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Understanding the information needs of public health practitioners: A literature review to inform design of an interactive digital knowledge management system

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Abstract

The need for rapid access to information to support critical decisions in public health cannot be disputed; however, development of such systems requires an understanding of the actual information needs of public health professionals. This paper reports the results of a literature review focused on the information needs of public health professionals. The authors reviewed the public health literature to answer the following questions: (1) What are the information needs of public health professionals? (2) In what ways are those needs being met? (3) What are the barriers to meeting those needs? (4) What is the role of the Internet in meeting information needs? The review was undertaken in order to develop system requirements to inform the design and development of an interactive digital knowledge management system. The goal of the system is to support the collection, management, and retrieval of public health documents, data, learning objects, and tools.

Method: The search method extended beyond traditional information resources, such as bibliographic databases, tables of contents (TOC), and bibliographies, to include information resources public health practitioners routinely use or have need to use—for example, grey literature, government reports, Internet-based publications, and meeting abstracts.

Results: Although few formal studies of information needs and information-seeking behaviors of public health professionals have been reported, the literature consistently indicated a critical need for comprehensive, coordinated, and accessible information to meet the needs of the public health workforce. Major barriers to information access include time, resource reliability, trustworthiness/credibility of information, and “information overload”.

Conclusions: Utilizing a novel search method that included the diversity of information resources public health practitioners use, has produced a richer and more useful picture of the information needs of the public health workforce than other literature reviews. There is a critical need for public health digital knowledge management systems designed to reflect the diversity of public health activities, to enable human communications, and to provide multiple access points to critical information resources. Public health librarians and other information specialists can serve a significant role in helping public health professionals meet their information needs through the development of evidence-based decision support systems, human-mediated expert searching and training in the use information retrieval systems.

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Keywords: Grey literature; Information needs; Information resources; Information systems; Knowledge management; Literature review; Public health

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Data, properly shared as information, are the currency of public health.

–Sosin & Thacker, 2002

1. Introduction

In October, 2005, the University of Washington was awarded one of the first Centers for Disease Control and Prevention (CDC) grants to establish a Center of Excellence in Public Health Informatics (CEPHI). CEPHI's mission is to improve the public's health through discovery, innovation, and research related to health information and information technology. A key CEPHI research area is design and development of an interactive digital knowledge management system to support the collection, management, and retrieval of public health documents, data, learning objects, and tools. A long-term goal of the project is the implementation of a successful knowledge management system that is tailored to the public health practitioners information needs, work processes, and environment and which improves access to and use of digital information resources in support of evidence-based public health practice. Ultimately the vision is a system which will create an environment in which public health professionals can pose questions and receive answers rather than simply a list of possible places to look for answers to those questions. Achieving this goal requires a comprehensive understanding of the information needs of public health practitioners.

This paper—a literature review of research examining the information needs of public health professionals—represents a first step towards establishing a framework for developing system requirements that will inform the design and development process.

2. Background

2.1. Rationale

The need for rapid access to information to support critical decisions in public health cannot be disputed. Relevant resources to support public health decision making span a multiplicity of publication formats (e.g., print and electronic) produced at local, state, national, and international levels—including, disease incidence data (county/state/national), vaccination guidelines, industrial effluent data, laws and regulations, legislative issues updates, metadata on data sets, outcome measurement resources, synthesized knowledge bases of information and guidelines, among others. However, a limited amount of this critical information is published through standard channels and consequently finding a resource, let alone locating the answer to a question within a resource, is extraordinarily difficult for busy public health professionals.

In the event of a disease outbreak or other public health emergency, public health professionals are often reduced to scrambling through piles of paper reports in their offices,

searching for the relevant recent report or statistical information that would help them develop an effective response. In this setting timeliness is a key concern, decisions cannot be delayed, and practitioners must be as well informed as possible.

Complicating the situation is the fact that public health includes many disciplines; its workforce is diverse; and public health job functions are variable and often overlapping. This diversity of backgrounds and roles presents a challenge to those studying public health information needs, ways to improve access and reduce barriers to needed information and public health information sources of most importance for meeting information needs.

A clear understanding of the unique information needs of public health professionals is vital to the design process for a digital knowledge management system. This review sought to synthesize findings from a comprehensive review of the literature into a coherent statement of current understanding regarding information needs of public health professionals.

2.2. Definitions and scope

The library and information science literature is rich in studies of information needs, information seeking behavior, and human-computer interaction. This literature indicates that: (1) users experience gaps in knowledge that interfere with their ability to articulate what they know and do not know; (2) information seeking is situational, contextual, and unique to the information seeker; and (3) knowledge of users' tasks can help point to systems designed to support those tasks [1,2].

However, the concept of a public health "information need" can be problematic to define, given its reliance on context, problem, and the organization in which the information need occurs. We used Forsetlund and Bjørndal's (2001) definition of information as "any stimulus that reduces uncertainty in a decision-making process" and an information need as both the recognition of what information can reduce this uncertainty as well as unrecognized or potential information needs [3]. We also used the Institute of Medicine's definition of a public health professional: "a person educated in public health or a related discipline who is employed to improve health through a population focus" [4].

The authors reviewed the public health literature to answer the following questions:

1. What are the information needs of public health professionals?
2. In what ways are those needs being met?
3. What are the barriers to meeting those needs?
4. What is the role of the Internet in meeting information needs?

Our multidisciplinary review team consisted of professionals representing the fields of library and information science; biomedical, health and public health informatics;

epidemiology; and public health practice. The team represented considerable experience of both research and practice in public health, informatics, and health care information systems.

3. Methods

3.1. Search strategy

The findings that public health literature is poorly indexed in bibliographic databases and dispersed across a wide variety of journals and other sources across many disciplines [5,6] required special attention in developing a comprehensive search strategy. The goal was to capture a comprehensive picture of public health information needs across the diverse literature of public health.

Table 1 lists resources searched by category: (1) bibliographic databases, searched for peer-reviewed articles, reviews, and meeting abstracts; (2) tables of contents of four public health journal titles, selected by Journal Citation Reports® ranking, were hand-searched; (3) Internet searching for books, meeting abstracts, and government reports; and (4) compilations of public health reference materials. Search strategies were tailored according to database or resource used.

A list of search terms used is in Table 2. In database searches, terms were combined in multiple ways using Boolean operators (AND, OR, NOT). Truncation and wild carding were used when available. Publications were limited to English. Terms were modified to reflect the organization of the database used.

The initial cross-resource search yielded 427 publications which were downloaded into a bibliographic software tool; the total was reduced to 281 after elimination of duplicates.

3.2. Inclusion/exclusion criteria

To maintain the focus on public health information needs, the following exclusion criteria were employed. Articles were excluded if they: (1) focused solely on public health workforce training and/or workforce development; (2) described information systems and/or technologies applied to public health settings; (3) described public health infrastructure; (4) only evaluated public health technology/digital literacy skills; or (5) focused on public health competencies. Articles that solely focused on public health information needs and/or information needs assessment but also included one or more of the exclusion criteria were included.

The selection procedure is depicted in Fig. 1. The first eligibility review applied the exclusion criteria to titles and abstracts (when available) of the citation list, resulting in 78 publications. Next, full-text documents—as well as examination of article references and key authors for additional publications—were reviewed and exclusion criteria applied.

4. Results

A total of 31 publications were included in the literature review and are shown in Table 3 at the end of the paper. Information was abstracted from each article and synthesized descriptively. Due to the heterogeneity of the data and methods it was not possible to perform a meta-analysis. It is important to note that several non-USA studies that appear to be conducted on non-public health workforce segments met the inclusion criteria. This is a reflection of the diversity of health services organizations outside of the USA that include those whose prime responsibility is the provision of core public health activities. For example, in the UK, “community nurse prescribers” perform the same role functions as public health nurses in the USA.

Literature in this review includes many disciplines: the “general” public health workforce (13 papers); communicable disease specialists and epidemiologists (7); public health clinicians (5); health officers (3); public health nurses (3); health policy makers (3); environmental health specialists (2); veterinarians (2); and occupational health and safety workers (1). Also included are 4 studies by libraries that provide public health information services. All but 6 publications were from the USA. Included are reviews (15 papers); studies using qualitative methodologies (13); pilot studies (2); and one comparative study. Qualitative methods included studies utilizing questionnaires and surveys (8 papers); focus groups (7); interviews (4); and observations (3).

A summary of public health information needs can be found in Table 4.

Content was sorted into four categories reflecting the focus of the review questions:

1. Identification of public health information needs;
2. How information needs are being met;
3. Access vs. barriers to meeting information needs; and
4. Use of the Internet as a vehicle for systems that provide resources that meet public health practitioner information needs.

4.1. Identification of public health information needs

4.1.1. Synthesized and collated information

The need for timely, easy to digest, and up-to-date information that is filtered, summarized, and synthesized from authoritative content sources was reported in nine studies [7–15]. Content sources cited included external databases, research reports and research findings, meta-analyses and systematic reviews. The need was specifically for synopses of information that had been proactively read, filtered, reviewed, and made easily accessible [7,12,15–18]. Five studies also cited the need for collated information from agencies or institutions, both public and private (e.g., state health department, CDC, local emergency room diagnoses) [8,9,11–13].

Table 1

Resources searched

Bibliographic databases	Coverage
BiosisPreviews®	International life sciences journals and meetings
CINAHL®	Nursing and allied health literature
Current contents®	Research journals, books, reviews and meeting abstracts in the sciences and social sciences
LISA (Library and Information Science Abstracts)	Library and information science
Library Literature and Information Science (12/1984 to 01/2006)	Library and information science
National Library of Medicine's MEDLINE® (01/1966 to 02/2006) database through the PubMed® interface ^a	Biomedical literature
PAIS International	Social and public policy
Web of Science®	Science and social science journals and cited references
Journal tables of contents <i>American Journal of Public Health</i> <i>Annual Review of Public Health</i> <i>Journal of Public Health Management & Practice</i> <i>Public Health Reports</i>	Journals selected on the basis of ranking by Journal Citation Reports®
<i>Internet-based publications</i>	
CDC website ^b	Centers for disease control and prevention
Librarian's Internet Index ^c	Websites selected, described and organized by librarians
New York Academy of Medicine's Grey Literature (NYAM GreyLit) library ^d	Grey literature
Scout Report ^e	Part of NSF's National Science Digital Library Project, provides guides to online resources
www.google.com search engine	General searches
GPO Access ^f	Government reports
NLM Gateway ^g	Biomedical books and meeting abstracts
<i>Compilations</i>	
Annotated bibliography for syndromic surveillance ^h (CDC)	Evidence-based Practice for Public Health Project ⁱ (Lamar Soutter Library at the University of Massachusetts)
Public Health Information Needs and Information-Seeking Behavior Bibliography ^j (MN Dept of Health Library)	
Current Bibliographies in Medicine ^k (NLM)	Partners in Information Access for the Public Health Workforce website ^l

^a <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed>.
^b <http://www.cdc.gov/>.
^c <http://lii.org/>.
^d <http://www.nyam.org/library/greylit/>.
^e <http://scout.wisc.edu/>.
^f <http://www.gpoaccess.gov/>.
^g <http://gateway.nlm.nih.gov/gw/Cmd>.
^h <http://www.cdc.gov/epo/dphsi/syndromic/>.
ⁱ <http://library.umassmed.edu/ebpph/>.
^j <http://www.health.state.mn.us/library/infoneeds.html>.
^k <http://www.nlm.nih.gov/pubs/cbm/>.
^l <http://phpartners.org/>.

Table 2

Search terms

Grey literature	Information needs	Information technology	Public health
Health information systems	Information resources	Information use	Public health informatics
Health sciences libraries	Information seeking	Information users	Public health nursing
Human–computer interaction	Information storage and retrieval	Knowledge management	Public health practice
Information access	Information systems		Public health workforce

4.1.2. Content sources

In addition to filtered and summarized information, four studies identified grey literature (e.g., policy documents, government reports, legislative summaries, industry group publications, and descriptions of best practices) as a source for needed information [7,17,19,20]. Other important sources included early reports of newly identified

health risks and preventive behaviors, emerging practices and programs, new interventions, and “best practice” and evidence-based resources [7,12,15].

4.1.3. Data

Public health practitioners must implement and evaluate public health services, assess and monitor the health of

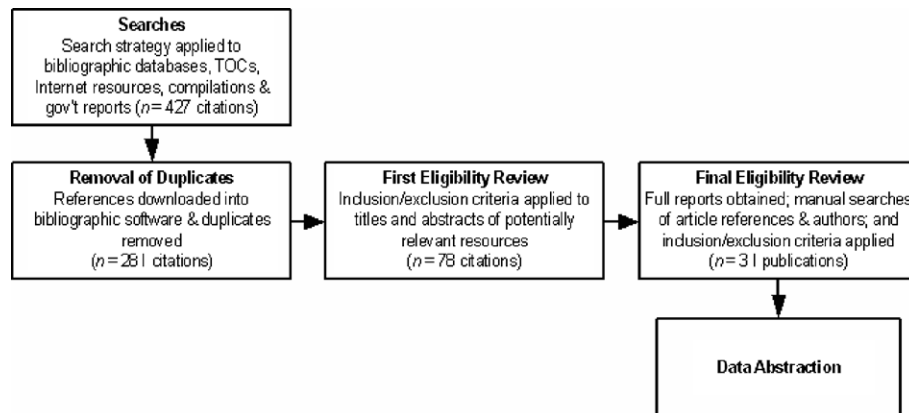


Fig. 1. Search and selection procedure.

their community, disseminate timely information, and identify emerging threats. To do this they need current national, state, and local information—which might include data such as birth rates and emergency room visits, practices and programs directed at specific health interventions, policies, and guidelines such as immunization schedules—was also reported [13,14,17,21]. In addition, statistical and epidemiologic information [17,19,21,22] and metadata characterizing the content of data sets [7] support the need to have the most current information readily accessible whenever needed.

4.1.4. Access to needed information

Three papers observed that the decentralization, varied roles, and sheer enormity of information public health practitioners necessitates a centralized information service or “place to find out where to find out” [12,15,23], as well as directories and resources for contacting experts [7] and a source for answers to clear, discrete research questions [14,17]. Providing multiple avenues of entry to information resources [8,21,24–26] is also cited.

In summary, although public health information needs may differ according to role (epidemiologist vs. nurse), setting (urban vs. rural), or availability of computer/Internet access, the qualities associated with the information needs can be universally described as: vetted; high quality; generated by an authoritative content source; verifiable by a trusted source; up to date and known to be regularly updated; convenient; and accessible [7,12,15–17].

4.2. How information needs are being met

Numerous studies have looked at the type of information public health professionals seek and how they access and use this information. While the ability to access information across many disciplines is a necessary component of public health work [16,24,27], a recurrent theme that emerges from the literature is the importance of colleagues, peers, and other people for meeting information needs.

4.2.1. Other people

Thirteen studies report that colleagues are frequently the information resource that public health professionals first turn to with an information query [3,12,15,16,18,23,24,27–32]. This is similar to studies of information-seeking behaviors of other professionals—engineers, health care professionals, social scientists, lawyers, and life scientists—that have repeatedly shown human resources are a primary source of information [33–35].

Lee et al. conducted a comprehensive information needs survey of public health workers in Tennessee and found that resources or categories of information that were rated most highly in terms of daily use included colleagues and internal communications such as telephone calls, memoranda, and personal conversations [27].

This finding does not appear to differ when specific public health roles are studied. Public health clinicians [3,23] and nurses [16,32] rank other people as a highly reliable and accessible source of needed information. For example, in the UK, public health “prescribing nurses” described networking, face-to-face consultation, and colleagues as invaluable information resources, both for support and for keeping up to date, describing them as “the richest source of information” [16]. Veterinary public health workers—an auxiliary workgroup concerned with diseases transmitted between people and animals (zoonoses)—seek information first from colleagues and in a critical care situation, nearly 60% are likely to consult other practitioners or university contacts [18].

4.3. Access vs. barriers to meeting information needs

4.3.1. Environmental barriers

External characteristics, such as time, setting (urban, rural), staffing, and size of a public health department’s service area can facilitate or hinder the public health practitioner’s ability to meet information needs. Decentralization, unavailability of Internet services in a rural environment, inadequate equipment, and lack of organized library services are cited as environmental barriers to meeting information needs [23,26,27].

Table 3
Publications included in the review

Author, year	Workforce segment	Methods	Outcome
Baker et al. (1995) [8]	EPI, GEN	REV	Electronic resources: needs, reasons, types Information: databases, needs, obstacles Internet: needs
Bravata et al. (2002) [9]	HO, PHMD, PHP	REV	Information: databases, needs, sources, types Information-seeking: reasons
Cahn et al. (1998) [19]	PHP	REV	Electronic resources: types Information: databases, sources, types
Cash and Narasimhan (2000) [29]	EPI (International)	REV	Information: needs, sources, types Other people
Chambers et al. (1991) [24]	GEN	Q/SUR	Electronic resources: types Information: needs, sources, types, usage
Cheng and Lam (1996) [42]	LIB (Hong Kong)	Q/SUR	Information: needs, sources, types, usage Information-seeking: reasons
Cohen et al. (2006) [21]	GEN	REV	Electronic resources: reasons, types Information: databases, needs, obstacles, sources, types Information-seeking: obstacles
Eldredge and Carr (2005) [41]	GEN	COM	Information: types, usage
EHPC (2001) [37]	ENV	FOC	Information: needs, obstacles
Forsetlund and Bjørndal (2001) [3]	PHMD (Norway)	FOC, OBS	Information: databases, needs, obstacles, sources, types Information-seeking: obstacles Other people
Forsetlund and Bjørndal (2002) [23]	PHMD (Norway)	FOC, OBS	Electronic resources: needs, types Information: databases, needs, obstacles, sources Information-seeking: obstacles, reasons, time spent Other people
Forslund and George (2002) [11]	CDS, EPI	REV	Electronic resources: needs, reasons, types Information: databases, needs, obstacles, sources, types
Friede et al. (1993) [25]	EPI	REV	Electronic resources: needs, reasons, types Information: databases, types Information-seeking: time spent Internet: needs, skills
Friede et al. (1995) [43]	GEN	REV	Electronic resources: needs, types Information: databases, needs, obstacles, sources, types Internet: needs, skills, obstacles
Friedman et al. (2001) [22]	GEN	REV	Electronic resources: needs, types Information: databases, needs, obstacles, types Information-seeking: obstacles Internet: needs
Garrett and Yasnoff (2002) [40]	PHMD	PIL	Electronic Resources: needs, types, usage Information: databases, needs, sources, types Internet: needs, obstacles
Gray (1998) [38]	PHP	REV	Information: databases, needs, sources, types Information-seeking: obstacles
Hall et al. (2003) [16]	PHN (England)	INT, QUAL	Information: needs, obstacles, sources, types, usage Information-seeking: reasons Other people
King et al. (2004) [45]	VET	REV	Information: needs, obstacles, sources, types, usage
Knight et al. (2001) [26]	LIB	Q/SUR	Information: needs, types Information-seeking: reasons
Lee et al. (2003) [27]	GEN	QUAL, Q/SUR	Information: databases, needs, obstacles, sources, types, usage Information-seeking: obstacles, reasons Other people
Martin et al. (2005) [12] and LaPelle et al. (2006) [15]	GEN	QUAL, INT, Q/ SUR, FOC, OBS	Electronic resources: needs, obstacles, types, usage Information: databases, needs, obstacles, sources, types, usage Information-seeking: obstacles, reasons Other people
O'Carroll et al. (1998) [17]	HO, PHMD	REV	Information: databases, needs, sources, types, usage Internet: needs, skills, obstacles, usage
Pappaioanou et al. (2003) [36]	EPI (International: Bolivia, Cameroon, Mexico, Philippines)	REV	Information: obstacles, sources, types Information-seeking: cost, obstacles

(continued on next page)

Table 3 (continued)

Author, year	Workforce segment	Methods	Outcome
Pelzer and Leysen (1991) [18]	VET	Q/SUR	Information: sources, types Other people
Rambo (1998) [13]	GEN	QUAL, INT, FOC	Information: needs, sources, types
Rambo et al. (2001) [14]	LIB	REV	Information: databases, needs, sources, types, usage Information-seeking: reasons
Rambo and Dunham (2000) [7]	ENV, EPI, GEN, HO, PHN	FOC	Information: databases, needs, sources, types Other people
Scheiber et al. (1998) [30]	GEN (Germany)	Q/SUR	Electronic resources: needs, obstacles, types Information: obstacles, sources, types Information-seeking: obstacles Internet: skills, obstacles, usage Other people
Schulte et al. (2003) [44]	OH	REV	Information: sources, types, usage
Telleen and Martin (2003) [31]	GEN, LIB	COM, Q/SUR, FOC	Electronic resources: needs, types, usage Information: databases, needs, types Information-seeking: obstacles Internet: needs, obstacles Other people
Turner (2005) [20]	GEN	PIL	Information: needs, obstacles, types Information-seeking: obstacles
Turner et al. (2005) [32]	PHN	INT	Information: needs, obstacles, sources, types Information-seeking: obstacles

Abbreviations used: *Workforce*: CDS, communicable diseases; ENV, environmental health; EPI, epidemiology; GEN, general/public health “workforce”; HO, health officer; LIB, librarian; OH, occupational health; PHN, public health nurse; PHMD, public health doctor; PHP, public health policy maker/analyst; VET, public health veterinarian. *Methods*: COM, comparative study; FOC, focus group; INT, interview; OBS, observation; PIL, pilot study; Q/SUR, questionnaire and/or survey; QUAL, qualitative study; REV, review.

Table 4
Summary of public health information needs

Category of information need	Description
Access to varied resource formats	Availability of grey literature, reports, guidelines, practices, programs, interventions, datasets, epidemiologic data Availability of information from both public (e.g., government institutions, CDC) and private (e.g., industry associations) sources
Authority	Vetted Generated by an authoritative content source Verifiable by a trusted source
Centralized access	A “place to find out where to find out” answers
Improved access/availability of information	Convenient Multiple avenues of entry to information sources
Improved delivery	Portal to information and resources
Quality	High quality information and resources
Reduced barriers to information	Reduce time to find resources. Reduce “information overload” of both relevant and irrelevant information. Improve access to people/public health experts who are critical source of information
Reliability	Persistent resources, both in content and availability Trustworthiness/credibility of information
Synthesized/collated information	Summarized, pre-digested, filtered information
Timeliness	Up-to-date information that is known to be regularly updated

4.3.2. Psychological barriers

The information seeker’s preferences, prejudices, self-evaluation of knowledge and skills, interests, and knowledge of the subject are all potential psychological barriers to meeting information needs.

In Norway, Forsetlund and Bjørndal conducted a series of focus groups, observations, and interviews of public health clinicians. They report that while the practitioner may have recognized an information need, s/he still may

not act on that need because of the perception that the information may not be found [3,23].

Pappaioanou et al. identified several barriers known to affect the use of epidemiologic data in decision making, including the failure of epidemiologists to: analyze and frame issues in a policy context for decision makers; package and present data in an understandable and compelling format; lack of trust on the part of decision makers in the accuracy of data which has resulted in their

discounting the information; and fear of social or economic consequences [36].

4.3.3. Source characteristics

An information source's accessibility, relevance, trustworthiness, currency, quality, and reliability can determine whether an information need is met or is not fulfilled. Limited access to needed information is a major obstacle for public health practitioners, including access to research-based information sources, medical literature, electronic full-text journal articles, conference websites, and grey literature [12,15,23,27]. In addition, access to relevant information found in resources that are outside traditional public health (e.g., marketing literature, organizational behavior, etc.) is another barrier to obtaining needed information [12,15].

Information overload when searching or evaluating the information found presents further obstacles [23,37]. Additional barriers include the complication of different interfaces for different resources; widely dispersed information resources; quality of information; gaps in information; and barriers to overcoming gaps [23,37,38].

4.3.4. "Unique" barriers

Global disease surveillance, particularly in countries which do not have adequate disease-monitoring infrastructures, can be hampered by fear of sanctions, inaccurate reports and rumors, concern over social disruption on a national level and unwarranted international panic that can lead to economic losses [29]. The need for timely, reliable, and accurate information early in an outbreak is critical for preventing harsh international reaction against countries that report disease outbreaks, especially poorer countries that are more economically vulnerable in the event of an outbreak.

Data set "overload"—the consequence of increasingly large data sets generated by surveys and other data collection tools—has forced many epidemiologists to become data managers, making it more difficult to analyze data from a variety of sources in order to detect disease outbreaks at an early stage [11,25].

4.4. Use of the Internet by public health practitioners

4.4.1. Role-based Internet use

Telleen and Martin found that Internet use varied depending on public health work segment. For example, they report that public health workforce roles influence what information needs are met by using the Internet. For example, public health nurses use the Internet for access to clinical treatment information; patient education materials; network with other clinics; and abstracts and full-text journal articles. This is in contrast to nurse administrators/clinic coordinators who go online to find: grant requests for proposals (RFPs); grant writing help; community demographics; national norms for various health indicators; health outcome studies and other comparative data;

government documents; literature reviews and journal abstracts; and to network and interface with other clinics and agencies [31].

4.4.2. Internet portals for meeting information needs

Anecdotal evidence (Madhavan A. personal communication, 2006) suggests that Google is the primary tool used by public health practitioners to locate relevant information. However, there is recognition of the need among public health practitioners for a centralized information service or "place to find out where to find out." Four approaches to using the Internet to provide access to information resources and tools are highlighted.

The MassCHIP (Massachusetts Community Health Information Profile) system is an online data query system that resides locally on the public health practitioner's hard drive or network server. It provides access through multiple avenues of entry to a database of public health information that includes data sets from Massachusetts and other state agencies to reflect a broad view of public health. MassCHIP also has the capacity to retrieve data for multiple levels of geography, from the neighborhood through the state, including planning districts and hospitals. Access is tailored by public health domain so a wide variety of users—students, community workers, epidemiologists, nurses, academic researchers, journalists—can build queries, download data, and build maps and charts on the basis of the data (e.g., national, state and local data; census data; data generated by the state's Departments of Education, Social Services, Employment and Training; births; hospital emergency department visits; etc.). Users can create customized, user-defined geographies to examine need, generate statistics that apply to the custom aggregate geography, and design interventions for target areas [21].

CDC WONDER was developed in response to the large data sets generated by surveys, questionnaires, etc. It was designed to simplify the management of data by placing timely, action-oriented information in the hands of public health professionals. WONDER provides data sets with online documentation regarding how the data were collected, how questions were phrased, sampling methods, known biases and errors, and references; ability to conduct full-text searches of textual databases and data sets of preformatted tables. In addition, WONDER provides access to: numerical data sets (AIDS, Behavior, Cancer, Census, Hospitalization, Mortality, Notifiable disease, STDs); tabular databases (Alcohol, BRFSS, Diabetes, General US health); text databases (ASTHO, CDC Resource Index, ICD-9, Documentation, MMWR, NACHO/CDC National Profiles of Local Health Departments); and SAS data sets [25].

Another CDC system, NEDSS (National Electronic Disease Surveillance System), is a major component of the Public Health Information Network (PHIN). NEDSS integrates information between healthcare providers and epidemiologists by providing electronic transfer of information from clinical information systems in the health care

industry in order to promote early detection of disease outbreaks. The goal is an integrated and interoperable surveillance system at the state and local levels. Part of this effort is development of the Public Health Conceptual Data Model, a high level conceptual model which provides the foundation for standardization of public health data collection, management, transmission, analysis, and dissemination [11,39].

CDC generates a large body of information that is published in various forms, but not always in the form most accessible to end users [14]. CDC Recommends is a compendium of prevention guidelines with CDC recommendations and guidelines for the prevention, control, treatment and detection of infectious and chronic diseases, environmental hazards, natural or human-generated disasters, occupational diseases and injuries, intentional and unintentional injuries and disabilities, and other public health conditions [40].

5. Discussion

This literature review focused on the information needs of public health professionals prior to developing system requirements to inform the design and development process of an interactive digital knowledge management system that will support the collection, management, and retrieval of public health documents, data, learning objects, and tools. What do the cumulative findings from this review tell about the effective system design for public health information?

Given the variety of roles and background of public health workforce, a one-size-fits-all system cannot meet public health information needs. Ideally, the development of online public health information resources should reflect the complexity and diversity of the public health workforce itself [7,20]. Public health job functions and disciplines are variable and influence not only selection of information resources but also information needs that must be met. The roles of public health vary widely and different segments of the public health workforce have different information needs [7,27]. Also, information needs within workgroups vary by level of training (e.g., graduate degree in public health vs. associate degree vs. certification, etc.) [14,20] and some groups of the public health workforce are more used to incorporating external information resources in their work than others [17].

To best serve public health professionals, the design of knowledge management systems should offer ready access at the point of need, with a minimum of security barriers (e.g., logon and password). Information system design must be intuitive and take into consideration public health workflow.

While much valuable public health information is located on governmental websites navigating these websites to find specific answers to questions is problematic. System design should focus on providing user-friendly interfaces

and smart search systems that can navigate complex, multi-layered websites [22].

Customized information “toolkits” for practitioners are needed. These could be developed for different work groups, for example, or in conjunction with the Healthy People 2010 objectives. A toolkit would consist of source documents (e.g., practice guidelines), news and announcements, legislative updates, search interfaces to relevant data sets, directory and contact tools, and preformatted searches to selected databases [14].

Public health practitioners meet their information needs by using information resources that are easy to access and use, up-to-date, flexible, free or low cost, pre-digested or summarized, stable, and are focused on the practitioner’s particular field(s). Public health professionals rely on timely, up-to-date information. Therefore, information systems should support frequent regular updates [12,16,17].

Programs such as CDC’s Information Network for Public Health Officials, the Health Alert Network, and the National Library of Medicine’s Partnership in Information Access for Public Health Officials are designed to strengthen the information infrastructure of state and local public health agencies. The success of these initiatives will depend not only on technology but also on the information content being delivered, how it used, and on a workforce trained to effectively use these new tools and resources. Further research is needed to determine optimal development, structure, delivery, and marketing of public health information to specific public health workforce segments [7].

The common theme of people as public health knowledge resources points to the need to provide timely access to public health experts via up-to-date directories that are organized by content area, as well as reliable information mediators such as librarians and information specialists.

6. Limitations of the review

There are several limitations to the findings of this literature review. The focus of this review is the information needs of public health professionals (not public health researchers in academic settings) in the United States. Although some studies from non-USA publications are included, our limitation to publications in English may have introduced a bias in inclusion to those studies conducted in the USA. Another limitation is the focus on the public health workforce in general. Given the numerous disciplines represented by the label “public health” it is possible that pertinent studies were missed in the comprehensive search that was performed. In addition, given the very elusive nature of public health publications, it is possible that searches may have overlooked a pertinent publication.

Our results suggest that many of the information needs assessments focused on public health professionals involved in clinical care. However, clinicians make up only a small percentage of the public health workforce in this county. Only a few studies have investigated the information needs

of diverse aspects of the public health workforce. It is very likely that the information needs of local health professionals, particularly in rural areas may differ from their urban counterparts. Filling these gaps should help direct future systematic information needs assessments of public health professionals.

This literature review is limited to published accounts of information needs assessment and consequently, it is likely that many unpublished public health information needs assessments exist. For example, the joint NLM and National Network of Libraries of Medicine (NN/LM) “Partners in Information Access” program has funded a number of outreach projects with the goal to: (1) increase public health professionals’ awareness of NLM, NN/LM and CDC services; (2) assist public health professionals in getting connected to the Internet; (3) provide information technology and information services training; and (4) increase awareness of public health information needs and resources among NN/LM members (for a list of projects see http://phpartners.org/nnlm_projects.html). Although 18 programs have been funded since 1999, few have published the results of their needs assessments. In addition, over the last ten years several public health information needs assessments have been performed through NLM’s Regional Medical Libraries (RMLs) that remain unpublished.

Hopefully this review, which highlights the need for more systematic evaluations of the information needs of public health professionals, will encourage publication of such efforts.

7. Conclusion

While there have been other reviews of public health information needs, to the best of our knowledge this is the first review that has searched beyond traditional bibliographic databases to include the diversity of information resources public health practitioners routinely use or have need to use—for example, grey literature, conference proceedings, government reports, websites, etc. This innovative methodology has produced a richer and more useful picture of the information needs of the public health workforce than previous literature reviews.

There are four consistent findings from this study: (1) although much progress has been made in developing online web resources to support the work of public health professionals, the problem of rapidly finding the needed answer (no more and no less) continues to expand; (2) few formal studies of information needs and information-seeking behaviors of public health professionals have been reported; (3) major barriers to information access include time, resource reliability, trustworthiness/credibility of information, and “information overload” of both relevant and irrelevant information; and (4) people are a critical source of information in public health—therefore, information system design needs to include avenues that support access to human communication networks (e.g., providing accurate directories, listservs, etc.).

Useful information, while theoretically available, is buried within voluminous and difficult-to-search local, state, national, and international websites. In addition, there remains much critical information buried in print reports, publications of policies and procedures, and databases which lack useful search and retrieval interfaces.

Regardless of category of information need, public health role, setting (urban vs. rural), or availability of computer/Internet access, the information sources used to meet a public health information need can be universally described as resources that are: vetted; high quality; generated by an authoritative content source; verifiable by a trusted source; up to date and known to be regularly updated; convenient; and accessible [16,17]. Systems developed for public health agencies must take into consideration the users’ needs, role and tasks. Given the diversity of public health activities it may be necessary to design customizable interfaces. Systems design and implementation need to incorporate: coordination; national facilitation; interstate and inter-county collaboration; and standards for data content, data format, and statistics [22].

Peers, administrators, program personnel, and state contacts are critical sources of public health information. Colleagues, peers and other people are the most reliable, available and commonly used information resources for training and carrying out the day-to-day work of public health. Information systems to provide access to public health resources need to be designed to enable human communication and not interfere with this critical public health resource [32]. As mentioned previously, information systems can assist in this need for human networking with directories to subject experts and other contacts. In addition, public health librarians and other information specialists can serve a significant role in helping public health professionals meet their information needs with human-mediated searching and training to use information delivery systems.

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