MODERNIZING PUBLIC HEALTH SURVEILLANCE: AN EVALUATION OF ELECTRONIC LABORATORY REPORTING IN GEORGIA

by

NADINE OOSMANALLY

(Under the Direction of Justin Ingels)

ABSTRACT

Disease surveillance is a critical component of the ten essential public health services. State laws or regulations mandate notifiable disease reporting and require healthcare providers, hospitals, and laboratories to report to health departments. Although public health surveillance is shifting toward electronic reporting, health departments face challenges in engaging stakeholders and maintaining adequate resources to receive and manage the reports received through electronic laboratory reporting (ELR). ELR requires significant investment by public health and hospital facility staff to ensure all the data needed to complete a case report are transmitted despite the efficiency of electronic submissions. Furthermore, electronic reporting has resulted in an increased volume of information received by health departments, often including duplicate laboratory reports.

The primary research objectives of the evaluation were to 1) describe and evaluate ELR data received in Georgia statewide, including an assessment of timeliness, completeness, and geographic differences in laboratory reporting, and 2) identify barriers, challenges, and successes associated with ELR adoption.

To evaluate the first objective, ELRs and surveillance data from 2017 to 2021 were analyzed for timeliness, demographic completeness, and geographic differences. To evaluate the second objective, a survey was administered to stakeholders in 2022 to assess their awareness about notifiable disease reporting, ELR capabilities, and resource needs.

While the adoption of electronic reporting increased between 2017 and 2021, the number of reports received and case reports created electronically has remained steady. In addition, the timeliness and completeness of electronic reports could be improved. Despite support for electronic reporting, barriers and challenges exist to electronic reporting, including workload and availability of IT support.

With finite resources to support ELR reporters, outreach needs to be prioritized. In addition, improved support for IT staff and training may strengthen electronic reporting.

INDEX WORDS: Communicable diseases, Disease notification, Electronic laboratory reporting, Evaluation, HITECH, Infectious disease reporting, Meaningful use, Notifiable disease reporting, Public health, Public health informatics, Public health surveillance

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DEDICATION

To my parents for their continued support and encouragement through all of my academic endeavors.

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CHAPTER 1

INTRODUCTION

Background

Moving from paper-based disease reporting toward electronic laboratory reporting (ELR) is promoted as a measure that would significantly improve public health surveillance. The main benefit of electronic reporting is that it allows information to be shared more quickly and easily between laboratories and public health agencies. Timelier communication allows public health agencies to follow up more rapidly on the information received. Specifically, infectious disease surveillance had the greatest potential to benefit from the transition to ELR use (Gluskin, Mavinkurve, & Varma, 2014). Timely and accurate data to confirm diagnoses and prevent transmission of diseases is a critical goal of public health surveillance (Gluskin et al., 2014). For example, with ELR and timelier reporting, there is potential for outbreaks to be detected in a timelier manner, thus, triggering outbreak response more quickly. Potential gains from faster outbreak response are controlling the spread of disease more quickly, reducing the number of people who become ill, and facilitating the identification of the causative agent more quickly (Gluskin et al., 2014; Lenert & Sundwall, 2012).

In addition, ELR has the potential to enhance the monitoring of disease trends, in particular chronic diseases, because it has the capability to manage high volumes of data. The burden of chronic disease has been increasing over time, and it has become a greater public health priority to monitor the trends in chronic diseases (Shapiro, Mostashari, Hripcsak, Soulakis, & Kuperman, 2011). Many chronic diseases, such as high blood pressure or

hypertension, are preventable, and the availability of data to monitor trends in these diseases can inform public health policies to target the reduction of chronic diseases. Given the larger volumes of information that must be exchanged for complete chronic disease reporting, electronic reporting is an ideal solution for sharing information (Shapiro et al., 2011).

Furthermore, reporting through electronic means also has the potential to reduce workload, specifically for data entry and data entry errors (Gluskin et al., 2014). Prior to the availability of ELR, most notifiable disease information was shared through paper-based reporting methods, via mail or fax, requiring information to be manually entered into the surveillance system.

Moving from paper-based systems to electronic systems for managing health information has been a slow process, even though it has the potential to reduce costs, increase patient safety, and improve the quality and efficiency of healthcare services. In 2010, 42 states reported having a communicable disease surveillance system that could integrate ELR (Gluskin et al., 2014). As of 2009, 27 states reported being able to receive automated ELR messages, and by 2011 more than 80 percent of states reported being able to exchange information electronically (Assessment of Epidemiology Capacity in State Health Departments — United States, 2009.2009; Gluskin et al., 2014).

Funding

After the September 11, 2001, attacks, the Terrorism Preparedness and Emergency Response funds were implemented by Congress to support response activities conducted by the Centers for Disease Control and Prevention (CDC). A significant portion of this revenue was used to implement ELR systems at the state and local levels (Gluskin et al., 2014). Also, since 2010 resources have been provided to state, local, and territorial health departments through the

Epidemiology and Laboratory Capacity for Infectious Diseases Cooperative Agreement. Funding was allocated through the Prevent and Public Health Fund of the Affordable Care Act (Lamb et al., 2015). In addition, CDC has implemented reporting standards through the National Electronic Disease Surveillance System (NEDSS) (Gluskin et al., 2014). NEDSS is CDC's surveillance system that receives and processes data from state health departments (National electronic disease surveillance system | CDC.2022).

Health Information Technology for Economic and Clinical Health (HITECH) Act

In 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act was passed with the aim of increasing the adoption and use of electronic health systems. The act allocated $30 billion to assist providers with implementing EHRs, but providers were required to use systems that met defined criteria for meaningful use. Meaningful use is defined by the Department of Health and Human Services as using an EHR system in "a manner that improves quality, safety, and efficiency of healthcare delivery, reduces healthcare disparities, engages patients and families, improves care coordination, improves population and public health, and ensures adequate privacy and security protections for personal health information (The Office of the National Coordinator for Health Information Technology, (ONC),)." Three stages were included as part of implementation: Stage 1, which included data capture and sharing, Stage 2, which included advanced clinical process; and Stage 3, which focused on improved outcomes. To receive incentive payments, providers must exchange information with specific types of data, such as immunization, syndromic surveillance, and notifiable disease data (Health IT legislation.; Lenert & Sundwall, 2012; The Office of the National Coordinator for Health Information Technology, (ONC),).

Physician practices and hospital systems that met meaningful use guidelines were eligible to receive incentive payments from the Centers for Medicare and Medicaid Services (CMS) starting in 2011. The maximum incentive from Medicare was $43,720, and the maximum incentive from Medicaid was $63,750. Entities not using an EHR by 2015 received reduced CMS reimbursement. Penalties included a one percent reduction in Medicare and Medicaid fees in 2015 that increased to a three percent reduction in 2017 and later (Health IT legislation.). One of the disadvantages of meaningful use is that it does not provide financial incentives to commercial laboratories. Instead, there is a focus on provider exchange of information with public health agencies (Lenert & Sundwall, 2012).

Meaningful use requires public health to be able to receive data in a format specified by the Office of the National Coordinator (ONC) (Lenert & Sundwall, 2012). However, public health funding for IT was not outlined as a priority for ONC (Lenert & Sundwall, 2012). Over 30 billion dollars were spent on Stages 1 and 2 of meaningful use, but only approximately $30 million of HITECH funding was given to public health. This included $12 million for immunization registries, $5 million for public health laboratory interoperability, and $5 million to link 500 hospital laboratories to health departments (Health IT legislation.; National electronic disease surveillance system | CDC.2022; Lenert & Sundwall, 2012). Funding resources provided to states by CDC have also declined over time, and little emphasis has been placed on the maintenance of systems. In 2010, approximately $70 million was given to states and local health departments by CDC, and in 2011, $40 million was allocated to states (Foldy, Grannis, Ross, & Smith, 2014; Lenert & Sundwall, 2012).

Funding Outcomes

As of February 2018, more than 540,000 healthcare providers received payment for participating in the Medicare and Medicaid Promoting Interoperability (PI) Programs. However, despite the success of the HITECH Act in spurring the adoption of EHRs, many physicians have expressed dissatisfaction with the process. In a recent survey, more than 67 percent of over 600 physicians surveyed reported dissatisfaction with their EHR system, and a survey conducted by the American Academy of Family Physicians found that 31 percent of EHR users were considering replacing their EHR system because of dissatisfaction with its functionality (Emani, 2017). Complaints include usability issues, workflow disruption with too much time spent on data entry, diminished patient care, lack of interoperability, and reduced quality in documentation with the potential to lead to medical errors (Emani, 2017).

As of July 2014, 67 percent of the 20 million laboratory reports received nationally were transferred electronically (Lamb et al., 2015). Also, in 2014, 21 health jurisdictions were receiving more than 75 percent of their laboratory reports electronically (Lamb et al., 2015). Commercial laboratories accounted for 39 percent of the total volume of ELRs, while hospital laboratories accounted for 23 percent (Lamb et al., 2015).

Problem Statement

Despite these investments and advances, barriers exist, for both, health departments and laboratories. Health departments face challenges maintaining systems and resources to receive and manage ELR reports. Human review is required to map ELRs for each facility that reports by ELR. For example, when hospitals start sending ELR messages, they must be interpreted and mapped by the health department, and interpretation of ELR messages requires extensive programmer and public health staff time. However, this exercise has also allowed some

processes to be automated. As an example of the additional burden this can create, Gluskin et al. reported that after the implementation of ELR, over 800 messages had to be manually reviewed by the New York Department of Health and Mental Hygiene in 2013 (Gluskin et al., 2014).

Since the adoption of ELR, some successes and challenges have been observed. Successes include an increased volume of reports received by health departments and timelier reporting from hospitals and laboratories. Challenges include missing or incomplete information. Receiving an electronic report typically requires additional follow-up by public health staff. ELR reports typically contain the minimum pieces of information, such as patient address or date of birth, needed to complete a case report form or even less. The subsequent follow-up is often completed through non-electronic means, such as by telephone or fax. Providers typically do not report through electronic methods, and the information they provide is a key part of a complete case report form. The data must be manually entered into the surveillance system; thus, it can be argued that electronic reporting does not save as much time as intended.

The volume of reports received creates an added burden for public health staff. For example, there are often duplicative messages or false positive reports. It has been hypothesized that this would be an adverse effect of ELR due to the variety of IT systems, the number of providers, standards, and the cost of being compliant (Lenert & Sundwall, 2012).

Laboratories face barriers to transmitting results to different stakeholders, including physicians, patients, insurance companies, and public health, because each stakeholder may use different systems or standards for reporting. Further, laboratories also have competing priorities, and reporting to public health is likely the lowest priority for a laboratory facility that needs to generate revenue to cover its costs.

Laboratorians and infection control practitioners also face challenges with using their systems. Historically, most laboratorians and infection control practitioners completed the steps for notifiable disease reporting, but with the use of electronic systems, IT staff are needed to create the notifiable disease reports or reminders in the systems because most laboratories are unable to make the changes themselves. With paper-based reporting, laboratories were much more independent.

Multiplex tests that test for multiple pathogens can also complicate sending and interpreting ELR messages. These test types provide reports for each of the pathogens that must be carefully reviewed. Occasionally, multiplex tests result in multiple positive reports. Also, the implementation of a new test may result in the creation of a new code that requires remapping and interrupts ELR automation. This results in delayed reporting or missed cases until the change is identified (Gluskin et al., 2014).

Although the adoption of ELRs has increased since the implementation of the HITECH Act, many providers have struggled with using and maintaining their systems, particularly those with limited resources or those located in rural areas. Many have become dissatisfied with systems implemented under meaningful use, and many hospitals have started to switch their systems, which can result in delayed public health reporting. These changes have shaped the research question and study design. Most studies examined the immediate improvements in public health surveillance provided by ELR. However, the intermediate or long-term outcomes have not been assessed. As hospitals change systems, new and different challenges arise, often with disruption of the timely reporting that has been touted as one of the successes of the investments in electronic reporting. Therefore, a more thorough evaluation of the impact of ELR is warranted.

Meaningful use created a need for specialized staff; implementation of ELR has resulted in investments in IT staff but little investment in training surveillance staff how to navigate ELR obstacles that might come up and be easily troubleshooted without costly programmer time. Studies have suggested that IT updates and workforce development are needed (CSTE/CDC ELR Task Force, 2011).

Additionally, the estimated cost of ELR start-up and maintenance ranged from $221,000 to $633,000 per year (CSTE/CDC ELR Task Force, 2011). Ongoing maintenance and the ability to respond to changes quickly are other concerns for health departments. Changes in hospital systems or coding often become problematic for receiving messages at the health department. And this results in delayed reporting.

Surveillance in Georgia

Several diseases and conditions are notifiable to the Georgia Department of Public Health. These primarily include infectious diseases, and notification is triggered by a positive laboratory result. Georgia's population is just over 10 million, with about half of the population residing in the metropolitan statistical area of Atlanta. Given the size and geography of the state, Georgia is divided into eighteen health districts. A district may include only one higher-population county or be comprised of multiple smaller, less-populated counties (Georgia Department of Public Health,). For example, Fulton County is a health district. This distribution allows for a more equitable distribution of resources. More highly populated areas tend to have hospital facilities with more resources that are able to report via ELR. However, smaller hospital facilities may lack the ability to report electronically either due to training or IT limitations.

This geographical structure has been utilized in making surveillance staff assignments at DPH. Georgia is one of ten Emerging Infections Program (EIP) sites that collaborate with the CDC to conduct active population-based surveillance for nine foodborne pathogens, including *Salmonella*, *Shigella*, and Shiga-toxin producing *E. coli*, and five invasive bacterial infections, including *Haemophilus influenza* and *Neisseria meningitidis* ((Hadler et al., 2015). As part of participation in the EIP program, laboratory reports are audited to ensure all positive results for this subset of pathogens have been reported. To facilitate this activity, surveillance staff are assigned to particular health districts and monitor cases reported by hospitals in those regions. In addition, they maintain contacts at hospitals that are asked to provide audit reports to ensure all cases with a positive laboratory result are reported to DPH. Since surveillance staff are actively and routinely monitoring these data reports, it is easier to identify when there is a gap or delay in reporting. Recently, it has been noted that delays are often due to system changes or changes in laboratory testing practices.

Although there are dedicated staff to follow up with facilities, their training in informatics is limited, and they rely on programmers, supervisors, or IT support to help address reporting lags. The lack of training in this area is something that can be improved.

Research Aims

The primary objectives of the evaluation are to 1) describe and evaluate ELR data received in Georgia statewide from 2017 to 2021, including an assessment of completeness and timeliness of reporting, and 2) identify barriers, challenges, and successes associated with ELR adoption.

Specific research questions are:

1. How complete and timely are the data received through ELR?

2. What are the successes, barriers, and challenges associated with ELR adoption?

Hypotheses for the first research question were:

1. ELR reporting is incomplete due to an increased volume of information.
2. ELR reports do not meet the required reporting timelines outlined by the Georgia regulations.

For the second question, the hypothesis was that resources and IT support are the primary barriers or challenges to ELR adoption, while improved workload was a success.

CHAPTER 2

LITERATURE REVIEW

Notifiable Disease Reporting

Public and private laboratories play a critical role in notifying health departments about infectious diseases, which helps with monitoring disease trends and detecting outbreaks. Laboratory testing provides definitive diagnoses for pathogens, including bacteria, viruses, and other biological agents (Varma, Taylor, & Sharfstein, 2023). They also may detect new infectious diseases or new strains of pathogens. Most initial notifiable disease reports are made by laboratories to health departments (Overhage, Suico, & Mcdonald, 2001). One study found that over 80 percent of initial enteric reports were provided by laboratories, while fewer were provided for Haemophilus influenzae and meningococcal disease (Overhage et al., 2001; Vogt, 1996).

COVID-19 and Laboratory Reporting

The COVID-19 pandemic highlighted some of the weaknesses associated with laboratory reporting, resulting in an increased emphasis on electronic reporting. The laboratory system was not prepared to develop and implement new diagnostic testing methods rapidly. This was further compounded by limitations for reporting results on a large scale (Varma et al., 2023).

Electronic Laboratory Reporting

An examination of the peer-reviewed literature showed limited information related to electronic laboratory reporting and public health surveillance, which demonstrates a gap in the

literature. The results included a variety of topics related to ELR, ranging from the impact of ELR on reporting for specific diseases to how electronic reporting can be used in smart technology for monitoring measures of chronic disease. Additionally, much of the literature on electronic reporting evaluates electronic health systems and health information exchanges (Johnson, M. G., Williams, Lee, & Bradley, 2014; Lamb et al., 2015; Overhage et al., 2001; Samoff, Fangman, Fleischauer, Waller, & Pia D.M. MacDonald, 2013).

During the early phases of ELR, several studies described the potential benefits and challenges of transitioning from paper-based reporting methods to electronic reporting methods in an effort to advocate for the shift from paper to electronic reporting (Potential Effects Of Electronic Laboratory Reporting on Improving the Timeliness of Infectious Disease Notification--Florida, 2002-2006.2008; Dixon, Siegel, Oemig, & Grannis, 2013). Many articles focused on the gaps created by paper-based reporting and described the flaws or limitations, including delayed receipt of reports by public health agencies, inaccurate data entry, and time required to complete data entry (Dixon, Gibson, & Grannis, 2014; Dixon et al., 2017; Johnson, Matthew G., Williams, Lee, & Bradley, 2014; Samoff et al., 2013; Samoff, Fangman, Fleischauer, Waller, & MacDonald, 2013).

Once funds were allocated toward the investments in ELR, many articles and studies began to measure the effects of ELR on reporting to state health departments. States that have examined the impact of ELR reporting include Florida, Kentucky, and North Carolina (Assessment of Epidemiology Capacity in State Health Departments — United States, 2009.2009; Samoff et al., 2013). Many of these studies measure the impact of electronic reports within a specific disease area, such as hepatitis or Lyme disease, within a particular state or region of a state (Effect of Electronic Laboratory Reporting on the Burden of Lyme disease

Surveillance--New Jersey, 2001-2006.2008; Moore, Reddy, Kapell, & Balter, 2008). In addition, few studies evaluated multiple disease reporting areas in a siloed approach that parallels the structures of most health departments and notifiable disease reporting. Increased workloads and the use of resources, such as servers, were often mentioned but not quantified.

Even fewer studies examine the effects of ELR on public health surveillance processes and resources. In addition to conducting some of the same types of assessments described above, North Carolina conducted a study in which they estimated the per-case cost of public health follow-up, which ranged from $71 to $124 per case reported (Samoff et al., 2013).

As ELR systems have become more automated, a study also evaluated the completeness and time required to complete a case report form, if it is electronically generated and sent to a provider to request additional information upon receipt of the ELR (Dixon, Siegel, Oemig, & Grannis, 2013; Dixon et al., 2014) This study showed that reports sent electronically were received more quickly than paper-based reports from providers, but that paper-based reports were more complete (Dixon et al., 2014).

Since many of the studies were focused on evaluating ELR when it was initially prioritized by CDC and HITECH, information related to electronic laboratory reporting and public health surveillance has declined in recent years. However, as described in previous sections, now that electronic reporting has been in place for several years, shifts are being observed, including transitions to new systems. This might be the result of dissatisfaction with electronic systems, hospital mergers, or other management decisions. It has also been observed that system changes can result in reporting delays, which may take a significant amount of staff time and resources to resolve. Furthermore, fewer resources have been allocated toward maintaining state health department systems over time (Lenert & Sundwall, 2012). The lack of

evidence evaluating these changes provides a gap in the literature that can be evaluated and is an important topic for public health surveillance planning.

Mapping Electronic Laboratory Reports

Mapping ELR test results is often difficult to standardize because they often include free text results rather than SNOMED codes. This may result in the inclusion or exclusion of results for a particular pathogen (Overhage et al., 2001). For panel tests, a series of pathogens may also be included in the results making mapping challenging and difficult to interpret or automate. As a result, electronic reports are often duplicated, mapped incorrectly, or require public health staff review.

Public Health Information System Evaluation

Public health information systems (HIS) are large and complex, making them challenging to evaluate. Due to this complexity, several evaluation frameworks have been developed to evaluate HIS. Multiple studies have focused on assessing the components of the frameworks and their ability to address evaluation objectives, incorporating who, what, when, where, why, and how (Eslami Andargoli, Scheepers, Rajendran, & Sohal, 2017; Yusof, Maryati M. & Arifin, 2016; Yusof, Maryati Mohd, Stergioulas, & Zugic, 2007). The frameworks often included some of the evaluation elements but not all of them. Most evaluation frameworks focus on the technical or clinical aspects of the system with less emphasis on the context and users of the system (Andargoli, Scheepers, Rajendran, & Sohal, 2017).

In addition, systems were often implemented without evaluation in mind, but they have garnered greater increased interest because they allow organizations to make more informed decisions about policies and the use of resources. Over time the frameworks have been adapted to include organizational issues in addition to technical elements (Yusof, Maryati Mohd et al.,

2007). For example, Yusof et al. developed the HOT-fit framework that merges the IS Success and the IT-Organizational Fit Models to include human, organizational, and technology components of evaluation. The model includes the elements of system quality, information quality, and service as part of the technology component, system use and user satisfaction as part of the human component, and structure and environment for the organization component (Yusof, Maryati Mohd, Kuljis, Papazafeiropoulou, & Stergioulas, 2008). This model provides a comprehensive approach to HIS evaluation and can be used to guide an evaluation of ELR.

CHAPTER 3

METHODS

Data Sources and Data Collection Methods

Three data sources were included in the analysis: electronic laboratory reports received through HL7 messages from 2017 to 2021, notifiable disease case report data from 2017 to 2021, and data collected from a survey of key stakeholders conducted in 2022.

Electronic Laboratory Reports and Notifiable Disease Surveillance Data

Select hospitals and reference laboratories report notifiable diseases to the State Electronic Notifiable Disease Surveillance System (SendSS) electronically once they have been identified through laboratory testing. Additional data collected for a complete case report form include demographics, such as gender and race, hospitalization status, and symptom information. All reports and these data elements are entered into SendSS, and variables included in the case report forms can be queried and downloaded for analysis. In addition, variables are collected that identify if the case report was initially reported through ELR, the date it was received, and the date the case report was confirmed.

Emerging Infections Program (EIP) Surveillance Data

Surveillance data collected by two of the core components of the Emerging Infections Program (EIP), the Foodborne Diseases Active Surveillance Network (FoodNet) and Active Bacterial Core Surveillance (ABCs) from 2012 to 2021, were analyzed for data completeness

and timeliness after ELR implementation. Data collected from 2017 through 2021 are closed out and complete. Pathogens included in these surveillance activities include the following:

FoodNet

- *Campylobacter*
- *Salmonella*
- *Shigella*

Active Bacterial Core Surveillance (ABCs)

- *Haemophilus influenzae*
- Group A *Streptococcus*
- Group B *Streptococcus*

Automated case creation, or the creation of a case report form (CRF) using data received through ELRs, is currently in place for the selected pathogens. Additionally, if a CRF was manually created, the ELR message will link to the CRF.

Variables included in the analysis are listed below.

- Address
- County
- Rural/nonrural
- Date of birth
- Race
- Ethnicity
- First reporter
- Date of specimen collection
- Date of report

- Disease
- Testing hospital or laboratory facility
- Specimen type

Stakeholder Survey

A secondary source was data collected by a stakeholder survey distributed to laboratory partners responsible for notifiable disease reporting in 2022. The survey assessed hospital awareness about notifiable disease reporting, focusing on successes, barriers, and challenges associated with electronic laboratory reporting. The survey was administered to 86 stakeholders directly involved in notifiable disease reporting. Participants were identified from contacts identified through EIP active surveillance procedures that routinely participate in reporting activities. They included infection control practitioners, laboratory managers, and information technology staff.

The survey questions (Appendix A) focused on what activities have been beneficial, what activities could be improved, what are the challenges or barriers, and what additional support could strengthen electronic reporting. In addition, questions were included to assess awareness about notifiable disease reporting in general and to obtain feedback about reporting policies.

The study protocol, detailing data collection and the proposed analytical plan, was approved by the Institutional Review Boards (IRBs) at the Georgia Department of Public Health and the University of Georgia.

Analytical Methods

Analysis of Electronic Laboratory Reports and Surveillance Data

ELRs received from hospitals and laboratory facilities, notifiable disease surveillance data, and the data collected from the stakeholder survey were analyzed. Laboratory messages

and surveillance data were analyzed for trends over time and to evaluate any geographic differences. The assessment of ELRs received included an evaluation of the timeliness and completeness of the information received. Data were recoded using classifications designated by the United States Census Bureau to examine geographic differences in reporting. Counties with populations of less than 50,000 persons were considered rural, while nonrural counties have populations greater than 50,000 persons. The analyses were conducted using SAS, R, and Microsoft Excel.

Analysis of Key Stakeholder Survey Responses

Quantitative and qualitative methods were used to analyze the data collected using the stakeholder survey. Descriptive statistics were used to characterize the number of respondents, respondent reporting roles, and hospital type. Thematic content analysis was used to identify and summarize themes for the questions that open-ended questions.

CHAPTER 4

RESULTS

Analysis of Electronic Laboratory Reports, 2017-2021

Electronic laboratory reports (ELRs) received for three Active Bacterial Core (ABCs) pathogens: *Haemophilus influenzae*, Group A *Streptococcus*, and Group B *Streptococcus*, and three FoodNet pathogens: *Campylobacter*, *Salmonella*, and *Shigella* were analyzed. From 2017-2022, 124,019 ELRs were received for all six diseases. On average, 2,036 reports were received annually for Campylobacteriosis, 1,375 for Haemophilus influenzae, 10,116 for Salmonellosis, 2,161 for Shigellosis, 1,873 for Group A Streptococcal Disease, and 7,245 for Group B Streptococcal Disease.

Table 4.1 Number of Electronic Laboratory Reports Received, 2017-2021

Disease	2017	2018	2019	2020	2021	Average per Year	Total
Campylobacteriosis	2,219	2,409	1,754	1,696	2,104	2,036	10,182
Haemophilus Influenzae (Invasive)	1,614	1,616	1,356	1,180	1,108	1,375	6,874
Salmonellosis	9,088	10,186	12,736	9,337	9,231	10,116	5,0578
Shigellosis	2,168	1,596	2,468	2,612	1,960	2,161	10,804
Streptococcal Disease, Group A (Invasive)	1,899	1,979	2,202	1,636	1,647	1,873	9,363
Streptococcal Disease, Group B (Invasive)	8,037	8,078	5,049	6,181	8,873	7,244	36,218
Total	25,025	25,864	25,565	22,642	24,923	24,804	124,019

The data were deduplicated, resulting in 124,019 ELRs included in the analysis. Variables used to deduplicate the number ELRs were disease, collection date, specimen type, patient name, date of birth, observation identifier, and observation text. Figures 4.1 and 4.2 show the number of reports received for each pathogen by month from 2017 to 2021.

Figure 4.1 Number of Electronic Laboratory Reports for Active Bacterial Core Surveillance Pathogens, 2017-2021

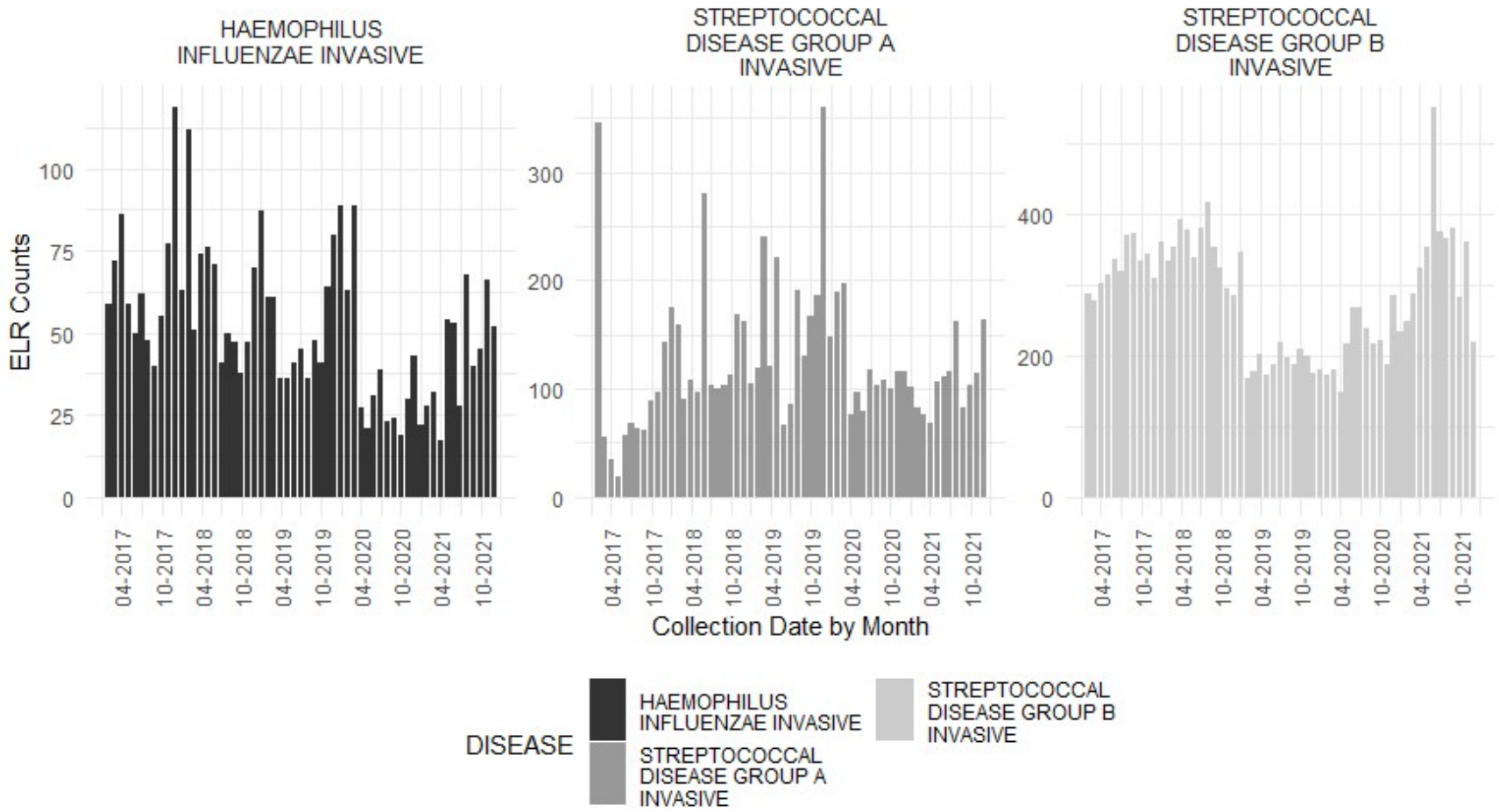
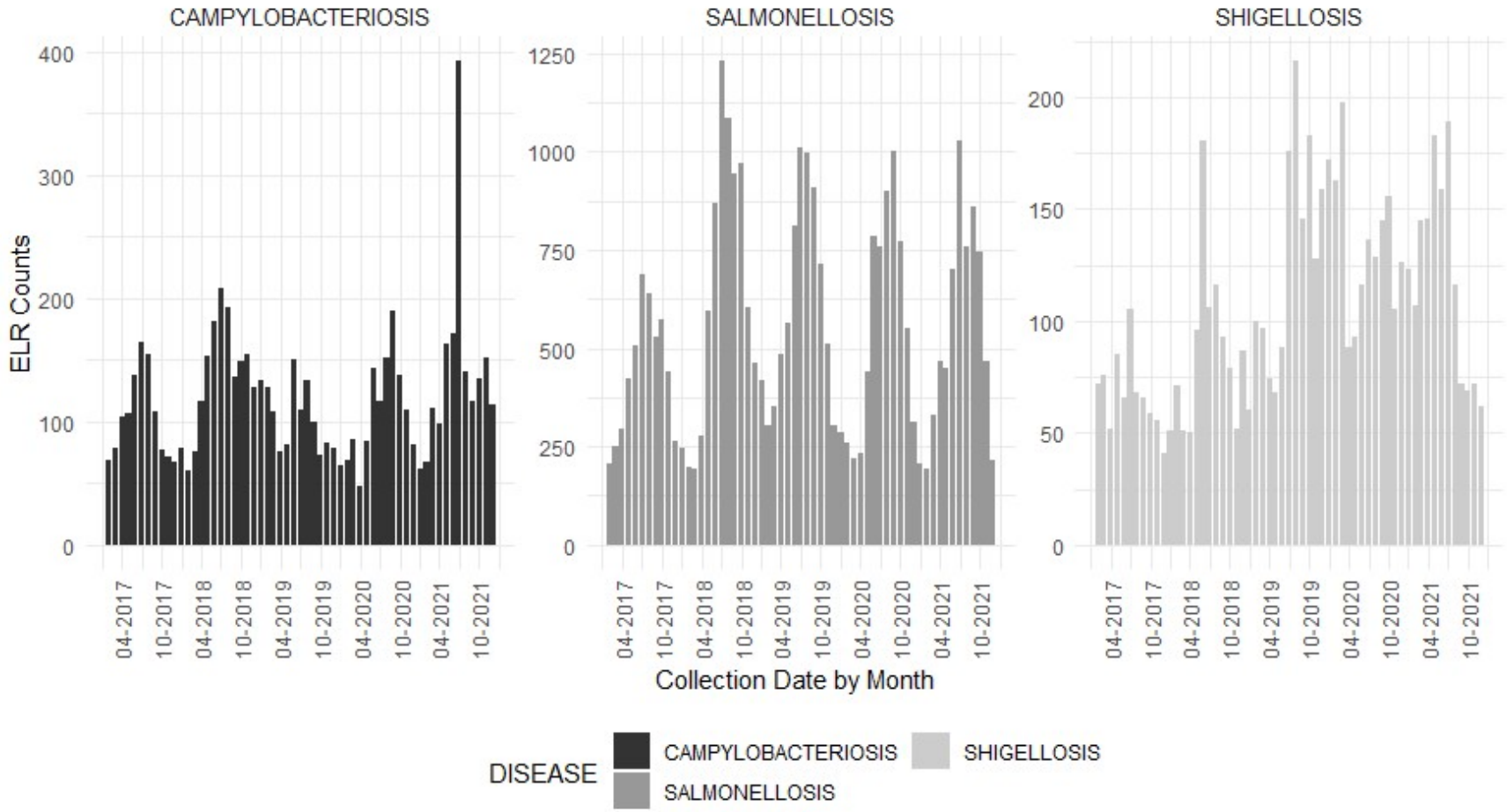


Figure 4.2. Number of Electronic Laboratory Reports for FoodNet Pathogens, 2017-2021



Timeliness

Figures 4.3 and 4.4 display the timeliness of reporting by laboratories to DPH for each quarter. The graphs display the percentage of reports received within four, seven, and 14 days from the specimen collection date. For the pathogens being evaluated, positive reports are requested within seven days from the date of specimen collection.

Overall, the reporting timeliness is better for the ABCs pathogens compared to the FoodNet pathogens, with over 90 percent of Group A *Streptococcus* and Group B *Streptococcus* reports received within seven days of specimen collection. About 70 percent of *Haemophilus influenzae* reports were received within seven days of specimen collection, with improvements observed in recent years.

For the FoodNet pathogens, the majority of reports are received within 14 days of specimen collection. About 25 to 50 percent of reports for *Campylobacter* and *Salmonella* are received within seven days from the specimen collection date. While reporting was similar for *Shigella*, the timeliness of reporting greatly improved in 2019 but then declined in 2021.

Figure 4.3 Timeliness of Electronic Laboratory Reports Received, ABCs Pathogens, 2017-2021

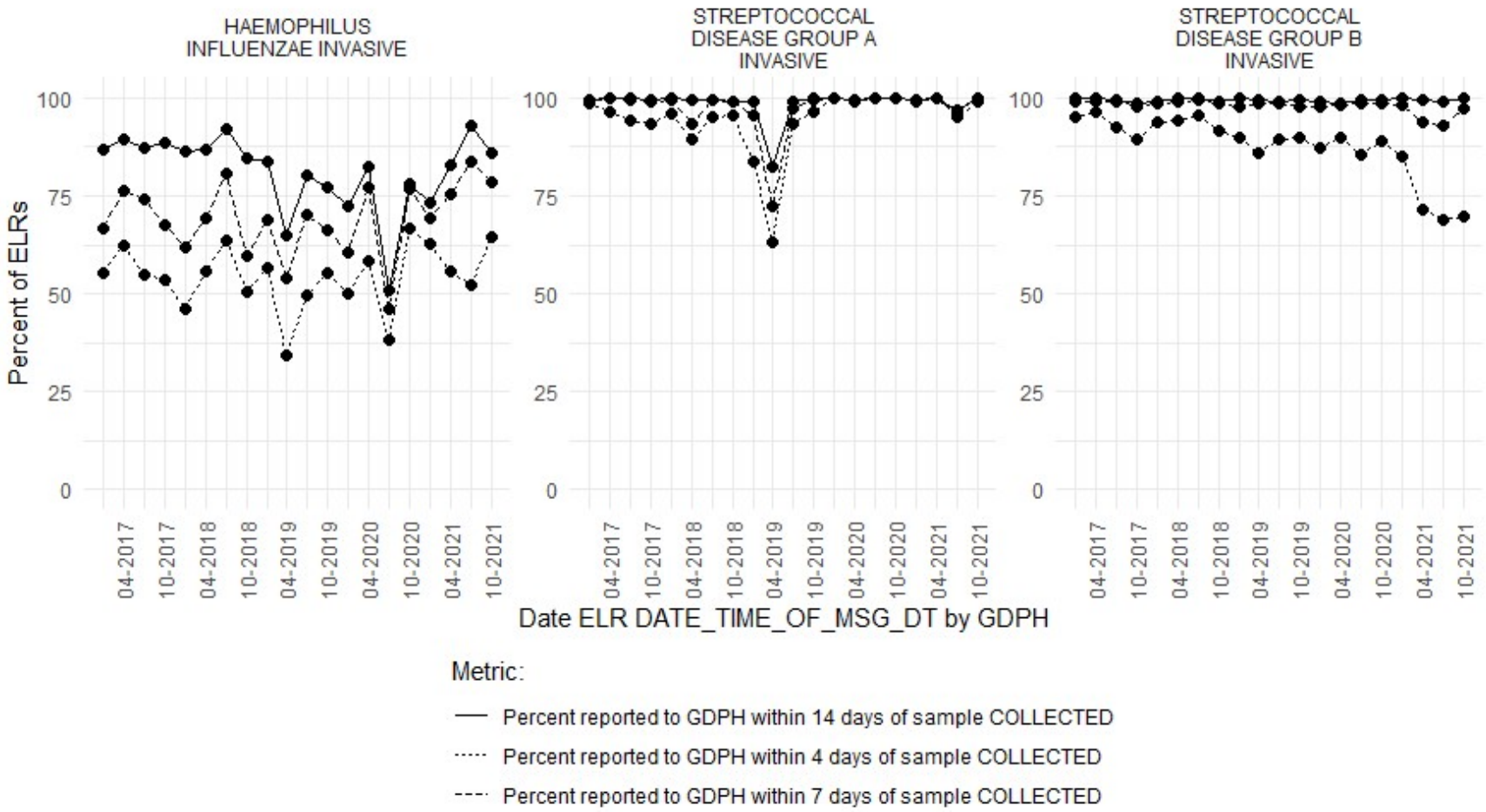
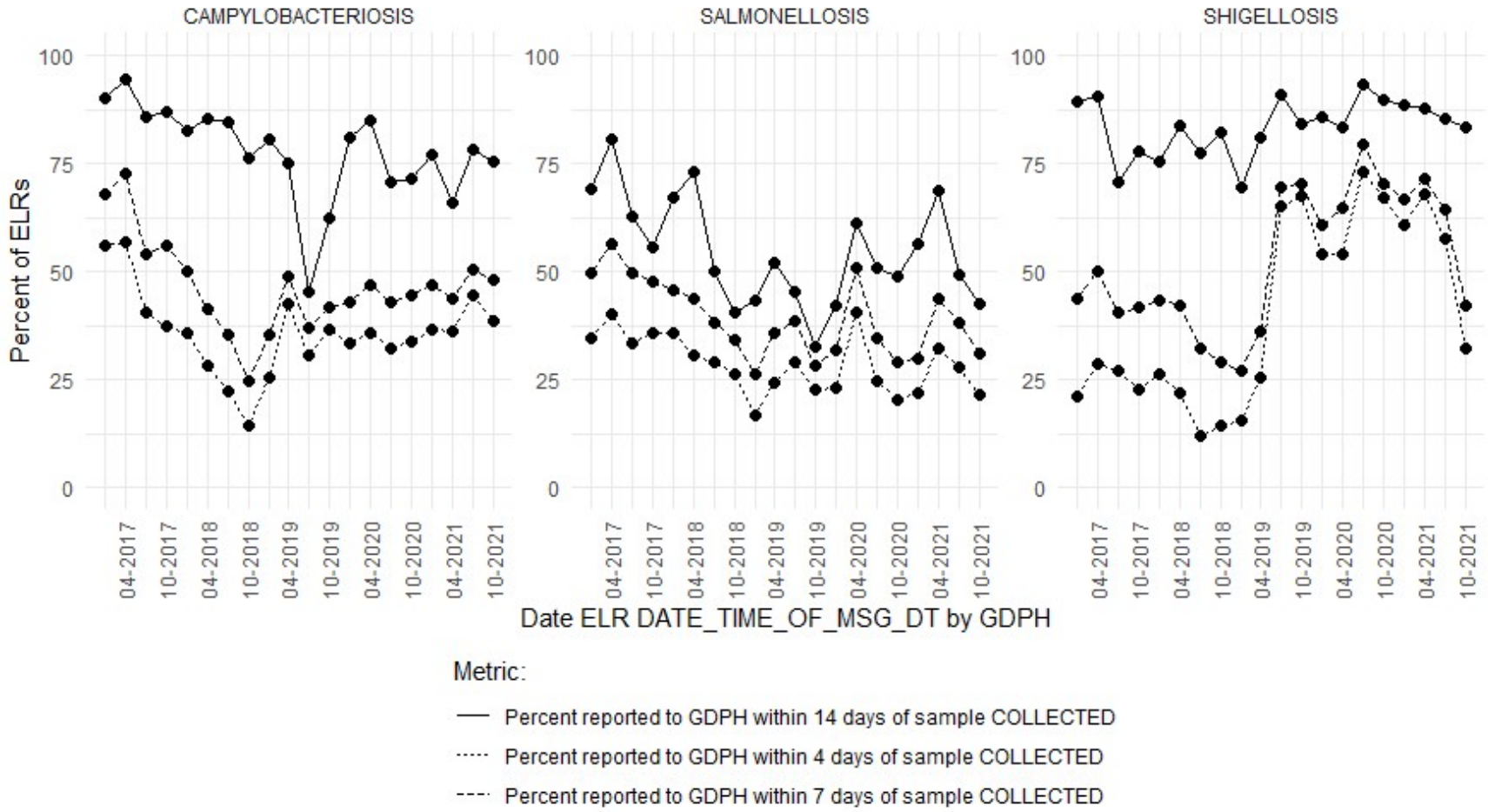


Figure 4.4 Timeliness of Electronic Laboratory Reports Received, FoodNet Pathogens, 2017-2021



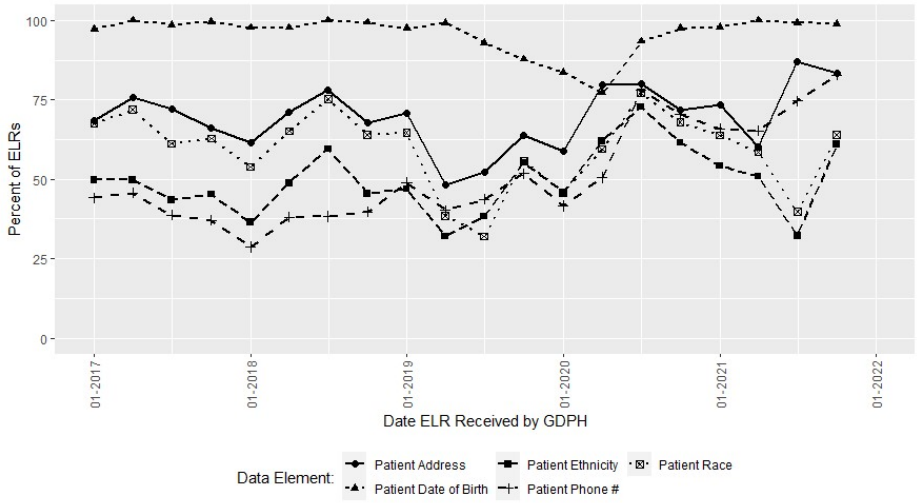
Completeness of Demographic Variables

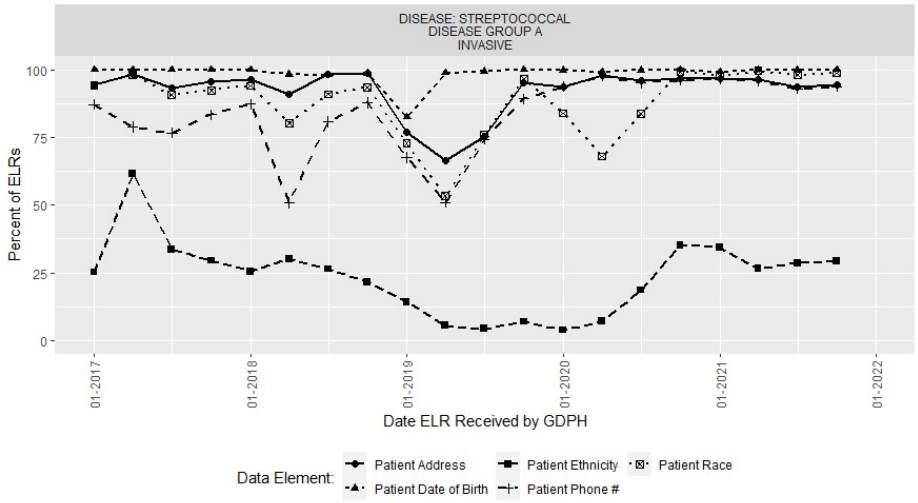
Completeness of demographic information varied by data element. Date of birth was the most complete, while ethnicity was the least complete. There was also variation in the completeness of the demographic variables by the type of disease reported.

Date of birth was included with almost all ABCs and FoodNet ELRs from 2017 to 2019. There was a slight decline in this variable for Group A *Streptococcus* in 2019 and *Haemophilus influenzae* in 2020, which may reflect a change in system or a mapping issue. Patient address was the second most complete variable and typically included in more than 75 percent of the ELRs for each quarter. Patient phone number was included less often than address but included in approximately 50 percent of ELRs for each quarter.

Race and ethnicity were the least complete demographic variables. Race tended to be included in the ELR more often than ethnicity. Race was included in at least 40 percent of the ELRs each quarter, with improvements observed in 2020 and 2021 for almost all pathogens. Ethnicity was included in as low as four percent of ELRs reported for Group A *Streptococcus* during the second and third quarters of 2019. While the inclusion of ethnicity was better for the other diseases, it was not included in more than 80 percent of the quarterly ELRs.

Figure 4.5 Percentage of Demographic Variables included in Electronic Laboratory Reports, ABCs Pathogens, 2017-2021





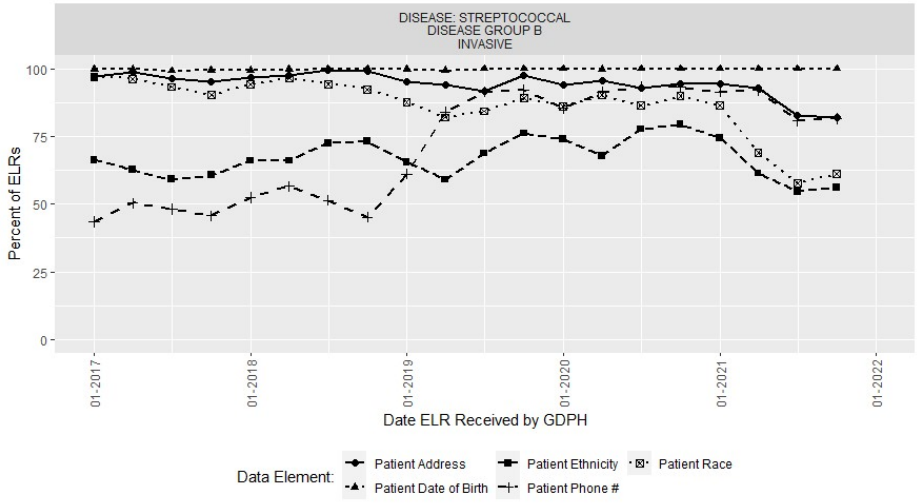
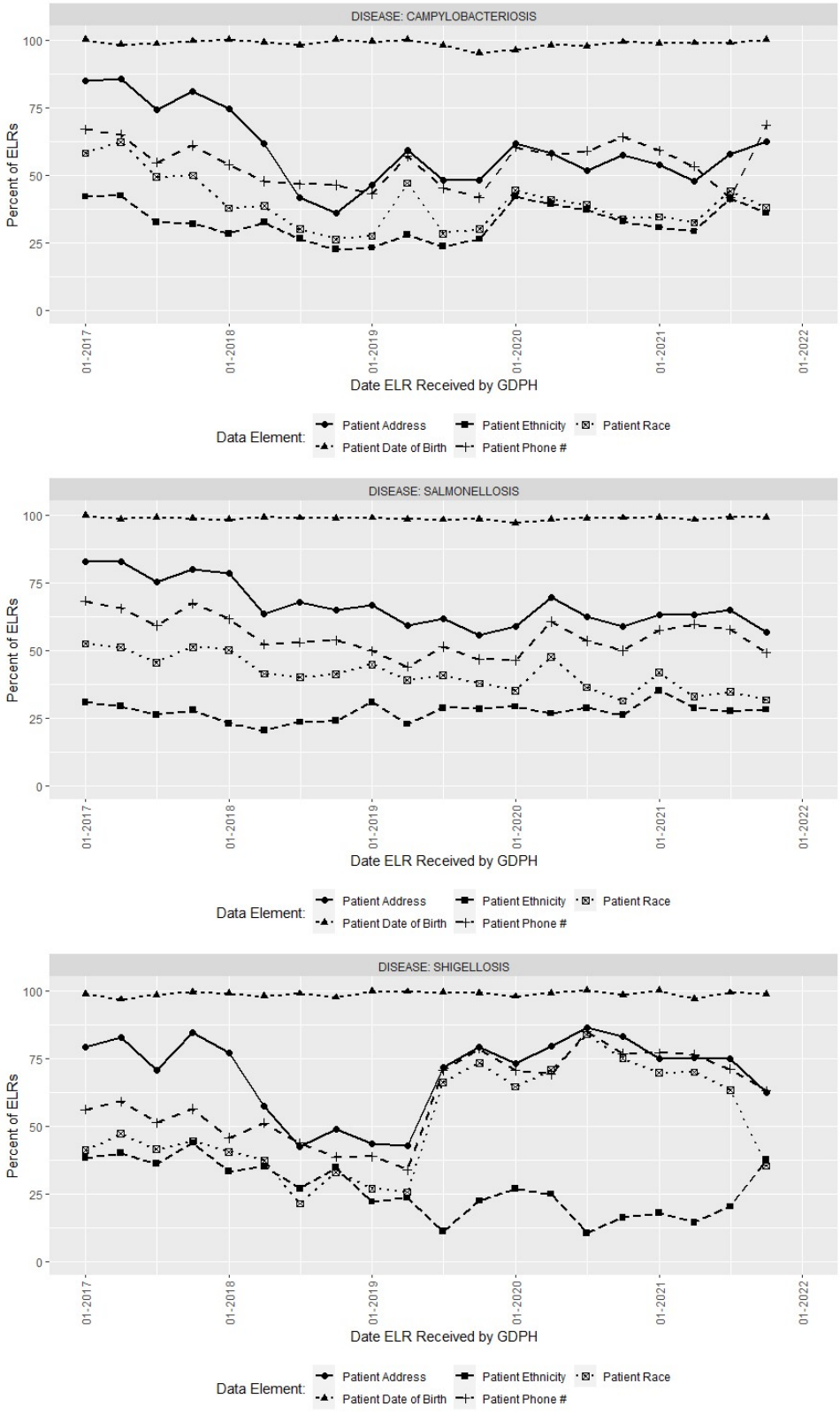


Figure 4.6 Percentage of Demographic Variables included in Electronic Laboratory Reports, FoodNet Pathogens, 2017-2021



Geographic Analysis of Electronic Laboratory Reports

ELRs were categorized into rural and nonrural using patient address and designations from the 2010 United States census. Any county with a population less than 50,000 is considered rural, and any county with a population greater than 50,000 was considered nonrural. Due to the missingness of address, a larger proportion of ELRs were unable to be categorized as rural or nonrural.

Figures 4.7 and 4.8 show the proportion of ELRs received for patients residing in rural or nonrural areas for the ABCs and FoodNet pathogens. The proportion of ELRs received for patients residing in rural areas was slightly lower than the proportion received for patients in nonrural areas. For ABCs pathogens, the proportions were relatively constant over time while for the FoodNet pathogens, the proportion of rural increased over time.

Figure 4.7 ABCs ELRs and Rurality. 2017-2021

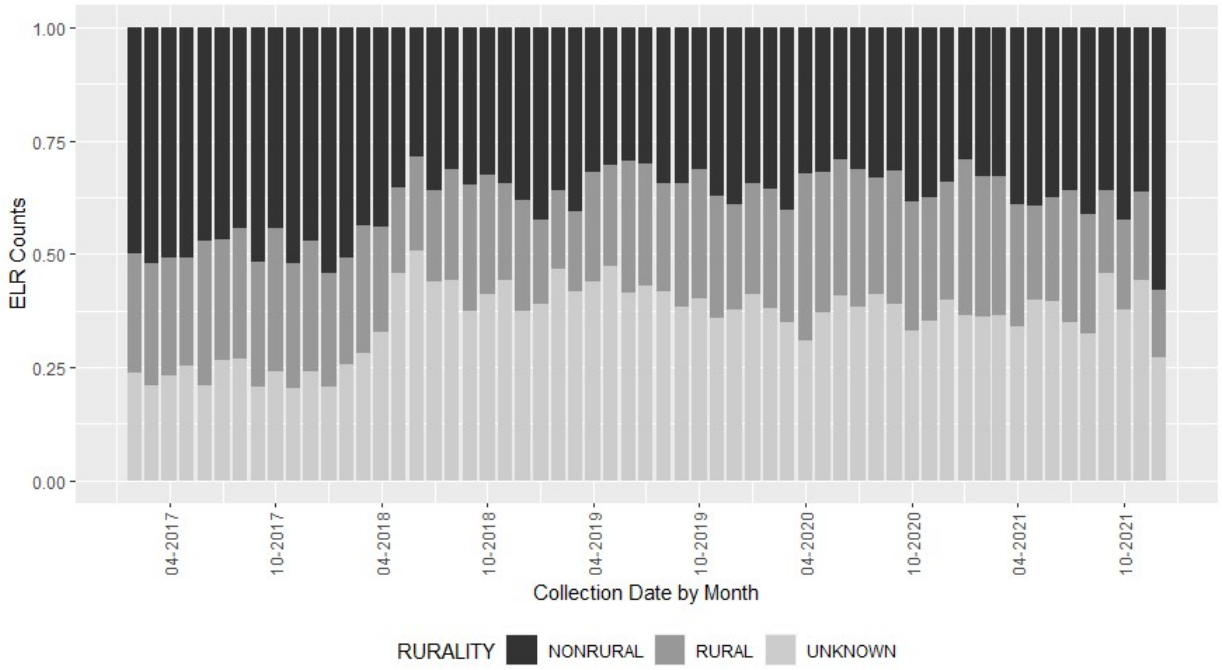
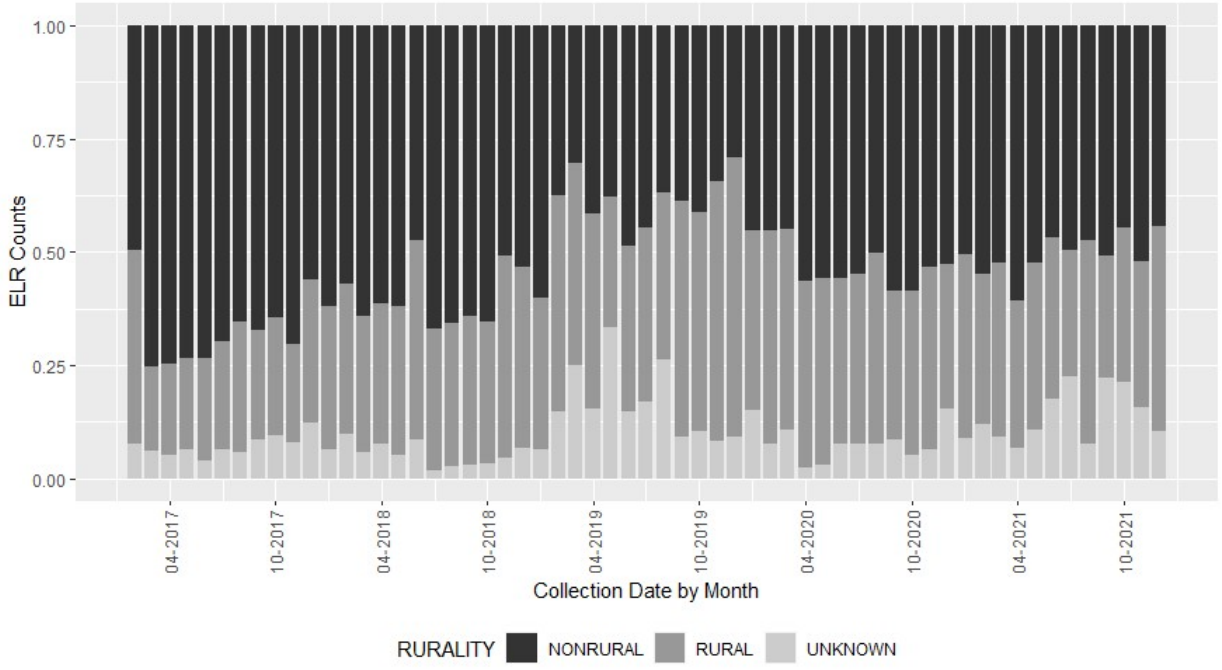


Figure 4.8 FoodNet ELRs and Rurality, 2017-2021



Analysis of Surveillance Data

Table 4.2 shows the number of confirmed cases for the pathogens included in the analysis. Figure 4.10 shows the number of cases created by automation compared to the number of cases that were reported through other methods. The number of cases created through automation has slightly increased over time, but the majority of cases are reported through other methods. Figure 4.11 shows the proportion of cases created through automation in rural and nonrural areas. Paralleling the ELR messages, the proportion of reports created through automation in rural and nonrural is similar.

Table 4.2 Number of Confirmed and Probable Cases, ABCs and FoodNet Pathogens, 2017-2021

Disease	2017	2018	2019	2020	2021
ABCs Pathogens					
Haemophilus Influenzae (Invasive)	253	242	251	138	172
Streptococcal Disease, Group A (Invasive)	370	371	472	343	1,647
Streptococcal Disease, Group B (Invasive)	921	977	1,011	999	8,873
FoodNet Pathogens					
Campylobacteriosis	1,179	1,417	1,395	1,242	2,104
Salmonellosis	2,351	2,937	2,702	2,299	9,231
Shigellosis	536	582	607	437	384

Figure 4.9 Cases Created by Automation by Pathogen, 2012-2021

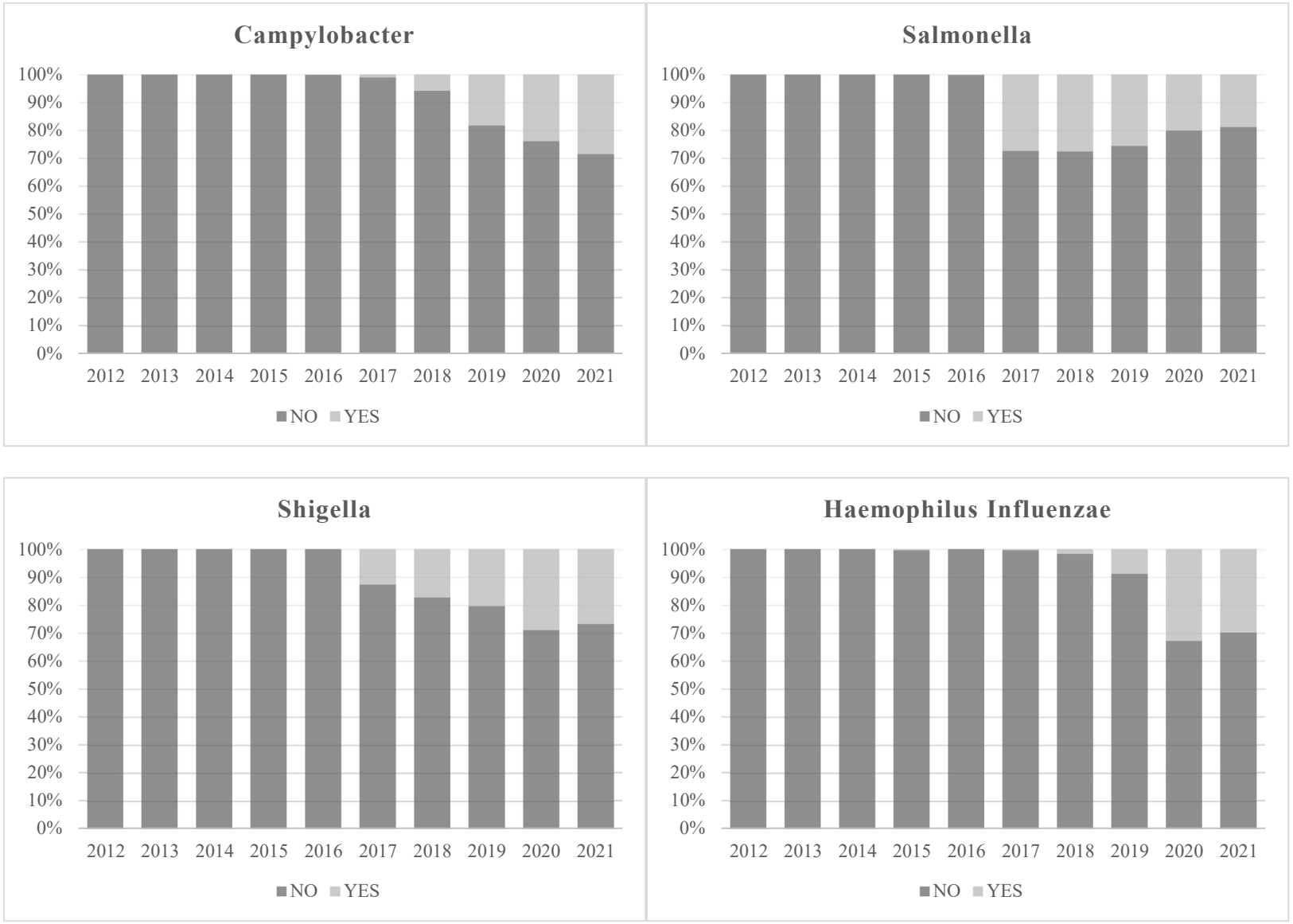
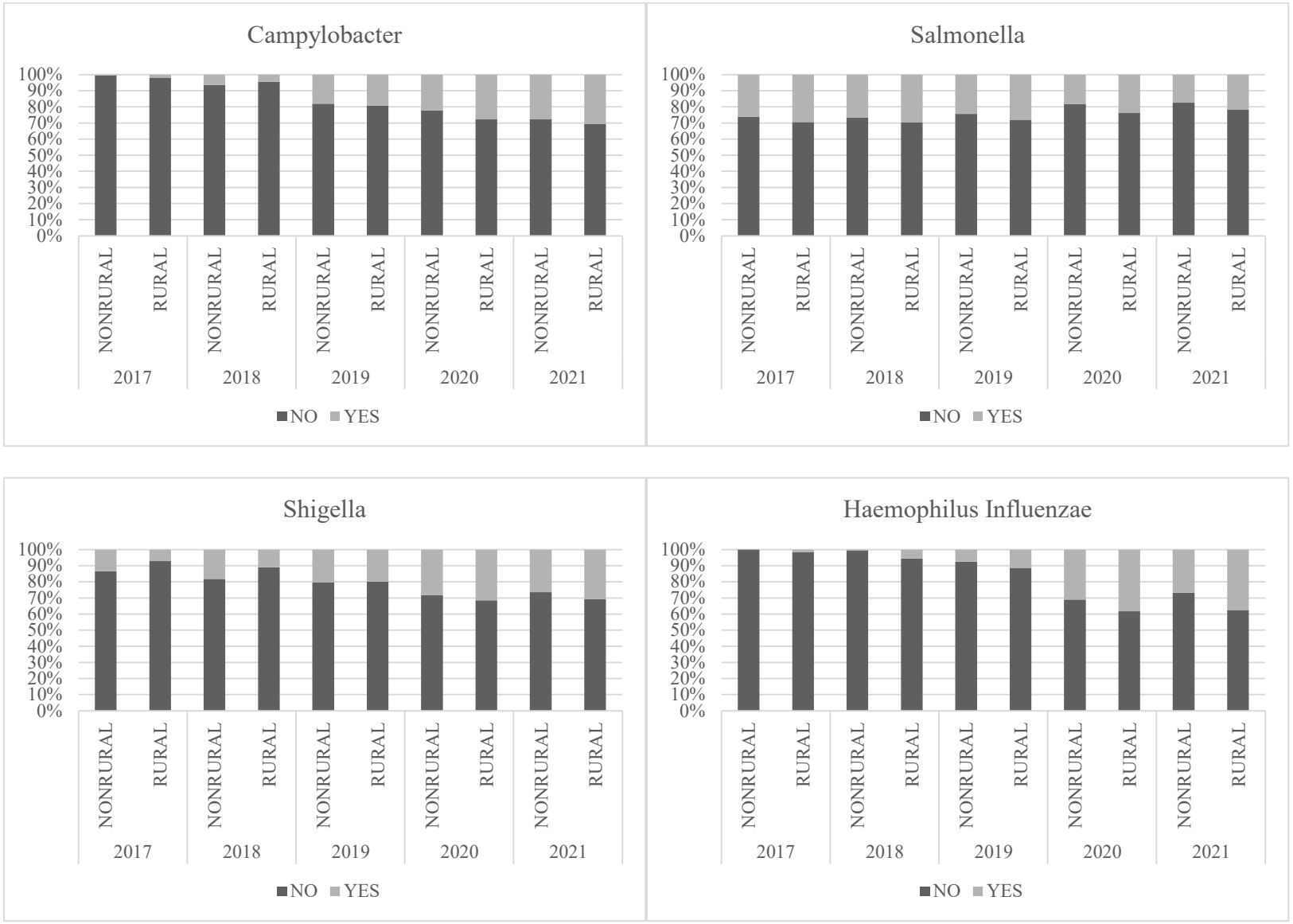


Figure 4.110 Cases Created by Automation by Geography, 2017-2021



Survey Results

Descriptive Analysis of Respondents and Facilities

The survey was distributed to infection preventionists, microbiology laboratorians, and IT staff at 82 hospitals. Forty-seven respondents started the survey, but twelve did not complete the full survey and were excluded from the analysis. The survey was completed by multiple staff at three facilities so only 32 (39%) hospitals that received the survey are represented in the analysis. Of the 34 respondents that provided their reporting role, 15 (44.1%) worked in infection prevention and control, in clinical and managerial positions; ten (29.4%) worked in a microbiology role, including manager, supervisor, and medical technician; three (8.8%) identified as laboratory managers or directors; two (5.9%) respondents held regulatory affairs positions; and four (11.8%) respondents had other roles, including Registered Nurse, Laboratory Information Systems, Data Support, Epidemiologist. Twenty-nine respondents provided their reporting roles/responsibilities, and three primary reporting roles/responsibilities were identified. Fourteen (48.3%) respondents said they had general reporting responsibilities, such as database set up, faxing reports, and manual reporting; eight (27.6%) respondents said that their primary responsibilities were SendSS-related, such as reporting and data entry; and seven (24.1%) respondents indicated their primary role was managerial or infection prevention.

Twenty-five (71.4%) respondents indicated their facility was part of a hospital system, and 13 hospital systems were represented in the survey responses. Of the responses collected, 17 (68.0%) responses indicated their facility used a centralized system for notifiable disease reporting, and 19 (58%) reported using a laboratory information management system (LIMS) to report. Five respondents (4%) reported using another system to identify and report notifiable disease cases to DPH. Twenty (83%) indicated their LIMS is automated to alert or report a notifiable disease case.

COVID-19 Impact on Reporting

Twelve (34%) reported COVID-19 impacted their facility's awareness of notifiable disease reporting, and 14 (40%) reported COVID-19 resulted in a change to their facility's process for notifiable disease reporting. Among the 11 respondents to the previous question that mentioned COVID-19's impact, nine provided additional detail. Three mentioned the volume increase of reporting had an impact, five noted the increase in staff workload and time required for reporting, and one noted that COVID-19 made them more aware in general of how ELR works. Of the 14 respondents who reported that COVID-19 did have an impact on their facility's notifiable disease reporting process, thirteen provided additional details. Specific impacts included:

- Increase in frequency of reporting (n=4)
- Reporting became automated (n=2)
- Only use ELR for COVID-19 (n=2)
- Using ELR for COVID-19 encouraged other conditions to be added to the ELR list, as well as increased awareness among staff (n=2)
- Became familiar with the HL7 interface (n=1)
- Facility is now dependent on outside labs to report (n=1)
- Facility is now playing catch up for other condition reporting that was put on hold due to COVID-19 (n=11)

Seventeen (49%) reported having to make modifications to their notifications or audit reports in the previous year.

Successes, Barriers, and Challenges

About half of respondents reported that it was extremely difficult or somewhat difficult to make changes to their notifications or audit reports although most respondents reported having dedicated IT support to assist with their LIMS. Slightly more than half, 19 out of 34 respondents reported their facility had a process for validating or confirming all notifiable disease cases have been reported to DPH. Eighteen respondents who affirmed their facility had a validation process in the previous question described their methods for ensuring the reporting of notifiable diseases. These additional details included:

- Responsibility of infection prevention to ensure reporting (n=6)
- Manual and/or periodic checking of reporting (n=6)
- Reliance on various communication tactics to ensure reporting, such as reconciliation emails or contact with DPH, district epidemiologists, or EIP (n=4)
- Reports and notes are built into ELR system (n=2).

Three respondents described other challenges and barriers with SendSS electronic reporting. One shared that they struggle with lag time, one mentioned difficulty with the specific ELR system they use, and one said that they fax reports instead of transmitting electronically through SendSS.

Respondents were asked to select successes from a set list of options: workload, time spent completing data entry, availability of IT support, availability of financial support, support from hospital leadership/management, significant administrative or other changes since COVID, or other, with the option to provide more detail. There were twenty-seven total respondents, with eight (29.6%) who selected two or more successes. The percentage of respondents that selected each success included:

- Workload - 11.8%
- Time spent completing data entry - 23.5%
- Availability of IT support - 23.5%
- Availability of financial support - 2.9%
- Support from hospital leadership/management - 26.5%
- Significant administrative or other changes since COVID - 5.9%
- Other – 17.6%

Among those who replied "other" to the previous question, three respondents provided detail. One success was the decrease in manual data entry. One mentioned that previously their lab did not have to report, and another mentioned that their lab reports directly to EIP and does not currently use SendSS.

The same list was provided with respect to challenges, and respondents were asked to select all that applied. The percentage of respondents that selected each challenge is below.

- Workload – 70.5%
- Time spent completing data entry - 70.5%
- Availability of IT support – 26.5%
- Availability of financial support – 11.8%
- Support from hospital leadership/management – 14.7%
- Significant administrative or other changes since COVID – 23.5%
- Other – 11.8%

Hospital Leadership and Engagement

Twenty-two respondents provided thoughts on how to increase engagement from hospital leadership and administration in the reporting process. These included:

- Already have engagement and involvement from hospital leadership (n=5)
- An easier system or process (n=4)
- Unsure, with two (2) respondents adding that either the lab or infection control use SendSS, but not in coordination (n=4)
- Nothing (n=3)
- Legal or regulatory requirements (n=3)
- Increasing awareness and understanding of the process (n=2)
- Financial motivation (n=1)

Resources

All respondents found available resources helpful. Nine respondents specified helpful resources that centered on four themes: staff assistance (n=4), online support or communications (n=3), reportable cheat sheets (n=1), and sending data electronically (n=1).

Notifiable Disease Reporting

Thirty-three respondents replied with their thoughts on potential improvements by DPH for notifiable disease reporting. Five remarked that nothing needs improvement. Four were unsure of possible improvements. Five respondents mentioned possible communication improvements (response time, notification/explanation of changes in format or options, coordinated rollout of updates), and two noted that the initial setup of an ELR system could be made easier. Two respondents thought it would be helpful to mandate using ELR, and fifteen said that improvements were needed to SendSS (including message capabilities, automating/connecting with electronic medical record systems, and speed/functionality). Eight respondents provided additional feedback on notifiable disease reporting in Georgia. General themes included:

- Burden of notifiable disease reporting (staff time/workload, duplicative reporting) (n=3)
- Need easier process, such as a way to transmit electronic medical record data electronically (n=6)
- Request for improved response from the department of public health DPH staff when there are questions (n=1)

Table 4.3 Characteristics of Survey Respondents and Facilities

	Yes N (%)	No N (%)	Unknown N (%)	Total
Hospital System	10 (28.6)	25 (71.4)		35
Familiar with SendSS	33 (97.1)	1 (2.9)		34
Centralized reporting	17 (68.0)	8 (32.0)		25
Facility uses a LIMS	19 (57.6)	14 (42.4)		33
Facility uses another system for reporting	5 (38.5)	8 (61.5)		13
LIMS automated to report	20 (83.3)	4 (16.7)		24
COVID impacted reporting awareness	12 (34.3)	23 (65.7)		35
COVID-19 resulted in reporting change	14 (40.0)	21 (60.0)		35
Modified notifications or audit reports for reporting in past year	17 (48.6)	18 (51.4)		35
Has process for validating all cases are reported	19 (55.9)	15 (44.1)		34
Has dedicated IT support to assist with LIMS	25 (73.5)	5 (14.7)	4 (11.8)	34

Table 4.4 Reported Successes, Challenges, and Barriers Associated with Electronic Laboratory Reporting

	Successes N (%)	Challenges/Barriers N (%)
Workload	4 (11.8)	24 (70.5)
Time spent completing data entry	8 (23.5)	24 (70.5)
Availability of IT Support	8 (23.5)	9 (26.5)
Availability of financial support	1 (2.9)	4 (11.8)
Support from hospital leadership/management	9 (26.5)	5 (14.7)
Significant administrative or other changes since COVID	2 (5.9)	8 (23.5)
Other	6 (17.6)	4 (11.8)

CHAPTER 5

DISCUSSION

Conclusions

Timeliness and Completeness

The evaluation of the ELR and surveillance data showed that reporting has been consistent over the five-year analytical time period. For most of the pathogens, reporting timeliness and data completeness were steady over time with little improvement or decline. This indicates that hospitals and laboratories are utilizing ELR to report notifiable disease data, but data quality has not changed, which indicates there is an opportunity to improve the timeliness and completeness of reports. In addition, the majority of cases were not created by ELR, demonstrating another gap that could be strengthened.

The timeliness of reporting for the ABCs pathogens was much better compared to the FoodNet pathogens. Most cases were reported within four days for Group A Streptococcus and Group B Streptococcus, while reporting was less timely for Haemophilus influenzae. Timeliness may have been better for ABCs pathogens because only invasive, more severe, cases are notifiable, whereas all positive reports for FoodNet pathogens are notifiable regardless of specimen source. Thus, for FoodNet pathogens, the illness may not have been as severe, and a case may have been treated in an outpatient setting. Specimens collected in an outpatient setting are more likely to be sent to a reference laboratory for testing. Due to the volume of testing at reference laboratories, reporting processes may be slower or less complete.

Furthermore, reporting timeliness may be slower during seasonal peaks due to the volume of case reports. The declines observed for ABCs pathogens in 2020 and 2021 may be attributed to the lower number of reports for those years due to the COVID-19 pandemic when enhanced precautions were taken to mitigate disease spread. Declines were also observed for foodborne pathogens during this time period, which may be attributed to COVID-19 pandemic when fewer people were dining out, and healthcare-seeking behavior may have changed to reduce exposure to COVID-19.

Data completeness varied by data element included in the analysis. Date of birth was the most complete, likely, because it is used as a key patient identifier for healthcare facilities. Likely for similar reasons, address was the second most complete demographic variable because it is needed for patient follow-up and billing purposes from a healthcare perspective. Patient phone number was also included for the majority of cases but less often than address. This variable is essential for public health follow-up, and improvements can be made. Phone number is needed to complete case interviews which allow health departments to collect data about exposures. The information collected during patient interviews is needed to identify sources of illness and outbreaks so that public health interventions can be implemented. This may include healthcare facility inspections, restaurant inspections, and food production inspections if a common source is identified.

Race and ethnicity were the least complete demographic variables and included less than 50 percent of the time. Similar to the other demographic variables, completeness of race and ethnicity was better for ABCs pathogens than FoodNet pathogens. It is possible that greater emphasis is placed on collecting race and ethnicity in a hospital setting compared to an outpatient setting. Race and ethnicity data are self-reported and also may not be completed by

patients. Ethnicity was reported less often than race. Some hospitals do not collect ethnicity data, which may contribute to the missingness. In addition, there may be reduced emphasis by reference laboratories for ensuring race and ethnicity are complete. Race and ethnicity are vital to assessing disease trends and health disparities. They can be used to identify gaps in healthcare delivery and services, and this information can be used to target the allocation of resources to improve health outcomes. Thus, increased emphasis should be placed to strengthen collection and reporting of race and ethnicity data.

The completeness of demographic information required to complete a case report form could also be improved. Since these data elements were missing, public health staff needed to follow up with facilities in order to obtain information to complete the case report, which in turn places an additional burden on hospital staff to respond to requests for information.

The number of ELRs received exceeded the number of confirmed cases for each pathogen each year, demonstrating a significant number of duplicative reports requiring review. Multiple reports may be received for several reasons, including inclusion of updated laboratory results or updated demographic information. For example, a laboratory may report preliminary or presumptive test results initially and a subsequent message will be sent when the results are final. In addition, antibiotic susceptibility results may be added once they are available. Another reason for duplicate reports is reporting the results of panel tests, which may include positive and negative results for several notifiable diseases. Duplicate results may also be the result of a process issue. Laboratories may send duplicate reports due to a system change or mapping issue in error. However, there is no systematic process in place to review or note updated information, and updates may require some manual review to ensure all of the data are captured in the SendSS surveillance data.

Despite the use of electronic reporting, timeliness could be improved. While most reports were received within the required reporting period within seven days from the specimen collection date for the ABCs pathogens, reports for the FoodNet pathogens were more frequently received outside of the reporting period. The majority of FoodNet pathogens were reported within 14 days. Electronic reporting is typically associated with greater efficiency due to reduced data entry. Further evaluation is needed to determine the reasons for the reporting delays and to identify methods to improve reporting timeliness in order to meet the reporting guidelines.

No significant differences in the use of ELR between rural and nonrural areas were observed, and automated case creation was consistent in both rural and nonrural areas during the analytical time period. Upon further examination, smaller facilities tended to report more duplicates compared to hospitals that were part of a large health system. This demonstrates that most facilities have adequate resources to support electronic reporting, but some hospitals may need additional IT support or outreach to improve their data quality.

Successes, Barriers, and Challenges to ELR Adoption

Although the survey response rate was low, it captured staff in a variety of notifiable disease-reporting roles, including infection preventionists, microbiology laboratory managers, and data support. Most of the facilities were familiar with notifiable disease reporting and reported having adequate IT support as well as support from hospital leadership and management. They also noted that ELR resulted in a reduced burden of data entry. Despite these resources, many respondents noted barriers or challenges, including workload, time spent completing data entry, and availability of IT support. Few noted a need for additional support, while others noted that notifiable disease reporting could be burdensome.

Most respondents were satisfied with the resources provided by the health department. Positive comments centered around staff assistance, communication, and availability of reportable disease cheat sheets. However, they often indicated that notifiable disease reporting was burdensome, and that the initial setup of ELR could be improved. In addition, several suggestions were made for improving SendSS, including enhanced messaging, functionality, speed, and potential linking to EMR, which would reduce follow-up burden on both public health and healthcare staff. COVID-19 also resulted in increased ELR reporting for other notifiable disease conditions.

Limitations

Surveillance Data

Assessing surveillance outcomes for the selected subset of diseases may not be representative of all notifiable diseases, and the findings of this study may not be generalizable to other disease surveillance programs. For example, other diseases may be detected through more complex testing methods that are not as easily interpreted as the results for foodborne diseases. This makes mapping the results for automation more complex and may affect the number of duplicate messages received.

The adoption of new systems and processes is often the result of management decisions, and public health surveillance may not be a priority or consideration when decisions about system implementation are made at the facility level. Adoption of a system or a change in system may lead to delays in reporting to public health agencies and can impact the reporting timeliness and completeness. Furthermore, it is unpredictable whether reporting facilities will change its system or if a change will result in reporting delays. Changes in hospital systems occurred during the analysis time period and likely impacted the results. In addition, several

facilities did not adopt electronic reporting until the COVID-19 pandemic, which may have affected the study results.

Stakeholder Survey

Participation in the survey was limited to EIP partners who are routinely involved in reporting the notifiable diseases included in this study. As a result, potential participants involved in notifiable disease reporting for other diseases or staff with a greater focus on ELR may have been missed. This is a missed opportunity to collect feedback. Thus, the survey could be expanded in the future. In addition, conducting focus groups should be considered to collect more in-depth feedback.

The survey was also conducted at a time when laboratories had an increased workload or were catching up due to COVID-19, and this may have contributed to the low response rate for the survey. In addition, several routine surveys assessing laboratory testing practices had been administered prior to the distribution of this survey. In responses to those surveys, concern was expressed about the number of survey requests. Aligning future surveys with other requests may help improve the response rate.

Recommendations

Lastly, the findings can be aligned with the HOT-Fit framework that was used as a guide for designing the study. Unlike other models, it considers the human, organization, and technology elements that are vital for an effective public health information system.

Human

While ELR creates efficiencies through reduced data entry and workload burden, the results showed delays in reporting still exist. Minimizing delays and meeting the required reporting requirements should be one of the primary goals for ELR. Prior to ELR adoption,

delays were often associated with the need for manual data entry into the state notifiable disease system, but ELR replaces that need. Thus, a root cause analysis could be conducted to identify the sources of the delays and to create a plan to address them. This was beyond the scope of the study. Delays could be the result of technology, or they may be the result of staff limitations, such as the need for additional training or the need for increased IT resources.

Survey responses mentioned that the process of using ELR could be easier demonstrating a need for increased IT support and resources to support ELR. As ELR adoption continues and improves, workforce development in this area would be beneficial. From a public health perspective, it would be an asset for staff to be trained and familiar with ELR processes so that they can provide better support to reporting partners when needed. Feedback from the survey also indicated communication between public health staff and reporting facilities could be improved. This could also potentially reduce the burden on IT staff.

Due to the volume of information being provided through electronic reporting, more IT support is needed to maintain and sustain this tool. Support for greater IT resources can improve hospital outreach to improve the timeliness and completeness of reporting.

Organization

Hospitals and laboratories are familiar with the necessity and advantages of ELR. However, challenges and barriers to electronic reporting exist despite improvements made during the COVID-19 pandemic. Use of ELR increased during the pandemic and many users found it to be beneficial, but administrative changes can be burdensome. Most laboratories already had a LIMS in place that they are using to identify and report notifiable disease cases, but many did not start reporting electronically until the pandemic due to the volume of reports that needed to be made to the health department. Some mentioned they found the process of reporting

electronically difficult to implement, which may be a reason for the delay in the uptake of this technology. Laboratory staff also indicated that communication and response time from the health department could be improved. Addressing these resource and process concerns could improve the implementation of electronic reporting.

Stakeholder feedback was collected using a survey tool due to the timing and the environmental landscape of the COVID-19 pandemic. Using the survey and study findings as a guide, enhancements could be made to expand the survey to capture additional information and responses from more stakeholders involved in the notifiable disease and ELR processes. In addition, focus groups may garner more information and allow researchers to probe for additional information to focus on key themes. It may also be valuable to survey or interview health department staff for feedback about their use of ELR, needs, and potential improvements.

Technology

Most of the key findings from this study centered around technology and data quality. Improvements are needed in data quality, including the timeliness of reports and the completeness of demographic variables. Timeliness of reporting could be improved for all pathogens, but specific focus should be placed on the foodborne diseases because these reports are critical for disease investigations, identification of outbreaks, and public health action. Demographic variables are also important for disease investigations. They are critical to evaluating disease trends, assessing health equity, and creating health policies. Additional analyses could be conducted to determine how to target interventions for improving data completeness of race or ethnicity. This might include training hospital staff or making adjustments to HL7 messages. Another recommendation from the survey was to connect the

reports to the electronic medical record data to reduce the requests to laboratorians and infection preventionists. This may also lead to improvements in demographic completeness.

The volume of duplicative reports could be greatly reduced. Duplicate reports are often the result of updated information, but there is no systematic way for tracking updates. An enhanced method to track and manage changes could be implemented. A large proportion of the duplicate messages were received from smaller hospitals. This could be the result of limited IT resources available at these hospitals compared to hospitals that are part of larger hospital systems. Further investigation is needed to determine if additional resources or support could improve the data quality and reduce duplicative reporting. Additional information can also help with prioritizing the allocation of resources.

Significance and Policy Implications

The findings of this study can be utilized to inform program planning and decisions to strengthen public health surveillance processes at the local and state health department levels. Advocating for additional policies that provide ongoing support for maintaining ELR and interoperability may be necessary to make improvements in data quality and for its continued success. In addition, the findings from this project can be used to strengthen program outreach and messaging with external partners, such as hospitals and laboratories. Lastly, the findings can be used to inform policies on a larger scale, as it is likely that Georgia is not the only state experiencing increased volumes in disease reporting, data incompleteness, and systems challenges associated with ELR. Additional resources to strengthen ELR may be necessary to make significant improvements in data quality.

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Appendix A. Stakeholder Survey

This survey is targeted to external partners, who are responsible for any notifiable disease reporting, including hospital laboratorians, infection preventionists, and information technology staff with a focus on electronic laboratory reporting (ELR). If you are not involved with reporting notifiable diseases to the Georgia Department of Public Health (DPH), please provide the contact information for the person(s) responsible or forward this survey as appropriate.

1. Please provide information about your current role as it relates to notifiable disease reporting. If relevant,
    - Name
    - Title
    - Reporting responsibilities/role(s)
    - Facility

2. Is your facility part of a hospital system with multiple hospitals and laboratories?
    - Yes
    - No

3. Please consider your process for notifiable disease reporting and staff that are involved in follow-up. Is your team familiar with the Georgia State Electronic Notifiable Disease Surveillance System (SendSS)? https://sendss.state.ga.us/sendss/login.screen
    - Yes
    - No

4. If part of a hospital system, is notifiable disease reporting centralized?
    - Yes
    - No
    - Not Applicable

5. Does your hospital/facility use a laboratory information system to identify and report notifiable disease cases electronically through HL7 messages to SendSS?
    - Yes (Please specify.)
    - No

    a. If no, does your hospital/facility use another system to identify and report notifiable disease cases to the Georgia Department of Public Health (DPH)?
        - Yes
        - No

    a. If yes, is notifiable disease reporting centralized?
        - Yes
        - No
        - Not Applicable

4. Is your laboratory information management system automated to alert (or report) a notifiable disease case?

- Yes
- No

5. Has COVID-19 impacted your facility's awareness of notifiable disease reporting?

- Yes (Please specify.)
- No

6. Has COVID-19 resulted in a change in your process for notifiable disease reporting?

- Yes (Please specify.)
- No

7. Have you had to modify your notifications or audit reports for notifiable disease surveillance reporting in the past year?

- Yes
- No

b. If yes, how easy or difficult is it to modify your notifications or audit reports for notifiable disease surveillance in your internal process?

- Very difficult
- Difficult
- Neutral
- Easy
- Very easy

8. Does your laboratory have a process for validating or confirming all notifiable disease cases have been reported to the department of public health?

- Yes
- No

a. If yes, please describe your method(s) for ensuring notifiable disease cases are reported.

9. Do you have dedicated IT support to assist with your laboratory information system?

a. Yes
b. No
c. Don't Know

10. What are/were some of the challenges or barriers with SendSS electronic laboratory reporting?

- Workload

- Time spent for completing data entry
- Availability of IT support
- Availability of financial support
- Support from hospital leadership/management
- Large changes since COVID or administrative
- Other, _____

11. What are/were some of the successes?
    - Workload
    - Time spent completing data entry
    - Availability of IT support
    - Availability of financial support
    - Support from hospital leadership/management
    - Large changes since COVID or administrative
    - Other, _____

12. What would help engage hospital leadership or administration in the process?

13. Have resources provided by the Georgia Department of Public Health (DPH) been helpful?
    - Yes (If yes, what resources have helped you with reporting and response?)
    - No (What resources have not been helpful?)
    - Have not received resources from DPH
    - Not sure

14. What could be improved with notifiable disease reporting by DPH?

15. Do you have any additional feedback about notifiable disease reporting in Georgia?