# Brief Communication

## National Health Information Infrastructure Model: A Milestone for Health Information Management Education Realignment

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## Abstract

***Objective:*** Challenges and drawbacks of the health information management (HIM) curriculum at the Master's degree were examined, including lack of well-established computing sciences and inadequacy to give rise to specific competencies. Information management was condensed to the hospital setting to intensify the indispensability of a well-organized educational campaign. The healthcare information dimensions of a national health information infrastructure (NHII) model present novel requirements for HIM education. ***Materials and Methods:*** Articles related to challenges and barriers to adoption of the personal health record (PHR), the core component of personal health dimension of an NHII, were searched through sources including Science Direct, ProQuest, and PubMed. Through a literature review, concerns about the PHR that are associated with HIM functions and responsibilities were extracted. In the community/public health dimension of the NHII the main components have been specified, and the targeted information was gathered through literature review, e-mail, and navigation of international and national organizations. Again, topics related to HIM were evoked. ***Results:*** Using an information system (decision support system, artificial neural network, etc.) to support PHR media and content, patient education, patient–HIM communication skills, consumer health information, conducting a surveillance system in other areas of healthcare such as a risk factor surveillance system, occupational health, using an information system to analyze aggregated data including a geographic information system, data mining, online analytical processing, public health vocabulary and classification system, and emerging automated coding systems pose major knowledge gaps in HIM education. ***Conclusions:*** Combining all required skills and expertise to handle personal and public dimensions of healthcare information in a single curriculum is simply impractical. Role expansion and role extension for HIM professionals should be defined based on the essence of HIM roles and responsibilities. Forming a curriculum development team consisting of various professional profiles brings divergent views regarding the HIM curriculum and paves the way for HIM to branch out at the Master's and Ph.D. levels based on advanced information technology.

**Key words:** health information management, national health information infrastructure model, education, health information technology, e-health, information

## Introduction

With the digitizing of information systems in healthcare organization, the role of health information management (HIM) professionals has infiltrated into information technology (IT).[1] Evolution of this profession in its second wave has become blurred by its convergence with health IT functions. The common grounds between HIM and health IT functions and their partnership would amplify the role of IT in the healthcare arena, although defining role boundaries and task identities specifies a series of required skills and expertise for HIM professionals in virtual practice.[2] The healthcare industry encompasses a broad range of users with diverse interests in hospitals, public health, and personal health practice. Having appropriate responses to their needs requires a more qualified and advanced HIM workforce through concentrated training and education in the given heathcare practice.[3] Although we have been bombarded with many newly emerged postgraduate informatics disciplines like medical informatics, nursing informatics, dental informatics, bio-informatics, public health informatics, consumer informatics, population informatics, and behavioral informatics, the HIM profession has lagged behind in this competition. The present focus of HIM curriculum is truncated to meet information needs in acute care settings and electronic health records (EHR) adoption.[4,5] The HIM profession should reshape itself by relying on its unique skills and expertise to tackle tasks of HIM in diverse fields of the healthcare industry. The extended role of HIM professionals requires an enriched curriculum and a well-organized educational campaign.[6] After reviewing the

challenges and drawbacks of HIM curriculum for the Master's degree, this article uncovers the future avenues of health information by virtue of the national health information infrastructure (NHII) model through which HIM professionals should augment their knowledge and skills at the Master's and Ph.D. levels.

## Master of HIM Education: Challenges and Drawbacks

The HIM discipline has a long history of serving in planning, collecting, analyzing, and disseminating patient information since the early 1900s.[7] Although the health information complexities through advances in IT placed them as forerunners in IT,[8] this is no longer true for today. The crossing of medical care and state of the art technology has exposed the healthcare arena to a wide range of postgraduate courses in informatics, which reminds HIM professionals to step wisely. In this regard, existing curricula for the Master's degree in HIM were evaluated, and their problematic areas were pinpointed and debated.

### STRESS ON BASIC COMPUTING AND INFORMATION PROCESSING SCIENCES

The false assumption that the HIM profession is only academic preparation in informatics in the healthcare realm[9] has caused the HIM curriculum to focus on basic computing and capabilities of information processing sciences in comparison with newly emerging informatics disciplines.[9–14] Courses in informatics rely more on computer-assisted tools in term of simulation of processes, patient reaction, computer hardware and software, telecare, and use of computers to fulfill their traditional roles.[8]

### DISQUALIFIED TO EXHIBIT HIM TRADITIONAL ROLES IN THE INFORMATICS DOMAIN

Although the origin of the informatics field was ascribed to medical record education programs,[8] HIM professionals disable to exploit of this opportunity and exhibit their unique role in informatics arena. Health record content standards (e.g., the HL7 functional model) and classification and terminology standards (e.g., Systematized Nomenclature of Medicine [SNOMED])—underpinning standards in electronic environment[15]—both constitute HIM professionals' responsibilities from the early history of medical record formation.[16,17] HIM professionals must not only put the spotlight on their traditional roles, but also amplify them through role expansion and role extensions in the area of advanced IT. Otherwise, other rapidly growing disciplines may take advantage of this vacuum and attribute HIM responsibilities to their given domain. For example, in medical informatics, physicians assert that they have been in charge of medical coding with the International Classification of Diseases.[8]

### FOCUS ON DIDACTIC VERSUS LABORATORY INSTRUCTION

The HIM curriculum entails a broad spectrum of topics, including management, health information, information systems, and quality management. Squeezing a diverse field of practices into one curriculum does not ensure HIM professionals' elaboration of knowledge that is in response to specific skills and competencies. HIM education should focus on "mastery" of subjects and the promotion of higher forms of thinking in term of application, analysis, and synthesis domains of learning. While the postgraduate informatics curriculum has focused on computer technology, computer-aided patient care, computer networks, and computer-assisted learning tools, HIM education concentrates on fact-transfer and information recall—the lowest level of training (e.g., introduction to consumer health informatics). Several universities still cover the history of patient records and case mix in their curricula.[9,11] Although most HIM content[9–15] is provided through case studies and discussion, these are not sufficient to keep pace with the virtual environment. HIM professionals should have been instructed through case studies in addition to related computer-aided software and information system. For example, instruction on workflow management should be through case studies in addition to business process management, modeling, and simulation software including UMLS and Business Process Modeling Notation.[18]

### TRUNCATE TO INFORMATION NEEDS IN ACUTE CARE SETTINGS AND EHR ADOPTION

The most important missing link in HIM education program is the narrowly focused view of traditional settings (hospital) for patient-specific data and the abandonment of aggregate clinical data and personal health information.[9–14] Aggregated clinical data are applied to protect public health threat events and to monitor the population's health status. The emerging new connectivity form in terms of the EHR–public health has intensified the necessity of partnership between the clinical care setting and public health agencies, as well.[19] Public health information, personal health information, and knowledge-based information[15] present a major knowledge gap in the HIM curriculum that must be addressed through branching out (ramification) of HIM. Ramification of the HIM profession at the Master's level by virtue of the NHII model and its required competencies and expertise will be debated throughout this article.

## Materials and Methods

To specify a common ground for ramification of the HIM profession at the Master's level, healthcare information dimensions including the personal health dimension (PHD), the healthcare provider dimension (HCPD), and the community/public health dimension (CHD) were clarified based on the NHII model in the United States. From an IT perspective, HCPD consists of electronic data within the EHR and electronic medical record. Because the Joint Workforce of the American Health Information Management Association in partnership with the American Medical Informatics Association has focused on key capabilities of HIM staff in these areas of practice,[4,5] only PHD and CHD are spotlighted in this article. PHD encompasses data about health status and healthcare in the format of a personal health record (PHR). Because from an IT viewpoint the stress in PHD is on PHR adoption, articles related to challenges and barriers to adoption of PHRs were searched through

Science Direct, ProQuest, and PubMed. Through this review, concerns of PHRs that are associated with HIM functions and responsibilities were extracted.

The CHD of the NHII encompasses a broad range of information, including population-based health data and resources, necessary to improve public health. In this area, public health informatics and its main components of vital statistics systems, morbidity data, risk factor data, environment health, and occupational health have been specified. Targeted information was gathered through literature review, e-mail, and searching Web sites of international (e.g., European Centre for Environment and Health) and national (U.S. Centers for Disease Control and Prevention, Institute for Occupational Safety and Health, Environmental Public Health Tracking, National Center for Chronic Disease Prevention and Health Promotion, Canadian Centre for Occupational Health and Safety, Association of Workers' Compensation Boards of Canada, Public Health Agency of Canada, Health Canada, and Environmental Health Directorate Western Australia) organizations. The key words "environmental health surveillance system," "occupational health surveillance system," "behavioral risk factor surveillance," "occupational injury," and "disease classification" were used to search authoring organizations in diverse countries. Again, related topics to HIM were extracted.

## Results

### CANADIAN AND U.S. NATIONWIDE HEALTHCARE INFORMATION INFRASTRUCTURE

Recognizing the opportunities and interest in integrated health information strategies, the Canadian government has outlined a vision and a process for building a Canadian pan-health infrastructure titled Canadian Health Info-Structure.[20,21]

The U.S. NHII is the vision of the National Committee on Vital and Health Statistics, formed in 2001 and charged with conducting U.S. nationwide data exchange of healthcare information.[22] The key goal of the NHII is sharing information appropriately with a variety of stakeholders and health information users, such as consumers, healthcare providers, and public health professionals. The applications that meet their respective needs are distinct dimensions of the infrastructure including PHD, HCPD, and CHD.[22] From an IT prospective, HCPD consists of electronic data within the EHR and electronic medical record[22]; this is discussed in depth elsewhere.[4,5]

### PERSONAL HEALTH DIMENSION

Electronic PHR systems hold great promise for patient empowerment and transforming the physician–patient relationship.[23,24] The features inherent in the PHR cause some concerns for debate before its adoption that must be addressed.[12]

*Privacy, confidentiality, and security.* Privacy, confidentiality, and security of health information are serious concerns of consumers. Personal health information ownership and an Internet-based PHR system pose privacy and security concerns, and measures must be taken to clarify the respective rights, obligations, and potential liabilities of consumers, patients, and providers in PHR systems.[25,26]

*PHR media and data collection.* PHR care management requires collection and assembly of accurate and complete personal health information. Each person controls his or her own PHR and is in charge of keeping the information up-to-date and accurate. A PHR assists consumers to accumulate, organize, and store medical data in a diversity of media forms: among others, Web-based services, computer hard drives, removable drives, and nondigital cards (paper/cardboard and watch bands).[27,28]

*Terminology.* Wide variability in the clinical terminology used by different professionals has created a dilemma for consumers (lay people, far from specialized in this arena) to make sense of medical terms.[29,30] Because these are not patient-friendly terms, they fail to assist patients in understanding their conditions and being able to manage and treat them. According to a study, nearly one of every two adults has difficulty in perceiving the basic information necessary to make appropriate health decisions.[31]

*Decision support system.* Consumers need to make decisions at any time of care, such as selecting a treatment, and deploying the abilities of a computer may amplify the human capacity to interpret the different alternatives and make an informed decision. The spread of usage of PHRs has provided vast opportunities to incorporate consumer knowledge-based systems (e.g., decision support system [DSS]) in the form of behavioral reminders, alarms, advice and treatment recommendations, and clinical guidelines such as distributed guidelines. Consumer knowledge-based systems function as a tool in helping individual consumers perceive their health data like an expert.[32]

*Information-seeking behavior.* Patient empowerment emerges in the form of access to health information to help in making one's own health-related decisions and understanding consumer information-seeking behaviors.[30] Analyzing what consumers need and monitoring their information-seeking behavior pave the way for improving public health practice in term of "infodemiology." The term infodemiology is an amalgam of information and epidemiology and can be defined as the "science of distribution and determinants of information in an electronic medium, specifically the Internet, or in a population, with the ultimate aim to inform public health and public policy."[33] An award-winning article published in 2006 by Eysenbach[33] indicated a correlation between influenza-related searches on Google and influenza cases occurring in the following week in Canada. Today, 79% of Internet users have searched online for information on at least one health topic.[30]

### COMMUNITY HEALTH DIMENSION

In contrast to medical care and individual health, public health has stressed prevention of disease or injury of people in the aggregate. Public health encompass a wide range of services, including communicable disease control, lead poisoning prevention, vital registration, injury control, newborn screening, immunization, and surveillance.[34–37] Effective public health practice requires timely,

accurate, and authoritative information to identify public health threats, to assess population health, to focus programs and policies on well-defined health problems, to evaluate programs and services, to conduct research to address health issues, and to perform other essential public health services. Therefore, information access is of critical importance for the practice of public health, such that the need for informatics development has been recognized within all public health domains. Public health informatics/information systems serve as part of the public health domain to automate and integrate client health records and reporting systems that support public health services.[38] The vital statistics system, morbidity data, risk factor data, environment health, and occupational health serve as major sources of data in public health informatics.[38,39]

Vital statistics system. Such a system collects data on health dynamics of the population and information about vital events that include birth, death, marriages, and divorce through the registration system. The mortality file encompasses demographic and medical information recorded on death certificates and thus is extremely useful for assessing the impact of different causes of death.[40]

Morbidity data. Morbidity data show statistics on incidental sicknesses and/or diseases (usually within a specific community or population).[41] Information to record morbidity data may be accumulated from a number of sources: disease registries, syndromic surveillance, reports of health events such as a national notifiable disease surveillance system, and special surveys such as a national health interview survey.[38,42] Aggregated clinical data are used to perform surveillances to detect public health threats and the status of the population's health. Surveillance or "tracking" represents a data-driven activity that is crucial for detecting and characterizing the conditions that put a population at risk.[43]

Environmental public health tracking program. There has been a dramatic shift in health burden from communicable diseases (infectious) to noncommunicable diseases such as cancer, birth defects, and asthma, many of which may be associated with environmental exposures. Environmental public health tracking/environmental health surveillance is a public health system for tracking environmental health threats[44,45] and links the environmental data with the chronic diseases data in order to improve our understanding of the environmental risk factors in connection with diseases.[46,47]

Risk factor information system. This system works as a supplement to vital statistical data systems and many morbidity data systems by providing information about preventive health practices and risk behaviors that are linked to chronic diseases, injuries, and preventable infectious diseases in the adult population. The Behavioral Risk Factor Surveillance System (BRFSS) and other risk surveillance systems assist in identifying certain information about unhealthy behaviors.[48,49]

Occupational safety and health surveillance. As part of the mission in support of public health to prevent diseases, injuries, and deaths, numerous professional commissions (for example, the National Institute for Occupational Safety and Health) have established surveillance programs and classification systems to estimate and report the extent of identified occupational hazards.[50–52]

## Discussion

### REALIGNMENT OF THE HIM EDUCATIONAL PROGRAM WITH PHD

As the findings of this study indicate, the PHR presents numerous building blocks where the unique role of HIM professionals as the coordinator among providers, clinical staff, and patients will pave the way for its adoption.

### USING INFORMATION SYSTEMS TO SUPPORT PHR MEDIA AND CONTENT

Although the storage medium for health information has changed, the importance of the content of the medical records and the quality of data are still paramount.[53] HIM professionals are now the custodian of paper-based records in an electronic cradle. The study of Kim and Johnson[54] reveals that most of the functionality and usability of current PHRs has focused on health information tasks. Traditional tasks include form management systems, which are now replaced with design/revision of templates within the PHR application. Also, quantitative and qualitative audit and monitoring of the data quality are conducted through the "document filtering model" based on the fuzzy logic prototype.[55]

The fuzzy logic provides the framework for building the set of linguistic "if–then" rules and can provide a framework for handling subjectivity and uncertainty associated with the data.[56,57] Fuzzy logic works closely with an artificial neural network (ANN) and expert systems[58,59] to support data analysis paradigms, machine learning, scheduling and planning, inventory control, quality control, group technology, and forecasting in the healthcare industry.[59] HIM professionals must arm themselves with a great deal of knowledge and expertise in state of the art technology to handle their tasks (e.g., using Fuzzy logic to monitor data quality).

Patient education. Most of the functionalities and utilities of PHRs have concentrated on individual consumers who need to be trained to use PHR features, including electronic data entry, mapping with medical terminology, DSS application, protecting privacy, and PHR selection. HIM professionals can exert a leadership role in patient education to assist them and to handle the workflow around PHR adoption.[60,61]

Communication skills. In order to train patients for PHR features, HIM professionals must be equipped with a good deal of interpersonal communication skills and patient education through a well-developed curriculum.[62] Otherwise, the nursing staff's reliance on their previous background about client education will take over leadership of patients. Nursing professionals claim that PHRs bring some e-World positions in the form of personal record update information, self-directed health record keeping, and documentation.[63]

Consumer health information. On the consumer side, patient empowerment in the form of consumer information-seeking behaviors has created infodemiology, which allows tracking of diseases, outbreaks, and trends. This union of epidemiology and the power of the search engine Google creates a new expertise in the HIM profession with connection with searching and navigating medical databases that consider patients' typical information-seeking behavior, including MEDLINEplus, NHS Direct, Health insite, Pocket Doctor, and Medhelp,[64] and patient forums, information-sharing, and peer counseling.[26]

## REALIGNMENT OF THE HIM EDUCATIONAL PROGRAM WITH THE CPH DIMENSION

As the findings of this study indicate, the HIM profession and public health have emerging opportunities to collaborate with each other.

Conducting surveillance systems. The foundation of public health activities in disease and injury preventions relies on comprehensive and integrated approaches to collecting and analyzing the related data through surveillance systems.[65] Historically, HIM professionals were in charge of conducting syndromic surveillance such as cancer registry, tumor registry, and injury surveillance.[66] However, existing surveillance usually covers just one condition or disease. Today, public health has been realized through national networks of health surveillance and integration of biological, behavioral, environmental, and social determinants; the multifactorial nature of diseases has made the cancer registry system interrelated with the environmental public health tracking program or the BRFSS.[44,45,67] Therefore, HIM professionals need ongoing training about surveillance and population-based registries in other areas of healthcare such as the BRFSS, occupational health, and numerous emerging fields of surveillance.

Research and epidemiological studies. Studies have revealed that a single surveillance system cannot ensure a successful and sustained public health intervention for the purpose of prevention. Research input enhances information obtained via surveillance.[68] Although HIM professionals have been serving tremendously in leadership roles in public health research in the last decade,[3] it is imperative to provide training courses to ensure the HIM staff's sufficiency in knowledge and skills are adequate to conduct epidemiological studies and other public health research studies.

Using an information system to analyze aggregated data. Aggregated population health data often contain many millions of records, and accessing these large files quickly requires special database design. Therefore, HIM staff must be trained to use and design data warehouses in order to manage the data obtained from multiple sources in public health domains and surveillance systems using a Geographic Information System (GIS) to analyze and display geographic data and working with data mining to find models and patterns from available data to accelerate and facilitate decision-making and policy development.[69–71] DSS, data mining, GIS, and expert systems are at the focal point of competencies with which HIM staff must be equipped to assume their unique leadership role in managing public health information. Otherwise, employees with competency in public health will take advantage of the absence of HIM staff and fill the vacancy as a public health informatician.[72]

Public health vocabulary and classification system. Development of the Occupational Injury and Illness Classification System by the U.S. Bureau of Labor Statistics,[73] the Type of Occurrence Classification Systems by the National Occupational Health and Safety Commission in Australia,[74] and the Work Injury Statistics Program of the Association of Workers' Compensation Boards of Canada,[75–77] along with designing public health classification,[78] has yielded fresh educational pathways for HIM professionals.

Automated coding systems. Computer-assisted coding and automated coding with assistance of an experienced nosologist (an HIM professional) open new doors to HIM professionals to uncover their unique role and skills in classifying in areas other than acute care conditions. Automated systems such as Automated Classification of Medical Entities, Translation of Axes, and Mortality Medical Indexing, Classification, and Retrieval have been developed for entry classification and retrieval of information reported on death certificates.[38]

HIM professionals are pioneers in using a broad spectrum of terminology and classifications in the healthcare arena, as well as serving as the best option to handle all related classification systems in different dimensions of healthcare.[79] Because automated coding products incorporate ANNs to enhance accuracy and efficiency of coding, HIM professionals must be equipped with robust knowledge regarding using, developing, and functionality of ANNs.[80]

## KEY STRATEGIES TO LINE UP WITH IT EMERGING FIELDS

Enhancement of accountability and autonomy among profession in a given domain should clarify new roles and responsibilities through "role extension and role expansion."[81] One obvious example of this kind of role evolution is demonstrated in the expansion of nurses' roles into areas of practice that have traditionally been considered as the sole domain of medical practitioners.[81] Role extension and role expansion deployed in the area of a given profession pave the way to develop fresh educational pathways in a discipline.[82]

This theme can serve as a model for spreading the essence of HIM roles and responsibilities on the cutting edge of IT. Davis and LaCour [83] depict HIM as a profession dealing in the sources and application of health information and that collects, stores, retrieves, and reports it.

Role expansion. Expansion of HIM's role implies that the core foundations of practice still are used but that additional skills and areas of practice have emerged within the specialist's role that embody greater responsibility, accountability, and autonomy.[84] The healthcare industry today produces and collects a huge amount of data, which calls for an automated way to extract useful knowledge. In the HIM profession role expansion is noticeable in applying

**Table 1. Role Expansion Based on the Essence of Health Information Management Roles in an Electronic Environment**

| | ESSENCE OF HIM ROLES | HIM ROLE EXPANSION IN ELECTRONIC ENVIRONMENT |
|---|---|---|
| Collect | Medical record content, form design, data quality, analysis of medical record | • Designing database and database management, data warehouse, data marts, query language (SQL), data modeling and structure<br>• Data capture tools (voice recognition)<br>• Screen and templates design<br>• HL7 content standards (V2, V3)[15]<br>• Using expert system (fuzzy logic) for data quality analysis[55] |
| Stores | Medical record filing, privacy, access, security and confidentiality of health information, retention and destruction of medical records | • Security of information system, administrative, physical and technical standards (biometrics, password, encryption, role-based access control, firewall)[15]<br>• Using data mining/knowledge discovery database to address intrusion detection and access control and data anonymity (de-identification)[85–87] |
| Analysis | Classification and nomenclature, outcome management, risk management, utilization review, quality management, process management | • Vocabulary, classification, and terminology standards (LOINC, SNOMED, UMLS, RxNorm)<br>• Data mining for risk management, data mining for quality management, DSS for patient safety, DSS for utilization review[88–90]<br>• ANNs to automated coding and to detect fraud and abuse[80,89–91]<br>• Using software for business process management, modeling and simulation software, including UMLS, BPMN[18] |
| Retrieve | Disease and procedures indexes, discharge data abstraction, registers | • Data mining for early disease outbreak detection[92]<br>• GIS for surveillance system[93] |
| Report | Reports of statistical data to agencies and organizations outside of healthcare facility, using dataset, glossary of healthcare terms, percentages and rates, census (e.g., bed occupancy), research and epidemiological studies | • Data mining for prediction of inpatient length of stay[94]<br>• DSS for bed occupancy management[95]<br>• GIS for public health research<br>• Using text mining in biomedical research[86] |

ANN, artificial neural network; BPMN, Business Process Modeling Notation; DSS, decision support system; GIS, geographic information system; HIM, health information management; LOINC, Logical Observation Identifiers Names and Codes; SNOMED, Systematized Nomenclature of Medicine; UMLS, Unified Modeling Language System.

information system tools comprising data mining, such as online analytical processing, DSS, GIS, knowledge discovery databases, executive information systems, etc., to collect, analyze, and report health information. Table 1 plots out some examples of role expansion for HIM professionals based on the definition by Davis and LaCour[83] of HIM.

Role extension. Extension of a role usually refers to a particular skill or responsibility in an area of practice that was previously not related to the given profession.[84] In the HIM profession role extension has occurred in the domains of patient education associated with PHR features and of conducting surveillance in other areas of healthcare such as BRFSS, occupational health, and applying classification systems for occupational injuries and illnesses.

## Conclusions

The findings of this study revealed a stress in HIM curriculum on basic computing and information processing sciences. Today, most HIM activities have being conducted through state of the art technology such as DSS, GIS, data mining, ANNs, expert system, SQL, and online analytical processing. Furthermore, the HIM curriculum has spotlighted acute care, while the public and personal health dimensions of healthcare information entail a fertile area for HIM practitioners to divulge their expertise and skills. Therefore, HIM education should catch its second wave to support HIM role expansion and extension through branching out at the Master's level and stay up to date with information systems and medical computing. In fact, differentiation of health information is a theoretical need to put in place in a series of evaluations and pilot projects. Forming a curriculum development team consisting of various professional profiles like HIM, computer science, administrator, IT, management information system, informatics, public health, partnership of professional associations, academia, and key government agencies brings divergent views regarding the HIM curriculum and enriches its content.

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REFERENCES

1. Birnbaum C, Gustafson P, Hall T, Hanson SP, Melvin C, Quinsey CA. EHR career opportunities: Sample HIM job descriptions. *J AHIMA* **2005;**76:56A–56H.
2. American Health Information Management Association. HIM and health IT: Discovering common ground in an electronic healthcare environment. *J AHIMA* **2008;**79:69–74.

3. Houser SH, Tesch L, Hart-Hester S, Dixon-Lee C. Roles and challenges of the health information management educator: A national HIM faculty survey. *Perspect Health Inf Manag* **2009;**6:4.
4. Joint Work Force. Task Force. Health Information Management and Informatics. Core competencies for individuals working with electronic health records. October **2008**. http://library.ahima.org/xpedio/groups/public/documents/…/bok1_040723 (last accessed June 2011).
5. Langelier M, Wing P. Data for decisions: The HIM workforce and workplace: AHIMA members as managers: A summary of responses to Part 3 of the 2002 AHIMA member survey. June **2004**. Available at www.ahima.org/ (last accessed June 2011).
6. Zeng X, Reynolds R, Sharp M. Redefining the roles of health information management professionals in health information technology. Available at http://perspectives.ahima.org/index.php (last accessed September 2011).
7. Brodnik MS, Houser SH. Redefining the health information management scholar role. *Perspect Health Inf Manag* **2009;**16:1e.
8. Mantas J. *Health and medical informatics education in Europe*. Amsterdam: IOS Press, **2000:**6.
9. The University of Tennessee Health Science Center. Master of Health Informatics and Information Management. **2011**. Available at www.uthsc.edu/allied/him/masters (last accessed November 2011).
10. La Trobe University. Master of Health Information Management. **2011**. Available at www.latrobe.edu.au/handbook/2012/postgraduate/health-sciences (last accessed November 2011).
11. Curtin University of Technology. Master of Health Information Management. **2011**. Available at http://student.handbook.curtin.edu.au/courses/31/313455.html (last accessed November 2011).
12. University of Illinois at Chicago. Health Informatics and Health Information Management. **2011**. Available at http://healthinformatics.uic.edu/health-informatics/health-informatics-degree-course (last accessed November 2011).
13. The College of St. Scholastica. Master of Science in Health Information Management. **2011**. Available at www.css.edu/academics/catalog/graduate-catalog/graduate-curriculum/school-of-health-sciences (last accessed November 2011).
14. Temple University College of Health Professions and Social Work. Health informatics/health information management. **2011**. Available at http://chpsw.temple.edu/him (last accessed November 2011).
15. Wager KA, Lee FW, Glaser J. *Managing healthcare information systems: A practical approach for healthcare management*. San Francisco: Jossey-Bass, **2005:**233–244.
16. Skurka M. *Health information management*. San Francisco: Health Forum, Inc., **1998:**19.
17. Huffman EK. *Health information management*, 10th ed. Berwyn, IL: Physician's Record Company, **1994:**49.
18. National Institutes of Health. Workflow/business process management (BPM) service pattern. **2007**. Available at http://enterprisearchitecture.nih.gov/ArchLib/AT/TA/WorkflowServicePattern.htm (last accessed January 2010).
19. Kukafka R, et al. Redesigning electronic health record systems to support public health. *J Biomed Inform* **2007;**40:398–409.
20. Health Canada, Office of Health and the Information Highway. The Canadian Health Info-Structure: A Conceptual Overview. **1997**. Available at www.hc-sc.gc.ca/hcs-sss/alt_formats/pacrbdgapcr/pdf/pubs/ehealthesante/1997-chiics-overview-survol/1997-chiics-overview-survol-eng.pdf (last accessed June 2012).
21. Office of Health and the Information Highway. Health Canada tactical plan for a pan-Canadian health infostructure. **2001**. Available at www.hc-sc.gc.ca/hcs-sss/pubs/ehealth-esante/2001-plan-tact/index-eng.php (last accessed November 2011).
22. Stead WW, Kelly BJ, Kolodner RM. Achievable steps toward building a national health information infrastructure in the United States. *J Am Med Inform Assoc* **2005;**12:113–120.
23. Civan A, Skeels MM, Stolyar A, Pratt W. Personal health information management: Consumers' perspectives. *AMIA Annu Symp Proc* **2006:**156–160.
24. Detmer D, Bloomrosen M, Raymond B, Tang P. Integrated personal health records: Transformative tools for consumer-centric care. *BMC Med Inform Decis Mak* **2008;**6(8):45.
25. HIMSS Personal Health Records Definition and Position Statement. June 27, **2007**. www.himss.org/content/files/phrdefinition071707.pdf (last accessed July 2011).
26. Cushman R, Froomkin AM, Cava A, Abril P, Goodman KW. Ethical, legal and social issues for personal health records and applications. *J Biomed Inform* **2010;**43(5 Suppl):S51–S55.
27. Wright A, Sittig DF. Encryption characteristics of two USB-based personal health record devices. *J Am Med Inform Assoc* **2007;**14:397–399.
28. Sittig DF. Personal health records on the internet: A snapshot of the pioneers at the end of the 20th century. *Int J Med Inform* **2002;**65:1–6.
29. Paterno MD, Rynberg SJ, Giannangelo K. Terms for terms. A terminology guide for e-HIM professionals. *J AHIMA* **2009;**80:54–58.
30. Ball MJ, Smith C, Bakalar RS. Personal health records: Empowering consumers. *J Healthc Inf Manag* **2007;**21:76–86.
31. Markle Foundation. Connecting Americans to their healthcare. Working group on policies for electronic information sharing between doctors and patients. **2004**. Available at www.markle.org/ (last accessed July 2011).
32. Yaqub E, Barroso A. Distributed guidelines (DiG): A software framework for extending automated health decision support to the general population. *Perspect Health Inf Manag* **2010;**1(7):1b.
33. Eysenbach G. Infodemiology and infoveillance: Framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. *J Med Internet Res* **2009;**11(1):e11.
34. Yasnoff WA, Overhage JM, Humphreys BL, LaVenture M, Goodman KW, Gatewood L, Ross DA, Reid J, Hammond WE, Dwyer D, Huff SM, Gotham I, Kukafka R, Loonsk JW, Wagner MM. A national agenda for public health informatics. *J Public Health Manag Pract* **2001;**7(6):1–21.
35. Public Health Informatics Institute. Public health opportunities in health information exchange. **2005**. Available at www.phii.org/resources (last accessed March 2011).
36. Yasnoff WA, O'Carroll PW, Koo D, Linkins RW, Kilbourne EM. Public health informatics: Improving and transforming public health in the information age. *J Public Health Manag Pract* **2000;**6:67–75.
37. Public Health Data Standards Consortium. Building a roadmap for health information systems. Interoperability for public health. Public health uses of electronic health record data. **2007**. Available at www.ihe.net/ (last accessed March 2011).
38. O'Carroll PW, Yasnoff WA, Wilhoite W, Ward ME, Ripp HL, Martin EL. *Public health informatics and information system*. New York: Springer-Verlag, **2003**.
39. Public Health Agency of Canada Canadian Integrated Public Health Surveillance. **2006**. Available at www.phac-aspc.gc.ca/php-psp/ciphs-eng.php (last accessed March 2011).
40. Centers for Disease Control and Prevention. Integrating public health information and surveillance systems: A report and recommendations from the CDC/ATSDR Steering Committee on Public Health Information and Surveillance System Development. Atlanta: Public Health Service, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, **1995**. Available at www.cdc.gov/nedss/Archive/katz.pdf (last accessed January 2010).
41. California Policy Research Center. Strategies for establishing an environmental health surveillance system in California. **2004**. Available at www.catracking.com/resources/ewg/sb702report/EHSSrpt.pdf (last accessed January 2010).
42. Yi Q, Hoskins RE, Hillringhouse EA, Sorensen SS, Oberle MW, Fuller SS, Wallace JC. Integrating open-source technologies to build low-cost information systems for improved access to public health data. *Int J Health Geogr* **2008;**7:29.

43. Morris G, Snider D, Katz M. Integrating public health information and surveillance systems. *J Public Health Manag Pract* **1996;**2(4):24–27.

44. European Centre for Environment and Health Implementing Environment and Health Information System in Europe. **2005**. Available at http://ec.europa.eu/health/ph_projects/2003/…/2003_1_28_frep_en.pdf (last accessed September 2011).

45. Health Canada. Inventory of federal, provincial and territorial environmental and occupational health data sources and surveillance activities. **2008**. Available at http://dsp-psd.pwgsc.gc.ca/Collection/H46-2-04-340E.pdf (last accessed June 2011).

46. McGeehin MA, Qualters JR, Niskar AS. National environmental public health tracking program: Bridging the information gap. *Environ Health Perspect* **2004;**112:1409–1413.

47. Mather FJ, White LE, Langlois EC, Shorter CF, Swalm CM, Shaffer JG, Hartley WR. Statistical methods for linking health, exposure, and hazards. *Environ Health Perspect* **2004;**112:1440–1445.

48. Surveillance and Epidemiology Branch Centre for Health Protection, Hong Kong Department of Health. Behavioral risk factor survey. October **2004**. Available at www.chp.gov.hk/en/behavioural/10/280.html (last accessed February 2011).

49. Agency for Healthcare Research and Quality. 2010 national healthcare quality & disparities reports: Data sources appendix. **2010**. Available at www.ahrq.gov/qual/qrdr10/datasources (last accessed September 2011).

50. U.S. Department of Health and Human Services, U.S. Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Tracking occupational injuries, illnesses, and hazards: The NIOSH surveillance strategic plan. **2001**. Available at www.cdc.gov/niosh/docs/2001-118/pdfs/2001-118.pdf (last accessed November 2011).

51. State-based occupational safety and health surveillance cooperative agreement (announcement par-04-106). **2005**. Available at www.cdc.gov/niosh/oep/pdfs/state-based-surv-fy05-v.2.pdf (last accessed November 2011).

52. Australian Institute of Health and Welfare Canberra. Asthma, chronic obstructive pulmonary disease and other respiratory diseases in Australia. **2010**. Available at www.aihw.gov.au/WorkArea/DownloadAsset (last accessed February 2011).

53. Weaver S, Dick M, Dougherty M, Anderson D, Everhard L, Mansell J, McGlaughlin C, Moen M, Niederkorn S, Updegrove J, Watson M. EHR adoption in LTC and the HIM value. *J AHIMA* **2011;**82:46–51.

54. Kim MI, Johnson KB. Personal health records: Evaluation of functionality and utility. *J Am Med Inform Assoc* **2002;**9:171–180.

55. Romero F, Caballero I, Serrano-Guerrero J, Olivas JA. An approach to web-based personal health records filtering using fuzzy prototypes and data quality criteria. *Inf Processing Manag* **2012;**48:451–466.

56. Sangiovanni G. Definition of fuzzy logic rules representing finite element method experts' reasoning. *Fuzzy Sets Systems* **2009;**160:1444–1456.

57. Bajpai S, Sachdeva A, Gupta JP. Security risk assessment: Applying the concepts of fuzzy logic. *J Hazard Mater* **2010;**173:258–264.

58. Graham I. Fuzzy logic in commercial expert systems—Results and prospects. *Fuzzy Sets Systems* **1991;**40:451–472.

59. Ting Du T, Wolfe P. Implementation of fuzzy logic systems and neural networks in industry. *Comput Ind* **1997;**32:261–272.

60. AHIMA Foundation. A study of healthcare fraud and abuse: Implications for professionals managing health information. **2010**. Available at www.ahimafoundation.org (last accessed June 2011).

61. Burrington-Brown J, Claybrook D, Dolan M, Goethals C, Kelly CD, LaMoureaux L, Shaffer H, Wolter J; Personal Health Record Practice Council. Defining the personal health information management role. *J AHIMA* **2008;**79:59–63.

62. Syx RL. The practice of patient education: The theoretical perspective. *Orthop Nurs* **2008;**27:50–54; quiz 55–56.

63. Kupchunas WR. Personal health record: New opportunity for patient education. *Orthop Nurs* **2007;**26:185–191; quiz 192–193.

64. Kiley R. *Medical information on the Internet: A guide for health professionals*. Edinburgh: Churchill Livingstone, **2003:**146–150.

65. Meriwether RA. Blueprint for a national public health surveillance system for the 21st century. Available at www.cste.org/pdffiles/Blueprint.pdf (last accessed February 2010).

66. Houser SH, Manger BJ, Price BJ, Silvers C, Hart-Hester S. Expanding the health information management public health role. *Perspect Health Inf Manag* **2009;**6:1b.

67. Laflamme DM, Vanderslice JA. Using the Behavioral Risk Factor Surveillance System (BRFSS) for exposure tracking: Experiences from Washington State. *Environ Health Perspect* **2004;**112:1428–1433.

68. Mullan N, Ferguson C, Paech D. Environmental Health Directorate Western Australia environmental health surveillance—A feasibility study. **2008**. Available at www.public.health.wa.gov.au/cproot/2713/2/11176%20 (last accessed February 2011).

69. Lavrac N, Bohanec M, Pur A, Cestnik B, Debeljak M, Kobler A. Data mining and visualization for decision support and modeling of public health-care resources. *J Biomed Inform* **2007;**40:438–447.

70. Holt JB, Mokdad AH, Ford ES, Simoes EJ, Mensah GA, Bartoli WP. Use of BRFSS data and GIS technology for rapid public health response during natural disasters [abstract]. *Prev Chronic Dis* 2008;5:A97.

71. Jenks RH, Malecki JM. GIS—A proven tool for public health analysis. *J Environ Health* **2004;**67:32–34.

72. Cunningham DJ, Ascher MT, Viola D, Visintainer PF. Baseline assessment of public health informatics competencies in two Hudson Valley health departments. *Public Health Rep* **2007;**122:302–310.

73. Occupational Injury and Illness Classification Manual. **2010**. Available at www.bls.gov/iif/oshoiics.htm (last accessed June 2011).

74. National Occupational Health and Safety Commission Canberra. 2004. Type of occurrence classification system. Available at www.nohsc.gov.au (last accessed September 2011).

75. Canadian Centre for Occupational Health and Safety. Work injury statistics. **2009**. Available at ccohs.ca/oshanswers/information/injury_statistics.html (last accessed September 2011).

76. Association of Workers' Compensation Boards of Canada. National work injury statistics program (NWISP). **2007**. Available from:www.awcbc.org/en/nationalworkinjuriesstatisticsprogramnwisp (last accessed September 2011).

77. Health Canada. Environmental and workplace health work injuries and diseases database (NWISP). **2009**. Available at www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/nwisp-eng.php (last accessed September 2011).

78. National Public Health Partnership. Public health classifications project Phase One: Final report. **2006**. Available at www.nphp.gov.au/workprog/phi/…/report_ph_classifications_phase01.pd (last accessed February 2009).

79. AHIMA Coding Policy and Strategy Committee. Clarification of clinical data sets, vocabularies, terminologies, and classification. *J AHIMA* **1999;**70:72–73.

80. American Health Information Management Association; Foundation of Research and Education Automated Coding Software: Development and use to enhance antifraud activities. **2005**. Available at www.ahima.org (last accessed June 2009).

81. Elsom S, Happell B, Manias E. Australian mental health nurse' attitude to role expansion. *Perspect Psychiatr Care* **2009;**45:100–107.

82. Eddy A. Work-based learning and role extention: A match made in heaven? *Radiography* **2010;**16:95–100.

83. Davis N, LaCour M. *Introduction to health information technology*. Philadelphia: W.B. Saunders Co., **2001:**53.

84. Daly WM, Carnwell R. Nursing roles and levels of practice: A framework for differentiating between elementary, specialist and advancing nursing practice. *J Clin Nurs* **2003;**12:158–167.

85. Zhang D. Data mining for role based access control. Melbourne, Australia: Department of Computer Science and Software Engineering, The University of Melbourne. Available at www.cs.mu.oz.au/~zhangd/publications/conversion07.pdf (last accessed September 2011).

86. Chen H, Fuller S, Friedman C, Hersh W. *Integrated series in information systems: Medical informatics: Knowledge management and data mining in biomedicine*. New York: Springer, **2005;**109.

87. Oliveira S, Zaiane O. Foundations for an access control model for privacy preservation in multi-relational association rule mining. **2002**. Available at http://webdocs.cs.ualberta.ca/~zaiane/postscript/PSDM02-1.pdf (last accessed September 2011).

88. Young M, Chae YM, et al. Analysis of healthcare quality indicator using data mining and decision support system expert systems with applications. *Expert Systems Applic* **2002;**24:167–172.

89. Canlas R. Data mining in healthcare: Current applications and issues [M.S. in Information Technology thesis]. Adelaide: Carnegie Mellon University Australia, **2009**.

90. Tsumoto S, Yokoyama S, Matsuoka K. Mining risk information in hospital information systems as risk mining. *IEEE/ICME Int Conf Complex Med Eng 2007* **2007:**1917–1921. Available at http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4382082 (last accessed September 2011).

91. Koh HC, Tan G. Data mining applications in healthcare. *J Healthc Inf Manag* **2005;**19:64–72.

92. Wong WK. Data mining for early disease outbreak detection. Pittsburgh, PA: School of Computer Science, Carnegie Mellon University, **2004**.

93. Tsumoto S, Hirano S, Tsumoto Y. Towards data-oriented hospital services: Data mining-based hospital management. *2011 IEEE/ICME Int Conf Complex Med Eng* **2011:**279–284. Available at http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber (last accessed September 2011).

94. Shepard CW, Gortakowski HW, Nasrallah H, Cutler BH, Begier EM. Using GIS-based density maps of HIV surveillance data to identify previously unrecognized geographic foci of HIV burden in an urban epidemic. *Public Health Rep* **2011;**126:741–749.

95. McClean S, Millard P. A decision support system for bed-occupancy management and planning hospitals. *Math Med Biol* **1995;**12:249–257.

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