The Role of Health Information Technology in Quality Improvement in Pediatrics

Alan E. Zuckerman, MD[a,b,*]

KEYWORDS

• Health information technology • Quality improvement
• Pediatrics • Children • Interoperability

Health information technology (HIT) will play an important role in most efforts to improve the quality of pediatric medicine, as evident from the range of investigations and projects discussed in this volume. The importance of using information technology as an integral component of quality initiatives was identified early in the development of electronic medical records (EMR) in the classic paper by Clement McDonald, "Protocol-Based Computer Reminders, the Quality of Care and the Non-Perfectability of Man,"[1] That paper, published in 1976, demonstrated the need for computerized reminders in a crossover study in an internal medicine clinic. The role of HIT in quality improvement is not limited to tools integrated into EMR, but that remains an important strategy. Today, much attention is focused on interoperability of clinical systems that integrate and share data from multiple sources. There are also additional freestanding quality-improvement tools that can be used without an EMR. This article explores the many roles of HIT in quality improvement from several perspectives.

IDENTIFYING ROLES FOR HEALTH INFORMATION TECHNOLOGY WITHIN THE INSTITUTE OF MEDICINE DEFINITION OF QUALITY

In its 2001 report, *Crossing the Quality Chasm*, the Institute of Medicine set forward a six-part definition of quality and closely aligned each dimension of quality to the

[a] Department of Family Medicine, Georgetown University Hospital, 3800 Reservoir Rd NW # PHC2, Washington, DC 20007, USA
[b] Department of Pediatrics, Georgetown University Hospital, 3800 Reservoir Rd NW # PHC2, Washington, DC 20007, USA
* Department of Pediatrics, Georgetown University Hospital, 3800 Reservoir Rd NW # PHC2, Washington DC 20007.
E-mail address: aez@georgetown.edu

Pediatr Clin N Am 56 (2009) 965–973
doi:10.1016/j.pcl.2009.05.018 **pediatric.theclinics.com**
0031-3955/09/$ – see front matter

use of HIT.[2] Since that time, several pediatric investigators, most recently Spooner,[3] have expanded on this framework and illustrated its application. While it is easy to see how information technology directly affects safety, effectiveness, timeliness, and efficiency of care, the dimensions of equity and patient-centeredness are more elusive and harder to illustrate in meeting the quality-assurance needs of children. Equity is best represented as the use of HIT to reduce health disparities in children. Patient-centeredness represents the task of delivering patient care in the context of the patient's family and values. This has long been a quality goal for pediatric practice and an essential component of a medical home.[4] In 2009, a new report in the Institute of Medicine *Quality Chasm* series, *Computational Technology for Effective Health Care: Immediate Steps and Strategic Directions,* raises the challenge of ''crossing the health care IT chasm'' and creates a vision for twenty-first century health care and wellness through patient-centered cognitive support.[5]

FUNCTIONAL STRATEGIES FOR QUALITY IMPROVEMENT

Functional strategies separate systems that play an active, passive, or reporting role in quality improvement. A primary role of HIT is to help visualize data in an EMR. Documentation of care is often the focus of information system design. But attention should also be given to improving access to information in the record by making information more readily available and displaying that information in a way that can be understood quickly to support informed decision-making in a time-constrained patient-care environment. An important strategy for visualization is to aggregate and integrate data from multiple sources through interoperability among computer systems. Evaluation of growth and obesity, for example, is facilitated by extraction of all growth measurements and graphical display.[6] This function is more effective if measurements from other practices are combined with data in the current record. Complete immunization histories can be assembled by immunization registries[7] and aggregated medication histories are available through prescription benefit claims histories and data exchange among the inpatient, emergency, and ambulatory settings. Computer systems that deliver content and guidelines to the point of care assist quality improvement by integrating visualization of patient data with expert- and evidence-based guidelines. The Health Level 7 (HL7) information buttons enable integration of these external links into electronic record applications.

Systems that provide active clinical decision support represent a key goal for HIT and a national strategy and roadmap has been proposed by American Medical Informatics Association.[8] Such decision support may involve simple reminders for tasks that the clinician must perform or specific computer-generated orders and plans of care that can be implemented with a single click. Alternative HIT architectures for clinical decision support include self-contained decision-support modules used on the clinician's workstation or through access to a Web site. Interoperable clinical guidelines distribute decision logic using a rule-writing syntax, such as the Arden Syntax or GuideLine Implementability Appraisal,[9] that allows the EHR to run the rules on individual patient records at the time of care and generate advice that can be implemented during the visit. Because of the complexity and variability of decision-support requirements, focus has shifted to interoperable clinical data formats and Web services that separate the patient-care activities of the clinician (who may use a variety of computer systems) from the decision-support activities that can be performed at a central site independent of the site of patient care. Use of centralized Web-based decision support requires the use of deidentified

data so that only the responsible clinician knows the patient identification and the decision recommendations. The development of the HL7 Decision Support Service[10] has created a framework for this type of Web service, which has the potential to make decision support widely available. It eliminates the need for each vendor or each health care institution to develop its own version of the same decision-support tool because data from diverse systems and organizations can share a single provider of decision support. Immunization forecasting (reviewing the vaccine history to assess what additional vaccines are required or recommended) has been one of the greatest decision-support needs for children and also has been a very complex task to implement in multiple environments. Through the work of Integrating the Healthcare Enterprise, standard profiles for sending immunization data[11] are now available and standard Web services are under development that can be shared by multiple EHR vendors and provided by multiple decision-support providers.

The newest role for HIT is to extract data for external quality reporting by providing an automated alternative to manual chart review. This task is most challenging because quality measures are more complex than the types of chart abstraction tools used for clinical research chart review. Many quality measures are population based and call for reports of percentages of children receiving appropriate services. Many others are time based and seek to identify status and outcomes at a point following initial diagnosis or treatment. Exclusion and inclusion criteria must be considered and some may require a minimal sample size. The Agency for Healthcare Research and Quality and the National Quality Forum are working to develop templates for automating chart review and quality reporting. The needs of children must be included.[12]

TYPES OF HEALTH INFORMATION TECHNOLOGY TOOLS FOR QUALITY IMPROVEMENT

Tools that are integrated into an EMR have become the standard approach to the use of HIT at the point of care, but other approaches should be considered. Tools that provide interoperability among information systems address the task of aggregating and assembling data for quality care decisions. Such tools are important in the care of children because of the need to monitor longitudinal data and be aware of events in other provider settings, particularly when a child is not accompanied by the parent who may have brought the child to an emergency room or to another encounter. Tools that are freestanding and used separately from the process of documenting care, are important because of the low EHR adoption rate in pediatrics.[13] Freestanding quality assurance is usually performed with Web-based tools and applications for mobile or handheld devices, such as cell phones and personal digital assistants. The mobile Internet browser on a cell phone is merging the two technologies of handheld applications and Web access in a single device. Tools for data mining and information discovery can use practice records to seek evidence for quality initiatives, evaluate specific needs of a practice for quality improvement, and generate patient-specific reminders for deficiencies, such as missing immunizations or screening tests. The use of service-oriented architecture (SOA) or Web services is an important strategy for sending patient data to a Web service that reviews the data and returns assessments and advice. SOA can also be used as a strategy to extract specific data elements from a practice information system through queries that select patients and return only the information needed for quality measurement or improvement, thus protecting patient privacy by excluding data not needed for the current analysis.

FEDERAL STRATEGIES FOR USING HEALTH INFORMATION TECHNOLOGY FOR QUALITY IMPROVEMENT

The Decade of Health Information, which began with the executive order creating the Office of the National Coordinator for Health Information Technology on April 27, 2004, has a 10-year goal for computerizing medical records for most Americans.[14] It was inspired by "Revolutionizing Health Care Through Information Technology,"[15] a report of the President's Information Technology Advisory Committee, and a later report, "Ending the Document Game," from the Congressional Commission on Systemic Interoperability.[16]

The federal strategy for using HIT for quality improvement, articulated through the strategic plans of the Office of the National Coordinator for Health Information Technology, involves a five-step process: (1) setting priorities for breakthroughs or transformations in health care than can be achieved through use of HIT, (2) development and harmonization of standards, (3) certification of EHR based on use of standard criteria, (4) creation of the Nationwide Health Information Network, and (5) monitoring of implementation and adoption. Throughout this process, attention is also given to protection of privacy of personal health information and to governance of networks and information exchange with goals of improving transparency of information while improving safety, increasing effectiveness, and reducing cost through quality improvement.

The setting of priorities began with the American Health Information Community and its workgroups and is now moving to successor organizations and advisory committees. The Health Information Standards Panel[17] has been responsible for standards harmonization and the Commission for Certification of Health Information Technology[18] has been the certification body. Several trial implementations of the Nationwide Health Information Network have demonstrated the breakthrough priorities in a variety of communities.[19] Many federal agencies have played a role in using HIT for quality improvement in children. The Agency for Healthcare Research and Quality[20] has funded a range of related projects, called Transforming Healthcare Quality Through Information Technology, and the Health Resources and Services Administration[21] has developed an HIT Toolkit to assist community health center networks in deploying HIT to improve quality. The National Institutes of Health has launched several translational research network projects to gather evidence for quality improvement, including the Newborn Screening Translational Research Network.[22] The Centers for Disease Control and Prevention has established the Public Health Information Network and provides important child health data on its Web site.[23]

A review of activities from the Office of the National Coordinator for Health Information Technology shows that use cases initiated under the federal HIT initiatives cover a wide range of quality-improvement targets:[24]

Consumer Empowerment: Registration & Medication History
: This is a core summary record that transfers critical data from a personal health record or another EHR that might otherwise come from a waiting room clipboard and allows updates at each visit. Its use for children is an important strategy for supporting safe electronic prescribing in the context of past and current problems, medications, and allergies along with administrative assistance with demographics, insurance, and usual pharmacy.

Electronic Health Record: Laboratory Result Reporting
: This assures that results are correctly transcribed into an EHR for review by a provider and for comparison with previous values. The challenges of result

management in pediatrics have been identified as a quality-improvement target in pediatrics suitable for HIT interventions.[25]

Bio-Surveillance: Visit, Use, and Lab Result Data Remote Monitoring

This was intended as a tool for uncovering patterns of disease in the community, which could then inform providers of the risk of problems they might not otherwise expect. The target measures for bio-surveillance are designated by a separate data committee and transmitted using a standard set of electronic messages to capture data about visits or laboratory tests. The intended setting is primarily the emergency room, but the methods can also be applied to ambulatory visits in sentinel practices or to hospital admission. Separate tools are used to analyze and identify patterns in the data, which are reported on a continuous and timely basis.

Emergency Responder Electronic Health Record

This represents an attempt to improve quality through delivery of essential medical data in the field at times of accidents or disasters so as to maintain continuity of care and to avoid medication errors in emergencies. Data are moved from a previous medical summary to first-responder records, to emergency department records, and to definitive care, and are available to future primary care providers.

Consumer Empowerment: Consumer Access to Clinical Information

This extended the original use case to include a broader view of personal health records and their use to inform patients about their care. Children with special needs and chronic conditions can benefit as well as parents of all children. Adolescents create special privacy concerns as well as the need to assess their readiness to review their own laboratory results.

Medication Management

This addresses the medication reconciliation process at times of changes in providers, such as on admission and discharge from the hospital.

Quality

This is a use case for automated extraction of quality measures from an electronic health record based on a query template. Like bio-surveillance, the use case provides tools for sending data. Other committees must generate the targets of what data to send.

Patient Provider Secure Messaging

This extends encounters for patients with chronic conditions by messaging between office visits.

Personalized Healthcare

This brings genomic information to the provider through the collection of family health histories that can be transferred between systems and used as input for risk-analysis programs. The use case also provides a means of storing genetic testing data in an EHR. Genomic data carry lifelong significance and use of genetic testing and family history data should be part of quality child health care.

Consultations and Transfers of Care

This uses a structured medical summary to replace letters and can improve the sharing of data between primary care and specialists, thus facilitating better comanagement. Electronic documents that conform to the HL7 Clinical Document Architecture have a header section that allows automated filing of the letter into the correct patient chart with annotation of subject, type of document, and clinical encounter that generated the letter. Such electronic documents represent an improvement over dictated letters scanned into an

EHR. Clinical Document Architecture documents also include optional discrete coded data fields extracted from the human readable text. These make it possible for such data as diagnoses and codes, medication and doses, laboratory results, and vital signs to be extracted from the letter and copied into the patient's EHR for reuse and graphical display.[26]

Public Health Case Reporting

This sends electronic messages to health departments for reportable diseases.

Immunizations & Response Management

The most important use case for children, this enables sharing of immunization records between practices and immunization information systems or immunization registries.

Newborn Screening

This is a use case that addresses the mandatory interoperability that must occur among hospitals, public health workers, consumers, and ambulatory practices both for the initial screening as well as confirmatory testing and referral for management and follow-up of conditions detected. These data exchanges occur on paper and by phone if HIT tools are not mobilized to assure the completion of the process.

Medical Home: Problem Lists & Practice-Based Registries

This identifies key EMR enhancements required to deliver HIT support for a pediatric medical home model through enhanced problem lists and practice-based registries that allow tracking of services and guideline compliance for patients with chronic diseases and other special needs.

Maternal and Child Health

This addresses data integration issues among various providers and public health agencies needed to deliver available services to pregnant women and their infants.

Additional use cases, gaps, and extensions

Additional use cases, gaps, and extensions under development include those related to general laboratory orders, order sets medication gaps, clinical note details, common device connectivity, long-term care—assessments, consumer adverse event reporting, scheduling, prior authorization in support of treatment, payment, and operations.

STATE STRATEGIES FOR USING HEALTH INFORMATION TECHNOLOGY FOR PEDIATRIC QUALITY IMPROVEMENT

State strategies for using HIT for quality improvement are of special importance to children because of the role states have in controlling Medicaid and State Children's Health Insurance Programs and in integrating quality monitoring requirements into those programs. In October 2008, the State Alliance for e-Health issued its first report to the nation, *Accelerating Progress: Using Health Information Technology and Electronic Health Information Exchange to Improve Care*.[27] The report addresses recommendations on the state role in using HIT and health information exchange, including making a patient-centered, interoperable, and portable EHR available for every child by 2014. Medicaid Transformation Grant Programs have the potential to support new quality initiative infrastructures for children and many focus on improving data integration among diverse systems for Early and Periodic Screening Diagnosis and Treatment programs, immunization registries, and lead screening. School health programs represent another opportunity for quality improvement outside of conventional practice settings. Payer strategies for using HIT for pediatric quality

improvement are often referred to as pay for performance. Projects within state Medicaid programs also have private-sector counterparts that may share criteria. Consumer strategies for using HIT for pediatric quality improvement include personal health records and efforts to improve transparency of quality and cost though health value exchanges.

Health information exchange strategies for using HIT for pediatric quality improvement may include placing HIT in practices so they can communicate with each other. The New York City Department of Health has installed electronic health records in over 1000 practices. MassShare, the state-level health information exchange for Massachusetts, is engaged in similar community-wide HIT implementations.

Section 1139A(d)(1)(D) and 1139A(f) of the Children's Health Insurance Program Reauthorization Act of 2009 calls for a project to demonstrate the impact of a model EHR format for children as part of quality measures for child health. This format will ''allow interoperable exchanges that conform with Federal and State privacy and security requirements,'' will be ''structured in a manner that permits parents and caregivers to view and understand the extent to which the care their children receive is clinically appropriate and of high quality,'' and will be ''capable of being incorporated into, and otherwise compatible with, other standards developed for electronic health records.'' Newborn screening and newborn hospital discharge summaries could be a foundational component.

PRIVATE SECTOR STRATEGIES FOR USING HEALTH INFORMATION TECHNOLOGY FOR PEDIATRIC QUALITY IMPROVEMENT

The private sector has also developed strategies for using HIT for pediatric quality improvement through initiatives of professional societies and the work of organizations that advocate for the health of children. The Alliance for Pediatric Quality brings together several professional societies working on quality care for children.[28] The American Academy of Pediatrics Partnership for Policy Implementation seeks to create computable guidelines that will allow HIT to be mobilized to implement guidelines for care.[29] The special pediatric requirements for use of HIT have been well articulated in a policy statement from American Academy of Pediatrics[30] and in the HL7 EHR functional model for children. Children's hospitals have played an important role in advancing the use of HIT for quality improvement and also in providing personal health records for the children they serve to help maintain continuity of care among children with special needs and chronic diseases.[31] The use of HIT to reduce health disparities in children remains a frontier where HIT may be able to exert a leveling influence to improve quality and health outcomes.

DISASTER PREPAREDNESS AND USING HEALTH INFORMATION TECHNOLOGY FOR PEDIATRIC QUALITY IMPROVEMENT

Experiences of children following Hurricane Katrina have created a new awareness of the vulnerability of children.[32] The disruption of newborn screening programs and management of children with genetic disorders is a problem that HIT might address by helping to maintain continuity of services. The joint policy on emergency information forms for children with special needs developed jointly by The American Academy of Pediatrics and the American College of Emergency Medicine should be applied to all children. Forms are available on the Web and families are encouraged to keep these forms available when emergency care is needed. HIT can address this need and improve transfer of data from electronic records.

ON THE HORIZON

On February 17, 2009, President Obama signed the economic stimulus package, the American Recovery and Reinvestment Act, which provides $19 billion for health care information technology. The funds will be Medicare and Medicaid incentives for the adoption of the EHR and support for health information exchanges, EHR adoption, and other HIT efforts that depend on the evolving definition of ''Meaningful Use''.[33]

SUMMARY

HIT holds great promise for supporting quality-improvement efforts in pediatrics. Activities will continue to include a variety of strategies to make more data available when care decisions are made, to make guidelines on appropriate care available at the point of care, to automate the decision process and reminder process through clinical decision support, and to monitor the need for targeted intervention through quality reporting. Quality-improvement and monitoring activities based on the use of paper charts are resource intensive and can reach only a limited population. The use of HIT tools for quality improvement can integrate quality improvement into routine care for all children and make continuous quality improvement feasible.

REFERENCES

1. McDonald CJ. Protocol-based computer reminders, the quality of care and the non-perfectability of man. N Engl J Med 1976;295(24):1351–5.
2. Institute of Medicine, Committee on Quality of Health Care in America. Crossing the quality chasm. A new health system for the 21st century. Washington, DC: National Academy Press; 2001.
3. Spooner SA, Classen DC. Data standards and improvement of quality and safety in child health care. Pediatrics 2009;123(1):S74–9.
4. American Academy of Pediatrics, Medical Home Initiatives for Children with Special Needs Project Advisory Committee. Policy statement: the medical home. Pediatrics 2002;110(1):184–6, Reaffirmed May 2008.
5. Stead WW, Lin HS, editors. Computational technology for effective health care: immediate steps and strategic directions. Washington, DC: The National Academies Press; 2009.
6. Rattay KT, Ramakrishnan M, Atkinson A, et al. Use of an electronic medical record system to support primary care recommendations to prevent, identify, and manage childhood obesity. Pediatrics 2009;123(1):S100–7.
7. Fiks AG, Grundmeier RW, Biggs LM, et al. Impact of clinical alerts within an electronic health record on routine childhood immunization in an urban pediatric population. Pediatrics 2007;120(4):707–14.
8. Osheroff JA, Teich JM, Middleton B, et al. A roadmap for national action on clinical decision support. J Am Med Inform Assoc 2007;14(2):141–5.
9. Shiffman RN, Dixon J, Brandt C, et al. The GuideLine Implementability Appraisal (GLIA): development of an instrument to identify obstacles to guideline implementation. BMC Med Inform Decis Mak 2005;5:23.
10. Kawamoto K, Lobach D. Proposal for fulfilling strategic objectives of the US Roadmap for National Action on Decision Support through a service-oriented architecture leveraging HL7 services. J Am Med Inform Assoc 2007;14(2):146–55.
11. Integrating the Health Care Enterprise. Immunization profile page. Available at: http://www.ihe.net. Accessed April 7, 2009.
12. National Quality Forum. Project pages. Available at: http://www.qualityforum.org. Accessed April 7, 2009.

13. Kemper AR, Uren RL, Clark SJ. Adoption of electronic health records in primary care pediatric practices. Pediatrics 2006;118(1):e20–4.
14. Thompson TG, Brailer DJ. The decade of health information technology: framework for strategic action: delivering consumer-centric and information-rich health care. Washington, DC: Department of Health and Human Services; 2004.
15. President's Information Technology Advisory Committee. Revolutionizing health care through information technology. Washington, DC: National Coordination Office for Information Technology Research and Development; 2004.
16. Commission on Systemic Interoperability. Ending the document game: connecting and transforming your healthcare through information technology. Washington, DC: Government Printing Office; 2005.
17. Health Information Technology Standards Panel. Available at: http://www.hitsp.org. Accessed April 7, 2009.
18. Commission for Certification of Health Information Technology. Available at: http://www.cchit.org. Accessed April 7, 2009.
19. Office of the National Coordinator for Health Information Technology. Nationwide health information network pages. Available at: http://www.hhs.healthit/nhin. Accessed April 7, 2009.
20. Agency for Healthcare Research and Quality. Health information technology pages. Available at: http://www.ahrq.gov. Accessed April 7, 2009.
21. Health Resources and Services Administration. Maternal & child health pages. Available at: http://www.hrsa.gov. Accessed April 7, 2009.
22. National Institute of Child Health and Human Development. Newborn screening translational research network pages. Available at: http://nichd.nih.gov. Accessed April 7, 2009.
23. Center for Disease Control. Public health information network pages. Available at: http://www.cdc.gov. Accessed April 7, 2009.
24. Office of the National Coordinator for Health Information Technology. Use case pages. Available at: http://healthit.hhs.gov under Standards and Certification. Accessed June 19, 2009.
25. Ferris TG, Johnson SA, Co JPT, et al. Electronic results management in pediatric ambulatory care: qualitative assessment. Pediatrics 2009;123:S85–91.
26. Dolin RH, Alschuler L, Boye S, et al. HL7 clinical document architecture, release 2. J Am Med Inform Assoc 2006;13(1):30–9.
27. National Governors Association Center for Best Practices. State alliance for e-health pages. Available at: http://www.nga.org/center/health. Accessed April 7, 2009.
28. Miles PV, Miller M, Payne DM, et al. Alliance for Pediatric Quality. Alliance for Pediatric Quality: creating a community of practice to improve health care for America's children. Pediatrics 2009;123(1):S64–6.
29. American Academy of Pediatrics. Partnership for policy implementation pages. Available at: http://www.aap.org/qualityimprovement. Accessed April 7, 2009.
30. Spooner SA, Council on Clinical Information Technology. Special requirements of electronic health record systems in pediatrics. Pediatrics 2007;119:631–7.
31. Menachemi N, Brooks RG, Schwalenstocker E, et al. Use of health information technology by children's hospitals in the United States. Pediatrics 2009;123:S80–4.
32. Rath B, Donato J, Duggan A, et al. Adverse health outcomes after Hurricane Katrina among children and adolescents with chronic conditions. J Health Care Poor Underserved 2007;18(2):405–17.
33. Blumenthal D. Stimulating the adoption of health information technology. N Engl J Med 2009;360(15):1477–9.