
Informing Health Choices

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Overview

"Better information for better health... alberta we//net will enable health professionals across Alberta to share necessary information and best practices, to make evidence-based decisions about treatment and about resource management." (<http://www.albertawellnet.org>)

A health policy agenda is emerging that is preoccupied with evidence. From National Agencies to Regional Health Authorities, and from sub-specialist clinics to primary health centres, every participant in the health care endeavor is aware of evidence: the need for it, the lack of it, the various definitions of it. How is it that physician practices vary so much and that solid information takes so long to find its way to practice? That the best evidence should always buttress health choices is blindingly obvious to most lay people.

A health informatics agenda is emerging that is preoccupied with technology. After years of under-investment in information systems, the Canadian National Forum on Health placed evidence-based information systems on a par with women's health as a key deliverable for the next decade of health reform. (National Forum on Health, 1997) Major financial commitments -- including Canada's InfoWay -- fuel the expectation that "better information" will beget "better health." (Advisory Council on Health Infostructure, 1999) Alberta we//net, like other efforts to build strategic information networks, asserts that improvements will occur because better information will affect the choices of patients, practitioners and policy-makers.

In reality, more information may worsen the plight of busy decision-makers. They experience information hunger in the midst of plenty. The content of health knowledge is so volatile and expansive that physicians increasingly must manage, not contain, information. (Harris, 2001) For, "better information" yield "better health," at least three things must happen. First, health care decision-makers must discern better from worse information. Second, changes in knowledge must trigger changes in health practices. Finally, improved outcomes must result from altered practices. In short, better information begets better health through the medium of better choice. For patients, practitioners and policy-makers to make more informed choices, they need to:

- **Know what to do...**
because best information supporting best practices is readily available at the point of decision-making,
- **Do what is known...**
with aids to problem recognition, question formulation, resource selection, information acquisition and use, and

- **Understand what is done...**
because information use is monitored and managed.

Informed choice is facilitated when information about health is connected with information about how to improve health. To attract clinician attention, a health information system must be ubiquitous, accessible, dependable and credible. It must present all information – patient reported, clinician observed and research derived -- in a way that highlights its validity, importance and applicability for individual patients. To retain clinician attention, a health information system must complement, not conflict with, the predominantly oral culture of information exchange in health care. The information tools must make it easier for decision-makers to find and use high quality information when reflecting with colleagues, consultants and clients. Most importantly, information tools must decrease the clinician's total informational burden while easing communications with colleagues and participation in virtual learning and decision-making communities. Their work should be supported by an information culture that rewards explicit approaches to uncertainty and acceptance of just-in-time knowledge.

This chapter explores the informational requirements of informed decision-making, illustrates how changes in information tools can affect health care practice, and highlights possible implications for a new culture of knowledge integration.

Information Needs

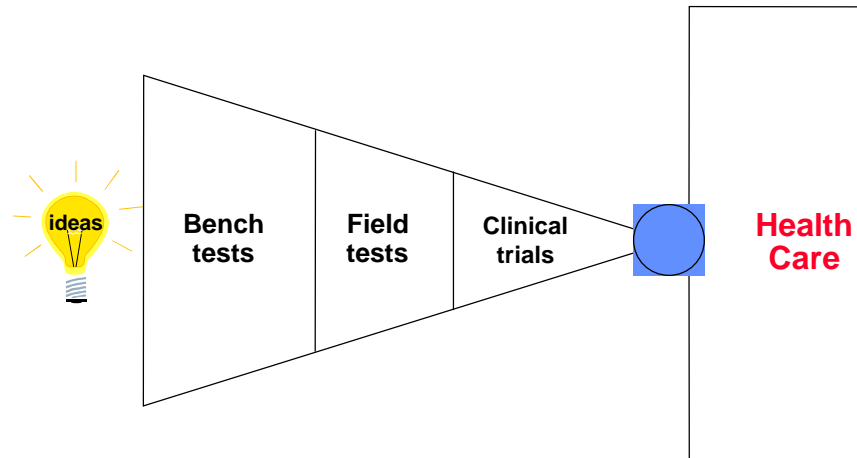
Individual patients hope that health practitioners will identify real health problems, articulate relevant options for managing each problem, assemble the best available information about the outcomes associated with each option, solicit patient preferences for each outcome, and promote practices that win compliance and achieve valued results. Groups of patients hope that practitioners will work to prevent, detect, and treat health problems in a way that is fiscally responsible and that maximizes the opportunity of all patients to avail themselves of high quality health care. To meet patients' expectations, individually and in aggregate, clinicians face forbidding tasks of information management.

Capable information managers discern uncertainty, craft answerable questions, map questions to different types of knowledge, seek valid evidence from appropriate sources, and prudently apply knowledge in patient care. Over the last decade, Internet advances have removed technical barriers to just-in-time knowledge. We are left struggling with how best to facilitate the better application of knowledge to practice, and how to know which information behaviors are most effective.

Evidence-based Practice

"Evidence-based Practice" (EBP) is a particular conceptualization about what it means to enable informed choice. EBP tries to bridge the gap between evidence and practice. This gap may be illustrated with the image of a wedge, where promising ideas are subjected to progressively more rigorous testing on their way from bench to bedside. (Haynes et. al, 1995)

Evidence to Practice



Knowing that there is premature adoption of incompletely tested ideas on the one hand, and failure of adoption of proven knowledge on the other, scientists suggest that there is a faulty connection at the point of the wedge. It is distressing to those who produce and summarize evidence that so much strong evidence remains unheeded in day to day practice. *For the producers of evidence, the starting point for EBP is the meritorious clinical trial.*

Potential consumers of evidence, however, are distressed by the huge backlog of common and important clinical problems for which evidence is unavailable, and may never become available, or exists but is confusing, conflicting or, because of mismatches to clinical circumstances, inapplicable. *For the consumers of evidence, the starting point is a specific clinical problem.*

From the clinician's point of view, health care contains many informational wedges. Even when good, pertinent evidence is readily available, clinicians must apply it in a fuzzy context that implicitly or explicitly includes consideration of costs, patient preferences, comorbidity and a broad range of health outcomes, many of which do not figure in clinical experiments. It is little wonder, then, that busy clinicians often are intimidated by the call to EBP. They protest that it is difficult, time-consuming and impractical. It devalues expertise and it forebodes Hamlet-like indecision.

In response, the proponents of EBP ask clinicians to focus on being more aware of the type and strength of any link between what we do and why we do it. The evidence-based decision-maker should greet any source of information with questions about:

- **Validity**
Is the information likely to be true?
- **Importance**
If true, will the information make a difference that patients will care about?
- **Applicability**
Can the information be used?

Promoting EBP is, at its core, an approach to information management. It holds that informational support for informed decision-making must make explicit the following implicit attributes of clinical problem-solving:

- recognition of patient or population health problems,

- exposing uncertainty in how we manage those problems,
- articulating questions that must be answered to resolve the uncertainty,
- selecting appropriate sources of knowledge to answer the questions,
- finding information from those sources,
- sifting believable from distracting information, and
- determining if and how any new information can be used.

These tasks are not restricted to the use of results from clinical trials. They pertain as much to books, papers and experts as to primary research reports.

Evidence-based Policy

EBP heralds a major change in the philosophy driving health care decisions as well as a shift in sources, types, and applications of health information. In *Creating a Culture of Evidence-Based Decision Making in Health*, the National Forum on Health defined evidence-based decision-making as “the *systematic* application of the *best available* evidence to the evaluation of options and to decision making in clinical, management and policy settings.” (National Forum on Health, 1997) Its adoption as a new mode of addressing health policy has pivotal implications for those who generate and those who use health information. Evidence-based health care expresses commitment to:

- improve the transparency of reasoning behind policies,
- increase accountability by justifying decisions on the basis of valid information that can stand up to scrutiny,
- gauge uncertainty by making explicit the strength of evidence supporting policy,
- make policy decisions driven by the best outcomes for the health care dollar.

The nature of health care accountability has changed significantly within a generation. Consumers are better educated, more informed and more skeptical than ever before. The public has access to information previously only available to professionals. In addition to consumer demands, every health profession is being challenged to demonstrate that they are making a positive impact on the health of the people that they are treating. Evidence of effectiveness of interventions, and impact on health outcomes is being demanded from all providers.

Evidence-based Informatics

More evidence does not make evidence based practice. Indeed, by removing technical and operational barriers to information access, we have exposed a more fundamental problem: busy physicians have difficulty applying new knowledge to patient care. (Guyatt et al, 2002) The last thing busy clinicians need is knowledge dumped at the bedside while they are ill equipped to discern the relevant details. What they do need are highly refined distillates of valid, important and applicable patient-reported, clinician-observed and research-derived evidence; all presented in a way that is easy to understand, readily available, and tightly linked to patient priorities.

Evidence-based Informatics (EBI) accepts this challenge. It is the study of how knowledge-aware systems can improve the application of best evidence about the effects of health care: coupling what is known to what is done. EBI makes at least two important contributions. It helps decision-makers:

- know how to know by helping them voice meaningful questions, direct the questions to the right type of knowledge, and then search, select and synthesize information, and
- use what is known by highlighting the settings, patients and practitioners to which the knowledge pertains.

Evidence-based health information systems are a subset of knowledge-based systems. They answer questions of validity with links to evidence supporting recommendations, answer questions of importance with presentations of information in clinically meaningful terms, and answer questions of applicability with details about the patients and circumstances to which the information applies.

EBI promotes timely access to accurate synopses of clinical data together with digests of relevant evidence about the meaning of the data. Tapping the efficiency and overwhelming power of computerized information systems, EBI links knowledge with practice with technologies that can put information at the bedside.

Implications

EBP portends a change in what it means to become a clinician. Proficiency with just-in-time knowledge requires more than good information retrieval skills. Rapid access must be paired with rapid assessment. The core assumption of EBP is that the way one knows is as important that what one knows. The imperative for EBP is a given, as is the rapid shift from static paper-based information resources to dynamic electronic resources. What remains is for professionals and professional associations to determine how they will bring themselves in line with an approach to health care that emphasizes competency in informed decision-making. A health care environment driven by evidence-based practice will require:

- stakeholders to make practical changes in the way health information is managed and presented,
- continuing change management paired to clinical information systems deployment, highlighting that continuing professional development is inseparable from continuing clinical practice,
- a renewed understanding of how considerations of validity, importance and applicability affect ways of knowing in a particular health discipline.

At this time most medical education institutions have an inadequate “infostructure” across the continuum of teaching. Standards for health informatics teaching are not uniform, and few schools have facilities that support experiential learning with the types of information systems that clinicians encounter in practice. There are few if any links between educators and the information systems infrastructure of the health regions in which Universities reside. Stakeholders wishing to improve their profile in the area of evidence-based informatics will need to define the types of health information that matter most, how such evidence is being generated, where it resides and how it might be accessed by learners.

Informatics initiatives need to be seen as allies by practitioners and policy makers in their efforts to choose wisely and knowledgeably. These groups already feel overwhelmed by information overload. They want to be making right decisions: right for patients, right scientifically, right for the demands of society for cost-control. The health education communities have a huge opportunity to facilitate the transition practitioners feel they must make. This can be done by addressing the barriers to EBP, using experiential learning approaches to teach practical ways to overcome them and working with health regions to make evidence training available at the point of care. (Lau et al., 1999)

Information Tools

These are times of great expectation for health informatics. In a world frenzied by an information revolution, many anticipate knowledge beamed to the bedside in service of a new, better, health system. These also are times of great challenge for health institutions. As hospitals reorganize, regionalize and downsize, their patients, practitioners and funders demand better application of what is known to what is done:

- patients want reassurance that they are getting quality care,
- practitioners want fast access to data and knowledge that is easy to find, easy to read and easy to apply, and,
- policy makers want new approaches to disseminating information and managing its impact on care.

That information technologies continue to grow in quantity, quality and sophistication, is encouraging. That health institutions must compensate for years of deferred maintenance and under-investment in information

systems, is discouraging. Although costs-per-computing-event are decreasing, user appetite for information services is growing faster. The gap between demand and capacity for information management is growing.

This section examines some of the immediate information problems of health institutions and the emerging strategies that can be used to meet those needs. New information systems must be deployed to serve:

- **information convenience...**
because the right information presented the right way at the right time for the right person,
- **information discrimination...**
because valid and important information discerned from misleading and distracting information, and
- **information integration...**
because meaningful relationships between information from different sources are highlighted.

Information Needs

The emergence of a knowledge-based health economy is changing the information behaviours of hospitals, community practices, libraries, and the general public.

Need	Implication
As health systems are regionalized, with different care specialties concentrated at different locations, health information networks are being developed to facilitate reliable access to multiple information resources at multiple locations . Multi-tasking personal computers have become popular but are potentially costly to support .	Different practitioners have different information needs . Information systems need to allow for these differences by customizing how information is presented for each user type. The computer industry produces hugely powerful workstations and computer operating systems. But health practitioners need ways to focus them for individualized clusters of information tasks.
High quality knowledge software is now widely available. Electronic textbooks, drug information databases, decision support systems, practice guidelines and medical education programs are available and affordable. New software appears daily and changes frequently.	Demand for knowledge-integration services increases because the experience, skills and tools required to manage knowledge-based software are rare.
Most practitioners, patients and policy-makers are too busy to attend computer courses.	Users need on-line training opportunities and simple aids for selecting appropriate software for a particular clinical question.
The Internet has become a powerful and popular source of health information.	Health institutions are looking for ways to provide controlled Internet access without risking exposure to computer viruses and inappropriate use of the World Wide Web.
Software vendors frequently demand reimbursement based upon the number of users or uses. New confidentiality laws mandate that health institutions monitor who accesses information found in clinical systems.	Health institutions need information about who uses software, when, and for what purpose .
Hospitals and practitioners have come under intense pressure to control costs . Many use practice guidelines, care maps, clinical pathways and other information tools to try to influence practitioner behavior.	Health organizations need to monitor information behaviors and usage patterns and track who has interacted with the information tools, with what results. They need to survey staff about new information policies and practices.
The knowledge and skills concentrated in libraries make them the best candidates for meeting the knowledge management needs of offices, hospitals and regions.	Libraries need to be integrated into regional information networks and they need to be equipped with systems and skills for wide-area knowledge management . In the past, practitioners were urged to go to libraries. Now the

Need	Implication
<p>As society shifts from passive multimedia information dissemination (e.g., television) to active multimedia dissemination (e.g., Internet) patients are becoming avid health information consumers. Indeed, many patients enjoy better access to health knowledge databases than the health practitioners they go to for help.</p>	<p>libraries must use the Internet to go to practitioners. Better still, Librarians should use the Internet to offer a virtual presence to clinicians.</p> <p>Patients need help to recognize better quality sources of information and to understand the relevance and applicability of information to their unique circumstances. Physicians need to hone new skills in rapid assessment of Internet resources and new approaches to patient education.</p>

The above needs are made all the more urgent by a growing conviction that less-than-optimal information services are a treat to patient safety. (Leape et al, 1998)

Information Technology

Computers have become so commonplace that changes in the healthcare workplace are now coupled to changes in computing technology. An organization's "infostructure" is determined by how computers are deployed to support its mission-critical functions. The healthcare infostructure is undergoing profound change now that multiple information products (**multi-source**) can be delivered at the same time (**multi-tasking**) to multiple hardware platforms (**multi-platform**) using multiple communications media (**multi-media**).

Multi-source

A world-wide health information community

Document standards

Perhaps the most far-reaching change in clinical computing relates to the creation of a world-wide health care information community, on Internet, in which all healthcare practitioners and institutions can participate. No longer are personal computers limited to local software. In the age of inter-personal computing, the Internet provides a robust medium for inter-computer communication, universal standards for document and database exchange, and opportunities for decentralized healthcare data and knowledge management.

Communication standards

The Internet is defined by a protocol (TCP/IP) that governs how messages are sent from one computer to another. Layered on top of this protocol are methods for creating secure communication channels between multiple computers at the same institution or between institutions. The Internet can and has been used to create multi-institutional networks and regional health information systems.

Software standards

Internet communications protocols also facilitate software-to-software communication. Functions like electronic mail, discussion lists, file transfer and software updates are available under a common interface, available to all Internet-aware software applications. Documents and databases can be stored in forms that will display on any computer, with links to these communications tools. The user need only "click" on an item or link of interest to download or display information, send a message to the author, check a reference or place an order for a reprint. One information resource can query another resource using standardized protocols for sending information requests from one place to another. Indeed, computing resources from around the world become indistinguishable from those stored on the local computer. "Place" is immaterial on the Internet. The advent of XML has brought features of databases and documents together in ways that are easy for non-experts to manipulate and customize.

By making virtually unlimited numbers and types of health information resources available in a consistent, compatible format, Internet communication and mark-up protocols remove barriers to information exchange, promotes access and use of knowledge, and fundamentally change the role of health care libraries.

Ubiquitous health publishing

Now that popular word processors can produce, save, and publish information in an Internet-ready form, anyone can share information on the Internet. Although this removes barriers to the exchange of health knowledge, it encourages informational anarchy because there are few controls on the quality, authenticity, or durability of Internet-based information.

Intellectual property

In general, Internet developers can create links to a wide range of independent information resources on Internet. Health practice recommendations can be seamlessly linked to supporting evidence. In this way, a new domain of intellectual property has been created. Over and above the content of a document, there is value in the relationships that have been created between that document and other information resources.

Just-in-time knowledge

Healthcare knowledge is highly volatile, changing at an ever-increasing rate. The Internet makes it possible to view large public databases the instant they are updated, to subscribe to "channels" broadcasting just the most recent changes in databases, and to provide instant feedback to database authors concerning problems in the content of health knowledge resources. The best electronic journals include alert services that automatically send practitioners updates about new information in their field of interest.

Virtual libraries

As journals, textbooks, government databases and other resources proliferate on the Internet, this distributed network is starting to replace the library as a preferred source of health knowledge. Most Canadian health libraries have shifted from paper to electronic journal subscriptions. A new generation of librarians is emerging, focused on managing Internet-based information resources and "virtual" collections assembled from multiple databases at multiple locations.

Multi-tasking

Terminal-mainframe dyad

Computer networks of the 1970's and 1980's commonly enslaved computer terminals to one or more mainframe computers. The terminals could display only one type of information at a time. Even systems allowing access to knowledge-based resources such as pharmacopoeia, required the user to exit from one application, connect to the database, then navigate a number of keyboard-driven menus to get the desired information. Another set of menus must be negotiated to get back to the clinical information that prompted a search for evidence.

Client-server myad

Multi-tasking

In the 1990s, computers have been liberated from the terminal-mainframe hierarchy. Modern operating systems support "multi-tasking", so that more than one software application can be available on the same computer at the same time. The user can quickly switch from a laboratory test result display, for example, to one or more databases that help the user decide what to do about the test result. In this way, multiple software programs can access multiple, different, mainframe computers. With the emergence of secure Internet connections, those computers can be anywhere in the world. Indeed, now that the best information resources tend to be most current in their Internet iterations, the modern computer workstation again resembles a terminal... a multitasking terminal.

Multi-threading

Modern systems also support “multi-threading”, where multiple software applications can perform multiple functions simultaneously on one or more computer processors at one or more locations. The increasing power of computer workstations and the increasing capacity, or “bandwidth”, of computer networks, have enabled the development of decentralized computer networks; client-server communities with no fixed hierarchy. They are dynamic, can accommodate hardware and software changes more easily, support freer communications, and can collaboratively tackle very complex computational tasks. Moreover, remote desktop access protocols allow Internet devices to be used to control more powerful computers and software applications from remote and mobile locations; in effect nesting computers within computers within other computers.

Today's personal computers exceed the power of decade-old mainframes, with phenomenal increases in speed, storage capacity and display capabilities. This greatly extends the scalability of health information systems and brings previously esoteric capabilities of artificial intelligence, expert guidance, and decision-support within reach of everyday health care workers. Such opportunity highlights a need for investment, understanding of the best uses of these new tools, and for relatively greater attention to software than hardware in health institution spending.

Multi-platform

Diversification of hardware

The reach of computers has been greatly extended through miniaturization, mobilization and modularization.

Miniaturization

It is now possible to pack the power of a sophisticated multi-media workstation into a portable device the size of a notebook, and the power of a professional productivity workstation into a palmtop device the size of a pack of cards. Some portable computers dispense with keyboards altogether. Instead, a pen is used to interact with graphical data-entry screens. This miniaturization brings the functionality of desktop computing to the point of health care.

Mobilization

Networking technology has evolved to the point that the “local area network” is an oxymoron, without spatial meaning. Computing communities are defined more by interest and occupation than by location and it is perfectly possible to join health administrators at opposite ends of the country through virtual private networks. Wireless networks allow all kinds of devices, physically untethered, to remain in contact with health databases. Cellular and satellite networks combined with geographic positioning systems are now pre-installed in many mobile computing devices, allowing precise regional data collection anywhere.

Modularization

The most rapidly established computer technology in history, the “Palm” computer, exemplifies the power of modular computing. The device performs a specific subset of personal computing tasks, including contact management, scheduling, task management and other personal information chores. It does this extraordinarily well, extending the desktop computer with which it synchronizes at the touch of a button.

Classical computers, with keyboards and display screens, are giving way to a great diversity of personal computing “appliances”. Digital telephones can send and receive electronic mail, televisions can browse the Internet, and bedside technologies (e.g., automated vital signs monitors) are integrated with computer networks. Indeed, a number of hospitals are installing wireless drug dispensing systems, where medication carts are network devices that continuously communicate with a central database about which drugs are needed and received by patients, when and where.

The diversification of computing technology is changing health practices at the point of care and helping to streamline health data collection. However, most health sciences curricula do not attend to these developments and do not equip learners with the tools they need to decide how best to integrate these systems into their practice and continuing education. Students are rarely taught about the information properties of data collected and stored in these systems and how it can be used to measure their performance.

Point of care computing

A necessary but insufficient condition for the improvement of healthcare is the ability to detect possible patient care problems, make changes in healthcare processes, monitor changes in practitioner behaviors, measure health outcomes and link changes to outcomes with changes in processes. Until recently, process and outcome measurements have been blunt (e.g., duration of hospital stay, drug administration errors), supporting limited deductions about the effectiveness of quality improvement strategies.

Point of care network devices now permit capture of information about health care processes during the course of everyday work. Vital signs become part of the medical record as soon as they are measured, order-entry systems record who requests what services, where and when, and patients can use hand-held devices to answer surveys about their health status and healthcare experience.

The great challenge of the next decade is to harness all this data, create meaningful linkages between databases and form deductions that can be used to improve health care efficiency and effectiveness. Point of care computerized data entry devices can analyze data, detect inconsistencies, and prompt the user for additional information. Not only is legible, reliable and validated information captured, but it does not have to be re-entered from charts.

Multi-media

The sights and sounds of the healthcare environment are being digitized. As aging radiology equipment is replaced by digital imaging equipment, x-rays are acquired and stored as computer graphics files that are easily transferred from place to place. Electrocardiograms, electroencephalograms, ultrasounds, CT scans, MRI scans, pathology slides, photographs and endoscopic images also are captured and stored in electronic format. Indeed, health care progress notes are digitally recorded at many institutions. Many diagnostic units now use voice-recognition software to package automated reports with digital images. Because these paperless systems offer significant savings over conventional systems, they will become commonplace.

Modern computer workstations are becoming the eyes and ears of the healthcare environment. They can manipulate and display millions of colours on large displays while rendering high-quality video and digital sound. They replace conventional character-based computer monitors and can also replace display devices for most diagnostic and therapeutic interventions. Indeed, the multimedia computer is attracting clinicians to a single, preferred, source for data, information and knowledge. They are able to visit virtual laboratories, imaging units, surgical suites and libraries all without leaving the point of care.

Convergence of work, education and entertainment

The health information milieu is converging with the education and entertainment milieu. Perhaps the most radical information shift of our time is the move from uni-directional mass media (television, movies, videorecordings) to bi-directional mass media (Internet, interactive video, video conferencing) as the preferred method of information exchange. Engaging graphical interfaces present information in ways that resemble televisions more than books. With these changes, expertise from the entertainment and advertising industry is starting to influence the uptake of health information. Institutions that tap into the vast powers of multimedia are more likely to reach and influence practitioners and their patients.

Natural computing interfaces

The traditional information culture of healthcare is oral. Surveys of practitioners show that they prefer conversations with consultants and peers to books and computers. Given the hectic workplace of most hospitals, a fundamental barrier to the use of computers may be the need to sit down, focus, and communicate with a keyboard.

As computers evolve from multimedia output devices to multimedia input devices, they become more compatible with the predominantly oral culture of healthcare. Voice recognition software has become usable, inexpensive, and available. In the next few years, multimedia computing will merge with telehealth and telemedicine, bringing the information preferences of clinicians in synchrony with the power of modern computer networks.

Information Convenience

Evidence-based Informatics is helping to bridge the gap between demand and capacity for information management in two complementary ways: by expanding the range of information sources included in health information systems, and by defining the information skills required to use those resources appropriately.

Information Sources

For optimal decision making, health care decision-makers must attend to at least four major sources of information. These are:

- health care research about the effects of health interventions on patients and populations,
- health services research about the direct and indirect costs of interventions and their effects on the health care system,
- results of health assessments, laboratory tests and other clinical measurements,
- and each patient’s unique risks, circumstances, preferences, and ability to comply with interventions.

The first two sources constitute **external evidence**, derived from the systematic study of defined populations of patients and practitioners. Whereas clinical decision-makers try to adapt external evidence to the circumstances of individuals at a specific place and time, clinical policy makers consider how the evidence applies to patient and practitioner groups within a particular population or region.

The second two sources of information constitute **internal evidence**, derived from specific observations about the patients and practitioners for whom decisions are being made. Whereas decision-makers attend to internal evidence about individuals, policy-makers attend to aggregated evidence about the patterns of risk factors and disease in populations.

Information Source	Content	Comments
External Evidence	Health Care Research	Results of experiments about the effects of health interventions on patients and populations.
	Health Services Research	Systematic evaluation of the effects of health interventions on health care processes and systems.
Internal Evidence	Health Practice Observations	Individual or group observations from clinical investigations and measurements.
	Health Subject Observations	Patient-reported observations about health status, preferences and circumstances.

Information Systems

Health information systems may be grouped in four categories corresponding to the four information sources described above. In general, there are:

- knowledge-based systems that store, summarize and interpret what is known about the effects of health interventions,
- administrative systems that capture information about health processes and facilitate such tasks as appointment scheduling, billing, and accounting,
- clinical systems that capture, organize and display clinical observations (history and physical examination) and test results (laboratory reports, procedure notes, etc.), and
- consumer-centred systems that capture, analyze, interpret and store patient-reported data about health status, preferences and educational needs.

System Type	Purpose
Knowledge-Based	Store, summarize and interpret research about the effects of health interventions.
Administrative	Capture information about healthcare processes.
Clinical	Capture, organize and display clinical observations and interventions.
Consumer-Based	Capture, organize and interpret patient-reported data.

The last decade has seen great advances in the power and sophistication of administrative and clinical health information systems. Consumer-based systems are just beginning to grow. More recently, knowledge-based products have proliferated, with many traditional resources -- such as textbooks, drug information databases, and clinical policies -- converted to electronic format.

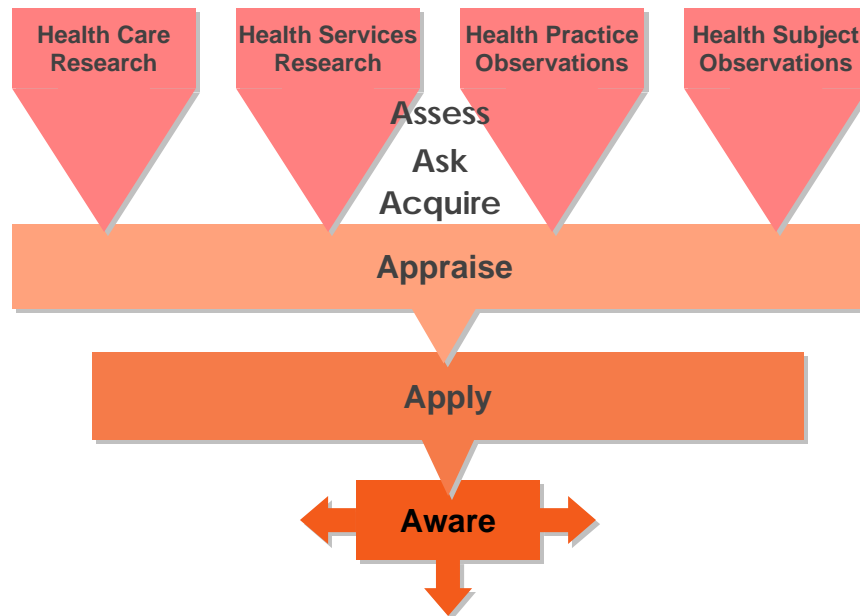
Although the **quantitative** tools for amassing health information are impressive, they may confuse practice unless linked to **qualitative** changes the organization and presentation of information at the point of care.

Information Discrimination

Each of these information sources calls for unique skills in:

- **Assessing** an initially disorganized information mix in order to recognize and detect important patient or policy problems;
- **Asking** specific questions that are directly relevant to the patient or population of interest, suggest an appropriate source of information, and are specific enough to facilitate an efficient search for evidence;
- **Acquiring** the most important and convincing evidence from an ever-expanding health literature, diverse clinical measurements, and ever-more complex mixes of patient preferences and circumstances;
- **Appraising** and synthesizing the best information to expose bias and variability; and
- **Applying** useful, valid and important evidence and monitoring health outcomes to see whether the patient or population goals are achieved.

Clinical Information Tasks



These are the five steps of the health information cycle: Assess, Ask, Acquire, Appraise, and Apply. Evidence-based health information systems favour software and resources that facilitate each of these steps to appropriate information use.

Information Integration

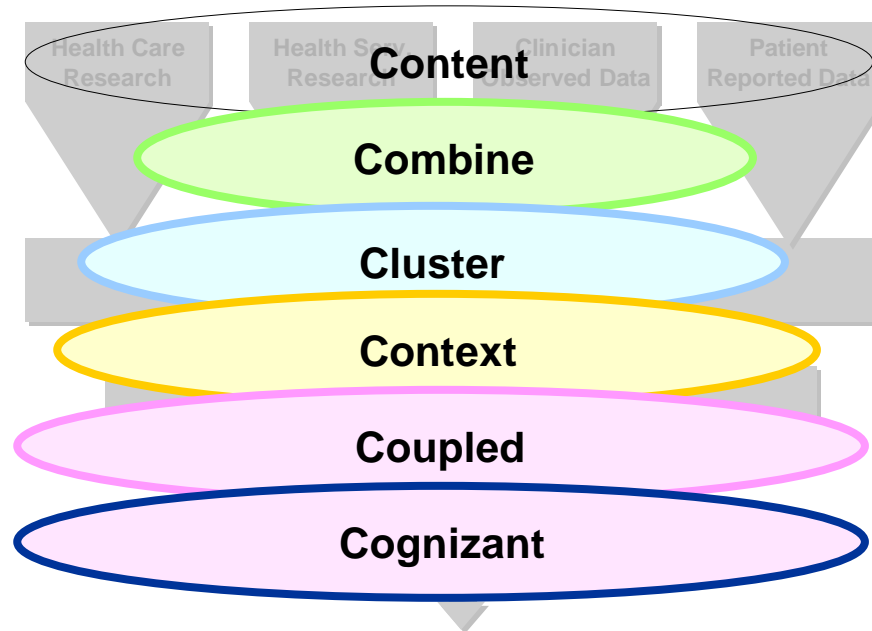
Administrative, clinical, consumer and knowledge management systems need not be mutually exclusive. Our present and future challenge is to build simple, sustainable, and affordable links between these categories of health information systems.

Integration of information systems can occur at a number of levels:

- **Combined** systems unite one or more components under a common interface. A combined drug prescription system, for example, may include menus that allow the clinician to search for dosing details or patient-advice handouts before generating prescriptions.
- **Clustered** systems use information about the provider to pre-determine which information tools to present the user with. Presentation of a relevant drug database, for example, can be automated upon recognizing that a particular type of physician is logged on.
- **Context-sensitive** systems are "aware" of the clinical context, allowing more efficient use of all context-compatible information systems that may be combined under a common interface. The context includes at least five elements: patient, practitioner, problem, procedure and policy. A context-sensitive drug prescription support system, for example, would allow the user to view a laboratory result in one software application, then immediately switch to a drug database where a search for drug dosing modifications can be made based on prior knowledge of the patient's age and primary medical problems.
- **Coupled** systems automatically link knowledge to observations, given a specific clinical event. A coupled drug prescription system, for example, would alert the clinician to alternative, potentially cheaper, interventions just before a prescription is generated.

- **Cognizant** systems use artificial intelligence to respond to clinical events, detect patterns, and determine which knowledge resources are most appropriate for problem solving. No such systems exist today.

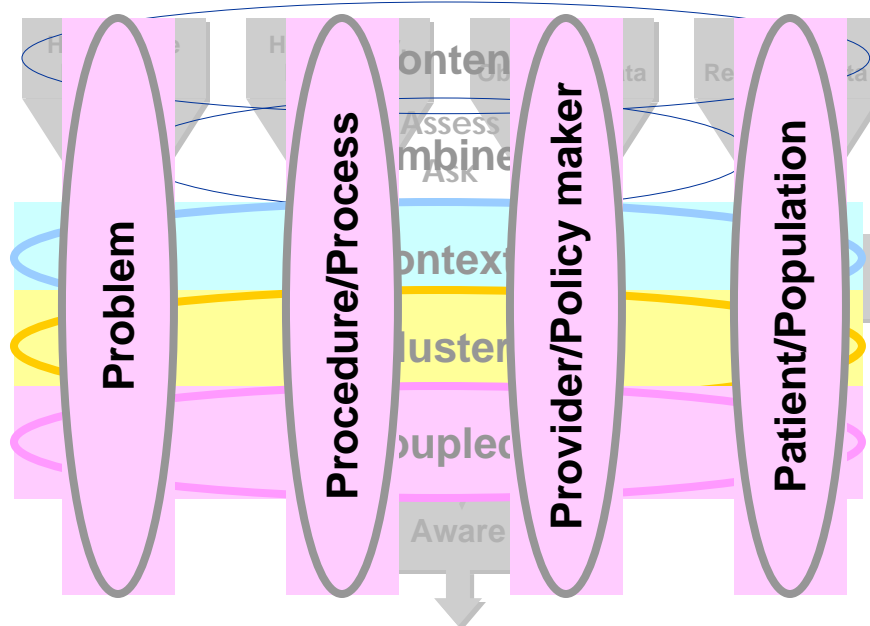
Health Information Integration



The most advanced clinical information environments present each user with their own unique mix of software, communications tools, educational resources and feedback. The user's information "personae" becomes part of a computing context that all software applications can access.

Indeed, a new Clinical Context Object Workgroup (CCOW) standard specifies how multitasking computers can set a **patient, practitioner, problem** and **practice** context known to all applications.

Health Information Integration



Implications

Governments and institutions realize that large investments in infostructure are required. Indeed, information communications technology is a healthcare expenditure that is expected, per capita, to steadily increase over the next decade. As hospitals begin to spend, they meet pent-up demand with relatively large system-wide hardware upgrades. Large investments in software systems follow. The biggest expenditures will be for integrated electronic medical records and the newest expenditures will be for knowledge-based software. Region-wide investment will emphasize inter-institution communication and exchange of data at all levels.

In general, available hardware is overpowered for the available software. Current computer hardware poses no functional barriers to health infostructure development. Indeed, from a functional point of view, the rate-limiting step is availability of useful, integratable computer software.

As software development tools become easier to use and standardized programming languages extend Internet-based information development, a new generation of clinician-informaticians will dilute the power and influence of computer engineers. New software will better reflect the needs of health practitioners, while generating byproduct databases that meet the needs of health administrators. Change management and professional development initiatives should alert physicians to emerging specialization and retraining options in health informatics.

The Internet as a source of health information is expanding at an exponential rate. The vision of using it for dissemination, education and communication is becoming widespread, even among information technology neophytes. Every organization in health care is spending money and effort to explore the way it can use the Internet. The unique features of internet-based projects are their immediacy, ease of access and interactive nature. Information organizations that want access to the health sector of the next decade, should focus their attention on Internet-based strategies for information and software dissemination. The power and potential of the Internet to reach providers and patients, as well as gather data on populations, will redefine the communication structures of health care, and transform expectations about the quantity and quality of evidence that can be gathered.

Information convenience is the first and most pressing need for busy practitioners. Even the provision of a simple drug information system and a general electronic textbook alongside clinical laboratory results would

represent a leap forward in most learners access to information. Stakeholders should not wait for replete, stable, information systems to appear or for electronic health records to be developed but should start soon with small, high-impact, combinations of existing clinical and knowledge-based systems. These will generate comfort, demand and taste for more online information.

The great promise of health informatics could be marred by a number of non-technical barriers:

- Overemphasis on technological protections of privacy hamper information access while failing to protect the interests of patients and populations.
- Lack of agreed standards for coding, classification and communication of health risks, clinical events, health outcomes, costs, and considerations of validity, importance and applicability.
- Poor connections between regional, provincial and national databases contribute to inefficient duplication of effort and lost opportunities for distilling intelligence from information.
- The profession of medicine has enjoyed a monopolistic control over its intellectual territory, demarcated by semantic (medical vocabulary and jargon) and intellectual (restricted distribution of medical knowledge) privileges. The Internet has broken down these barriers, giving full access to medical knowledge to the general public. But naïve users of these databases are equally exposed to casual and reputable sources, without clear distinctions between them.
- The Internet erodes traditional copyright, publishing, and intellectual property protections. Refined knowledge is in demand. But how can it be sold in ways that preserve both credibility and sustainability?

Information Culture

The organizational charts of most healthcare institutions feature sections for selecting, installing, maintaining and enhancing computer systems and software. In the days of mainframe computers, “Information Technology” (IT) departments focused on the things of computing – wires and machines – and employed specialized technicians to care for a centralized infrastructure. IT infrastructure is determined by the types and capabilities of computers, and the distribution of computing resources in a healthcare organization.

As personal computers proliferated, new computer users emerged with new demands for training and support. IT departments gave way to “Information Services” (IS) departments focused on the people of computing -- diverse consumers doing diverse jobs – and employed a new cadre of information specialists to build “infostructure” throughout the health care institution.

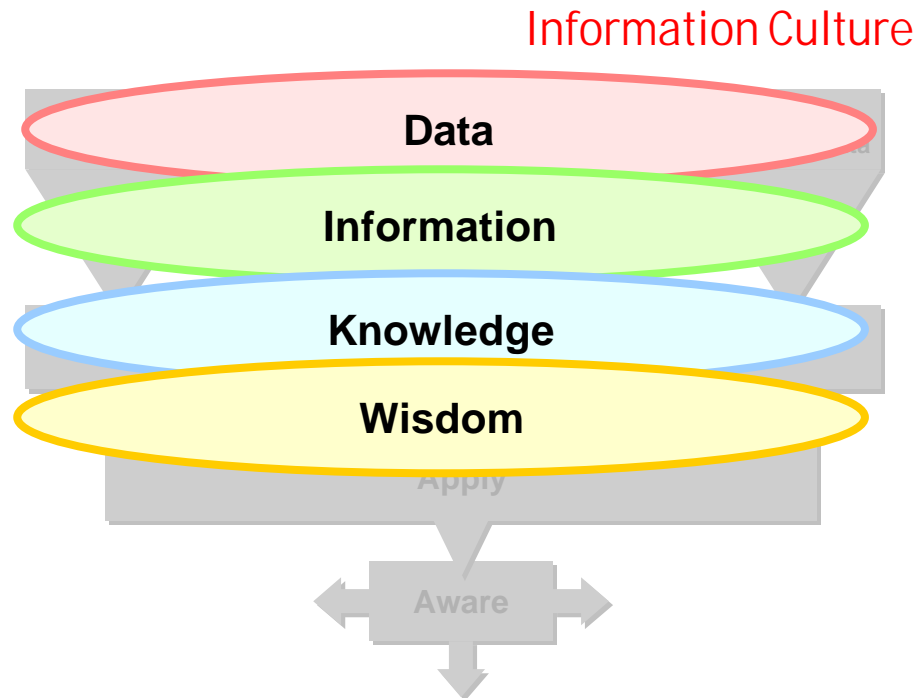
The organizational charts of healthcare institutions increasingly feature sections for optimizing the flow of information through an organization. “Information Management” (IM) departments treat information as a commodity; intellectual capital that can be acquired, channeled, and warehoused to improve the efficiency and effectiveness of healthcare processes. A few leading-edge health institutions are beginning to shift and influence the “Information Culture” that determines how organizations build and deploy intellectual capital.

Health Intelligence

An informed information culture emerges from explicit processes that support the following four strata of interpretation:

- **Data** constitutes the raw observations associated with health interventions (e.g., physical examination, laboratory tests, treatment result, etc.).
- **Information** exists when the significance of data is determined for a particular problem, patient and practitioner (e.g., the physical examination is abnormal, laboratory test elevated, or treatment result successful).

- **Knowledge** is abstracted from information when external evidence is used to anticipate how additional interventions could change the data (e.g., surgery will cure the physical finding, or a drug will normalize the laboratory test result and prevent disease).
- **Wisdom** is added to knowledge when internal data and external evidence is integrated with considerations of preference, values, and costs to determine whether and how the primary intervention should have been performed in the first place.



Key trends in information management relate to how internal health data is captured, information is codified, knowledge is coupled, and wisdom is generated.

Data

There is a push to move health data capture as close as possible to the data source. Instead of having clerical staff in hospital pharmacies enter medication orders to centralized databases, for example, physician and nurse order-entry systems increasingly are used to record information at source. This reduces duplication. It also allows clinical decision support systems to analyze and influence the medication requests by, for example, automatically identifying drug-drug interactions. By embedded data capture capabilities in tools commonly used during health care; it becomes possible to observe a much wider range of health care practices.

Data capture will become an integral, implicit, part of day-to-day healthcare. As more and more healthcare tasks are computerized, information systems will measure and record more information about how health practitioners work. This information can then be analyzed and used to generate feedback that could change health practices.

Information

With the capture of more data about health care processes and outcomes, huge databases accrue. But the data is of little value unless it can be classified and shared between health information systems.

Advances in codification of clinical observations, diagnoses, health interventions and outcomes have, more than any other development, enabled the harvesting of internal evidence from health databases. Standardized vocabularies for describing signs and symptoms (e.g., SNOMED index), allow better interpretation of health observations, converting them to secondary databases of health information. International classifications of disease allow the experiences of different healthcare environments to be compared. Protocols for communicating clinical information (e.g. Health Language 7, HL-7) allow different computers running different software to exchange information.

Sophisticated software has been produced to automate much of the yeoman's work of document indexing. But these systems still fail for lack of fail-safe methods for identifying patients, practitioners, and events. The simple act of recognizing a specific patient, provider, time and place has proved surprisingly difficult, yet is essential for dredging information from data. The development of regional health information systems has encouraged the creation of central patient registries and general person indexes. These will become increasingly influential for inter-database communications.

Knowledge

When decision-makers seek information about health problems, they need specific details about a health condition or intervention. In addition, decision-makers need to hone in on applicable (matching the patient, practitioner and circumstances of interest), important (reporting something that patients would care about), and valid (satisfying pre-defined criteria for believing what is reported) information. Most existing knowledge resources are not organized in ways that support clinical decision-making.

In general, existing coding and classification schemes emphasize questions of relevance over questions of usability. Some are optimized for describing clinical events, including diseases (e.g., ICD-9) and interventions (e.g., CPT), while others were developed for health knowledge. In order for knowledge-based software to be coupled with other information systems, there needs to be a middle-layer of "concepts" that the clinical software can refer to when linking to the knowledgebase.

By mastering the principles and techniques of concept mapping, software vendors will be able to maximize application of knowledge to health information databases.

Wisdom

The most difficult task in information management is to present data, information, and knowledge in ways that facilitate the accrual of wisdom about how to make the entire system perform better. Wisdom is not a derivative attribute; it is not something that can be deduced from observations. Experienced practitioners and policy makers observe growing databases for patterns and connections. This pattern recognition then leads to hypotheses about how data could be interpreted differently or knowledge could be applied alternately. To support the cognitive processes of wisdom-generation, management information systems will be developed to help decision-makers perceive patterns and trends in large data repositories.

Health Communication

The health care sector prefers oral communication to any other method of information exchange. Physicians, in particular, learn best when in conference with a trusted colleague or "opinion leader."

Much of the excitement about the potential of modern health information systems relates to their emerging ability to combine inter-professional communication with online information convenience and discrimination.

To the extent that electronic mail, discussion forums, electronic knowledge-bases and health data can be seamlessly combined in a common "virtual bedside", there is a greater likelihood that information systems will become an integral part of the health care information culture.

Implications

Improved access to internal evidence will result from investments in more efficient health administration practices:

- Case costing systems will generate information about the frequency and outcomes of health interventions.
- Health claims databases will be linked to hospital, practitioner and pharmacy databases, yielding new intelligence about health services utilization by health condition, health intervention and health practitioners and patients.
- Automated patient data-collection devices will improve surveillance of individual health risks, health status and preferences.

Improved access to external evidence will result from new regulatory requirements that health practitioners and institutions justify choices with best evidence about effectiveness:

- The accreditation of health institutions increasingly will require practitioner and policy-maker access to best evidence.
- Access to health practice training programs will become contingent upon rapid access to clinical and research data in clinical teaching environments.

Practitioner interest and adoption of new health information systems will be enhanced by:

- Simultaneous attention to information communication, convenience and integration needs in education and practice.
- Emphasis on the communicative capabilities of computers and their ability to enhance inter-professional discourse and reflection on health data and knowledge.

Change management initiatives should embrace and extend the emerging information culture in health care by:

- Building virtual learning communities that use information technologies to extend learning and communication across time and space.

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