investigation. A significant obstacle to the development of consistent data exchange deliverables is the sheer number of networks and reporting requirements. Table 16.3 shows what a laboratory must do, after discovery of a food-borne illness outbreak due to consumption of tainted hamburgers.

Issues with Interoperability

The following barriers to effective electronic laboratory information exchange were identified in the APHL-PHDSC White Paper, “Assure Health IT Standards for Public Health, Part 1: Health IT Standards in Public Health Laboratory Domain,” [12]:

- Barrier I – The *incomplete and inconsistent adoption of existing standards* by the wide array of laboratories responsible for reporting laboratory results as well as by the Electronic Health Record systems (EHR-S) and public health information systems they report to.
- Barrier II – The *lack of adoption of EHR-S* [18] in clinical settings (i.e., test order senders and result receivers) preventing electronic communication between providers and LIMS.
- Barrier III – The *use of proprietary, non-standardized information systems* in public health preventing electronic communication between LIMS and public health programs (i.e., receivers of test results on public health threat conditions).
- Barrier IV – The *absence of a sustainable approach and funding* to support the development of laboratory standards and their testing; and of certification and adoption of standards-based IT products in clinical, laboratory and public health settings.
- Barrier V – The *need for informatics-savvy personnel in PHLs* to operate in a new HIT and information communication environment.

Table 16.2 Examples of laboratory networks in the United States [7]

Network	Description
LRN [13]	The CDC manages the Laboratory Response Network (LRN). This includes the CDC LRN-Biological (LRN-B) and CDC LRN-Chemical (LRN-C). The mission of the LRN is “to maintain an integrated national and international network of laboratories that are fully equipped to respond quickly to acts of chemical and biological terrorism, emerging infectious diseases, and other public health threats and emergencies.” Due to the sensitive nature of CDC’s bioterrorism preparedness activities, details of LRN-B operations are protected against general public access and distribution. These details, designated as “Sensitive But Unclassified,” are maintained at CDC, and require coordination with the LRN LIMS Integration team to obtain. The LRN provides specifications about the message format (HL7 [®] v2.x) and data content, including standardized vocabulary (for example LOINC [®] and SNOMED CT [®])
ERLN [14]	The Environmental Response Laboratory Network (ERLN) is managed by EPA. The ERLN consists of federal, state, and commercial laboratories that focus on responding quickly to an environmental chemical, biological, or radiological terrorist attack, as well as natural disasters affecting human health and the environment. The ERLN provides an <i>Electronic Data Deliverable</i> (EDD), which can be either a spreadsheet or the recommended XML format and a Data Exchange Template (DET) with data element definitions and groupings. The ERLN also provides a Web-based Electronic Data Review tool that automates the assessment of EDDs by providing web access for upload by the laboratory and review by project personnel
FERN [15]	The Food Emergency Response Network (FERN) is managed by United States Department of Agriculture (USDA)’s Food Safety and Inspection Service and the Food and Drug Administration (FDA). The primary objectives of FERN are to help prevent attacks on the food supply through utilization of targeted food surveillance; prepare for emergencies by strengthening laboratory capabilities to respond to threats, attacks, and emergencies in the food supply; and to assist in recovery from such an incident. FERN uses the Electronic Laboratory Exchange Network (eLEXNET) that allows multiple government agencies engaged in food safety activities to compare, communicate, and coordinate findings of laboratory analyses
NAHLN [16]	The National Animal Health Laboratory Network’s (NAHLN) purpose is to enhance the nation’s early detection of, response to, and recovery from animal health emergencies. Such emergencies might include bioterrorist incidents, newly emerging diseases, and foreign animal disease agents that threaten the nation’s food supply and public health
GISN [17]	The WHO Global Influenza Surveillance Network (GISN) receives result reports and samples of isolates from participating state and municipal PHLs to monitor influenza disease burden, detect potential novel pandemic strains, and obtain suitable virus isolates for vaccine development

Public Health Laboratories’ Influence on Informatics Standards

The Association of Public Health Laboratories (APHL) is a national non-profit, member-based organization representing governmental laboratories of all levels in all aspects of operation. APHL is especially active as the primary advocate for PHLs

Table 16.3 Food outbreak investigations and the PHL: the Saga of a Hamburger [7]

Reason for data exchange	Receiver of the data	Data format
Contamination related to food (lettuce, ketchup, mayo, bun), but NOT the meat	Food and Drug Administration (FDA)	HL7 [®] v3 messages or XML based EDD
Contamination related to meat	U.S. Department of Agriculture (USDA)	XML based EDD
A person became ill	Centers for Disease Control and Prevention (CDC)	HL7 [®] v2.x message
	Local and/or state public health department based on patient's residence	HL7 [®] v2.x message
	Local or state public health department based on lab's location, if different from patient's residence	HL7 [®] v2.x message
Offending contaminant is biologic, i.e. a bacteria or virus or organism created toxin	Centers for Disease Control and Prevention (CDC) – biological network	HL7 [®] v2.x message
Offending contaminant is chemical, i.e. a fertilizer, other chemical toxin	Centers for Disease Control and Prevention (CDC) – chemical network	HL7 [®] v2.x message
Contamination is related to environmental reasons, i.e. flooding	Environmental Protection Agency (EPA) – several networks for water, air, waste or response mitigation	XML based EDD
Follow-up testing of food animals	National Animal Health Laboratory Network (NAHLN)	HL7 [®] v2.x message

by promoting workflow improvements and refining laboratory science operations within the laboratory. It provides a forum for member collaboration, education, and workforce development [19]. The fruits of this collaboration are evident in the success of APHL's Informatics Committee in identifying and subsequently improving many of the functions required of LIMS and in the domain of laboratory informatics in general. One such example is the effort to standardize LIMS functionality across vendors. APHL LIMS user groups provide ways to prioritize and consolidate development efforts among customers of a specific vendor, which in turn can be easily compared to overall standardization approach. In partnership with other PH organizations, under the umbrella of the Joint Public Health Informatics Taskforce (JPHIT), APHL also influences national e-health policy.

Internationally, APHL helps to build laboratory capacity in developing countries, including the selection and implementation of information systems.

As part of every implementation, validation testing according to test cases also employs informatics principles. Having identified the need to harmonize the adoption of standards across federal programs and PHL functional areas, APHL is actively involved in national standards harmonization activities for laboratory-related use cases (information exchange standards for laboratory orders and results, reporting in clinical and public health settings, as well as functional standards for

Electronic Health Record System (EHR-S) interactions with PHLs). Due to limited informatics funding at PHLs and the ongoing struggle for these laboratories to support informatics trained specialists, APHL provides hands on informatics technical assistance to PHLs and their partners. These services include project management, national standards implementation and technical architecture support.

PHLs are continually providing expertise to support the standards development process. They were instrumental in creating an implementation guide for newborn screening; working alongside Standards Development Organizations (SDOs) like the Regenstrief Institute to develop the required vocabulary and to make sure the HL7[®] message contained all the data elements needed for proper newborn screening result reporting. APHL provides leadership for the Laboratory and Messaging Community of Practice (LabMCoP), assisting PHLs and partners in harmonizing terminology and related standardized vocabulary to properly describe the specimen submitted for testing.

On a national scale, when the Office of the National Coordinator for Health Information Technology (ONC)'s certification process for commercial Electronic Health Record products was announced, PHL expertise was utilized by providing real-world testing scenarios to ensure that specific result formats are properly represented in this information exchange paradigm. By ensuring a basis in reality, this effort will ensure greater patient safety, and improve public health's response to emerging diseases, terrorism, and natural disasters.

In summary, PHLs are a critical public health resource and service. They detect, identify and monitor infectious disease outbreaks, chemical or biological contamination in people, animals, food and the environment. They provide testing that other labs cannot provide and screen for diseases that haven't even shown symptoms yet (i.e. newborn screening). PHL testing supports food and environmental safety law enforcement and their data contributes vital information to support local, state and federal health policies. PHLs are at the forefront of population based health threats due to bioterrorism, newly emerging disease and natural disasters and they continue to ensure quality service by inspecting and certifying other laboratories in their jurisdiction.

Information systems enable PHLs, or any laboratory for that matter, to more predictably forecast testing demand and assist with human resource utilization during an outbreak or response. Auditing functionality help to monitor the quality of testing and this analysis can be used to improve laboratory workflow over time. Data derived from these systems can assist with both state and federal efforts to forecast disease, help with outbreak management as well as health policy development.

But to ensure the long term operational capacity of our PHLs to provide these services and remain relevant in patient and population care, informatics must be considered a pivotal core business function.

The use of electronic test orders, communicating between disparate systems about order statuses and specimen results as well as contributions to both electronic health records and personal health records submitters all require use and continual development of national data exchange standards. The work in this field has barely

begun, yet the continual evolution of standards will drive greater collaboration and cooperation between all levels of PHLs – local, state and federal as well as their commercial partners.

Review Questions

1. List at least 6 of the 11 core PHL functions and discuss how each of them can be supported by informatics.
2. How does the workflow in a PHL change when an emergency arises – for example a disease outbreak, a bioterrorism event or a natural disaster?
3. List the different partners of a PHL and their importance for Public Health.
4. Contrast the differences and similarities between a PHL and a commercial clinical lab.

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