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Timeliness of Electronic and Traditional Laboratory Reporting in Southern Nevada, 1999-2012

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TIMELINESS OF ELECTRONIC AND TRADITIONAL LABORATORY REPORTING IN SOUTHERN NEVADA, 1999-2012

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Abstract

This study compares the timeliness of Electronic Laboratory Reporting (ELR) with traditional reporting. ELR has been implemented in parts of the United States, and is perceived to be faster than traditional reporting. Faster reporting leads to faster public health response to prevent outbreaks, and to reduce the burden of infectious disease in communities. Nevada State law requires that diseases be reported within certain time frames. Timeliness of laboratory reporting at the Southern Nevada Health District (SNHD) from 1999-2012 was assessed by analyzing cases of four common diseases in this retrospective secondary analysis of extant data.

The difference in timeliness regarding public health response (for public health investigation response time) and the difference in timeliness for legal state reporting requirements between ELR and traditional reporting were evaluated using independent samples t-tests. A two-way analysis of variance (ANOVA) was conducted to determine whether each disease had interactions with report type or influence on timeliness.

The data contained 1,082 traditional reports and 1,343 ELR results. The diseases in this study were campylobacteriosis, giardiasis, salmonellosis, and shigellosis. Both t-tests, for public health response timeliness, and legal compliance timeliness were statistically different. However, it was determined that public health response time difference was not significant in later tests with a smaller confidence interval.

There was no significant interaction between disease type and report type regarding public health response time. The result was significant regarding legal compliance time. This study showed that with both ELR and traditional reporting, it is impossible to prevent secondary infections when basing public health response on laboratory confirmation. The legal requirements time was inconclusive because the data

were provide in days, rather than minutes. In addition, the ANOVA for ELR and legal time suggested batched results when using ELR. This study showed that response timeliness is too long in Southern Nevada, with ELR and traditional reporting. More studies of timeliness should be conducted in Southern Nevada.

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Table of Contents

List of Tables

List of Figures

Chapter 1 – Introduction

This study compares the timeliness of traditional reporting and ELR at the Southern Nevada Health District (SNHD). Traditional reporting includes phone, fax, and paper reports. ELR is defined as the transmission of laboratory results sent from the testing laboratory to the public health authorities using electronic means (Centers for Disease Control and Prevention, [CDC] 2011a).

Faster reporting can lead to faster response by public health officials to prevent potential outbreaks and new cases, and to reduce the burden of infectious disease in the community. Nevada State law requires that diseases be reported in certain time frames. For many common diseases this timeframe is within 24 hours of a test result (Nevada Administrative Code [NAC] 441A, 2012).

Electronic Laboratory Reporting (ELR) has been or is being implemented in many states and counties. ELR is faster and has fewer errors than traditional paper reporting (Nguyen, Thorpe, Makki & Mostashari, 2007). In 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act, part of the American Recovery and Reinvestment Act (ARRA), became a law intended to expand the use of health information technology (HIT). Health care policy experts believe that HIT can improve quality, lower costs, and benefit the health of patients in multiple other ways. However, the use of HIT is considered to be low (Buntin, Burke, Hoaglin, & Blumenthal, 2011). The HITECH Act makes incentive payments to healthcare providers for implementing electronic medical records, as a part of the healthcare quality and efficacy goal of the Patient Protection and Affordable Care Act of 2010 (Buntin, et al. 2011). In addition to accelerating HIT, the HITECH Act provides incentive payments to reimburse providers for meaningful use updates of electronic health systems (Lenert & Sundwall,

2012). Incentive payments are important because the implementation of electronic systems can be expensive, and there has been a lack of federal funding for health IT. Meaningful use regulations (part of HITECH) require electronic health record systems to include incentives for healthcare providers who are able to demonstrate the ability to send ELR data to health departments (Lenert & Sundwall, 2012).

The goal of this study is to assess the timeliness of laboratory reporting in Southern Nevada with regard to public health response, (i.e. is the time frame sufficient to implement appropriate public health investigations and responses to prevent and contain potential outbreaks?). The timeliness of laboratory reporting will also be assessed with regard to requirements set forth by Nevada state law. The objective is to discover whether ELR is faster than traditional reporting. Timeliness will be examined from 1999, when the Office of Epidemiology (OOE) began collecting data in a standardized database through May 2012.

Data from four infectious gastrointestinal (GI) illnesses were analyzed in this study, as GI infections are common in Southern Nevada; five of the top 10 illnesses reported to the OOE at SNHD are GI infections. National reporting timeliness of these illnesses on a case by case basis is not often very important or useful (unlike diseases such as anthrax); however it is very important locally. This information is necessary to contain and investigate outbreaks, which lowers the burden of disease in the community (B.J. Labus, personal communication, February 16, 2012). The diseases in this study are campylobacteriosis, salmonellosis, shigellosis, and giardiasis. They are the four most common reportable GI infections in Southern Nevada for which data are collected on a case by case basis. Outbreaks of these diseases can be fast and spread easily to children, who can get sicker, or die more often than other populations (B.J. Labus, personal

communication, February 16, 2012). The type of disease was also examined with regard to timeliness of reporting.

This is the first assessment of timeliness of reporting in Southern Nevada.

Chapter 2 – Background and Significance

Disease Reporting History and Policy

In the United States, infectious disease reporting legislation falls to the states. In some states, diseases are reported to local health departments. Some local health departments provide epidemiologic services. All US states and territories choose to participate in a national program though the Centers for Disease Control and Prevention (CDC) to report cases of diseases on the list of Nationally Notifiable Conditions (CDC, 1990). The list of Nationally Notifiable Conditions is based on the Council of State and Territorial Epidemiologist's (CSTE) position statements, and voted upon yearly by state epidemiologists (CDC, 2012c). Reportable diseases are those that are required by state law to be reported to state or local health authorities. Notifiable diseases are diseases that are reported voluntarily to CDC by state or local health authorities (CDC, 2011b). Salmonellosis, shigellosis, and giardiasis are notifiable diseases. Campylobacteriosis is not nationally notifiable (CDC, 2011b). All of the diseases in this study are reportable in Nevada (NAC 441A, 2012).

Although standardized reporting methods, such as the use of the Nationally Notifiable Conditions list are fairly recent, reporting of communicable diseases to authorities is not a new phenomenon. In 1741, in the colony of Rhode Island, tavern owners were required by law to report customers with contagious diseases to authorities (Smith, Hadler, Stanbury, Rolfs, & Hopkins, 2012). Voluntary disease reporting to health authorities began in Massachusetts in 1874 (CDC, 1990). In 1878, the Public Health Service was commissioned by Congress to collect data on cholera, smallpox, plague, and yellow fever (Sickbert-Bennett, Weber, Poole, MacDonald, and Maillard, 2011). By 1901, all US states had reporting systems in place to report some infectious conditions to

the local health authorities (CDC, 1990). By 1925, all US states were participating in national infectious disease reporting, partially due to the 1916 poliomyelitis epidemic and 1918 influenza pandemic (CDC, 1990).

History of Electronic Health Systems

Historically, health care has trailed behind other industries in adopting and implementing electronic systems and technologies (Classen and Bates, 2011). In 1968, a physician, Lawrence L. Weed published a paper in the New England Journal of Medicine discussing how computers need to be used for medical records because the current state of records was unorganized and not complete (Weed, 1968). He explained how he had implemented computer programs in his own practice, and that by having a database with many patients, later one could review it and revise it as needed for efficiency (Weed, 1968). Weed has been called an "innovator" by Himmelstein and Woolhandler (2005), in their manuscript discussing history and Electronic Medical Record (EMR) systems. Himmelstein and Woolhandler (2005) also remark that Weed's innovation, as well as other systems created in the 1960s and 1970s, are "optimistic," but not practical with regard to cost. Hospital administrators believed that they had spent a lot of money on the electronic systems, but did not receive enough in return for them to keep the systems running. This was, in part, due to the systems being incomplete and creating problems such as medication errors (Himmelstein and Woolhandler, 2005).

Following in the footsteps of doctors such as Weed, a group of physicians and informatics scientists from Indianapolis, Indiana, hospitals and the Regenstrief Institute in Indianapolis began developing an electronic medical system in 1972. The goal of the Regenstrief Medical Record System (RMRS) developers was to simplify records by

eliminating paper and reducing paperwork, as well as making information more accessible to those who need it (McDonald et al. 1999). The Regenstrief Institute had success with their electronic programs, and is still working to develop improved reporting methods, and evaluating these methods (Overhage, Grannis, and McDonald, 2008).

Another evaluation of the use of technology in laboratory reporting, McLure and Barnett (1994), made the case that paper and phone reports were inferior to facsimile (fax) machines and personal computers. They state that the technology would produce faster and more complete reports. One comment from McLure and Barnett's 1994 paper notes a challenge that is still present: "true EDI [electronic data interchange] requires a standardized electronic format" (McLure and Barnett, 1994, Effler et al., 1999; Panackal et al., 2002; Zarcone et al. 2010).

State and County Laws and Policy

Staes et al. (2009) explain that public health infectious disease reporting is mandated by law in each state in the United States, and is "the key step in a chain of events that results in public health actions." Actions include investigation, immunization and chemoprophylaxis, treatment of infected contacts, control measures and identification of outbreaks. New cases of disease may occur when reports are delayed (Staes et al. 2009). Jajosky and Groseclose (2004) also examined disease reporting, and stated that a comparable review of disease reporting in multiple states was not possible, in part because states have different reporting laws and protocols. Jajosky and Groseclose (2004) also noted that the only disease analyzed in their review that had sufficient timeliness to contain a multistate outbreak was Hepatitis A, which has an incubation period of 30 days. Other diseases studied such as cryptosporidiosis (7 day

incubation period), *Escherichia coli* O157:H7 (4 day incubation period), salmonellosis (1.5 day incubation period), and shigellosis (3 day incubation period) did not have reports that were timely enough for appropriate public health response in the event of multistate outbreaks (Jajosky and Groseclose, 2004).

In 1998, North Carolina lawmakers amended the state's administrative code so that laboratories would need to report diseases that physicians already reported in hopes that double reporting policies would improve completeness and timeliness of surveillance (Sickbert-Bennett, et al, 2011). The researchers found that timeliness, completeness and accuracy of reporting varied greatly by disease, but that after the implementation of the new surveillance program, completeness of reports did increase (Sickbert-Bennett, et al., 2011).

Traditional Laboratory Reporting

In 1984, chief epidemiologists in every state, Puerto Rico and Washington, DC answered a survey that showed that 54% of jurisdictions required laboratory reporting of notifiable diseases (Sacks, 1985). For notifiable and reportable diseases to meet case definitions as "confirmed cases," laboratory confirmation is often required (CDC, 2012c). States are free to set their own laws regarding infectious disease reporting, as noted earlier (CDC, 1990), and Nevada requires laboratories to report reportable and notifiable diseases to health authorities (NAC 441A, 2012).

Another paper aiming to evaluate laboratory reporting assessed the National Notifiable Diseases Surveillance System (NNDSS), a non-electronic system maintained by the CDC. U.S. states territories report nationally notifiable diseases to the NNDSS. This system was examined in a paper reviewing studies of reporting timeliness (Jajosky

and Groseclose, 2004). Eight papers were assessed in Jajosky and Groseclose's (2004) manuscript; three analyzed national reporting time, and five assessed local or state reporting timelines. Seven diseases were selected by Jajosky and Groseclose (2004) for analysis. They used laboratory confirmation as selection criteria for the diseases. The papers varied too much to produce comparable results, and it was suggested that other studies should describe the processes that contribute to the timeliness measured, and a description of the reporting process so that other papers can be compared. One of the limitations noted in this review was that different states have different protocols which could account for some variation in timeliness (Jajosky and Groseclose, 2004).

The U.S. is not the only country evaluating laboratory reporting timeliness. Research from the Netherlands examined timeliness by phone, fax, e-mail or post. Reporting rates were based on incubation period (corrected to account for latent infectious time for two diseases), and varied from 0.4%-78.7% (after correction) of diseases being reported within one incubation period, with this being important for prevention of secondary infections. ELR is not used in the Netherlands; however, the authors suggest that it should be to improve the "disappointingly large" number of unreported infectious disease cases (Reijn, Swaan, Kretzschmar, and Steenbergen, 2011).

Electronic Laboratory Reporting

In 2006, the New York City Board of Health legally mandated ELR for notifiable diseases. The New York City Department of Health and Mental Hygiene (NYC DOHMH) ELR system was evaluated by interviewing informatics and surveillance employees about the benefits and barriers to the implementation of the system. Data examined showed that ELR was generally faster than paper (median of 6 days from

specimen collection to report compared to 25 days with paper), but testing that was complex or needed multiple tests was not faster using ELR. (Nguyen et al. 2007). For example, tuberculosis tests are conducted and reported on multiple specimens, Nguyen et al. (2007) also reported that because syphilis is not added to a registry until after past tests have been reviewed, ELR was not timelier (Nguyen et al. 2007).

In a similar study, research conducted at the Florida Department of Health (FDOH) showed that the full implementation of ELR could improve timeliness (Kite-Powell, Hamilton, Hopkins, DePasquale, 2008). Rather than evaluate the implementation of an electronic system, the authors assumed ELR would save time and calculated potential improvement for four diseases. The diseases varied in increased timeliness, with no change for meningococcal disease, 3 days faster for hepatitis A (from 13 to 10 days), 4 days faster for shigellosis (from 10 to 6 days), and 5 days faster for salmonellosis (from 12 to 7 days) (Kite-Powell et al. 2008).

Automated ELR

An evaluation of automated ELR shows faster report time (Overhage, et al. 2008; Panackal et al. 2002; Effler et al. 1999). Automated ELR means that there is not a person who manually sends all of the reports from the laboratory to the health department, rather, the system is set to code results in a standardized format, and the computers connect automatically. The Hawaii Department of Health used a prototypical automated ELR system and found that ELR was and average of 3.8 days faster than traditional reporting (Effler et al. 1999). Research in Allegheny County, Pennsylvania showed that automated ELR was a median of 4 days faster than traditional reporting (Panackal et al. 2002).

Also evaluating automated ELR, researchers from the Regenstrief Institute assessed timeliness in Marion County, Indiana. They found that automated ELR was 7.9 days faster than traditional reporting (Overhage et al. 2008). The investigators also evaluated the cost after ELR implementation, and reported that after the software was developed, there were very low maintenance costs, in part due to the standardized data format of the system. They also reported that "the improved completeness and timeliness of ELR reporting also lead to benefits in that the public health interventions can be initiated at an earlier point, leading in turn to fewer lost workdays, fewer direct medical costs, decreased probabilities that antimicrobial resistance will develop, and decreased mortality" (Overhage et al. 2008).

Infectious Diseases and Testing Methods

Research shows that testing methods have influence over timeliness of disease reporting (Nguyen et al. 2007; Staes et al. 2009). Multiple tuberculosis tests, as stated above, made ELR difficult for the NYC DOHMH; as did the review of past tests for syphilis. When multiple tests are required for a result confirmation, the time it takes to conduct and process the results from each test factors into timeliness (Nguyen et al. 2007). Staes et al. (2009) found in a survey that 82% of urgent care providers in clinics in Utah and Idaho ordered the recommended test for pertussis, which is a polymerase chain reaction (PCR). The remaining 18% ordered a test that would increase reporting time possibly by weeks (culture) or tests with low sensitivity and (direct fluorescent antibody [DFA]) (CDC, 2006). Essentially the study by Staes et al. (2009) showed that when providers used the wrong tests, report times could increase due to the time for the test to produce a result. In addition, using a faster test that does not work as well can cause false

positives or negatives, which can lead to incorrect prevalence rates of the disease in question (Staes et al. 2009).

In another paper examining infectious disease laboratory reporting, investigators found that in North Carolina that diseases with laboratory-based case definitions (such as salmonellosis) were more likely to be reported at all, as were diseases with few criteria because laboratory reporting is more straightforward than clinician reporting (Sickbert-Bennett, et al. 2011).

Salmonellosis is the most common reportable GI illness in Southern Nevada (B.J. Labus, personal communication, February 16, 2012). The infection is caused by *Salmonella spp.* bacteria which are ingested. Campylobacteriosis is a zoonotic bacterial infection caused by the organism *Campylobacter jejuni*. Shigellosis is caused by *Shigella spp.* bacteria, and can cause dysentery (Heymann, 2008). Giardiasis is a protozoal illness. *Giardia* cysts are difficult to kill with chlorine, so outbreaks of giardiasis often result from contaminated water. All of these illnesses cause diarrhea, vomiting, and other gastrointestinal symptoms (Heymann, 2008). Although all four of these diseases are reportable in Nevada (NAC.441A, 2012), campylobacteriosis is not a nationally notifiable disease. Campylobacteriosis does have a standard case definition (CDC, 2012c) (See Appendix 3 for case definitions).

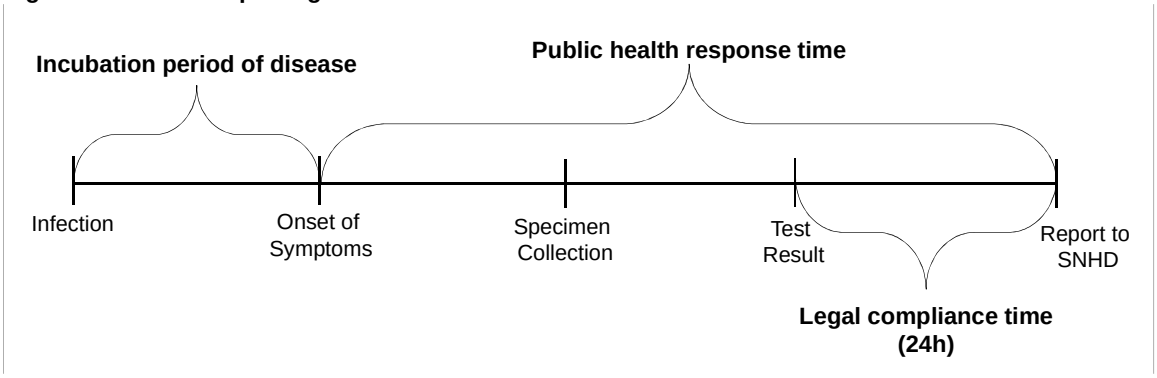
Salmonellosis and shigellosis are tested using culture, as is campylobacteriosis (Mims, Playfair, Riott, Wakelin, Williams, 1998; CDC, 2010), and giardiasis is confirmed by an ova and parasite (O&P) exam or immunoassay (CDC, 2012a).

A study of the use and timelines of clinical disease testing in laboratories in Georgia found that a giardiasis test (for one of three required O&P tests) could be completed in 1 day when performed in-house rather than sent to a commercial laboratory

(Brzozowski, Silk, Berkelman, Loveys, & Caliendo, 2012). Brzozowski, et al. (2012) also evaluated other diseases with regard to timeliness and found that in general, when specimens were sent to commercial laboratories rather than tested at hospitals or clinics, report time increased. Increased report time can cause the prevalence of diseases to appear lower than they are, and prevent appropriate measures from being implemented in the case of a potential outbreak (Brzozowski, 2012).

In this study, public health response time is defined as the timeframe from onset of symptoms to the report being received at SNHD. Legal compliance time is defined as the timeframe from the positive result in the laboratory to when SNHD received it (Figure 1).

Figure 1. Disease Reporting Timeline



Numerous studies of public health response timeliness use the onset of symptoms to report to the health authorities to evaluate this timeframe. This timeframe is important because it can provide public health authorities with information about epidemiologic contacts of those who test positive. The information can be used to help prevent or control outbreaks of disease, or to find the source of infection (Jajosky and Groseclose, 2004; Kite-Powell et al.; 2008; Reijn, Swaan, Kretzschmar, and van Steenbergen, 2011).

This timeframe can be subjective because it is often reported by patients to clinicians. Although, all of the diseases in this study have GI symptoms, giardiasis can be asymptomatic in some patients (Heymann, 2008).

The legal compliance timeframe is examined to determine whether or not ELR is faster than traditional laboratory reporting. The four diseases in this study are required to be reported 24 hours after a result is obtained from the laboratory test (NAC 441A, 2012).

Chapter 3 – Methods

Study Design

This study is a retrospective secondary analysis of extant data. The data were collected as part of legally mandated public health practice. These data have not been evaluated comparing the timeliness of ELR to traditional laboratory reporting in this way prior to this study.

Research Questions & Hypotheses

1. How does traditional reporting compare with ELR with regard to public health response timeliness (i.e. is the time frame sufficient to implement an appropriate public health investigation and response to prevent and contain potential outbreaks based on incubation period of diseases)?

H_o: There is no difference in report time.

H_a: There is a difference in report time with the prediction that ELR will be faster than traditional reporting. It is unknown whether the timeframe for each method will provide sufficient time for an appropriate investigation and response, if needed. It is predicted that timeframe will be sufficient with ELR. These predictions are based on literature that shows that the use of ELR speeds up report time.

2. How does traditional reporting compare with ELR with regard to timeliness reporting requirements set forth by state law?

H_o: There is no difference in report time.

H_a: There is a difference in report time with the prediction that ELR will be faster than traditional reporting. This prediction is based on literature showing that the use of ELR speeds up report time.

3. What is the impact of disease type when traditional reporting is compared to ELR with regard to public health response timeliness and legal timeliness requirements?

H_o: There is no difference in report time.

H_a: There is a difference in report time. The prediction is that ELR will be faster than traditional reporting; however giardiasis will have the longest timeframe. This prediction is based on literature showing that the microbiology of laboratory testing methods of specific diseases can affect the timeliness of reports.

Variables

Predictor (X_1): Report type (dichotomous: Traditional [1999-May 2004] ELR [July 2004-May 2012])

Predictor (X_2): Disease type (Categorical [4 categories]: Salmonellosis, campylobacteriosis, giardiasis, shigellosis)

Outcome (Y_1): Response time in days (continuous)

Outcome (Y_2): Legal time in days (continuous)

The predictor variables are both categorical variables. The first one is dichotomous (ELR or traditional laboratory reporting) which means that is has low statistical power. However, the two outcome variables are both continuous, but discrete as the data were provided in days. Continuous data are statistically more powerful (Hulley, Cummings, Browner, Grady, & Newman, 2007). Independent samples t-tests can be used with these variables.

The second predictor variable (disease type) is categorical, with four categories, or four diseases. To determine interaction effects, two-way analysis of variance (ANOVA) tests can be used (Pallant, 2007).

Data Acquisition and Ethical Concerns

The data used for this study were collected as part of legally mandated public health surveillance activities (NAC.441A, 2012) by the Office of Epidemiology at the Southern Nevada Health District (SNHD), as authorized by Nevada Revised Statute [NRS] 439.

The data were de-identified to comply with NRS 441A.220 (2011). No patient identifiers were used. The data set includes disease name and year of occurrence (See Appendix 1: Data Dictionary). Dates were removed and the number of days between onset date, test result, and report date, were calculated to conduct an appropriate statistical analysis.

The reports come from two large commercial laboratories in Southern Nevada that provide approximately 90% of SNHD's reports (B.J. Labus, personal

communication, February 16, 2012). Data from the two labs only is used because secondary infections identified by a diseases investigator could potentially be reported in a more timely manner than reports from a laboratory, and this is an evaluation of laboratory timeliness not investigator speed. In addition, smaller laboratories do not yet have ELR data to compare with traditional reports (B.J. Labus, personal communication, February 16, 2012).

The University of Nevada, Las Vegas Institutional Review Board approved an exemption for this study in July 2012 (Protocol #1205-4153).

Inclusion and Exclusion of Data

Timeliness will be examined using four common diseases in Southern Nevada from 1999 when the OOE began a morbidity database through May 2012. The diseases chosen for this study are salmonellosis, campylobacteriosis, giardiasis, and shigellosis. Figure 2 shows the ten most common diseases reported to the SNHD from 1999 to 2012. These diseases include respiratory syncytial virus (RSV), rotavirus, novel A influenza, salmonellosis, campylobacteriosis, giardiasis, shigellosis, aseptic meningitis, and coccidioidomycosis (Valley Fever). RSV and novel A influenza were excluded from this study because the data is aggregated weekly – there are no case-level data. Rotavirus was excluded because the SNHD database was missing four years of case-level rotavirus data (B.J. Labus, personal communication, February 16, 2012). Aseptic meningitis and coccidioidomycosis were excluded because neither of those two diseases requires a public health response from SNHD. This left salmonellosis, campylobacteriosis, giardiasis, and shigellosis in the data set (Figure 2).

The Office of Epidemiology provides investigation protocols to employees via

SNHD intranet. The following paragraphs are summaries of these protocols. Currently, the routine investigations (not outbreak-related) for campylobacteriosis and giardiasis are limited to children who are three years of age or younger. Prior to June 8, 2009, all campylobacteriosis and giardiasis cases were investigated. All salmonellosis and shigellosis cases are investigated (B.J. Labus, personal communication, October 15, 2012).

The response for campylobacteriosis includes notification of the patient's health care provider. If the patient is ≤3 years old, the report is from an outbreak, or the patient works in sensitive occupation, such as food handler or child care provider, an investigation is initiated, and information regarding the onset date, symptoms, test results, medications, and parental occupation if the patient is a child. Education is provided to the patient or parents about disease transmission, personal hygiene, and food safety. Children who are positive for campylobacteriosis cannot attend child care, and workers in sensitive occupations may not attend work until symptoms are gone (B.J. Labus, personal communication, October 15, 2012).

The response for giardiasis is similar to the response for campylobacteriosis. In addition to the information noted above collected for patients three years of age or younger, parents of giardiasis cases are also questioned about travel and exposure to child care facilities, other people with GI illness, pets, and water (drinking and recreational). Children and contacts of children with giardiasis cannot go to child care facilities until treatment (anti-parasitic medication) has been provided and diarrhea has stopped. Giardiasis cases in a daycare setting are treated as potential outbreaks to identify whether other children or staff members could have giardiasis (B.J. Labus, personal communication, October 15, 2012).

Salmonellosis cases are all investigated. If the case is part of an outbreak, demographic, epidemiologic and laboratory information are collected. If the case is not related to an outbreak, disease investigators look for matching laboratory results (from other patients), to identify possible clusters or outbreaks. Patients are contacted and educated regarding transmission of the disease, personal hygiene, carrier state possibility, and food safety. Carriers of salmonellosis are uncommon, but 1% of adults and 5% of children under age five can carry the disease asymptomatically for a year or more (B.J. Labus, personal communication, October 15, 2012).

The infectious dose of shigellosis is very small, so it is very contagious (Heymann, 2008). All shigellosis cases are investigated in Clark County. Demographic information is collected from the health care provider, as well as information regarding the disease. Laboratory results are examined to determine appropriate antibiotic treatment. Cases are contacted and provided with information regarding transmission, the small infectious dose, hygiene, food safety, refraining from oral and anal sex until the bacteria is no longer detected, and disposing of diapers (B.J. Labus, personal communication, October 15, 2012).

Control measures for salmonellosis and shigellosis include contacting school nurses, child care management, or food establishment management regarding other possible cases and determining when children or workers can come back. The Environmental Health department at SNHD will be notified if infections started at child care facilities or schools (B.J. Labus, personal communication, October 15, 2012).

The period of communicability for the four diseases in this study generally begins at the onset of symptoms, (Heymann, 2008) which means that there will be no need for extra calculations to account for infectious time before symptoms begin.

The OOE does not collect sexually transmitted infection, HIV/AIDS or tuberculosis reports, so those diseases were not considered. Further exclusion includes cases with blank cells, negative numbers of days, and with days above 30 because these four diseases have incubation periods that are generally less than two weeks (often only a few days) (Heymann, 2008). Also excluded were cases in June of 2004 during the time that ELR systems were implemented (B.J. Labus, personal communication, February 16, 2012). This was done to avoid errors from laboratory workers learning a new system. Incubation period was used as a proxy of period of communicability, as that is common in the literature reviewed (Jajosky and Groseclose, 2004; Kite-Powell et al. 2008).

Figure 2. Inclusion and Exclusion Criteria for Diseases

Statistical analysis:

The first predictor variable (report type) is a dichotomous variable. The year variable was recoded from year and month to 0 = Traditional reporting, and 1 = ELR. The second predictor variable (disease) is a categorical variable with 4 categories. The disease name variable was recoded from disease name to 1 = campylobacteriosis, 2 = giardiasis, 3 = salmonellosis, 4 = shigellosis. The outcome variables (time in days) are continuous (See data dictionary, Appendix 1).

Kolmogorov-Smirnov tests for normality were conducted. Independent samples t-tests were used to test first two hypotheses. The Levene's test for equal variance (conducted automatically in an independent samples t-test) was also conducted. The level of significance was set at $p < 0.05$.

Two-way analyses of variance (ANOVA) were used to test interaction effects for the third hypothesis, one for public health response time and one for legal compliance time. Levene's tests for equal variances were also conducted. In a two-way ANOVA, if the variance is unequal, a more stringent level of significance needs to be set to account for error (Pallant, 2007). The level of significance was set at $p < 0.01$. A Tukey's Honestly Significant Difference (HSD) post-hoc test is the standard test to further explore a two-way ANOVA. Tukey's HSD post hoc tests were conducted. To further explore significant interaction effects, the data set must be split by one of the interaction categories and one-way ANOVAs with Tukey's post hoc tests are run for each of two categories. These tests were also conducted.

Microsoft® Excel, 2010 and IBM® SPSS® Statistics software, version 20 were used for data management and analyses.

Chapter 4 – Results

Data Characteristics

A total of 2,425 laboratory results were used to conduct this study. The first result was from December of 1998, when the OOE began the morbidity database. The final result was from May 2012. The data consisted of 1,082 traditional reports (44.6%) and 1,343 ELR results (55.4%) (Table 1).

Table 1. Frequency of Electronic and Traditional Reports

	Frequency	Percent
Traditional Reports	1,082	44.6
ELR	1,343	55.4
Total	2,425	100.0

The four diseases in this study were campylobacteriosis (n = 716), giardiasis (n = 583), salmonellosis (n = 846), and shigellosis (n = 280) (Figure 3). Figure 4 shows annual disease rates.

Figure 3. Frequency of Diseases

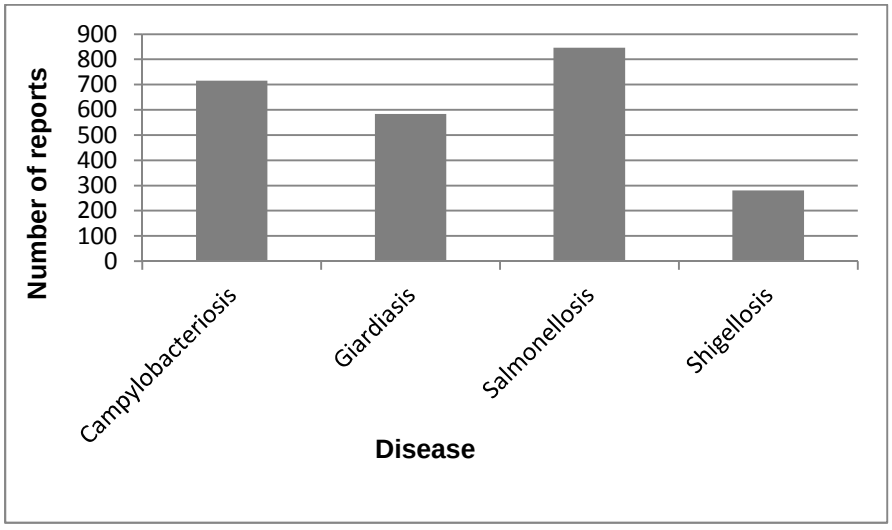
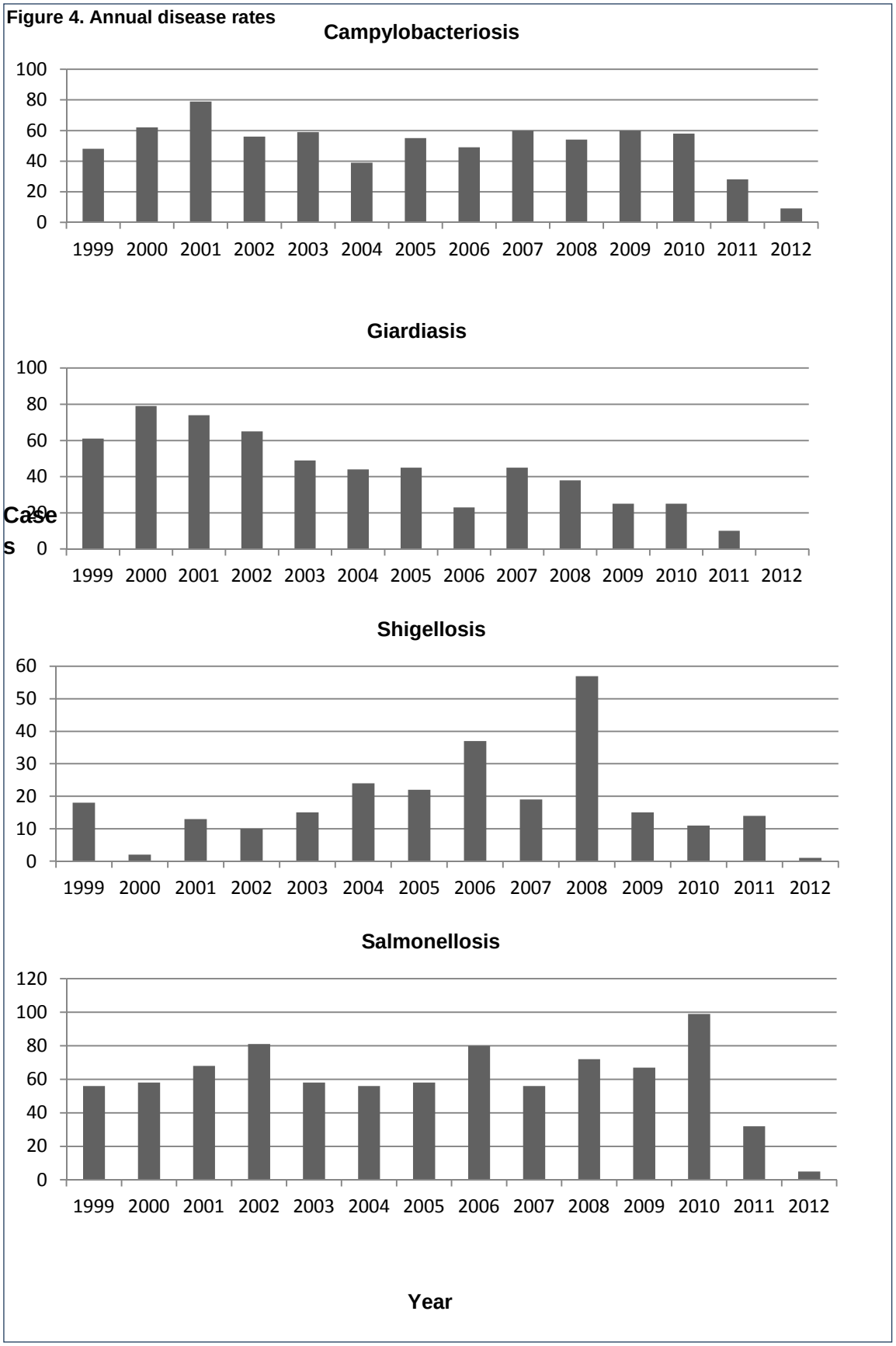


Figure 4. Annual disease rates



Kolmogorov-Smirnov tests for normality were conducted to determine whether to use parametric or nonparametric statistical tests, and the data were not normally distributed ($p < 0.001$, violating the assumption of normality). Histograms showed slightly negatively skewed data for public health response time reports, and positive kurtosis for legal time reports and negative skew. In general, the distribution appeared fairly normal (Figures 5 and 6). Due to the samples sizes containing more than 200 cases, the skew and kurtosis should not affect the results in a significant way (Pallant, 2007). The data were not adjusted.

Figure 5. Distribution of Public Health Response Data with Normal Curves

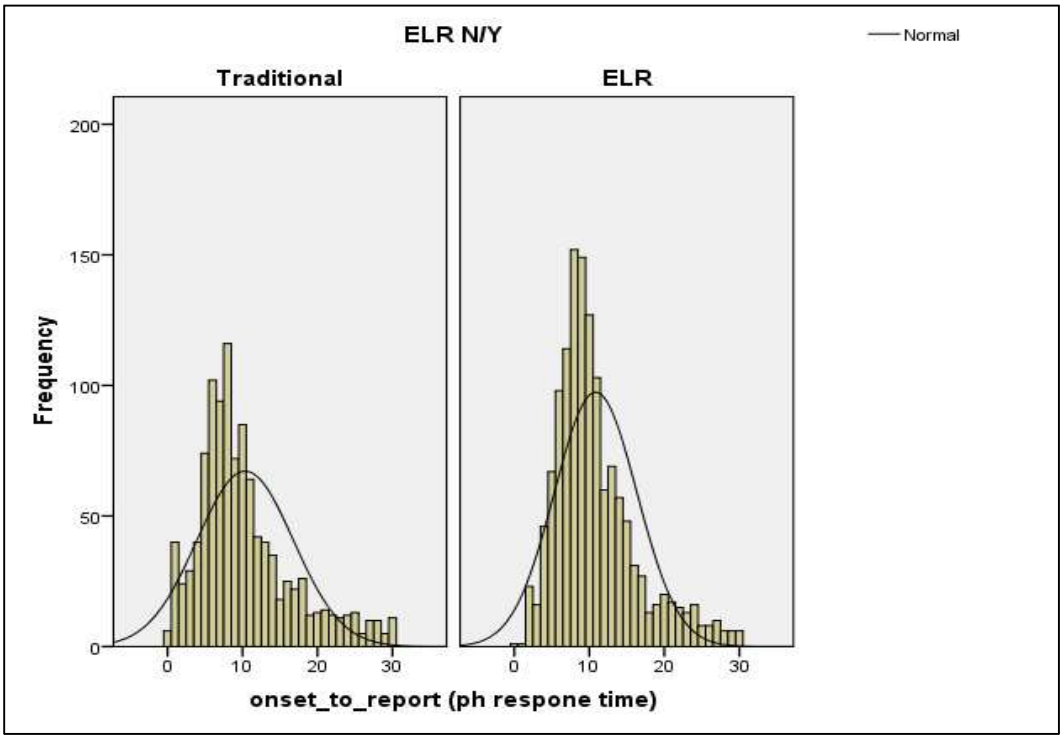
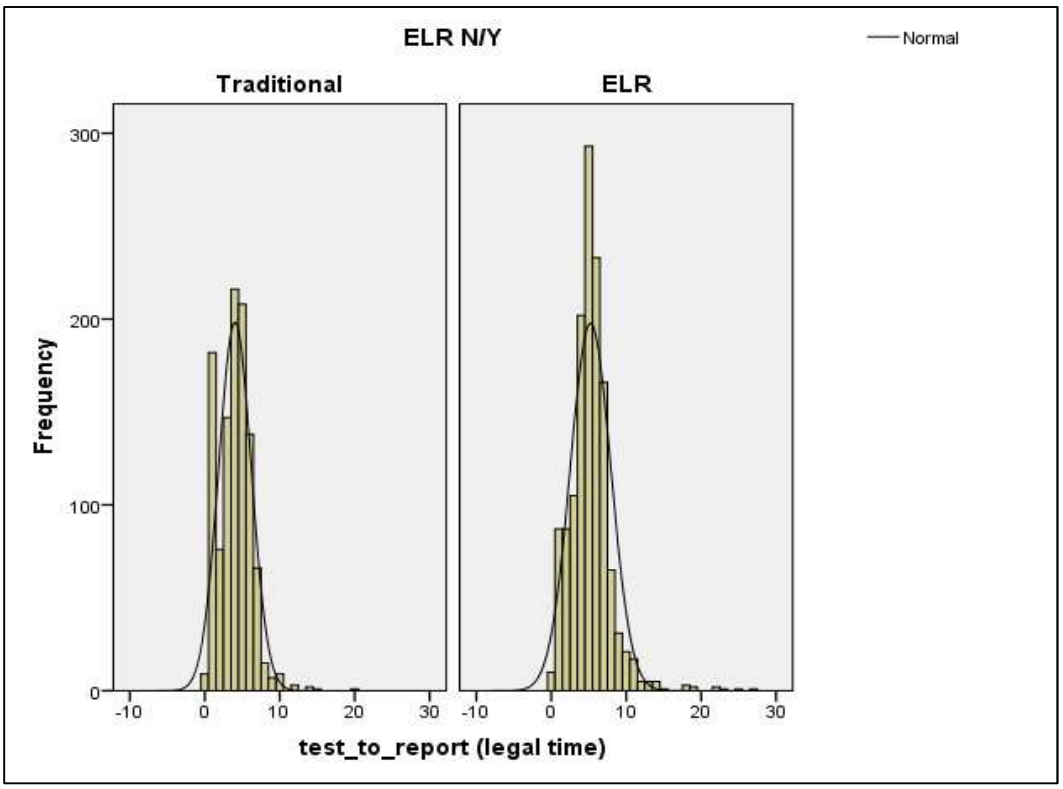


Figure 6. Distribution of Legal Time Data with Normal Curves



Public Health Response Timeliness

With regard to public health response, an independent samples t-test showed a significant difference in the timeliness in days between ELR (M = 10.84d, SD = 5.501) and traditional reporting (M = 10.35d, SD = 6.427); t = -1.991, p = 0.047 (two-tailed).

The effect size of the differences in the means (mean difference = -0.419, 95% CI: -0.974 to -0.007) was very small (eta squared = 0.002). The eta squared means that only 0.2% of the variance in dependent variable can be explained by the test type (ELR or traditional reporting) (Table 2 and Table 3). Levene's test for equality of variances showed unequal variance (F = 23.933, p > 0.001).

Table 2. Public Health Response Timeliness Data Characteristics			
	N	Mean (days)	Standard Deviation
ELR	1,343	10.84	5.501
Traditional Reports	1,082	10.35	6.427

Table 3. Public Health Response Timeliness T-test for Equality of Means					
T	Degrees of freedom	p	Mean difference	95% Confidence Interval	Eta squared
-1.991	2134.594	0.047	-0.491	-0.974 to -0.007	0.002

Timeliness of Legal Compliance

With regard to legal time, an independent samples t-test revealed a significant difference in time in days between ELR (M = 5.23d, SD = 2.706) and traditional reporting (M = 4.02d, SD = 2.173); t = -12.223, p > 0.001 (two-tailed). The effect size of the differences in the means (mean difference = -1.212, 95% CI: -1.407 to -1.018) was moderate (eta squared = 0.058) (Table 4 and Table 5). Levene's test for equality of variances showed unequal variances (F = 8.836, p = 0.003). ELR was slower than traditional reporting.

Table 4. Legal Timeliness Data Characteristics			
	N	Mean (days)	Standard Deviation
ELR	1,343	5.23	2.709
Traditional Reports	1,080	4.02	2.173

Table 5. Legal Response Timeliness T-Test for Equality of Means					
T	Degrees of freedom	p	Mean difference	95% Confidence Interval	Eta squared
-12.223	2420.987	0.000	-1.212	-1.407 to -1.018	0.058

REPORT TYPE AND DISEASE TYPE INTERACTIONS

Public Health Response Stratified by Disease

First, mean days of report type (ELR and traditional reporting) were stratified by disease with regard to public health response time using a two-way ANOVA. Campylobacteriosis, salmonellosis, and shigellosis were more timely with traditional reporting, however giardiasis was faster with ELR (Figure 7).

A Levene's test of equality of variances showed that the variance was unequal ($p < 0.001$), therefore significance was set at $p < 0.01$ to account for error (Pallant, 2007). A two-way ANOVA showed that disease type did not influence report type with regard to public health response. The interaction effect was not statistically significant ($F = 2.087$, $p = 0.10$).

There was a statistically significant difference between disease types ($F = 9.402$, $p < 0.001$). A Tukey's HSD post hoc test revealed that timeliness of giardiasis reports ($M = 11.71$d, $SD = 8.440$) was significantly different from campylobacteriosis reports ($M = 10.23$d, $SD = 5.021$), salmonellosis reports ($M = 10.40$d, $SD = 4.853$), and shigellosis reports ($M = 10.03$d, $SD = 4.269$).

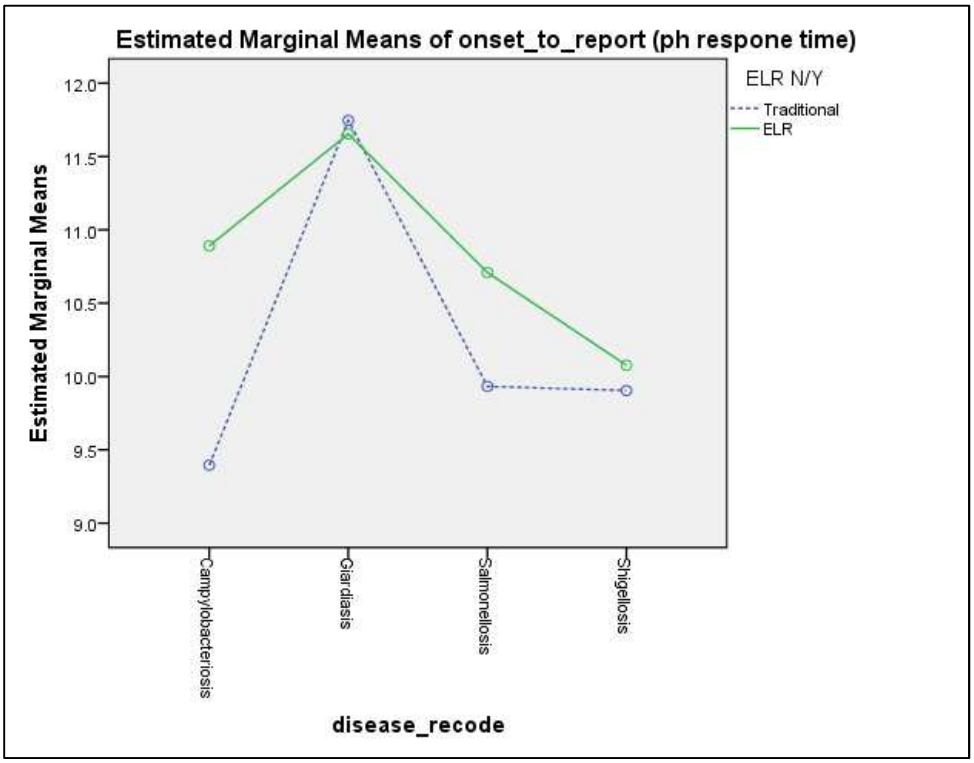
The ANOVA also revealed that with a more stringent alpha ($p < 0.01$), timeliness of test type was not significantly different between ELR and traditional reporting ($F = 4.591$, $p = 0.023$). The effect size was very small (partial eta squared = 0.002) (Table 6).

Table 6. Two-Way ANOVA Results – Public Health Response Timeliness

	F	p*	Partial eta squared
Disease type	4.591	0.000	0.012
Report type	4.591	0.023	0.002
Disease type*Report Type	2.087	0.100	0.003

***** Significant at $p < 0.01$

Figure 7. Public Health Response Time – Mean Days by Disease Type and Report Type



Legal Compliance Timeliness Stratified by Disease

Mean days for report type were then stratified by disease with regard to legal compliance time. All diseases were more timely with traditional reporting, however shigellosis was approximately the same (M = 5.52d for traditional reporting compared to a mean of 5.53d for ELR) (Figure 8).

A Levene's test of equality of variances showed that the variance was unequal for these data as well ($p < 0.001$). Significance was set at $p < 0.01$ (Pallant, 2007). A two-way ANOVA revealed a significant interaction between report type and disease type, suggesting that one could influence the other ($F = 22.257$, $p < 0.001$). Also significant were differences in timeliness between disease types ($F = 140.127$, $p < 0.001$) and between report types, as expected ($F = 60.849$, $p < 0.001$). The effect sizes were also higher with the legal compliance time than public health time, showing that more of the

variance in timeliness can be explained by report type or disease type (Table 7).

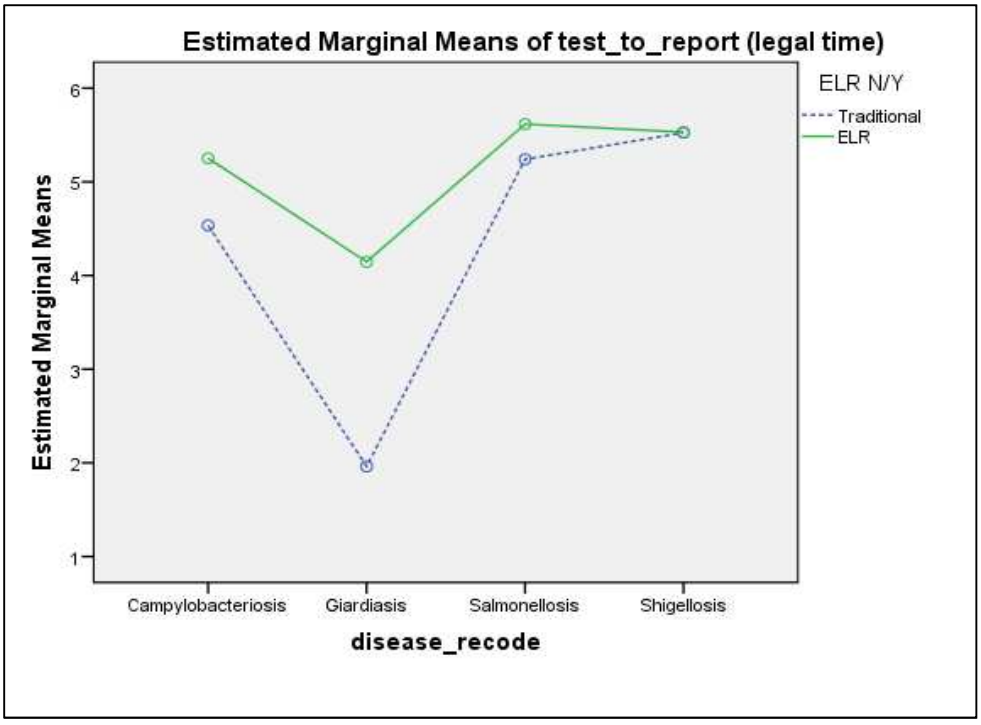
A Tukey's HSD post hoc test showed that all diseases differed significantly in average response days except campylobacteriosis (M = 4.94d, SD = 2.407) and shigellosis (M = 5.53d, SD = 2.211) (giardiasis M = 2.86d, SD = 2.610; salmonellosis M = 5.46d, SD = 2.084).

Table 7. Two-Way ANOVA Results – Legal Compliance Timeliness

	F	p*	Partial eta squared
Disease type	140.127	0.000	0.148
Report type	60.849	0.000	0.025
Disease type*Report Type	22.257	0.000	0.027

* Significant at p <0.01

Figure 8. Legal time – Mean days by disease type and report type



One-way ANOVAs were run (Pallant, 2007) with Tukey's HSD post hoc tests for

using traditional report type, showed that all diseases except salmonellosis (M = 5.24d, SD = 1.696) and shigellosis (M = 5.52d, SD = 2.176) differed significantly from each other in average response days (Traditional reports of campylobacteriosis M = 4.53d, SD = 1.674; giardiasis M = 1.96d, SD = 1.349) (Table 8).

The ELR test showed only giardiasis (M = 4.15d, SD = 3.340) differing in time from other diseases (campylobacteriosis M = 5.25d, SD = 2.812; salmonellosis M = 5.62d, SD = 2.298; shigellosis M = 5.53d, SD = 2.231).

Table 8. One-way ANOVA results – Legal Compliance time ELR compared with Traditional Reporting

	F	p*
Traditional Reporting	278.979	0.000
ELR	17.683	0.000

* Significant at p <0.01

Chapter 5 – Discussion

The aim of this study was to evaluate the difference between traditional laboratory reporting and ELR timeliness among two major laboratories that do infectious diseases testing for SNHD from 1999-2012. The findings suggest that for the four GI illnesses in this study (campylobacteriosis, giardiasis, salmonellosis, and shigellosis), traditional reporting is faster than electronic reporting.

The data were not normally distributed. The violation of normal distribution is common in large samples, such as the sample in this study (N = 2,425). The data were not adjusted due to the samples sizes containing more than 200 cases. The skew and kurtosis should not affect the results in a significant way (Pallant, 2007).

The first hypothesis, that report times between ELR and traditional reports will differ with regard to public health response time, was supported by the initial t-test performed. However, when further analysis was done, with a more stringent level of significance, the difference between ELR and traditional reporting failed to be statistically significant. The confidence interval was changed from 95% to 99% in the two-way ANOVA because there is no two-way ANOVA post hoc test to correct for unequal variance in the data. The way to correct for error is to change the level of significance to $p < 0.01$ (Pallant, 2007). The null hypothesis cannot be rejected. With regard to public health response (defined as the time in days between the onset of illness and the test result reported to SNHD), it was predicted that ELR would be faster than traditional laboratory reporting. The results showed the opposite – the mean number of days for ELR was 10.84 (SD = 5.501), and 10.35 (SD = 6.472) for traditional reporting. This was a significant difference when $p < 0.05$, but not when $p < 0.01$. The effect size measured with t-tests and ANOVA was 0.002, which is very small. That means that 0.2%

of the variance in the dependent variable (time) can be explained by the independent variable (ELR or traditional laboratory reporting) (Pallant, 2007).

In addition to determining if ELR is faster than traditional reporting, the objective of the public health response research question was to determine whether or not the time frame was sufficient to implement appropriate public health investigations and responses to prevent and contain possible outbreaks. The average number of days for all four illnesses in both report categories is above 10 days, which suggests that neither method is sufficient to implement public health responses. It could be impossible to prevent secondary infections of salmonellosis and shigellosis, which both generally have incubation periods of 1-3 days (Heymann, 2008). Although giardiasis testing can be completed in the mandated 24-hour timeframe, confirmation can require three specimens 24 hours apart (Heymann, 2008).

The second hypothesis, which states that report times will differ between ELR and traditional reporting with regard to timeliness requirements set forth by state law, was supported by the t-test performed, as well as the ANOVA. This time frame is defined as the amount of time in days between the test result in the laboratory and the report to SNHD. State laws NAC.441A (2012), require campylobacteriosis, giardiasis, salmonellosis, and shigellosis results to be reported within 24 hours of obtaining the result.

The laboratories evaluated in this study use a culture to test salmonellosis, campylobacteriosis, and shigellosis, which can take up to 72 hours to produce a result. The laboratories have 24 hours to report the result after the culture has produced a result. This can be up to 96 hours combined. Giardiasis is tested using an ova and parasite exam or antigen test (which can be completed in 24 hours) (B.J. Labus, personal

communication, February 16, 2012). However, confirmation of giardiasis by O&P requires three separate specimens 24 hours apart (Heymann, 2008).

The results of the t-test for this hypothesis show that the difference in time between ELR and traditional reporting was statistically significant. However, the prediction that ELR would be faster than traditional reporting was incorrect. The average number of days to report a result using traditional reporting was 4.02 days (SD = 2.173), with ELR, 5.23 days (SD = 2.709). These results are very close to the time frame set forth by state law. This research question is limited by the data, specifically a time frame reported in days. An ideal measure for this hypothesis would have been time in hours.

The third hypothesis, whether the disease type would make a difference in time between ELR and traditional reporting was supported by the results with regard to legal response time. Stratification by disease was tested because the testing methods for these diseases likely influence the timeliness. However, there was no interaction between public health response time and report type.

Post hoc test revealed that timeliness of giardiasis reports (M = 11.71d, SD = 8.440) was significantly different from campylobacteriosis reports (M = 10.23d, SD = 5.021), salmonellosis reports (M = 10.40d, SD = 4.853), and shigellosis reports (M = 10.03d, SD = 4.269). These results agreed with the prediction that giardiasis reporting did take longer than the other diseases, for public health response time. Campylobacteriosis, salmonellosis, and shigellosis were more timely with traditional reporting, as seen in the t-test, however giardiasis was slightly (though not significantly) faster with ELR – this was a new result (M = 11.75d [SD = 8.760] for traditional reporting, and a mean of 11.65d [SD = 7.980] for ELR).

When legal compliance timeliness was examined, a two-way ANOVA revealed a

significant interaction between report type and disease type, suggesting that disease type could influence the timeliness of ELR or traditional reporting. Due to the significant interaction effect, the data were split by ELR cases and traditionally reported cases, and one-way ANOVAs were performed on each report type separately, as this is the way to further test interactions (Pallant, 2007).

The ANOVA results for both types of reporting were significant. With traditional reporting, there were significant differences between the report times in days of all diseases except between salmonellosis (M = 5.24d, SD = 1.696) and shigellosis (M = 5.52d, SD = 2.176). However, when the ANOVA was run on the ELR data, the results showed that giardiasis was the only disease with report times (M = 4.15d, SD = 3.340) that differed significantly than the other three (campylobacteriosis M = 5.25d, SD = 2.812; salmonellosis M = 5.62d, SD = 2.298; shigellosis M = 5.53d, SD = 2.231).

This result could suggest that using ELR is resulting in more batched results from laboratories to health authorities (for example, tests are all sent by computer one time in a day, rather than paper reports or phone calls that could happen multiple times in a day). Batching occurs because although all results go into a computer, the results may only be sent to the health authorities one time each day, when someone pushes a send button. This is common in ELR systems that are not fully automated with real time reporting from laboratories to health authorities (B.J. Labus, personal communication, September 28, 2012). Although it does not seem practical that a laboratory worker would make a telephone call every time a result is found, telephone calls are not as batched as electronic reports.

As noted earlier, the traditional reporting data (M = 4.02d, SD = 2.173) for legal compliance time was significantly faster than the ELR (M = 5.23d, SD = 2.706). This is

also something that could be due to batching of results. An example of why this could happen is if the lab worker has already sent the results for the day to the health authorities at 4:58 pm, a new result shows up at 4:59 pm, and he is off work at 5:00 pm, it would not be uncommon for him to group this result with the next day's data, especially in cases of diseases that require 24 hour notice, not immediate notice. If the system was fully automated with real time ELR, the result could be immediately sent to the health authorities. To get fully accurate data for timeliness in cases such as these, the data would have to be analyzed in minutes, as it only takes people minutes to enter data.

Literature examining automated ELR systems shows that real time reports are more complete and faster. Overhage et al. (2008) discovered that the real time ELR system they used was on average eight days faster than paper reporting. Overhage et al. (2008) also examined other systems in the US, such as the ELR used in Hawaii. They determined that the Hawaii system, which used batched file transfer, failed with about one third of records (either the results were not received or the results were incorrect or incomplete) (Overhage, et al. 2008). Researchers in Allegheny County, PA found that by using real time ELR, there were fewer errors and duplicate reports. This was due to the use of a standardized set of results and faster reporting in general (Panackal et al. 2002).

The results of this study disagree with literature that says ELR is faster than traditional reporting (Kite-Powell et al. 2008; Nguyen et al. 2007). However, if the laboratories in the study were to implement fully automated, real time ELR systems, the results might be in agreement with more of the literature.

As noted in literature above, ELR is faster, has more complete information, and sometimes more accurate information (Kite-Powell et al. 2008; Nguyen et al. 2007; Sickbert-Bennett et al. 2011). Many studies evaluating automated ELR have found faster

report times. (Overhage et al. 2008; Effler et al. 1999; Panackal et al. 2002). The research team at the Regenstrief Institute found that ELR was 7.9 days faster than traditional laboratory reporting. They also determined that the maintenance cost after implementation was very low (Overhage et al. 2008).

Effler et al. (1999) state that they believe ELR will improve disease reporting quality with more complete and timely reporting. They also believe that ELR will be more cost effective than traditional laboratory reporting because it will reduce time that it takes for people to fill out paper forms (Effler et al, 1999).

Another benefit of using ELR found by Panackal et al. (2002) was less human error. In evaluating their ELR system, they determined that error in completeness and accuracy of reports was almost always caused when people were able to type free text, rather than using standardized disease codes. In addition, almost all false positives were caused by the use of free text, instead of standardized result codes (Panackal et al. 2002).

Limitations

There are several limitations to consider when discussing the results of this study. First, these data were not collected for research purposes. These data were collected as a part of legally mandated public health surveillance (NAC.441A, 2012). The research questions and hypothesis were not conceived until after the data collection, therefore, this is a secondary analysis.

In addition, only four diseases were studied, and while selected for convenience (short incubation time, obvious symptoms, and high number of reports), may not be representative of all diseases tested by the laboratories in the study. External validity may be limited with this study as Southern Nevada is unique. There are high volumes of

travelers, and this study does analyze diseases with short incubation periods (Las Vegas Convention and Visitors Authority, 2011).

Data from two commercial laboratories were analyzed in this study. Reports from one of the laboratories account for approximately 70% of laboratory results received by SNHD. The other laboratory accounts for approximately 20% of the results received at SNHD (B.J. Labus, personal communication, February 16, 2012). If the laboratory sending most of the reports is the slower one, that could add bias to the study.

Another limitation specific to the public health response hypothesis is that onset date of symptoms is often self-reported by patients. Although the beginning of a GI illness should be fairly easy to determine, self-reported data could have recall bias.

Finally, the timeframe of the report times was provided in days. If batching is occurring using electronic systems, it is not possible to know it from this study. Time would need to be provided in hours or minutes to get a more accurate picture of why the disease type does interact with report type.

Recommendations

In 2010, a new surveillance system was implemented at SNHD, which included more automation of electronic systems (B.J. Labus, personal communication, February 16, 2012), so it is possible that the timeliness of ELR will increase as more technology is implemented. In addition, the system could send results in real time, rather in batches.

The human component also cannot be completely ignored with ELR, because the systems in place now are not fully automated; laboratory employees must still enter in results and send in reports. If a human types in the wrong code or an extra number somewhere, it can change the results completely. It could be very hard to measure human

error, but it is expected that this will be an issue with slow times using electronic systems, especially immediately after implementation. One way to evaluate human error is to look for consistencies in the errors (fixed error), for instance the same wrong codes typed in every time by a certain person. If this is the case, it would be useful to determine so that educational interventions could take place if needed. Future studies could examine the fixed error, if any, among laboratory results.

Effler et al. (2002) found that most human error was caused by free text, and that standardized code sets eliminated a great deal of this error. It would be beneficial to laboratories in Southern Nevada to implement standardized code sets to try and eliminate human error.

Other studies to evaluate laboratories separately could also be useful in training purposes, especially if it was found that specific laboratories had faster or slower report times.

Full automation of ELR systems with real time reporting should be a goal for laboratories in Southern Nevada. However, it is important to remember that some diseases, such as highly-contagious measles, are best reported by a physician picking up a phone because they are reportable with clinical identification by a physician, which is the case in Nevada for certain highly infectious diseases. Viral laboratory cultures can take weeks to produce results, which would make them useless in outbreak prevention (NAC 441A, 2012).

Another way to investigate public health response timeliness is by using syndromic surveillance, rather than laboratory confirmation in communicable disease outbreaks. Syndromic surveillance is a preparedness measure that examines health indicators (such as disease symptoms) to determine whether there is a higher incidence of

symptoms of diseases that may lead to bigger clusters or outbreaks. It is often used in hospital emergency departments (EDs), and is a part of the Meaningful Use regulations (CDC, 2012b).

Researchers working with the NYC DOHMH conducted a syndromic surveillance study in EDs. They were able to show that symptoms were signals of outbreaks; 64% of respiratory signals and 95% of fever signals coincided with high incidence of influenza A and B (Heffernan et al. 2004). In addition, they found that 83% of diarrhea signals and 88% of vomiting signals coincided with suspected outbreaks of norovirus and rotavirus infections (Heffernan et al. 2004).

It could be beneficial to incorporate more syndromic surveillance activity into disease surveillance in Southern Nevada to increase report time, in general. However, the downside to syndromic surveillance is that while it may help to prevent outbreaks, only laboratory tests can determine exactly what the disease is.

Conclusions

The results of this study were somewhat inconclusive with regard to whether or not ELR is actually faster than traditional laboratory reporting. However, it is obvious that response time from laboratories is too long when health authorities are dealing with potential outbreaks. Testing methods of diseases can contribute to this, as can the fact that ELR is not fully automated with real time reporting in Southern Nevada, so human error may play a part in slow report times. In addition, standardized code sets are being implemented, but are not fully in place in Southern Nevada laboratories.

More studies of ELR would be greatly beneficial in Southern Nevada. Further studies to include more diseases, to evaluate human error, and to examine more aspects of

ELR such as accuracy and completeness of reports would likely benefit SNHD and the laboratories in Clark County. The report times are not fast enough, and more studies to determine why need to be conducted.

Appendix 1

Data Dictionary

Dataset prepared for Jennifer Lucas

Compiled by Brian Labus, Senior Epidemiologist

This dataset was prepared for Jennifer Lucas in response to a data request made to the Southern Nevada Health District on April 25, 2012. The data provided have been produced in accordance with NRS 441A.220 and HIPAA, and contain no information that could be used individually or combined with other information to identify an individual patient. All elements of dates have been provided as a difference between two dates, or in the case of the year reported, the month and year of the report.

Field Name	Type	Description
disease_name	Text	The name of the disease (Campylobacteriosis, Giardiasis, Salmonellosis, Shigellosis)
test_to_report	Integer	The number of days between the date of the laboratory test result and the date the test was reported to the health department
onset_to_report	Integer	The number of days between the reported onset of disease and the date the disease was reported to the health department
report_year	Long Integer	The month and year in which the case was reported, in the format of YYYYMM

Recodes

Field Name	Type	Description	Recode_Name	Recode_Description
disease_name	Text	The name of the disease (Campylobacteriosis, Giardiasis, Salmonellosis, Shigellosis)	disease_Recode	1= Campylobacteriosos 2= Giardiasis 3= Salmonellosis 4= Shigellosis
report_year	Long Integer	The month and year in which the case was reported, in the format of YYYYMM	ELR_Y/N	0= Traditional Reporting 1= ELR

Appendix 2

List of Abbreviations

AIDS	Acquired immune deficiency syndrome
ANOVA	Analysis of variance
ARRA	American Recovery and Reinvestment Act
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
CSTE	Council of State and Territorial Epidemiologists
d	Day(s)
DFA	Direct fluorescent antibody
ED	Emergency Department
ELR	Electronic laboratory reporting
EMR	Electronic medical record
FDOH	Florida Department of Health
GI	Gastrointestinal
HIT	Health information technology
HITECH	Health Information Technology for Economic and Clinical Health
HIV	Human immunodeficiency virus
HSD	Honestly significant difference
M	Mean
NAC	Nevada Administrative Code
NNDSS	Nationally Notifiable Diseases Surveillance System
NRS	Nevada Revised Statute
NYC DOHMH	New York City Department of Mental Health and Hygiene
O&P	Ova and Parasite
OOE	Office of Epidemiology
PCR	Polymerase chain reaction
RMRS	Regenstrief Medical Record System
RSV	Respiratory Syncytial Virus
SD	Standard Deviation
SNHD	Southern Nevada Health District
US	United States

Appendix 3

Case Definitions

Note: Definitions are reported verbatim from the public document, *2012 Case Definitions: Nationally Notifiable Diseases and Conditions and Current Case Definitions* from the Centers for Disease Control and Prevention.

(http://wwwn.cdc.gov/nndss/document/2012_Case%20Definitions.pdf)

Campylobacteriosis (*Campylobacter* spp.)

2012 Case Definition
CSTE Position Statement Number: 11-ID-10

Clinical Description
A diarrheal illness of variable severity.

Laboratory Criteria for Diagnosis
Suspected
Detection of *Campylobacter* spp. in a clinical specimen using non-culture based laboratory methods.

Confirmed
Isolation of *Campylobacter* spp. in a clinical specimen.

Case Classification
Suspected
A case that meets the suspect laboratory criteria for diagnosis.

Probable
A clinically compatible case that is epidemiologically linked to a confirmed case of campylobacteriosis.

Confirmed
A case that meets the confirmed laboratory criteria for diagnosis.

Comment
The use of culture independent methods as standalone tests for the direct detection of *Campylobacter* in stool appears to be increasing. Data available about the performance characteristics of these assays indicates there is variability in the sensitivity, specificity and positive predictive value of these assays depending on the test (enzyme immunoassay (EIA) test format -lateral flow or –microplate) and manufacturer. It is therefore useful to collect information on which type of EIA test and manufacturer are used to diagnose a case. Culture confirmation of culture independent (e.g., EIA) test positive specimens is ideal.

Giardiasis

2011 Case Definition
CSTE Position Statement Number: 10-ID-17

Clinical Description
An illness caused by the protozoan *Giardia lamblia* (aka G. *intestinalis* or G. *duodenalis*) and characterized by gastrointestinal symptoms such as diarrhea, abdominal cramps, bloating, weight loss, or malabsorption.

Laboratory Criteria for Diagnosis
Laboratory-confirmed giardiasis shall be defined as the detection of *Giardia* organisms, antigen, or DNA in stool, intestinal fluid, tissue samples, biopsy specimens or other biological sample.

Case Classification
Confirmed
A case that meets the clinical description and the criteria for laboratory confirmation as described above. When available, molecular characterization (e.g., assemblage designation) should be reported.

Probable
A case that meets the clinical description and that is epidemiologically linked to a confirmed
case.

Salmonellosis (*Salmonella* spp.)

2012 Case Definition
CSTE Position Statement Number: 11-ID-08

Clinical Description
An illness of variable severity commonly manifested by diarrhea, abdominal pain, nausea, and sometimes vomiting. Asymptomatic infections may occur, and the organism may cause extraintestinal infections.

Laboratory Criteria for Diagnosis
Suspect
Detection of *Salmonella* from a clinical specimen using a non-culture based method

Confirmed
Isolation of *Salmonella* from a clinical specimen

Case Classification
Suspect
A case that meets the suspect laboratory criteria for diagnosis

Probable
A clinically compatible case that is epidemiologically linked to a confirmed case, i.e., a contact of a confirmed case or member of a risk group as defined by public health authorities during an outbreak.

Confirmed
A case that meets the confirmed laboratory criteria for diagnosis. When available, O and H antigen serotype characterization should be reported.

Comment
Both asymptomatic infections and infections at sites other than the gastrointestinal tract, if laboratory confirmed, are considered confirmed cases that should be reported.

Shigellosis (*Shigella* spp.)

2012 Case Definition
CSTE Position Statement Number: 11-ID-19

Clinical Description
An illness of variable severity characterized by diarrhea, fever, nausea, cramps, and tenesmus. Asymptomatic infections may occur.

Laboratory Criteria for Diagnosis
Suspect
Detection of *Shigella* from a clinical specimen using a non-culture based method.

Confirmed
Isolation of *Shigella* from a clinical specimen.

Case Classification
Suspect
A case that meets the suspect laboratory criteria for diagnosis.

Probable
A clinically compatible case that is epidemiologically linked, i.e., is a contact of a confirmed case or a member of a risk group defined by public health authorities during an outbreak.

Confirmed
A case that meets the confirmed laboratory criteria for diagnosis. When available, O antigen serotype characterization should be reported.

Comment
Both asymptomatic infections and infections at sites other than the gastrointestinal tract, if laboratory confirmed, are considered confirmed cases that should be reported.

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