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ORIGINAL PAPER

e-Portfolio Competency Metadata: Pilot Study for a Call to Action

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Abstract The six competency domains required by the Accreditation Council for Graduate Medical Education (ACGME) have led to a proliferation of measurement tools, assessment methods, and all forms of data from paper to electronic. The need exists to develop a standardized electronic (e)-portfolio to provide the aggregate data to improve education and patient care. This process requires a sound methodology using XML metadata to allow portability of e-portfolio data. We surveyed publicly available metadata and developed an e-portfolio system for the Henry Ford Hospital General Surgery Residency Program. Based on our implementation of e-portfolios for 70 physicians, we call upon the ACGME, the Residency Review Committees, and the American Board of Medical Specialties to establish a method to formalize and develop a standard for residency competency metadata. Using an approach similar to that of our study can streamline data and lead to improved medical education and ultimately better patient care.

Keywords ACGME · Residency · Metadata · e-portfolio

Introduction

The six competency domains of patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice are the organizing framework for education at the residency level (Accreditation Council for Graduate Medical Education [ACGME]) [1] and will soon become the organizing framework for maintenance of certification at the practicing physician level (American Board of Medical Specialties [ABMS]). Standardized measurement tools for determining competence across the continuum of training and practice have not yet been developed. Current approaches to evaluating competence use tools that assess discrete domains of educational experience or behavior. Quantitative methods, such as in-training exams, are part of the evaluative landscape. Other evaluation forms and performance artifacts are not yet easily assimilated into a total picture of resident performance. The need exists not only to establish thresholds of competence across the six domains but also to develop methods for tracking performance during residency training and to use aggregate data for performance improvement.

Ongoing attempts to comply with ACGME competency requirements have led to an explosion of documentary artifacts and data across all types of residencies. Such artifacts take the form of any media type from paper to video, emanate from a variety of sources, and require mapping to the relevant competencies. The tools available to organize, catalogue, and create context for such documentation are extremely limited. Most residency programs continue to rely on a paper file for each resident, organized by competency and referred to as a "portfolio" which contains a sampling of the resident's work in the six competency domains.

The use of an electronic portfolio (e-portfolio) system with extensible markup language (XML) metadata tags would vastly improve the organization, aggregation, and cataloging of this multitude of residency performance artifacts and allow for portability of a resident's portfolio. Little information exists on metadata within the realm of

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resident education, particularly in the context of the ACGME criteria [2–12]. Studies have primarily focused on metadata-driven experiences in electronic patient health records, clinical studies, public health and epidemiology, and even allied health education.

We undertook a survey of publically available metadata [13, 14] with the aim to develop and pilot a metadata standard for use within medical resident e-portfolios, using metadata schema consistent with the ACGME/ABMS competencies and the day-to-day needs of a surgical residency program. This report highlights a case study of the e-portfolio system we developed and currently use for the Henry Ford Hospital General Surgery Residency Program. Once defined, metadata tags can be used in the construction of individual, residency program, and institutional e-portfolios, and also in forming the foundation of an e-portfolio for maintenance of certification.

Environmental and tools assessment

Residency program directors must track the multi-year progress of their residents in gaining competence using available or achievable measurements and artifacts [15]. Organizing, cataloging, and aggregating these disparate documents, e-mails, evaluations, results, scores, presentations, and CDs presents a near impossible task. The evaluation software currently available in most residencies and Graduate Medical Education (GME) offices is characterized by high variability, non-connectivity, low technology, and significant resource constraints. Individual programs often develop their own software systems that range from simple spreadsheets to relational databases to enterprise-level solutions. Data obtained from multiple assessment sources is not portable, exchangeable, connected, standardized, or even valid in many cases.

Large multi-system or national initiatives for educational improvement rely on the collection of shared aggregate data. The Northern New England Cardiac Collaborative tracked safety and training metrics to reduce their mortality rate in half in multiple competing institutions [10]. Vendors of the electronic medical record, electronic medical administration record, picture archiving and communication system, and a variety of other patient care-related software products have collaborated on a standard called HL7, which has become a working model of interoperability of systems although compliance issues remain. In GME, no standardized method exists to share important performance data between residencies and institutions. The MedBiquitous consortium has diligently aimed to create technology standards in the domains of professional certification, health care competencies and learning, medical education metrics, and professional networking based on existing organizational XML standards such as the World Wide Web Consortium, HL7, and the Advanced Distributed Learning Initiative [11, 12, 16]. Their work has been adopted by the ABMS to collect certification data from members. MedBiquitous standards, however, have not yet been accepted by large-scale organizations to evaluate residency competencies. Bhupatiraju et al. [17] created an online tool suite for authoring e-learning metadata systems via an open source system. Some researchers have detailed the use of traditional and e-portfolios for targeted aspects of their respective residency programs. One study demonstrated the value of portfolios to assess residency problem-based learning and systems-based practice competencies, while another detailed an e-portfolio system to measure specific competency-based criteria for resident promotion [18].

Table 1 Subject demographics

Title	Type
LastName	String
FirstName	String
UniqueID	String
GradYrorPGY	Integer

Digital imaging as metaphor and model Through a collaborative approach, stakeholders with different motivations can organize a variety of data types from dissimilar sources. Take the example of digital cameras and their images. Every digital picture is accompanied by a standardized set of metadata describing the conditions of the camera, the image, and image type; this data is then used by the computer to produce an image [19]. The shared standardized language allows almost any digital camera to work with almost any computer, printer, or imaging software at a high degree of connectivity and interaction. At the processing and analysis level, multiple competing software vendors have image browsing and image workflow software that can read, organize, and analyze imaging metadata. This data can even be exported for further processing. Standards such as IPTC and EXIF speak to the power of metadata in the digital imaging realm.

XML As the internet continues to mature, the display and appearance-oriented hypertext markup language (HTML) is gradually being replaced by XML. This represents a

Table 2 Evaluator demographics

Name	
UniqueID	String
Dates	
ActualCreationDate	Date
Datacreation	Date
Modified	Date

Table 3 System user information

UserCreated	String
UserLastModified	String

fundamental transformation of the World Wide Web from displays of text to understanding this text as structured data [20, 21]. Indeed, XML allows for the creation of specific database languages and standards. It is now possible to define an XML standard of competency metadata to organize and assure connectivity of all educationally related data contained in an e-portfolio.

Case study of e-Portfolio development

We developed our current metadata schema based on our existing electronics, relevant paper files, competency-based artifacts (CDs, DVDs), as well as administrative and regulatory documents. Documents from 2001 for "test residents" were scanned into the electronic system via the Fujitsu Scansnap Scanner (A versatile scanner, such as the Scansnap, that can scan multiple sizes and immediately convert documents into a PDF format is particularly user-friendly for support staff and others who may not be experts in technology). A data dictionary for the proposed data standards was drafted and included such topics as media type, source, and organizational level of relevance. Commercially available image portfolio software products were utilized for prototyping and to assess methods of display and organization. Data export and reporting models were created. XML exporting was trialed for organization of metadata.

Table 4 Artifact or document descriptions

Title	Type	Explanation
Media Type	String	Document, e-mail, letter, presentation, image, video, website, audio
File type	String	xls,ptt,pdf,doc,txt,html,mpg, mp3,wav,jpg,wmf
DocumentCategories	String	Letter, e-mail, fax, evaluation, semi-annual review, event results, scholarly work, disciplinary action, certification, licensing, OSCE, OSAT, Mock Oral Exams, In-service,
Memo	String	Comments or even potentially the document itself, for example an e-mail could be pasted into this field

Table 5 Organizational relevance

Resident	Boolean
Residency	Boolean
Division	Boolean
Department	Boolean
GME	Boolean

An electronic version of a resident portfolio was created, demonstrating methods of browsing and summarization. Endless reporting possibilities emerged. Tables 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 illustrate the layout of our e-portfolio system. Tables 1, 2, and 3 describe proposed evaluee demographic labels, the dates relevant to the entry, and the user modifying this data. Table 4 describes the document both technically as file-type, and from the program and resident perspective. Table 5 provides the opportunity to organize data at the appropriate level of relevance to the organization. As data is summarized and aggregated, this will become increasingly important for program improvement and institutional performance excellence. Table 6 anticipates that disparate documents and types in different programs will have different importance and relevance. A weighting method will be essential to distribute data across competencies. In Table 7, we anticipate the need for multiple assessment tools with a variety of score types. Some assessment tools will yield dichotomous variables in the form of pass or fail whereas others will have categorical results and some will have simple scores such as percentiles and percentages. As long as the context is defined in the type, the data can be consistently interpreted and later analyzed. Table 8 describes the opportunity to have datasets refer to each other, be subordinate collections, and even represent periodic aggregations of data.

Our e-portfolio system includes a total of 70 residents with a sum of 1,960 files (average of 28 files per resident). Tables 9 and 10 illustrate a breakdown of the resident e-portfolio system by broad metadata categories and files, respectively. Table 9 lists in descending order of frequency the various metadata categories used in the e-portfolio system. Table 10 lists in descending order of frequency the

Table 6 Competency related information weighting and distribution of weight

Document overall weight	Number
Medical knowledge allocation	Percent
Patient care allocation	Percent
Professionalism allocation	Percent
Communications and interpersonal skill allocation	Percent
Practice based learning allocation	Percent
Systems based practice allocation	Percent

Table 7 Competency related grading and scoring distribution of grades and scores

Scoring type or method	String
Document overall score	String
Medical knowledge score	Percent
Patient care score	Percent
Professionalism score	Percent
Communications and interpersonal skill score	Percent
Practice based learning score	Percent
Systems based practice score	Percent

common metadata files in the e-portfolio system. Health Stream refers to online tutorials such as institutional review board (IRB) and health privacy (health insurance and portability accountability act [HIPAA]). Evaluative summaries, Licensing and Regulatory, Mentorship, Certificates, and Human Resources files account for over 74% of the documents in the e-portfolios. Other categories include the Electronic Residency Application System (ERAS), Standardized Test Results, and Interview Documents. Assessment of the individual files reveals that semi-annual reviews and self-assessment scores, state licensure, contracts, American Board of Surgery In-Training Examination (ABSITE), and Henry Ford Hospital Internal Training Documents account for the majority of file types. Other documents not mentioned in Table 10 include Advanced Critical Life Support Documentation (21 files), Mentor Meeting Checklists (19 files), Annual Progress Notes (18 files), and Academic reprimand (11 files).

The following illustration of a chief resident's e-portfolio provides a snapshot into our system. Resident X, in his final year of our General Surgery residency program, has 79 individual metadata files in his e-portfolio system. He has 14 files under the category of evaluative summaries. These include evaluative letters, an internship safety evaluation, a research project evaluation, and semi-annual reviews. He has 23 files under the category of certificates. These include certificates for microsurgery certification, university competencies, Health Stream training for IRB and HIPAA, and surgical honors society. Resident X's ERAS portfolios are divided into three files including curriculum vitae and essays. The Human Resources category consists of six files that are all contract-related. The Interview category consists of two interview evaluation

Table 8 Data hierarchy

Unique ID	Numeric
Subordinate	Boolean
Parent unique ID	Numeric
Aggregate	Boolean

Table 9 Frequency of metadata categories in resident portfolios

Metadata categories	Frequency	Percent
Evaluative summaries	399	20.4
Licensing and regulatory	311	15.9
Mentorship	296	15.1
Certificates	272	13.9
Human resources	176	9.0
ERAS (Residency Apps)	135	6.9
Test results	121	6.2
Interview documents	69	3.5
Miscellaneous	59	3.0
OSCE	58	3.0
Red file	20	1.0
Clinical skills & simulations	18	.9
Archive	17	.9
Personal publishing	5	.3
Case log documents	4	.2
Total	1,960	100

summaries during the resident's application process. The Licensing and Regulatory category contains 14 files including controlled substance screening, state licensing, and USMLE Steps I, II, and III. The Mentorship category includes eight files consisting of resident goals and

Table 10 Frequency of most common metadata files in resident portfolios

File type	Number	Percentage
Semi annual review	318	16.2
Self-assessment	144	7.3
State license	136	6.9
Contracts	127	6.7
ABSITE	111	5.7
HFHS internal training	103	5.3
ERAS documents	96	4.9
USMLE steps 1–3	90	4.5
Controlled substances	70	3.6
Personal goals	67	3.4
ORCA	66	3.4
Interview documents	63	3.2
OSCE	58	3.0
Miscellaneous	56	2.9
Health stream	55	2.8
Evaluative letters	50	2.6
HR documentation	47	2.4
Curriculum vitae	39	2.0
Graduation certificate	36	1.8

objectives and resident self-assessment. In the category of test results, resident X has five files from annual ABSITE exam scores, feedback, and percentiles. The miscellaneous category includes letters of appreciation. The publishing category includes PowerPoint presentations given in a conference setting and several peer-reviewed publications. This e-portfolio remains accessible and portable to resident X after graduation.

Next steps

The information technology revolution has heralded a new era in health care. The transition from paper to electronic data-driven organizations in medical education as well as patient care brings about both challenges and opportunities [22, 23]. While the ACGME developed the six core competencies to ensure that residency education adapts to shifting health care paradigms and provides goal-oriented standards to measure a training program's effectiveness, we now need assimilation of electronic tools as part of the delivery and measurement, as well as portability, of these core competencies.

Our pilot of an e-portfolio system for the Henry Ford Hospital General Surgery Residency Program demonstrates that metadata tags allow for aggregate assessment information to be determined for the individual resident, program, and institution. The use of aggregate assessment data is necessary to drive educational change within programs and institutions, and is also important in residents' self-reflection regarding their progress and goals. Similar metadata tags can be adopted in an e-portfolio for maintenance of certification and professional competence standards [24, 25].

The implementation of our e-portfolio system allows rapid access to a variety of resident data categories and files for residency directors during annual site visits by ACGME reviewers. In the future, we will further refine reporting based on ACGME competencies.

While resident portfolios are often used to both assess and aim teaching toward the ACGME competencies, studies have highlighted the wide variability in portfolio quality and utilization [18]. We believe the ACGME, in collaboration with its Residency Review Committees and in partnership with the ABMS, should establish a method to formalize and develop a standard for residency competency metadata. The metadata schema will provide a foundation for the development of e-portfolios that are portable and follow best practice implementation and assessment guidelines [18]. By allowing the collection and reporting of aggregate data, this approach will allow us to become data-driven organizations and improve medical education and, ultimately, patient care outcomes.

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