Focus on **Informatics in Support of Evidence-based Practice**

Viewpoint ■

An Informatics Infrastructure Is Essential for Evidence-based Practice

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Abstract The contention of the author is that an informatics infrastructure is essential for evidenced-based practice. Five building blocks of an informatics infrastructure for evidence-based practice are proposed: 1) standardized terminologies and structures, 2) digital sources of evidence, 3) standards that facilitate health care data exchange among heterogeneous systems, 4) informatics processes that support the acquisition and application of evidence to a specific clinical situation, and 5) informatics competencies. Selected examples illustrate how each of these building blocks supports the application of evidence to practice and the building of evidence from practice. Although a number of major challenges remain, medical informatics can provide solutions that have the potential to decrease unintended variation in practice and health care errors.

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A number of authors have highlighted the ubiquity of variation in practice and have urged that clinicians move toward evidence-based practice.[1–4] However, a number of barriers have been identified. These include the rapid rate of medical knowledge development, inadequate access to clinically relevant information at the point of need, increased workload and patient complexity, and difficulty translating the evidence for use with a particular patient.[5–8]

While recognizing that medical informatics is not the panacea for reducing all barriers to evidence-based practice, the contention of the author is that an informatics infrastructure is essential for such practice. This contention is based on two underlying premises. First, in contrast to traditional conceptualizations of evidence-based practice, which typically refer to randomized clinical trials, systematic reviews, and practice guidelines as the sources of evidence that are integrated with clinical expertise for practice decisions,[9] evidence is more broadly conceptualized as a continuum of synthesized information. This continuum ranges from the "gold standard" of randomized clinical trial findings to aggregated data from the encounters of an individual clinician or experiences of an individual client. This is consistent with the vision of informatics pioneer Marsden Scott Blois, who stated

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Table 1 ■

Examples of How Proposed Building Blocks of an Informatics Infrastructure for Evidence-based Practice Support Applying Evidence to Practice and Building Evidence from Practice

Building Block	Applying Evidence to Practice	Building Evidence from Practice
Standardized terminologies and structures	Provide basis for indexing digital sources of evidence and matching sources to clinician-specific needs Standards for representation of knowledge facilitate the application of decision support rules	Facilitate the creation of "computable" electronic patient records Formalize the documentation of the clinical decision-making process "Computable" representations of terminologies support data aggregation and re-use across heterogeneous representations
Digital sources of evidence	Provide access to evidence	Acquire, monitor, and transform physiologic data in real time.
Data exchange standards	Support the communication among computer-based systems to bring together patient data and decision logic Facilitate the delivery of tailored health-related messages based on patient-specific data.	Support aggregation of data across time and geography to link process to outcomes
Informatics processes	Integrate and link heterogeneous sources of evidence Present clinician alerts related to potential adverse events Use decision analytic techniques to tailor evidence to specific patients	Perform data modeling and aggregation in clinical data repositories Perform data mining
Informatics competencies	Retrieve clinically relevant sources of evidence through the use of search tools Perform critical analysis of evidence for its applicability to practice	Analyze individual practice patterns over time from clinical data repository Evaluate effects of evidence-based practice recommendations in the clinical setting

Table 2 ■

Examples of Types and Sources of Digital Evidence

Types	Sources
Bibliographic:	
Primary literature—	
Traditional	MEDLINE, Cumulative Index of Nursing and Allied Health Literature (CINAHL)
Full text	OVID database; individual journals (e.g., *British Medical Journal, Australian Electronic Journal of Nursing Education*)
Structured reporting	Trial bank
Synthesized—	
Electronic textbooks	*Harrison's Principles of Medicine, Kaplan and Sadock's Comprehensive Textbook of Psychiatry*
Systematic reviews	Cochrane Collaboration, Joanna Briggs Institute for Evidence-based Nursing & Midwifery
Practice parameters:	
Standards of care	American Association of Critical Care Nurses
Practice guidelines	National Guideline Clearinghouse, American Academy of Pediatrics
Disease management plans	American Diabetes Association
Comparative databases:	National Nursing Quality Indicator Database, Health Plan Employer Data and Information Set (HEDIS); California Office of Statewide Health Planning and Development
Knowledge bases:	
Diagnostic decision support	DXplain, Iliad
Pharmacy	National Drug Data File, Micromedix
Genomic	Genbank, Molecular Modeling Database

that clinicians at the point of care should be able to query a database to answer questions such as "What did I do the last time I saw a similar patient?"[10] Second, most definitions of evidence-based practice (e.g., those given by Sackett et al.[9] and Friedland[11]) focus on accessing, critically analyzing, and applying evidence to practice. In contrast, the second underlying premise of the author is that an informatics infrastructure for evidence-based practice must also facilitate the building of evidence from clinical practice.

Five components are proposed as the building blocks of an informatics infrastructure for evidence-based practice: 1) standardized terminologies and structures (i.e., terminology models), 2) digital sources of evidence, 3) standards that facilitate health care data exchange among heterogeneous systems, 4) informatics processes that support the acquisition and application of evidence to a specific clinical situation, and 5) informatics competencies. Table 1 displays selected examples of how the building blocks support the application of evidence to practice and the generation of evidence from practice.

Tremendous progress in the development of the individual building blocks of an informatics infrastructure for evidence-based practice has occurred. In particular, sources of digital knowledge have rapidly increased. Representative sources are shown in Table 2 .

However, major challenges remain. These include:

- Development of business models that support cost-effective and efficient development and dissemination of high-quality digital sources of evidence[12]
- Achievement of consensus standards for describing, organizing, obtaining access to, and archiving electronic information sources[12]
- Optimization of information retrieval strategies for clinical relevance[8,13]
- Integration of the evidence-based practice infrastructure building blocks to support the context-specific retrieval and application of evidence in practice and to facilitate the development of evidence from practice
- Incorporation of principles of evidence-based practice and the supporting informatics tools into clinical processes and organizational structures
- Development of informatics competencies related to evidence-based practice in the health care professional work force

Although these challenges are not small, they suggest areas in which medical informatics can contribute solutions that have the potential to decrease unintended variation in practice and health care errors.

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References ■

1. Wennberg J. Understanding geographic variations in health care delivery. N Engl J Med. 1999;240(1):52–3.
2. Birkmeyer J, Sharmp S, Finlayson S, Fisher E, Wennberg J. Variation profiles of common surgical procedures. Surgery. 1998;124(5):917–23.
3. Smith L, Besser S. Dietary restrictions for patients with neutropenia: a survey of institutional practices. Oncol Nurs Forum. 2000;27(3):515–20.
4. Holzemer WL, Reilly CA. Variables, variability, and variations research: implications for medical informatics. J Am Med Inform Assoc. 1995;2(3):183–90.
5. Richardson WC. To err to human: building a safer health system. Washington, DC: National Academy Press, 1999.
6. McAlister F, Straus S, Guyatt G, Haynes R. Users' guides to the medical literature, part 20: integrating research evidence with the care of the individual patient. JAMA. 2000; 283(21):2829–36.
7. Daley J. Medical uncertainty and practice variation gets personal: What should I do about hormone replacement therapy? Ann Intern Med. 1999;130(7):602–4.
8. Hersh W. "A world of knowledge at your fingertips": the promise, reality, and future directions of online information retrieval. Acad Med. 1999;74(3):240–3.
9. Sackett DL, Richardson WS, Rosenberg W, Haynes RB. Evidenced-based medicine: how to practice and teach EBM. Edinburgh, UK: Churchill Livingstone, 1998.
10. Blois MS. Information and Medicine: The Nature of Medical Descriptions. Berkeley, Calif: University of California Press, 1984.
11. Friedland DJ. Introduction. In: Friedland DJ (ed). Evidence-based Medicine: Framework for Clinical Practice. Stamford, Conn: Appleton & Lange, 1998:1–8.
12. Humphreys BL. Electronic health record meets digital library: a new environment for achieving an old goal. J Am Med Inform Assoc. 2000;7:444–52.
13. Haynes R, Wilczynkski N, McKibbon A, Walker C, Sinclair J. Developing optimal search strategies for detecting clinically sound studies in medline. J Am Med Inform Assoc. 1994;1(6):447–8.