An integrative review of information systems and terminologies used in local health departments

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ABSTRACT

Objective The purpose of this integrative review based on the published literature was to identify information systems currently being used by local health departments and to determine the extent to which standard terminology was used to communicate data, interventions, and outcomes to improve public health informatics at the local health department (LHD) level and better inform research, policy, and programs.

Materials and methods Whittemore and Knafl's integrative review methodology was used. Data were obtained through key word searches of three publication databases and reference lists of retrieved articles and consulting with experts to identify landmark works. The final sample included 45 articles analyzed and synthesized using the matrix method.

Results The results indicated a wide array of information systems were used by LHDs and supported diverse functions aligned with five categories: administration; surveillance; health records; registries; and consumer resources. Detail regarding specific programs being used, location or extent of use, or effectiveness was lacking. The synthesis indicated evidence of growing interest in health information exchange groups, yet few studies described use of data standards or standard terminology in LHDs.

Discussion Research to address these gaps is needed to provide current, meaningful data that inform public health informatics research, policy, and initiatives at and across the LHD level.

Conclusions Coordination at a state or national level is recommended to collect information efficiently about LHD information systems that will inform improvements while minimizing duplication of efforts and financial burden. Until this happens, efforts to strengthen LHD information systems and policies may be significantly challenged.

BACKGROUND AND SIGNIFICANCE

Health promotion, prevention, and surveillance of priority health conditions, with epidemiology as a fundamental component, are major areas of focus in public health practice[1] necessitating robust information collection, analysis, interpretation, and communication methods.[2] Over the past decade, advances in technology have universally changed the way data are located, analyzed and communicated. However, healthcare has trailed other industries in the use of information systems for professional support,[3] and public health information systems have lacked the level of coordination necessary to improve understanding of the health of the population and to evaluate the outcomes of public health investments and initiatives.[4] While there are numerous reports with recommendations for public health information system development, implementation, and coordination, little is known about the current systems in use by local health departments. This integrative review explores relevant literature to identify information systems and standard terminologies currently being used by local health departments. This information may serve as a foundation for planning and coordination of public health informatics (PHI) at the local health department (LHD) level and better inform research, policy, and programs.

LHDs are agencies within each state that serve small jurisdictions, such as township, city, county, or multicounty areas.[5] Through the use of information technology, LHDs can improve efficiency and effectiveness in the delivery of care, yet the use of separate information systems and insufficient coordination between local and state public health entities is common.[6] An understanding of the systems currently in use is necessary to identify needs across systems and to initiate improvements.[7]

Increasingly, the need for public health data in support of public health services and systems research is emphasized.[8] Information technology is recognized for its ability to improve public health effectiveness through the collection, examination, and dissemination of data.[2 7 9] Whereas informatics is considered to be the science of information,[10] PHI is defined as 'a systematic application of information and computer science and technology to public health practice, research, and learning'[11] (p. 67). The benefits of PHI are actualized in multiple ways. For example, the timely collection and exchange of data through partnerships at local, state, and federal levels can support efforts to improve the health of the public.[12] The connection of data and information from numerous sources can inform public health research.[13] In addition, the use of informatics tools to implement standards-based interventions can transform public health practice.[3] For maximum effectiveness, however, PHI systems should share a common set of population-level indicators[4] supported through standardized languages or taxonomies to enable effective data sharing and analysis.[14]

The benefits of PHI are particularly relevant for LHDs, because well-designed information systems have the potential to provide access to current data for use in the planning and evaluation of health improvement efforts.[7] However, LHD efforts to assess program outcomes are challenged by a lack of sophistication in both data collection systems and the information technology infrastructure.[15] This is exemplified by a number of issues. Standardized organization and nomenclature is lacking;[2] established methodologies for information storage and

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sharing are absent;[16] population health data are not easily assessible in the USA because they exist in various formats across multiple agencies and web sites;[17] and national standards for safeguarding public health agency data have not been established.[18]

OBJECTIVE

Obtaining necessary data and information is challenging and requires effective and efficient use of financial and technological resources. However, these resources may not be readily available due to the rapid pace of informatics' advancements in an environment of dwindling funds and new legislative regulations.[19] Although there are numerous calls for improved PHI infrastructure and standards, there are few reports in the literature concerning the use of current information systems at the local public health level. The purpose of this integrative review of literature was to identify software programs and information systems currently being used by LHDs and to determine the extent to which standard terminology was used to communicate data, interventions, and outcomes. The goal is to inform future research, policy, and programs to improve PHI at the LHD level.

MATERIALS AND METHODS

Whittemore and Knafl's[20] five-stage review methodology was used to guide this integrative review. The process involved the following five steps: articulation of the research problem; execution of a well-defined literature search; evaluation of the literature for quality of data; analysis of the data; and statement of conclusions. Studies using different research designs were included with the aim of presenting diverse perspectives and expanding knowledge.[20]

A systematic search of existing professional literature on PHI was conducted with the assistance of a research librarian in February 2012. The PubMed computerized database was explored using the MeSH term 'public health informatics' and the subheadings of: 'classification'; 'instrumentation'; 'methods'; 'organization and administration'; 'standards'; 'statistics and numerical data'; and 'trends'. Limits were set for 'English language' and 'humans'. In addition, the Academic Search Premier and CINAHL computerized databases were searched using the key words: 'PHI and nomenclature'; 'PHI and semantics'; and 'public health and medical health records, computerized'. Ancestry searching of references of retrieved articles was conducted for additional relevant studies. A second step to the search process was conducted to identify relevant non-published data and additional articles published since February 2012. To improve the external validity, five content experts in PHI were consulted for a list of important websites and reports that should be included in the review. This included artifacts from websites such as the Public Health Data Standards Consortium, the American Medical Informatics Association (AMIA), the PHI Institute, RTI International, RAND International, the National Opinion Research Center (NORC), Mathematica, and Healthcare Information and Management Systems (HIMSS).

In alignment with the purpose of the study and integrative review methodology, published reports and research studies of diverse designs were included if they described information systems or standard terminology used in LHDs. All article titles and abstracts generated from the search (N=645) were examined for relevance to the study purpose and inclusion criteria. Those that did not meet the criteria specified above were screened out (n=397). The full article was reviewed if the study met inclusion criteria, alignment with inclusion criteria was unclear, or the abstract was unavailable (n=248). Among articles reviewed in full, four exclusion criteria were used: studies or articles that proposed new systems or frameworks or made recommendations for infrastructure improvements (n=101); described systems or nomenclatures outside the USA (n=17); described studies that piloted new software statistical methods (n=19); or did not identify information systems or standard terminologies used in LHDs (n=66) (see figure 1).

The final sample for this review included 45 articles and artifacts. Data were analyzed using the matrix method[21] according to study aim, design, sample, data sources and analytic strategy, findings, and critique (see supplementary appendix I, available online only). Descriptions of information systems and standardized terminology in use were extracted and summarized. Findings were then synthesized through comparison, interpretation, and elucidation of categories. In addition, each report was evaluated for methodological quality using a summed scoring system based on four criteria (see table 1).

RESULTS

This review of professional literature sought both to identify software programs and information systems used by LHDs and to determine the extent to which standard terminology was used to communicate data, interventions, and outcomes. The findings from each of these areas will be discussed separately in the sections below.

Public health information systems

Thirty-four of the 45 records reviewed included software programs and information systems used in LHDs. Most striking was the large number of different programs in use (see box 1). For example, in a survey of LHDs (n=344), Magruder *et al*[9] reported the use of more than 500 different software programs. In addition, a survey of LHDs in Oregon revealed that at least 27 different systems were considered to be 'working well'.[6] The information systems reported in the literature were used to support a variety of public health functions. Five categories aligned with these functions emerged from the data during the review process: administration; surveillance; health records; registries; and consumer resources. The findings will be presented accordingly.

Administration

Use of e-mail and Microsoft Office software were reported for administrative functions and documentation.[6 9] Magruder *et al*[9] reported that Microsoft Office programs such as Word, Excel, PowerPoint, and Access were among the most frequently used programs in LHDs. Microsoft Access databases were also used in western Oregon LHDs.[22] E-Chronicle was used in Minnesota to capture tobacco cessation activities.[23] Given the amount of administrative responsibilities of LHDs, the lack of information about systems being used to support this function is significant.

Surveillance

Among the responsibilities of public health agencies, disease surveillance is one of the most important.[5] Electronic surveillance systems provide a means of facilitating disease outbreak data collection, automated analysis, and information dissemination.[5] Information technology in the area of surveillance was a common theme in the literature (n=25). The National Association of County and City Health Officials (NACCHO)[7] found that 52% of LHDs used an electronic surveillance system for this purpose. Software or information system titles were not reported. Use of the Health Alert Network (HAN) was reported in five articles.[6 9 24–26] McDaniel *et al*[25] noted that it was used across the country to alert schools, emergency responders, and healthcare

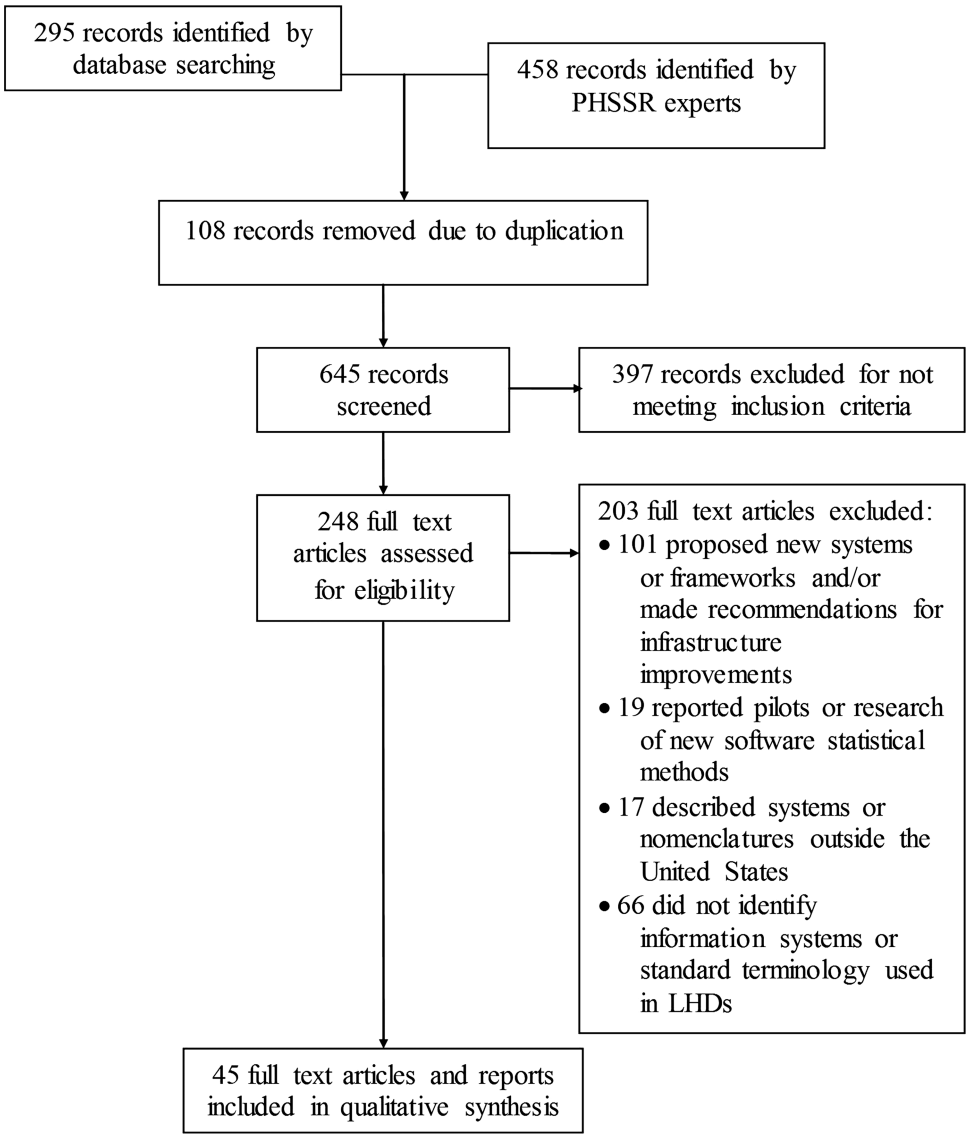

Figure 1 Flow of information through the integrative review. LHD, local health departments; PHSSR, Public Health Services and Systems Research.

agencies of disease outbreaks, natural disasters, and environmental threats. HAN was also identified as one of the programs most frequently used by LHDs[9] and one of several programs working well among Oregon LHDs.[6] The Electronic Surveillance System for Early Notification of Community-based Epidemics (ESSENCE) was another system reported. It was used at both state and local levels in eight states and Washington, DC for a variety of surveillance activities including rabies, influenza, and gastrointestinal outbreaks, as well as general monitoring of hospital and emergency department data.[22 27] In addition, it was used for disease surveillance at over 250 military health clinics.[28]

Surveillance using disease mapping systems was also reported. McDaniel *et al*[25] noted that one department used geographic information systems (GIS) to identify people at high risk of West Nile virus disease. Williams *et al*[29] also reported on the use of GIS in large LHDs to map risk factors and disease distribution. Brownstein *et al*[30] described the use of HealthMap, a free online resource for real-time surveillance and monitoring of disease outbreaks, noting that LHDs were among its many users. BioSense, a Centers for Disease Control and Prevention program that tracks health problems and notifies health officials, was another surveillance system reported, although locations of users were not specified.[31 32] Similarly, the National Electronic Disease Surveillance System (NEDSS) was used by many state and local agencies.[25 32–34] A variety of other systems was reported, such as EpiX,[35] Public Health Issue Management[36] and the Communicable Disease Database[37] in Washington, Communicable Disease Reporting and Syndromic Surveillance in New Jersey,[38] and EpiCom in Florida.[39] Multiple state-specific or home-grown systems were also described.[22 24 40–43]

The articles in this review indicated that several information systems are being used to support surveillance efforts in LHDs. More information is needed, however, regarding how extensively each of these systems is being used throughout the nation, how well they are working, and what other systems are in use.

Electronic health record and practice management systems

Health records provide a means of documenting client data and public health services. This was another information system category found in the literature. NACCHO[7] reported that among LHDs that provide primary care, 77% use electronic practice management systems. In this report, the names of the practice management systems were not specified. NACCHO[7] also reported that 55% of LHDs used either a partial or complete

Table 1 Methodological quality ratings of included studies*

Report	Type of study†	Sampling method	Data collection method detail provided	Analysis‡	Quality rating score
Magruder *et al*[9]	4: quantitative	3: random or 100%	1: methods and tools	2: descriptive	10
Foldy[56]	4: quantitative	2: purposive or CM	1: methods and tools	2: descriptive	9
Landis *et al*[46]	1: best practice report	0: not explained or NA	0: not explained or NA	1: narrative	2
McDaniel *et al*[25]	1: best practice report	0: not explained or NA	0: not explained or NA	1: narrative	2
Goedert[31]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Brownstein *et al*[30]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Smith *et al*[44]	5: mixed	3: random or 100%	1: methods and tools	2: descriptive	11
Nangle *et al*[32]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Savory *et al*[28]	4: quantitative	1: convenience	1: methods and tools	2: descriptive	8
Feuchtbaum *et al*[52]	4: quantitative	3: random or 100%	1: methods and tools	2: descriptive	10
OOHPR[6]	5: mixed	3: random or 100%	1: methods and tools	2: descriptive	11
NACCHO[7]	5: mixed	3: random or 100%	1: methods and tools	2: descriptive	11
Monsen *et al*[64]	4: quantitative	2: purposive or CM	1: methods and tools	3: inferential	10
Lewis *et al*[27]	1: best practice report	0: not explained or NA	0: not explained or NA	1: narrative	2
Heisey-Grove *et al*[61]	6: experimental	3: random or 100%	1: methods and tools	2: descriptive	12
Shapiro *et al*[57]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Monsen *et al*[65]	6: experimental	1: convenience	1: methods and tools	3: inferential	11
Monsen *et al*[66]	6: experimental	2: purposive or CM	1: methods and tools	3: inferential	12
NORC[22]	3: qualitative	2: purposive or CM	1: methods and tools	1: narrative	7
McHugh *et al*[51]	3: qualitative	0: not explained or NA	1: methods and tools	1: narrative	5
Williams *et al*[29]	3: qualitative	1: convenience	1: methods and tools	1: narrative	6
Ringle *et al*[54]	4: quantitative	3: random or 100%	1: methods and tools	2: descriptive	10
Kauerauf[33]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Octania-Pole[38]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Ising[41]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Le[42]	1: best practice report	0: not explained or NA	0: not explained or NA	1: narrative	2
Health IT News[59]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Pare[50]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
CDPH[62]	2: government report	0: not explained or NA	1: methods and tools	2: descriptive	5
Banger *et al*[45]	1: best practice report	0: not explained or NA	1: methods and tools	1: narrative	3
Wine *et al*[49]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
State of Michigan[26]	2: government report	0: not explained or NA	0: not explained or NA	1: narrative	3
State of Indiana[43]	2: government report	0: not explained or NA	0: not explained or NA	1: narrative	3
OHIP[60]	2: government report	0: not explained or NA	0: not explained or NA	1: narrative	3
State of NC[24]	2: government report	0: not explained or NA	0: not explained or NA	1: narrative	3
HIMSS[58]	3: qualitative design	2: purposive or CM	1: methods and tools	1: narrative	7
Hersh[34]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Guthrie[35]	1: best practice report	0: not explained or NA	0: not explained or NA	1: narrative	2
CIR[48]	1: best practice report	0: not explained or NA	0: not explained or NA	1: narrative	2.
PHIN[39]	1: best practice report	0: not explained or NA	0: not explained or NA	2: descriptive	3
Mackiewski and Taft[23]	5: mixed	3: random or 100%	1: methods and tools	2: descriptive	11
Smith[53]	1: best practice report	0: not explained or NA	1: methods and tools	1: narrative	3
Lawson *et al*[40]	1: best practice report	0: not explained or NA	0: not explained or NA	1: narrative	2
Pina *et al*[36]	3: qualitative design	2: purposive or CM	1: methods and tools	1: narrative	7
Turner *et al*[37]	3: qualitative design	2: purposive or CM	1: methods and tools	1: narrative	7

*For reports and articles covering multiple topics, the quality ratings pertain to only to methods and results regarding information system and standard terminology use in LHD.
†Type of study: 1=best practice report; 2=government report; 3=qualitative design; 4=quantitative descriptive design; 5=mixed with both qualitative and quantitative descriptive designs; 6=quantitative experimental design.
‡Analysis (highest level reported): narrative; 2=descriptive statistics; 3=inferential statistics.
CDPH, California Department of Public Health; CIR, California Immunization Registry; CM, case matching; LHD, local health departments; NA, not applicable; NACCHO, National Association of County and City Health Officials; OHIP, Ohio Health Information Partnership; OOHPR, Office for Oregon Health Policy and Research; PHIN, Public Health Information Network.

electronic health record. Other authors reported that some state health departments had implemented public health electronic personal health record systems.[22–24 32 44 45] In Oregon, approximately 87% of LHDs that provide direct primary and preventive care used either an electronic health record and/or practice management system with the majority using clinical management software available through Ahlers and Associates.[6] In Wisconsin, the Secure Public Health Electronic Record Environment (SPHERE) was developed with Federal Maternal and Child Health (Title V) Program grant funding specifically for monitoring, reporting, and documenting maternal, child, and family health data.[46]

Similar to the area of surveillance, the reviewed literature indicated that information systems are being used by LHDs for client health record keeping. However, there is a lack of information regarding specific systems being used, who is using

Box 1 Software programs and systems

Program
- Microsoft Office programs (including Access, Word, Excel, Powerpoint, Outlook)[6 9 22]
- Arcview [9]
- Health Alert Network (HAN)[6 9 22 24 26]
- WebbStarr[9]
- Epi Info[9]
- Kansas Integrated Public Health System (KIPHS)[9]
- Virginia Information System Integrated Online Network (VISION)[9]
- Human Services Information System (HSIS)[9]
- HOST programs[9]
- QS programs[9]
- Women, Infants, and Children (WIC)[9 23]
- Healthspace[9]
- Electronic Surveillance System for Early Notification of Community-based Epidemics (ESSENCE)[22 27 28]
- Massachusetts Virtual Epidemiological Network (MAVEN)[61]
- National Electronic Disease Surveillance System (NEDSS)[25 32–34]
- BioSense[31 32]
- Remote Outbreak Detection and Surveillance (RODS)[32]
- Early Hearing Detection and Intervention (EHDI)[32]
- Child Health Advanced Records Management system (CHARM)[32]
- Geographic Information System (GIS)[25 29]
- HealthMap[30]
- Secure Public Health Electronic Record Environment (SPHERE)[46]
- Ahlers[6]
- CareWare[6]
- ELR lab reporting[6]
- Family Net Alert[6]
- IRIS[6]
- ORCHIDS[6 22]
- TWIST[6 22]
- Raintree FP[6]
- Medicaid Management Information System[6]
- ORPHEUS[6 22]
- OVERS for vital records[6]
- Phoenix for food safety[6]
- SWS Online for drinking water[6]
- Webrad for lab results[6]
- Citrix[6]
- Alert[6]
- e-Sentinel[6]
- Family Net[6]
- E-Chronicle[23]
- Public Health Issue Management System[37]
- CD-Database[36]
- EpiCom[39]
- EpiX[35]
- NC DETECT[24 41]
- CDRSS[38]
- HIV/AIDS Reporting System[22]
- Merlin[22]
- MDSS[22]
- MSSS[22]
- CHAMPS[22 23]
- CareFacts[23]
- PH-Doc[23]
- PRISM[22 23]
- MAXIS[23]
- Client Care Management System[23]
- Social Security Information System[23]
- Win Clinic Assessment Software Application[23]
- Medical Fiscal Intermediary Shared System[23]
- MN-ITS[23]
- EMR-lite[45]
- NC Health Information System[24]
- Health Management Systems EMR[22]
- ADAP Database[22]
- CAREWare[22]
- SpecimenGate[22]
- NextGen HER[22]
- Netsmart Insight[22]
- EPIC HER[22]
- Home-grown systems[23 40]

CD, communicable disease; HER, health electronic record.

them, and how well they are working to meet documentation, billing, and outcome assessment needs.

Registries

Information specific to individuals who have certain diseases or health conditions can be collected, stored, and utilized in the format of a registry.[47] Another public health information system category identified in the literature was electronic 'registries' with immunization registries being the most frequently reported.[6 7 22–25 32 48–51] For example, NACCHO[7] stated that 65% of LHDs used a web-based database to store and access some or all immunization data. In Oregon, 88% (n=28) of LHDs use electronic immunization registries.[6] Other authors noted that immunization databases were commonly used in public health without specifying where they were being used.[25 32] Additional registries that were reported included those for death, child health, cancer, chronic disease, and newborn screening.[32 52 53] These descriptions did not include information about system effectiveness or specify geographical areas in which they were used.

Consumer resources

The final category, defined as 'consumer resources', included systems that provided a means for LHDs to provide information to the public. Several programs were reported. McDaniel *et al*[25] noted that one county public health department, as part of their GIS initiative, notified citizens at risk of West Nile virus and recommended prevention strategies. Ringle *et al*[54] investigated how well LHDs communicated H1N1 information on their websites and found that 34% (n=52) did so within 24 h of the public health emergency declaration, with more than half linking to the Centers for Disease Control and Prevention website. An additional consumer resource reported was Web 2.0 technologies. According to NACCHO,[7] these technologies were used by 53% of LHDs and included Facebook (47%), Twitter (37%), You Tube (16%), My Space (11%), and blogs (11%). LHDs serving more populated areas reported using more Web 2.0 technologies than those serving smaller populations.[7]

Use of standard terminologies in public health information systems

Standard terminologies are systems of approved words or phrases within a field or profession.[55] Use of standard

terminology by LHDs for communicating data, interventions, and outcomes was more difficult to ascertain from the literature. Although several articles addressed the topic (33%), few provided details regarding precisely what was being communicated with standard terminology, how, and by whom. Two categories were identified from the reviewed literature: health information exchange and specific data and terminology standards.

Health information exchange

Growing interest in the creation of health information exchange groups to facilitate electronic information sharing across organizations within communities or regions, linking LHDs with hospitals and primary care practices, was evident in the literature. NACCHO[7] reported that 30% of LHDs have a health information exchange group operating in their area; however, no details about the programs were reported. Similarly, in Oregon, the ability of LHDs to share information varied based on context. Only 19% (n=6) of LHDs were able to exchange data pertaining to disease surveillance electronically, but up to 88% (n=28) could do so with immunization registries.[6] Foldy[56] reported that 21 organizations in Wisconsin had health exchange projects in either the planning or operating phases. Shapiro *et al*[57] described the success of several health departments in New York regarding efforts to support biosurveillance activities. HealthBridge was described as a network being used in the greater Cincinatti–northern Kentucky tri-state area.[58 59] LHDs were reportedly part of HIE initiatives in North Carolina,[24] Ohio,[60] Utah,[45] Florida,[22] and Michigan.[22] Finally, Nangle *et al*[32] described the use of a health information exchange group by a LHD in Colorado for public health alert communication. Notably, details regarding use of standard terminology to facilitate information exchange including application of specific types of standards were not described.

Specific data and terminology standards

To facilitate electronic data exchange, Health Level Seven (HL7) was one standard recommended in the literature. Heisey-Grove *et al*[61] stated that HL7 messaging format was used in a project involving LHDs to improve the Massachusetts hepatitis C surveillance system. In addition, Nangle *et al*[32] asserted the importance of using national data standards such as HL7 for exchange of clinical health information, and cited Utah's clinical laboratory results program as an exemplar. Ohio,[60] Indiana,[43] and California[62] also reported using HL7 for data exchange.

Use of the Omaha System, a standardized taxonomy for client care documentation,[63] was also reported in the literature (n=3). Monsen *et al*[64] used the Omaha System to study low-income, high-risk maternal child health clients receiving services from county health departments. The authors reported an improvement of health problems and asserted that informatics tools and data supported description of client health problems and intervention effectiveness. In another study, the Omaha System was used to study family home visits provided by public health nurses.[65] The system was used to classify client risk, and the authors reported that it facilitated their examination of the relationship between home visiting interventions and outcomes. In a final study using the Omaha System, Monsen *et al*[66] reported mothers with and without intellectual disabilities showed improvement in all health problem areas following family home visits by public health nurses, suggesting that the use of standardized clinical data may be beneficial for describing problems, services, and outcomes in public health.

Synthesis

This review of literature indicated that a large number of information systems were used by LHDs, yet there was a lack of detail regarding specific programs being used, location or extent of use, or their effectiveness. Notably, different systems were reported to support diverse LHD functions. This would imply that most LHDs were using multiple systems, potentially contributing to financial and staffing burdens. This review also showed growing interest in health information exchange groups. However, few studies described the use of data standards or standard terminology in LHDs. In addition, only 42% (n=19) of the reports were conducted as research studies, and only 33% (n=15) used purposive or random sampling methodology. In summary, significant gaps in the area of information system and standard terminology use at the LHD level persist. Unless they are addressed, efforts to strengthen LHD informatics programs and policies may be significantly challenged.

DISCUSSION

The purpose of this review of literature was to identify information systems and programs used by LHDs and to determine the extent to which data and terminology standards were used to communicate data, interventions, and outcomes. The results revealed that a large number of different information systems was used, aligning with five categories: administration; surveillance; health records; registries; and consumer resources. Despite a lack of detail regarding specific systems or applications, this literature review indicated an increasing interest by LHD and public health organizations in programs to facilitate health information exchange.[7 55]

A variety of information systems is necessary to meet the functional needs of LHDs. However, the large number of programs reported in the literature raises concerns. In 2005, the PHI Institute and National Association of State Chief Informatics Officers asked the question, 'Why develop multiple, similar systems when our problem and information needs are similar?' They recommended an 'enterprise view of health information' in which data about populations are shared among partners. This review indicates that there has been little change since that time. The use of multiple, diverse systems is a barrier to efforts to catalog programs or document which departments are using each of them. LHDs may have difficulty determining which systems to use to meet their needs best while ensuring compatibility or connectivity with other state and regional organizations. This may result in a lack of coordination that duplicates efforts and increases the financial burdens on LHDs.

Efficiency in data entry, storage, and analysis are distinct benefits of information technology; however, capturing the full value of informatics in public health requires rapid ability to exchange data with stakeholders. This is particularly important with the development of health information exchanges in which local healthcare and public health services can be linked with federal activities such as the HITECH and the Affordable Care Acts and state Medicaid initiatives. Although numerous articles citing the benefits of standard terminology and proposing specific frameworks were found in the literature,[14 67–69] there were few publications specifically describing the use of standard terminology in public health at the local level and there was little evidence that this was occurring. Quite possibly this can be partly explained by lingering confusion regarding the meaning of informatics concepts. For example, NACCHO[7] reported that even among LHD staff, many people do not know the meaning of the term 'PHI'. Clearly, LHD staff must have a thorough understanding of the subject matter before they

will be able to implement and fully utilize standardized frameworks effectively. Therefore, education and training in this area may be beneficial.

The dynamic nature and rapid advances within information technology underscore an urgent need for research to examine current practices regarding the use of information systems and standard terminology among LHDs. In addition, significant gaps must be addressed to facilitate the research and evaluation needed for population health improvement.[70] This study revealed that a large number of different information systems was being used by LHDs, yet little has been documented regarding specific systems, extent and location of use, or system effectiveness. In addition, literature about environmental, dental, and other important service areas was scarce. Furthermore, few articles specifically described the use of standard terminology or provided evidence that they were used regularly in LHDs. It is critical that these gaps be addressed to provide current, meaningful data that inform PHI research and improvement initiatives at the LHD level. The public health data exchange hierarchy emphasizes local communication with reporting to regional centers, followed by state and then national agencies. Therefore, it would be beneficial for further LHD informatics enquiry and initiatives to be coordinated with state and national leadership. This would support the efficient collection of relevant information regarding current informatics practices, challenges, and priorities in LHDs that could be used to direct program and policy development. Initial enquiry at the state level may also enhance regional system coordination, thus diminishing duplication of efforts and financial burden. Public health practice and research may benefit from greater attention to each of the following areas: administrative processes; health registries; electronic health and practice management systems; consumer resources; and surveillance systems.

Limitations

This study is limited by the possibility that articles pertinent to the review may have been missed due to variances in key terms and concepts. Articles may also have been missed due to rapid changes in the field. These limitations were addressed by following a clearly articulated search method, consulting with a research librarian, and reviewing findings with multiple experts in the field.

CONCLUSION

Information systems and terminology standards have significant potential to support efforts to improve the health of the public. Future advancement in PHI will necessitate a systems approach and an infrastructure grounded in interdependence and integration.[69] Collaborating entities will need to use the same standards and compatible software.[15] Funding will be necessary to accomplish the integration of current non-standardized systems and to maintain them in the ever changing healthcare environment.[15] Results of this review indicated that a large number of information systems were being used by LHDs. However, there was a lack of data specifically reporting which systems were used, where or how extensively each was used, or how well they were working at the LHD level. In addition, literature on standard terminology use was minimal and details regarding its application to facilitate health information exchange were not described. These gaps in the literature must be addressed to provide current, meaningful data that inform PHI research and improvement initiatives at the LHD level. Coordination at a state or national level is recommended to collect information efficiently that will inform improvements to LHD information systems, minimizing duplication of efforts and financial burden.

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