

Georgia Southern University

## Georgia Southern Commons

---

Health Policy and Management Faculty  
Publications

Health Policy & Management, Department of

---

11-2016

### Local Health Departments' Partners and Challenges in Electronic Exchange of Health Information

Gulzar H. Shah

*Georgia Southern University*, [gshah@georgiasouthern.edu](mailto:gshah@georgiasouthern.edu)

Joshua Vest

*Indiana University*

Kay Lovelace

*University of North Carolina at Greensboro*

J. Mac McCullough

*Arizona State University*

Follow this and additional works at: <https://digitalcommons.georgiasouthern.edu/health-policy-facpubs>



Part of the [Health Policy Commons](#), and the [Health Services Administration Commons](#)

---

#### Recommended Citation

Shah, Gulzar H., Joshua Vest, Kay Lovelace, J. Mac McCullough. 2016. "Local Health Departments' Partners and Challenges in Electronic Exchange of Health Information." *Journal of Public Health Management and Practice*, 22 (Supplement 6): S44-S50. doi: 10.1097/PHH.0000000000000442 <https://digitalcommons.georgiasouthern.edu/health-policy-facpubs/157>

This article is brought to you for free and open access by the Health Policy & Management, Department of at Georgia Southern Commons. It has been accepted for inclusion in Health Policy and Management Faculty Publications by an authorized administrator of Georgia Southern Commons. For more information, please contact [digitalcommons@georgiasouthern.edu](mailto:digitalcommons@georgiasouthern.edu).

# Local Health Departments' Partners and Challenges in Electronic Exchange of Health Information

Gulzar H. Shah, PhD, MStat, MS; Joshua R. Vest, PhD, MPH; Kay Lovelace, PhD, MPH;  
J. Mac McCullough, PhD, MPH

**Background:** Unprecedented amounts of data are produced by the health care and other sectors, presenting opportunities for local health departments (LHDs) to access these data. LHDs will need to participate in health information exchange (HIE) with a number of partners in order to benefit from these data resources. LHDs' participation in HIEs with specific partners has not been studied. **Objectives:** To describe the level of and challenges in LHD participation in HIE with other partners, and variation by LHD population size and governance type. **Data and Methods:** This research uses data from the 2015 Informatics Capacity and Needs Assessment Survey, with a target population of all LHDs in the United States. A representative sample of 650 LHDs was drawn using a stratified random sampling design. A total of 324 completed responses were received with a 50% response rate. Survey data were cleaned, and bivariate comparisons were conducted using  $\chi^2$  and Somer's D. **Results:** Substantial variation existed in LHDs' participation in HIE by type of exchange partner. Although 71% participated in HIE with the state departments of health, only 12% with jail/correctional health, 14% with health or county-based purchasing plans, and 15% with home health agencies. Compared with large LHDs (jurisdiction populations of  $\geq 500\,000$ ), smaller LHDs were more likely to participate in HIE with state departments of health, but less likely with other exchange partners. The challenges to HIE participation were technological, and organizational/interorganizational in nature and variation existed by LHDs' population size and governance structure with respect to state authority. **Conclusions:** Local public health agencies more commonly participate in HIE with some partners, but may need to improve HIE with many others. National strategies targeting an

increase in HIE of LHDs may use our findings to focus those initiatives.

**KEY WORDS:** health information exchange, HIPAA regulations, information technology, IT infrastructure, local health departments, local public health agencies

## ● Background

Public health agencies have long relied on data and information produced by the health care sector.<sup>1,2</sup> Notifiable disease reporting, community health assessments, outbreak detection, intervention planning, and other activities can benefit from data and information generated in clinical contexts by physicians, hospitals, and other health care organizations. The good news for public health is that more opportunities exist now to access these data. Currently, the health care sector is undergoing a health information technology and informatics revolution with an unprecedented volume of health information being created. Furthermore, US health policy supports the sharing of this information between different organizations by encouraging the adoption of standards and interoperable technology.<sup>3,4</sup>

One avenue to increase access to health information and data, particularly for local health departments

**Author Affiliations:** Jiann-Ping Hsu College of Public Health, Georgia Southern University, Statesboro, Georgia (Dr Shah); Indiana University Richard M. Fairbanks School of Public Health at IUPUI, and Regenstrief Institute, Indianapolis, Indiana (Dr Vest); Department of Public Health Education, UNCG, Greensboro, North Carolina (Dr Lovelace); and School for the Science of Health Care Delivery, Arizona State University, Tempe, Arizona (Dr McCullough).

The authors declare no conflicts of interest.

This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially.

**Correspondence:** Gulzar H. Shah, PhD, MStat, MS, Georgia Southern University, PO Box 8015, Statesboro, GA 30460 (gshah@georgiasouthern.edu.)

DOI: 10.1097/PHH.0000000000000442

(LHDs), is participation in electronic exchange of health information (EEHI). EEHI is the process of electronically sharing (patient/health) information between different entities.<sup>5</sup> In this study, we use EEHI as the main focus, rather than health information exchange, another commonly used term that refers to an entity for data exchange. Various organizations across the United States provide the technical infrastructure and organizational governance necessary for EEHI to occur. These EEHI-facilitating organizations are variously referred to as health information organizations, regional health information organizations, or health information exchanges (HIEs). The laboratory encounters, demographics, diagnoses, and imaging data available through the HIEs have a wide range of potential benefits to public health, including disease reporting, outbreak surveillance, and population health monitoring, among others.<sup>6,7</sup> A small number of state health agencies and LHDs have realized that they produce higher quality as well as more accurate, complete, and timely data from participation in exchange relationships with HIE organizations. Also notable are epidemiologic, disease surveillance, and/or community assessment gains, and improved disaster response capabilities from this participation.

Although EEHI is promising, evidence suggests the public health system is underleveraging the potential benefits of EEHI. Advances in availability and timeliness of health information can offer public health agencies a wide range of potential avenues for improving public health service provision.<sup>6</sup> Health departments may benefit from better availability of more accurate and complete data supported by Electronic Data Exchange (EDT).<sup>8-10</sup> Public health agencies with robust informatics capacities may benefit from more thorough health monitoring, disease investigation, and assessment.<sup>11</sup> Real time data exchange between public health agencies and health care providers can allow continual surveillance and prediction of disease occurrences.<sup>2,12-15</sup> Evidence from the health departments using HIE suggests that these benefits are being realized in some settings.<sup>8,15</sup>

LHDs' capacity to electronically exchange data with health care providers can be significantly reduced if they are not connected to HIEs. Compared with other forms of public health informatics—including immunization registries, electronic disease reporting systems, electronic laboratory reporting, and electronic health records (EHRs)—HIEs are the least commonly used information system by LHDs.<sup>16</sup> National surveys indicate increasing but still very low levels of LHDs' adoption of the HIE. In 2013, just 1 in 10 LHDs reported HIE adoption, up from 7% in 2010.<sup>16,17</sup> Even considering the 19% of LHDs who reported plans to implement HIE in 2013,<sup>16</sup> it still leaves the majority of

LHDs without HIE participation, or without any plans to leverage the potential benefits of HIE in the near future. Considering the broad scope of potential benefits of LHDs' EEHI to public health practice, it is critical to understand the current national landscape of practices of EEHI. It is also imperative to understand the types of entities with which LHDs exchange data on an ongoing basis and the variation in frequency of exchange by partner types. This detailed information is not currently available in the published literature. Understanding whether there are certain patterns or predictors of EEHI may help to inform future directions or policy priorities in ensuring that interested LHDs are able to participate in EEHI. LHDs' low overall level of informatics capacity may imply that they face significant challenges in use of informatics, including EEHI. The purpose of this study is to utilize a novel, nationwide data to explore the current capacity for electronically exchanging information at LHDs, and the barriers to such an exchange.

## ● Methods

### Data and sampling design

Data were drawn from the 2015 Informatics Capacity and Needs Assessment Survey, conducted by the Jiann-Ping Hsu College of Public Health at Georgia Southern University in collaboration with the National Association of County and City Health Officials (NACCHO). This Web-based survey had a target population of all LHDs in the United States. A representative sample of 650 LHDs was drawn using a stratified random sampling design on the basis of 7 population strata: less than 25 000, 25 000 to 49 999, 50 000 to 99 999, 100 000 to 249 999, 250 000 to 499 999, 500 000 to 999 999, and 1 000 000 and more. LHDs with larger population were systematically oversampled to ensure inclusion of a sufficient number of large LHDs in the completed surveys. Respondents were informatics or information systems staff identified by LHDs before the main survey. A structured questionnaire that included measures to examine LHDs' current informatics capacity and needs was constructed and pretested with 20 informatics staff. The completed questionnaire was administered to the sample of 650 LHDs via Qualtrics survey software. The survey remained open for 8 weeks in 2015. A total of 324 completed responses were received (50% response rate). Statistical weights were developed to account for 3 factors: (a) disproportionate response rate by population size (using 7 population strata, typically used in NACCHO surveys), (b) oversampling of LHDs with larger population sizes, and (c) sampling rather than a census approach.

**Measures**

Two primary domains related to HIE were included in this study: (1) connectivity with exchange partners by type of partners and (2) challenges experienced. Exchange partners and the direction of exchange were captured concurrently. Respondents were asked whether the LHD was able to electronically send or receive health information from a listing of 10 exchange partner organizations (Table 1). The question specifically excluded fax and e-mail. Challenges to electronically sending and receiving information were identified through a series of yes/no questions. The list of challenges was developed from a review of the literature and expanded with the help of the project advisory committee, consisting of more than 12 subject matter experts from the industry.

**Analysis**

We described the proportion of LHDs' participation in electronic exchange of information for all LHDs by types of exchange partners, and challenges, using frequencies and percentage. We used  $\chi^2$  for examining the difference in HIE participation and challenges to information exchange by LHD governance category. To assess the differences in HIE participation and challenges by jurisdiction size, we used Somer's D. We performed all analyses for this study using SPSS version 23.0.

**Results**

Substantial variation existed in the level of LHD participation in EEHI by type of exchange partners (Table 1). LHDs most commonly exchange health information electronically with the state department of health and/or human services (71%). The next most common exchange partners included laboratories, hospitals, and other county/city departments. Least common exchange partners included jail/correctional health, followed by health or county-based purchasing plans and home health agencies.

There was a significant variation in LHDs' EEHI with all other partners by jurisdiction size with the exception of primary care clinics, and health and county-based purchasing plans. Small LHDs with a jurisdiction population of less than 50 000 were more likely to participate in EEHI with state health departments and home health agencies than large LHDs (population size  $\geq 500\,000$  people). Larger LHDs were more likely to participate in EEHI with other partners. Variation also existed in EEHI with other partners by the type of LHD-state health agency governance relationship, with one exception—exchange with other county/city

**TABLE 1 • Percentage of LHDs Which Send or Receive Health Information Electronically by Type of Organizations in the Exchange Relationship, 2015<sup>a</sup>**

Organizations in Exchange Relationship	LHD Jurisdiction Population Size						Governance Category					
	<50 000		50 000-499 999		$\geq 500\,000$		State		Local		Shared	
	Send, %	Receive, %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	Send or Receive (vs Neither), %	P
State department of health and/or human services	61.0	67.0	70.2	73.7	57.6	<.001	47.9	70.9	89.3	<.001		
Laboratories	29.0	54.0	52.2	58.9	60.9	.01	34.7	53.9	82.3	<.001		
Hospitals	25.0	39.0	36.0	39.9	59.3	<.001	21.2	39.8	47.6	<.001		
County/city departments/program outside local health department	30.0	33.0	30.6	39.5	44.5	<.001	34.9	34.7	32.7	.87		
Primary care clinics	21.0	25.0	25.0	25.3	34.5	.09	10.4	26.5	33.3	<.001		
Pharmacies	16.0	14.0	13.1	24.2	36.8	<.001	20.3	15.5	46.3	<.001		
Long-term care facilities	11.0	15.0	11.9	20.3	18.2	<.001	5.2	16.4	15.0	<.001		
Home health agencies	13.0	14.0	16.7	12.5	8.3	.01	7.8	15.6	13.2	.03		
Health or county-based purchasing plans	10.0	13.0	15.0	11.6	16.2	.13	0.0	15.3	14.4	<.001		
Jail/correctional health	8.0	12.0	8.8	13.7	34.8	<.001	7.8	11.4	24.3	<.001		

Abbreviation: LHD, local health department.  
<sup>a</sup> P values for the population categories are based on Somer's D, and for governance category, based on  $\chi^2$ . Italicized values show significance of subgroup differences at  $P \leq .05$ . Number of observations ranges from 220 to 274.

health departments. With the exception of exchange with other county/city LHDs, LHDs with shared and local governance were more likely to participate than state-governed LHDs in EEHI.

LHDs reported a number of challenges to exchanging health information electronically (Table 2). Forty percent of LHDs reported Health Insurance Portability and Accountability Act (HIPAA), privacy or legal concerns affected their electronic exchange of health information with outside organizations. Thirty-seven percent reported lack of access to technical support or expertise, and 36% reported that there were other competing priorities. Over a quarter of LHDs (28%) reported that they were unclear about the value of the return on investment of the development of information systems. An equal proportion of LHDs (28%) indicated that lack of knowledge about exchange partners' ability to electronically exchange health information presented a challenge. High subscription rates for exchange services, insufficient information on exchange options such as exchange partners, transport mechanisms, and message

formats, and lack of support from LHD, state, and local board of health leaders were each reported by 22% of the LHDs. One fifth of LHDs reported lack of capacity on the part of potential exchange partners and 9% reported that their LHD had limited broadband/internet access.

There was some variation in the challenges LHDs experienced by jurisdiction size and governance category. More LHDs in jurisdictions of fewer than 50 000 people than in jurisdictions of larger sizes reported challenges related to lack of resources, including lack of access to technical support or expertise, prohibitively high subscription rates, and lack of leadership support. A significantly higher proportion of LHDs with larger jurisdiction populations reported competing priorities, and exchange partners without the ability, interest, or incentive to electronically exchange health information. Although not having broadband was a challenge for 10% of LHDs in small and medium-sized LHDs, none of the LHDs in jurisdiction populations of 500 000 or more people reported broadband challenges to information exchanges.

**TABLE 2 • Percentage of LHDs by Largest Challenges Related to Electronic Exchange of Health Information With Outside Organizations<sup>a</sup>**

Challenges to Electronic Exchange of Information	All, %	Population Size, %			P	Governance Category, %			
		<50 000	50 000-499 999	≥500 000		State	Local	Shared	P
HIPAA, privacy or legal concerns	40	40	41	37	.96	56	39	39	<.001
Lack of or access to technical support or expertise	37	40	35	26	<.001	25	41	17	<.001
Competing priorities	36	32	41	50	<.001	31	37	33	.20
Unclear about value of ROI on development of appropriate information systems	28	33	17	35	<.001	12	31	15	<.001
Do not know exchange partners' ability to electronically exchange health information	28	29	27	18	.21	25	28	23	.21
Subscription rates for exchange services are too high	22	25	18	17	<.001	11	25	8	<.001
Insufficient information on exchange options available (eg, exchange partners, transport mechanisms, and message formats)	22	23	19	28	.52	16	21	32	<.001
Lack of support from leadership (eg, at LHD, state, LBOH level)	22	24	18	17	<.001	24	20	34	<.001
Exchange partners do not have the ability, interest, or incentive to electronically exchange health information	20	17	22	33	<.001	27	19	21	.04
Inability of our organization's EHR system to generate/receive electronic messages/transactions in standardized format	15	14	15	18	.24	15	13	28	<.001
Limited broadband/internet access	9	10	10	0	.02	11	8	16	<.001

Abbreviations: EHR, electronic health record; HIPAA, Health Insurance Portability and Accountability Act; LBOH, local board of health; LHDs, local health department; ROI, return on investment.

<sup>a</sup>n = 277; P values for the population categories are based on Somer's D, and for governance category, based on  $\chi^2$ . Italicized values show significance of subgroup differences at  $P \leq .05$ .

Challenges comparatively more common among *state-governed* LHDs than in LHDs in *local or shared governance* arrangements included HIPAA, privacy or legal concerns; lack of or access to technical support or expertise; and exchange partners not having the ability, interest, or incentive to electronically exchange health information. In contrast, a higher proportion of LHDs with local governance compared with those with state or shared governance arrangements experienced challenges in information exchange concerning lack of clarity about the development of information systems' return on investment; cost prohibitive? subscription rates for exchange services; and inability of the LHD's EHR system to generate or receive electronic messages or transactions in standardized format. LHDs in shared governance systems had more common exchange challenges with respect to insufficient information on exchange options available such as exchange partners, transport mechanisms; lack of support from leadership; and limited broadband/internet access.

## Discussion and conclusions

Public health's participation in EEHI with most partners seems to be low. This less-than-ubiquitous participation by public health agencies has already been noted in evaluation of EEHI efforts.<sup>18,19</sup> As a result of low levels of participation, a large proportion of the public health system does not have the opportunity to realize the benefits of EEHI that can accrue to both clinical and nonclinical services and functions. The low level of participation was most notable for LHDs serving smaller jurisdictions. Universally, organizational size (of which jurisdictional size is a proxy) is associated with innovation adoption, and particularly information technology innovations: smaller organizations do not adopt information technology at the same rate as larger organizations.<sup>16,20</sup> In this instance, however, LHDs serving small jurisdictions may be doubly challenged. These LHDs reported internal capacity needs (eg, broadband connection) more commonly than those serving large jurisdictions. At the same time, LHDs serving small jurisdictions may also face external capacity needs as small and rural jurisdictions are less likely to have an active HIE organization with which to participate.<sup>16</sup> As further described later, options exist for supporting small and medium-sized LHDs, but such options will not create exchange partners. In areas where no HIE organization exists, LHDs may consider taking on the role of "neutral convener"<sup>21</sup> to encourage the health system to explore EEHI.

The challenges to participation in EEHI identified in our survey can be subdivided into 2 broad themes: technological and organizational/interorganizational. The most common technical challenges included lack

of technical expertise, privacy concerns, and use of an EHR system that could not exchange information. Although locally governed and small LHDs most frequently reported a lack of technical expertise as a barrier, our survey suggests that LHDs across the board would benefit from an infusion of health information technology capacity and resources. HIE organizations have staff and expertise in sharing information, but connecting to and utilizing any new health information system can be a daunting task and requires organizational support and staffing. Prior survey work has indicated that increasing the numbers of information technology staff is associated with more public health information system usage.<sup>22</sup> LHDs with state-level governance also were significantly more likely to report HIPAA, privacy or legal concerns. Nevertheless, the challenge in exchanging information with health organizations is in some ways not surprising. Public health agencies have historically been challenged sharing information among themselves.<sup>9,20,23</sup>

We also identified the largest challenges related to EEHI with outside organizations. Those challenges varied according to governance type, suggesting that there are both advantages and disadvantages of having centralized public health governance. Overall, LHDs with shared governance had the highest levels of EEHI, followed by local and state. The low levels of usage for LHDs with state-level governance may point to a need for tailored interventions and policies for the LHDs governed by state health agencies. A corollary of this finding is that LHDs with local governance were significantly more likely to report lacking access to technical support or expertise as a challenge to EEHI. Solutions targeting increased adoption of EEHI should therefore be targeted to a specific audience, such as LHDs serving smaller jurisdictions, those with local governance, etc.

Our findings about the partners with which LHDs are most likely to connect to electronically exchange information have important implications. LHDs' knowledge of the most common exchange partners will be important in making decisions about resource allocation and building interoperability with other partners. For instance, when strategically prioritizing the resources to develop fully interoperable systems, it may be advantageous (at least in the short term) to build capacity for interoperability with laboratory systems rather than jails or correctional facilities, given the relative priority for these 2 systems shown by our results. However, longer term prioritization of information system interoperability should also be driven by the relative impact of that partner on an LHD's operational and strategic priorities.

Our findings, that LHDs of different sizes differ in nature of their challenges, have clear implications

for policy and advocacy efforts. LHDs serving larger jurisdictions (ie,  $\geq 500,000$ ) report challenges such as competing priorities rather than a lack of resources. This may be indicative of their relatively broader scope and scale as well as their informatics needs and resources. Efforts to incentivize HIE may benefit from prioritizing training and educating LHD staff about the importance of data and information exchange rather than providing technical or physical resources such as broadband. LHDs in jurisdictions of fewer than 50,000 people, on the other hand, need more resources such as technical support and expertise. Our findings suggest that leadership support is among important factors for improving data exchange capacity of LHDs with smaller jurisdiction and those in shared governance.

Our study has a few limitations. We aimed to capture perspectives of the LHD informatics staff. Therefore, before sending out the survey, the project team asked NACCHO's contact persons for the LHDs in the study sample (mostly top executives) to identify the most relevant informatics staff. Because roughly one fourth of the LHDs provided the informatics staff contacts, the mixed perspective of LHDs, informatics and the leadership staff may have implications for interpretation for our results. A related limitation is that self-reported survey responses are not independently verified. We could not stratify the use of data exchange by the type of services provided by LHDs because the survey did not collect data on types of services provided. This may be a question for a future study.

## ● Conclusions

HIEs have become more common throughout many parts of the health care sector over the past couple of decades and have shown some promise in improving our health care delivery system. Yet, LHDs have had relatively low participation in HIEs and thus may not fully benefit from these crucial data resources. Unlike health care, where market forces and federal programs such as payments associated with meaningful use of EHRs incentivize infrastructure development,<sup>24</sup> infrastructure development for public health informatics tends to be driven by political forces.<sup>13</sup> These forces may present substantial barriers to the development and use of public health information systems.<sup>13</sup>

Although our findings show a large proportion of LHDs participating in EEHI with some exchange partners, a small proportion participates in exchanges with many other partners. LHDs commonly exchange information with state departments of health, public health laboratories, and hospitals. Exchange with other partners was, however, less common, indicating opportunities to expand the exchange relationships with other

partners, including pharmacies, long-term care facilities, home health agencies, health- and county-based purchasing plans, and jail/correctional health. Regardless of LHD size, HIPAA, privacy or legal concern was the most common challenge, indicating a clear need for concerted effort to improve LHD staff's knowledge about this important aspect of data exchange. Training on HIPAA may cover at least the basic elements of the privacy rule, more specifically knowledge about who is covered under HIPAA regulations, the type of information that is protected, and ways to protect information. Challenges pertaining to electronic exchange of information differ for LHDs of different sizes and different governance relationships with states. Developing and managing robust information systems that allow sending, receiving, and integrating data and information with minimal human intervention is essential. For the local, state, and federal public health enterprise to continue to take advantage of health informatics, LHDs will need to address barriers to connectivity, including political ones; better coordinate across programs; look at new ways to implement systems; and place a greater focus on their informatics workforce.<sup>25</sup>

## REFERENCES

1. Dixon BE, Pina J, Kharrazi H, Gharghabi F, Richards J. What's past is prologue: a scoping review of recent public health and global health informatics literature. *Online J Public Health Inform.* 2015;7(2):e216.
2. Birkhead GS, Klompas M, Shah NR. Public health surveillance using electronic health records: rising potential to advance public health. *Front Public Health Serv Sys Res.* 2015;4(5):25-32.
3. Kern LM, Edwards A, Kaushal R, with the HITEC Investigators. The meaningful use of electronic health records and health care utilization. *Am J Med Qual.* 2016;31(4):301-307.
4. Office of the National Coordinator for Health Information Technology. Connecting Health and Care for the Nation: A 10-Year Vision to Achieve an Interoperable Health IT Infrastructure. <https://www.healthit.gov/sites/default/files/ONC10yearInteroperabilityConceptPaper.pdf>. Accessed March 13, 2016.
5. The National Alliance for Health Information Technology. Report to the Office of the National Coordinator for Health Information Technology on Defining Key Health Information Technology Terms. [https://www.nachc.com/client/Key%20HIT%20Terms%20Definitions%20Final\\_April\\_2008.pdf](https://www.nachc.com/client/Key%20HIT%20Terms%20Definitions%20Final_April_2008.pdf). Published April 28, 2008. Accessed March 13, 2016.
6. Shapiro JS. Evaluating public health uses of health information exchange. *J Biomed Inform.* 2007;40(6 suppl):S46-49.
7. Smith PF, Hadler JL, Stanbury M, Rolfs RT, Hopkins RS. "Blueprint version 2.0": updating public health surveillance for the 21st century. *J Public Health Manag Pract.* 2013;19:231-239.
8. Kierkegaard P, Kaushal R, Vest JR. Applications of health information exchange information to public health practice. *AMIA Annu Symp Proc.* 2014;2014:795-804.

9. Dixon BE, McGowan JJ, Grannis SJ. Electronic laboratory data quality and the value of a health information exchange to support public health reporting processes. *AMIA Annu Symp Proc.* 2011;2011:322-330.
10. Dixon BE, Siegel JA, Oemig TV, Grannis SJ. Electronic health information quality challenges and interventions to improve public health surveillance data and practice. *Public Health Rep.* 2013;128(6):546-553.
11. Savel TG, Foldy S. The role of public health informatics in enhancing public health surveillance. *MMWR Surveill Summ.* 2012;61(Suppl):20-24.
12. Ocampo JMF, Smart J, Allston A, et al. Improving HIV Surveillance Data for Public Health Action in Washington, DC: a novel multiorganizational data-sharing method. *JMIR Public Health Surveill* 2016;2(1):e3.
13. Ross DA. Implications of practicing informatics in the public health sector. *J Public Health Manag Pract.* 2002;8(3):v-i.
14. Merrill J, Bakken S, Rockoff M, Gebbie K, Carley KM. Description of a method to support public health information management: organizational network analysis. *J Biomed Inform.* 2007;40(4):422-428.
15. Dixon BE, Siegel JA, Oemig TV, Grannis SJ. Electronic health information quality challenges and interventions to improve public health surveillance data and practice. *Public Health Rep.* 2012;128(6):546-553.
16. Shah GH, Leider JP, Castrucci B, Williams K, Luo H. Characteristics of local health departments associated with their implementation of electronic health records and other informatics systems. *Public Health Rep.* 2016;131(1):272-282.
17. National Association of County and City Health Officials. *2010 National Profile of Local Health Departments.* Washington, DC: NACCHO; 2011.
18. Adler-Milstein J, McAfee AP, Bates DW, Jha AK. The state of regional health information organizations: current activities and financing. *Health Aff.* 2008;27(1):w60-w69.
19. Vest JR. Geography of community health information organization activity in the United States: implications for the effectiveness of health information exchange [published online ahead of print March 15, 2016]. *Health Care Manage Rev.* doi: 10.1097/HMR.0000000000000103.
20. Vest JR, Issel LM. Factors related to public health data sharing between local and state health departments. *Health Serv Res.* 2014;49(1, pt 2):373-391.
21. Hessler BJ, Soper P, Bondy J, Hanes P, Davidson A. Assessing the relationship between health information exchanges and public health agencies. *J Public Health Manag Pract.* 2009;15(5):416-424.
22. Cortese PA. Health education credentialing—an idea whose time has come. *Health Educ Q.* 1990;17(3):247-251.
23. Vest JR, Menachemi N, Ford EW. Governance's role in local health departments' information system and technology usage. *J Public Health Manag Pract.* 2012;18(2):160-168.
24. Blumenthal D, Tavenner M. The "meaningful use" regulation for electronic health records. *N Engl J Med.* 2010;363(6):501-504.
25. Kirkwood J, Jarris PE. Aligning health informatics across the public health enterprise. *J Public Health Manag Pract.* 2012;18:288-290.