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A Qualitative Study of State-level Zoonotic disease surveillance in New England

Matthew Scotch, Kristin Mattocks, Peter Rabinowitz, and Cynthia Brandt
Yale University, New Haven, Connecticut, USA

Summary

Zoonotic diseases are infectious diseases transmittable between animals and humans and outbreaks of these diseases in animals can signify that humans are also infected (or vice-versa). Thus, communication between animal and human health agencies is critical for surveillance. Understanding how these agencies conduct surveillance and share information is important for development of successful automated zoonotic monitoring systems.

Individual interviews were conducted with 13 professionals who perform animal or human zoonotic disease surveillance in one of the New England states. Questions centered on existing surveillance methods, collaborations between animal and human health agencies, and technological and data needs.

The results showed that agencies routinely communicate over suspected zoonotic disease cases yet there are barriers preventing automated electronic linking of health data of animals and humans. These include technological barriers and barriers due sensitivity and confidentiality of information. Addressing these will facilitate development of electronic systems for integrating animal and human zoonotic disease surveillance data.

Keywords

Zoonoses; Population Surveillance; Qualitative Research; State Government

Introduction

Zoonotic diseases are infectious diseases transmittable between animals and humans (Krauss, 2003), and represent the majority of emerging infectious diseases that affect humans (Daszak *et al.*, 2001, Glickman *et al.*, 2006). Evidence suggests that zoonotic infection in animals may serve as an important early indicator of infection in humans (Rabinowitz *et al.*, 2006, Glickman *et al.*, 2006). For example, the 1999 infection and subsequent death of a large number of crows from West Nile Virus (WNV) in New York provided evidence that surveillance of crow mortality could be useful for detecting human outbreaks of the disease (Eidson *et al.*, 2001, Kahn, 2006). Mostashari *et al.* showed that geographic clusters of dead bird sightings preceded the date of the first human case in that same geographic area by over a month (Mostashari *et al.*, 2003). Because of such links between animals and humans, it is important for agencies to collaborate with one another given a suspicion of a zoonotic infection. Such coordination involves different agencies and personnel at the local and state level, including health departments, agriculture departments, wildlife departments, and diagnostic laboratories. Many state health departments have a

state public health veterinarian who is responsible for investigation of zoonotic diseases in humans. These individuals have training in veterinary medicine and often additional training in epidemiology. Conversely, departments of agriculture often employ *state veterinarians* to monitor zoonotic infection among animal populations in the state. Wildlife departments also have state officials who monitor zoonotic infection in wildlife animals. However, for the purpose of this study, we focused on the relationship between agencies of domestic animals and agencies of public health. The researchers intend to examine wildlife agencies in future work.

Lack of early identification of emerging zoonotic diseases can postpone effective public health intervention, leading to increased morbidity and mortality. Thus, an understanding of state-level surveillance and the barriers to data sharing between animal and human agencies may facilitate the design of public health informatics systems that link disparate zoonotic disease surveillance data. Many studies have explored activities of local and state health departments without necessarily focusing on surveillance of zoonotic diseases (Revere *et al.*, 2007, Turner *et al.*, 2008, Turner *et al.*, 2000, Environmental Health Policy Committee, 1997). One study of animal health agencies on zoonotic disease surveillance suggested that lack of resources such as information technology (IT) infrastructure or personnel forces some state veterinarians to direct certain animal health matters elsewhere (Kahn, 2006).

A recent example of collaboration between animal and human health domains is the One Health initiative, which promotes interdisciplinary communication between veterinary and human medicine (Kahn *et al.*, 2008). One Health has successfully gained the support of prominent professional organizations such as the American Veterinary Medical Association (AVMA) and the American Medical Association (AMA), endorsed journal publications dedicated to the concept of One Health, and established a task force with members representing the CDC, private industry, US Department of Agriculture, and the US Public Health Service (Kahn *et al.*, 2008). While One Health emphasizes the importance of partnership between human and veterinary medicine, there has been little systematic investigation of the collaboration between animal and human health agencies during surveillance.

Materials and Methods

Semi-structured interviews were conducted with individuals involved in zoonotic disease surveillance at the state-level, including epidemiologists and public health veterinarians at state health departments, veterinarians at agriculture agencies, pathologists at veterinary diagnostic laboratories, and an administrator/pathologist at a human public health laboratory.

For recruitment, the emphasis was on the public health veterinarians and state veterinarians, because these individuals lead the zoonotic disease surveillance initiatives in each state. Because most states have one public health veterinarian and one state veterinarian, the goal was to include both from all six New England states. In addition, most states have a state human pathology laboratory and a state animal pathology laboratory, which test samples of human and animal isolates. The goal was to include at least one pathologist of human samples and one pathologist of animal samples.

State veterinarians were identified from a list provided by the United States Animal Health Association's website (United States Animal Health Association, 2009). Similarly, state public health veterinarians were identified from a list provided by the National Association of State Public Health Veterinarians (National Association of State Public Health Veterinarians, 2009). Pathologists were identified from the laboratory websites. Emails were

sent explaining the study and requesting participation. The interviews were conducted at the location of each of the participants. Each session typically lasted 45 minutes to one hour and was audio recorded for research purposes. Prior to study commencement, all study protocols were reviewed and approved by the Yale University Human Investigations Committee.

Grounded theory (Strauss & Corbin, 1990) was used as a model for this qualitative study. Briefly, grounded theory is a form of qualitative research design where the researcher(s) identifies a theory or explanation for the process being studied (in our example, zoonotic disease surveillance) based upon the opinions and views of participants involved in the process (Creswell, 2007).

The interview questions focused on understanding the participants' individual experiences with zoonotic disease surveillance. This included issues such as the kind of data that was utilized, the sources of the data, collaboration between outside agencies, and ways to improve surveillance in their state. The audio recordings of each interview were transcribed by a professional transcriptionist. From these transcripts, sets of codes were then identified inductively by agreement of two of the researchers (MS and KM). Codes in grounded theory represent concepts that emerge over a line-by-line review of all transcripts from the study (Bradley *et al.*, 2007). A taxonomy was developed from these codes to classify the relationships between the codes. Each participant was interviewed once.

Results

In total, 13 participants were included in the study, including five state public health veterinarians, five state veterinarians, two pathologists of animal samples, and one pathologist/administrator of human samples (Table 1). At least one individual from each of the six New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont) were involved in the study. At the time, one state, Maine, did not have a state public health veterinarian. In addition, one state veterinarian was unresponsive to the request for participation.

Table 2 shows the taxonomy that was developed from the set of codes. An integrative approach using both deductive and inductive methods was utilized to develop the taxonomy categories: *processes*, *dimensions*, and *concepts*. First, a starting list of categories was generated after a review of the literature. Specifically, the taxonomies of health science-related qualitative studies were examined. Then, the appropriateness of the three categories (processes, dimensions, and concepts) was assessed as the two authors identified the codes.

In total, eight surveillance processes were identified including: obtaining surveillance data, reporting of confirmed cases, collaboration between animal and human agencies, investigation of suspected or confirmed cases, data management of surveillance information, data analysis (epidemiology), laboratory analysis, and finally, ways to improve surveillance. Some of these processes are now discussed in detail.

Obtaining Surveillance Data

Many of the participants highlighted the importance of clinicians and diagnostic laboratories as sources for obtaining surveillance data. Other forms of receiving information included public reporting (largely with animals, in the case of dead birds, wildlife, and cattle). Often, concerned farmers called state agencies directly to report suspicions of infection. In addition, many participants discussed the value of extending surveillance beyond the state boundaries and working with other states and the federal government such as during national outbreaks. One example of such a scenario is the 2009 multi-state Salmonella outbreak that was linked to peanuts (FDA, 2009).

Reporting Confirmed Zoonoses

Reporting of zoonotic disease cases to federal agencies was a common process discussed in the interviews. For public health departments and labs, federal reporting is to the Centers for Disease Control and Prevention (CDC), and the United States Department of Agriculture (USDA) for state agriculture agencies. Participants described that federal reporting was required for certain cooperative agreements between federal and state agencies. With these cooperative agreements, the state agency receives federal money towards a surveillance initiative within the state (such as laboratory testing, case investigation, active surveillance, etc.). Participants also mentioned that certain diseases are supposed to be reported to the federal agency. The process of federal reporting is often web-based and many mentioned that it was easy. For example, CDC's National Electronic Disease Surveillance System (NEDSS) uses messaging standards to promote transmission of health data from the states to the CDC (CDC, 2009). One state public health veterinarian described the federal reporting process that has evolved over the years from a DOS-based command-line system to a web-based system.

“Actually, it [federal reporting] occurs multiple times a day, the way NEDSS is set up. In the old system-the old CDC system before NEDSS, it was a once-a-week transmission. With NEDSS, it's set up so that, whenever you have a closed case that's confirmed, you press the 'Notify' button and it transmits it to CDC. So you can do it as many times a day as you want”.

Federal agriculture reporting is to the USDA is often done using the National Animal Health Reporting System (NAHRS) (USDA, 2009). The state veterinarians described this as a monthly process of submitting summarized counts by reportable disease. Animal laboratories also report notifiable diseases to the USDA.

Both state veterinarians and state public health veterinarians mentioned the importance of federal reporting for proactive means in relation to creating awareness for potential disease threats, and further prevention of disease. As one state veterinarians said:

“As far as how we here about potential cases, a number of avenues, ranging from being notified by our federal USDA counterparts as a result of a disease trace-back, epidemiologic trace-back, finding out that there is, potentially, an animal, or group of animals that have been exposed to something that is here in the state”.

Collaboration

Participants mentioned that collaboration between other agencies is also an important method for obtaining surveillance information. Here, the link between veterinary and human medicine is realized as health officers investigate zoonotic cases. One participant, who works for a department of agriculture, discussed the collaboration with the state health department.

“We talk...again, maybe some of this is seasonal, but with regard to the horse issues, encephalitis and West Nile Virus. During the mosquito season, we're talking at least once a week about that because there's been a veterinarian that's called in and said, “I have a situation here. What should I do with it?” kind of thing. So we communicate regularly there. And then, during the other times of the year, with just various random things that come up. Avian influenza would be another point of communication. We exercised with them before on our avian influenza preparedness plan, and we've developed a communication protocol that both groups have agreed upon as far as if there is a positive case of one of these ... of avian influenza.”

While all of the participants expressed the importance of collaboration, barriers were identified that influence the ability of the agencies to share data. One important barrier is the lack of technological and informatics tools needed to share information electronically. While federal government reporting is often web-based, many of the participants discussed their intra-state information sharing as a phone call, email, or fax. File exchange, if any, was an excel spreadsheet sent through email.

Another barrier is the sensitivity about releasing certain information often based on the belief that it could create a financial loss to livestock and trade. This was one of the biggest differences in approaches between animal and human agencies. Many animal health officers discussed the sensitivity about releasing animal disease information because of its potential damage to the industry. This includes releasing information to the human health agencies. One participant noted:

“We’ve had problems when we’ve had avian influenza in [state] where in a relatively small operation where there was no virus isolated, but there was only antibody, that we were basically shut off and our people in the state couldn’t sell anything ‘cause they wouldn’t accept it, even though we didn’t put any movement controls on other products from our state, other states did and other countries did. And we were actually left on kind of a black list for several years before ... Even well after the chickens themselves had come and gone and everything else, that we still had an embargo against us from a standpoint of having that one serologically positive flock. So it does have very big ramifications of who knows what when from the standpoint of a positive regulatory disease.”

Many participants described their primary job function was to protect the people that they serve. Release of sensitive information such as sick chickens among a farmer’s flock could have drastic financial consequences to that farmer and to the state. Working relationships and trust factors was a theme that impacts collaboration. State veterinarians and state public health veterinarians that have been working with one another for some time can develop an understanding of how to deal with sharing of sensitive information. For example, one state veterinarian at an agriculture department said:

“There likely could be more. It’s—from what I gather—dramatically improved from where it was. [Name] and I started about the same time. And from what I gather, from talking to other people, it has dramatically improved in the last 3 ½ years from where it had been before that. And, for a variety of reasons, there is some concern. People don’t want proprietary data shared. They trust Agriculture with their information. They don’t want to share it with any other state agencies or federal agencies for that matter”.

Case Investigation

The amount of resources (time, personnel, pathology, etc.) invested in resources for investigation of investigation cases was greatly dependent on the disease. Case investigation often begins when a suspected case is reported by a clinician or laboratory and the health department or agriculture department veterinarian decides whether or not to perform (or request) more testing, field investigation, prevention or control measures, and collaboration with other agencies. Both the agriculture and public health agencies and laboratories emphasized the notion that this process was dependent on the disease. For example, diseases that are endemic (or enzootic for animals) receive fewer resources than diseases that are more rare. For example, one state veterinarian, when discussing case investigation, said this:

“Number one, we want to make sure that we know, very early, if we have a foreign animal disease. So we really want ... I mean, the vets know that, if they see a

vesicular condition in a ruminant that they're going to call. All the large animal vets know that and that we would respond immediately to that, whether it was on Christmas Day or on Sunday, or whatever. We probably would hear about it because our phone numbers are not secret and our e-mails are not secret. And we monitor e-mails all weekend. And we have cell phones and our cell phone numbers are out there. So there's that kind of tier priority, where we have a high priority for certain diseases."

Management of Surveillance Data

The management and storage of zoonotic disease surveillance varied by agency, and sometimes within the agency, by disease. Some participants discussed how surveillance data was kept in paper format, choosing simply to file away the faxed reports from laboratories or healthcare facilities. Some participants, whose agencies had electronic databases, indicated that laboratory data and clinical data were stored in separate databases (a heterogeneous storage system), while others kept both clinical data and laboratory data together (homogenous storage). In addition, cooperative agreements also seemed to influence which diseases were stored electronically, presumably to facilitate federal reporting as one state veterinarian indicated:

"Right now, it's entered into a number of databases. Our system is terribly antiquated. It's mostly handled in Excel spread sheets. But there is also a federal database that the test results that pertain to the various cooperative agreements that we have with the USDA, they're all uploaded into the federal database. We're in the process, actually, this spring; we will have an updated system-computer software system to handle all of this. But, right now, each of these diseases are handled in different Excel spread sheets."

Epidemiological Analysis of Surveillance Data

Statistical analysis beyond simple counts and descriptive statistics was rarely utilized. For example, there was little mention of using statistics to identify abnormal disease levels or potential outbreaks. The analysis that was performed typically involved yearly trend analysis to examine counts of a disease over a long period. The participants suggested that outbreaks could be identified with the presence or absence with as little as one case (for example in the case of a foreign animal disease) or through an obvious increase in a particular disease. They suggested that statistical significance was not a necessity for identifying abnormal trends. For example, one state public health veterinarian said:

"When we say we have an outbreak, what we're talking about is any level above normal for that particular disease event. So, in our state, a single case of plague would be significant in an animal or a person. One case of rabies or one case of leptospirosis or one case of West Nile Virus wouldn't be unusual. And how do we determine whether it's unusual or not? Well, two ways-one, within the current year, we look at the weeks leading up to the event, or even since the event if we're looking retrospectively. But we also look historically back at what has happened in past years. So, for example, let's take a disease like giardia. Well, we expect several hundred human cases of giardia every year. It wouldn't be unusual. We would trigger an investigation if, for example, we found that we had either an unusual total number or we had a number of cases in a particular town, among a particular age group during a narrow period of time, which may indicate, just for example, that we have an outbreak in a school, or in a child care facility. So, we determine unusual events by comparing back to what we've been monitoring over the course of years."

Similar examples were provided by the state veterinarians for zoonotic disease surveillance of domestic animals.

Laboratory Analysis

Laboratory analysis involving pathology of human and animal samples includes necropsy (for animals), histopathology, and microbiology. Full service laboratories that offer a wide-range of testing are limited. Each state generally has one public health laboratory that is affiliated with the state health department, while state animal laboratories are often associated with public universities. Pathology laboratories get specimens from hospitals, clinics, agencies, and in the case of animal labs, even get specimens from farmers and pet owners. Private (for-profit) laboratories also conduct testing and some have electronic laboratory reporting with the state agencies. Both the state veterinarians and state public health veterinarians viewed electronic laboratory reporting as a valuable facet to surveillance. Not surprisingly, budget impacted the amount and type of laboratory testing that can be done.

Improving Surveillance

As a means to improve surveillance, participants discussed the potential for advanced technology such as Geographical Information Systems (GIS), Electronic Laboratory Reporting (ELR), access to clinical databases, and electronic linkage with other state agencies. ELR was identified as a way to reduce redundancy and workload, as well as full-time equivalents (FTEs). The agencies that did have existing ELR in place were happy with its benefits.

The need to address both underreporting and timeliness of reporting by clinicians was also discussed. Many attributed this to busy clinicians who do not place a high priority on the reporting of endemic (or enzootic) diseases. In addition to data timeliness, data quality was also an issue. Some attributed it to the difference between an epidemiological framework and a clinical framework. For example, one participant said:

“The world of clinical medicine is so different from the world of surveillance and epidemiology that it’s hard to communicate across that barrier. So, oftentimes, the physician just wants to diagnose that one patient. And has no concept of why Public Health needs to know x, y, z and not a, b, c. And they tend to tell you everything, from a to z, when you need only three things in the middle. You’ve got everything. You just need l, m, n. And they don’t get why you need that, because they’re not trained in epidemiology.”

Some saw the acquisition of information technology as a way to improve deficiencies with underreporting, data timeliness, and data quality. For example, one state veterinarian mentioned how local veterinarians desired feedback as a way to see value in their participation.

“So we started to provide them with the rabies data. Now that’s not something that they report to us but, if we could get them to do better reporting on some of the diseases that they might have interest in, like Johne’s disease, Lyme disease, strangles in horses is a big one. Sore mouth in sheep and goats.” ... “And I also think it’s an educational process between us and the veterinarians to say, you know, “Here’s why we have the reportable diseases, here’s what we can offer you, here’s what we potentially could offer you in return, if we get that reporting.”

All participants mentioned the importance of budget in shaping how zoonotic disease surveillance was performed and how it could be used to improve current practices. This included an impact on the amount of staff they could hire, the type of IT resources they

could obtain, and the types of surveillance initiatives they could support including money for laboratory testing of samples. In discussing the impact of budget, one participant mentioned:

“Huge! Enormous! ‘Cause, if you had more money ... I mean, we’re always on a shoe string and especially now—it’s ugly.”

Discussion

Collaboration between animal and human health agencies during zoonotic disease surveillance is common; however automated linkage of electronic databases rarely exists. Many participants discussed a need for routine access to external data but cited budget issues and lack of informatics expertise as a barrier for implementation. For example, no participant (either from public health or agriculture) had access to systems that automatically link to clinical databases in (animal or human) hospitals or clinics. An informatics system like this could drastically improve the timeliness and quality of surveillance data. Also, information could be relayed back to the clinicians in the form of an epidemiology summary report, which shows the number of infected in their area by disease; as a way to provide feedback and maintain interest. Absence of willingness does not appear to be the reason for the lack of linkage between animal and human agencies. In some instances, it was lack of available electronic data from the other agency that was a barrier. Other barriers related to ‘protecting the client’ seem to be much more of an issue with animal health agencies. Interestingly, issues with sharing sensitive data seemed to come more from agriculture agencies than from the health departments while laws protecting the release of identifiable health data, such as the Health Insurance Portability and Accountability Act (HIPAA) (HHS, 2009), typically place greater restrictions on health departments than agriculture departments (e.g. the release of HIV data). Regardless of which agency is tentative to share sensitive information, the interviews suggested that working relationships and trust between state veterinarians and state public health veterinarians impact how data is shared. This trust evolves over time as both sides work together on zoonotic cases.

From these interviews, it is apparent that both animal and human agencies realize the importance of communication and involvement during investigation of zoonotic disease cases. Both sides realize the health of all species is important for maintaining a healthy world. This belief of One Health is essential for successful zoonotic disease surveillance.

State Variations in Informatics

Given the proximity and similar sizes, relative to other states in the Union, many of the findings were similar across the New England states. Automated collaboration between health departments and agriculture agencies was lacking in all states due to limited use of biomedical informatics. Biomedical informatics is a field that deals with the acquisition, storage, retrieval, and analysis of biomedical data for decision-making (Shortliffe & Cimino, 2006). Here we focus on informatics in the scope of sharing surveillance data between agencies. The ability to share data electronically goes beyond simply capturing data in electronic form (although that is a required starting point). Rather, in order to electronically share information from one agency to another, there must be terminologies used by the agencies wishing to exchange health information (and a way to map them). Terminologies offer a way to provide formal definitions for the data elements that are shared. In addition messaging standards, such as HL7 (2009), should be considered as a way to transfer and share the data. There has been extensive research in biomedical informatics in relation to semantic interoperability; see (Komatsoulis *et al.*, 2008, Garde *et al.*, 2009, Oemig & Blobel, 2009).

We did not find any examples of agencies using terminologies and messaging standards for sharing data with one another. However, the interview data did suggest that larger populated states such as Massachusetts and Connecticut had more of a current or near-term commitment to using technology to enhance capture and management of zoonotic disease surveillance data. For example, the Connecticut Department of Public Health is in the process of implementing a patient-centered system (rather than event-based) for electronic management and analysis of infectious diseases (zoonotic diseases included). The system will centralize the storage of both clinical and demographic patient data within the Department of Public Health and facilitate transfer and reporting of data to the CDC. This effort represents a significant upgrade from a long-standing DOS-based system. The Massachusetts Department of Public Health also has a similar patient-centric system that combines clinical data, demographic data, and laboratory data.

The examples in Massachusetts and Connecticut highlight potential for larger populated states to implement patient-centric data management systems, but do not address the biomedical informatics issues of inter-agency data sharing recently discussed. Terminologies and messaging standards must be considered when agencies invest in or develop new information technology (IT). Having biomedical informatics experts as employees or consultants during times of IT adoption would facilitate these issues.

In addition to issues related to sharing of data, IT systems must be developed that are accessible, cost efficient, and effective. Because budgets are low, open-source, inexpensive, and web-accessible technologies offer the most potential in the short-term. In addition, they must be easy to use, easily extendible to a changing public health environment, and must also adhere to the sensitive nature of data (where trade and financial gain can be greatly affected by identification of certain information). For example, CDC's National Center for Public Health Informatics (NCPHI), through the establishment of the Public Health Informatics (PHI) Research Grid, represents an initiative to support public health collaboration through grid-based technology (National Center for Public Health Informatics, 2009). Grid technology, coined from the national electrical power grid, enables users of different operating systems across different organizations to connect with one another (Jones, 2008). Each server on the grid is a *node* that contains the ability to share resources with other nodes such as data, software, and storage (Jones, 2008). Advantages of using grid technology include local control over data, which might address issues with sensitivity of data. With the grid, control of data remains local (Jones, 2008), meaning that an agency (or node) could specify who has rights to the data, and what levels of detail they are able to access. In addition, a data grid allows users to submit queries across the grid without needing to install additional technology or software. For example, if both the Connecticut Department of Public Health and the Connecticut Department of Agriculture joined the PHI grid, they could easily share zoonotic case data while maintaining local control. Potentially only the state public health veterinarian and the state veterinarian could view these data, and limits to geography, farm names, and diseases could be specified.

In addition to grid computing, advanced web technologies such as Web 2.0 and the semantic web (Web 3.0) also offer promise for zoonotic disease surveillance. Web 2.0 are new internet services that support collaboration and mashup of web resources and data (O'Reilly, 2005). For example, Yahoo! Pipes (Yahoo! Inc., 2009), is a free Web 2.0 mashup tool, enables users to integrate different resources on the web with a development environment intended to reduce the need for computer programming. In a previous study, we utilized Yahoo! Pipes to implement a West Nile Virus surveillance tool (Scotch *et al.*, 2008). While we concluded that Web 2.0 and mashup tools were currently not suitable for large-scale public health projects that are computationally intensive and deal with multi-year data, such technologies would likely facilitate certain aspects of surveillance such as geospatial

mapping of cases. In addition to Web 2.0, the semantic web has been used in many areas of healthcare including translational bioinformatics in order to support the annotation and understanding of large biomedical data sets. This environment could facilitate the sharing of cross-agency zoonotic disease data.

Limitations

Because this study only involved participants from New England, the results are not necessarily generalizable of zoonotic disease surveillance for the other states. Many larger states in the union, such as New York, Texas, and California, might have completely different processes. However, the authors feel that the inclusion of the different New England states, which themselves have variation in surveillance practices, represent a basis on which to understand the relationship and surveillance needs between animal and human agencies of health. Additional work will focus on developing an electronic survey to send to all of the other states (and both animal and human agencies of health) to identify variations in surveillance.

Conclusion

State agencies such as health departments and departments of agriculture routinely communicate over suspected zoonotic disease cases yet there are barriers preventing automated linking of this health data of animals and humans including technological barriers and barriers due to the sensitivity of the information. Informatics approaches that address these barriers will enhance the potential of automated linking of animal and human zoonotic disease surveillance data.

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Biography

Dr. Matthew Scotch is an Associate Research Scientists in the Yale Center for Medical Informatics at Yale University. His primary research interest is in the field of public health informatics; specifically in linking animal and human data for automated zoonotic disease surveillance systems.

Impacts

- New England state agencies such as health departments and departments of agriculture routinely communicate over suspected zoonotic disease cases.
- Overall, there are barriers preventing automated linking of this health data of animals and humans including technological barriers and barriers due to the sensitivity of information.
- Variations existed in the use of informatics to support automated sharing and capture of zoonotic disease surveillance data.

Table 1

Study participants by job type.

Job Type	Number
State Public Health Veterinarian	5
State Veterinarian	5
Pathologist – Animal Samples	2
Pathologist/Administrator – Human Samples	1

Table 2

Taxonomy of zoonotic disease surveillance

Processes	Dimensions	Concepts
Obtaining surveillance data	State reportable diseases	Laboratory reporting
		Clinical reporting
	Cooperative agreements	Federal initiative
		Allocated funds
	Public reporting	Citizens
		Industry workers
	Urgent Communication	Multi-state outbreak
Reporting confirmed zoonoses	Required reporting	Federal mandate
	Proactive reporting	Financial impact to livestock and trade
		Awareness
		Prevention
Collaboration	Technological barriers	Electronic Integration
	Sensitive Data barriers	Financial impact to livestock and trade
		Data ownership
	Working relationships	Trust
Case investigation	Case dependent	Magnitude of impact
		Disease dependent
Management of surveillance data	Electronic database	Heterogeneous
		Homogenous
	Paper records	Office storage
Epidemiological analysis of surveillance data	Trend analysis	Number of cases
		Number of years
Laboratory analysis	Pathology	Necropsy
		Histopathology
		Microbiology
	Tests offered	Full-service lab
Improving surveillance	Budget	Technology
		Data
		FTE
	Advanced technology	GIS
		Electronic laboratory reporting
		Electronic clinician reporting
		Inter-agency electronic integration
		Clinical database access
		Remote electronic field capture
		Integrated laboratory systems
	Underreporting	Lack of electronic feedback

Processes	Dimensions	Concepts
		Epidemiology v. clinical medicine
		Motivation
	Modeling other states	Practicality
		Political
	Data access	Non-reportable data