Published in final edited form as:
J Med Syst. 2017 May ; 41(5): 75. doi:10.1007/s10916-017-0716-5.

Structured Data Entry in the Electronic Medical Record: Perspectives of Pediatric Specialty Physicians and Surgeons

Ruth A. Bush, PhD, MPH,
University of San Diego: Beyster Institute for Nursing Research, Rady Children's Hospital: Clinical Informatics

Cynthia L. Kuelbs, MD,
University of California, San Diego: Department of Pediatrics

Julie Ryu, MD,
University of California, San Diego: Department of Pediatrics

Wen Jian, MD, and
University of California, San Diego: Department of Surgery

George J. Chiang, MD
Rady Children's Institute of Genomic Medicine

Abstract

The Epic electronic health record (EHR) platform supports structured data entry systems (SDES), which allow developers, with input from users, to create highly customized patient-record templates in order to maximize data completeness and to standardize structure. There are many potential advantages of using discrete data fields in the EHR to capture data for secondary analysis and epidemiological research, but direct data acquisition from clinicians remains one of the largest obstacles to leveraging the EHR for secondary use. Physician resistance to SDES is multifactorial. A 35-item questionnaire based on Unified Theory of Acceptance and Use of Technology, was used to measure attitudes, facilitation, and potential incentives for adopting SDES for clinical documentation among 25 pediatric specialty physicians and surgeons. Statistical analysis included *chi*-square for categorical data as well as independent sample *t*-tests and analysis of variance for continuous variables. Mean scores of the nine constructs demonstrated primarily positive attitudes toward SDES, while the surgeons were neutral. Those under 40 were more likely to respond that facilitating conditions for structured entry existed as compared to two older age groups ($p = .02$). Pediatric surgeons were significantly less positive than specialty physicians about SDES effects on Performance ($p = .01$) and the effect of Social Influence ($p = .02$); but in more agreement that use of forms was voluntary ($p = .02$). Attitudinal differences likely reflect medical training, clinical practice workflows, and division specific practices. Identified resistance indicate efforts to increase SDES adoption should be discipline-targeted rather than a uniform approach.

The final publication is available at Springer via http://dx.doi.org/10.1007/s10916-017-0716-5

Keywords

Electronic health records; Health information technology; Physicians; Survey

Introduction

Mandatory electronic health record (EHR) adoption has created an enormous volume of electronically-accessible patient data for clinical practice analysis and patient outcome measurement. Increasing use of EHR systems has facilitated clinical documentation data for research, quality initiatives, and automated decision support [1]. Because this collected information was designed primarily for patient care billing/reimbursement purposes and permitted individual provider documentation styles, EHRs often lack the granularity and standardization necessary for secondary data analysis. Ideally, documentation methods are flexible and efficient, and support the quality and expressivity of generated patient notes, and simultaneously integrate efficiently into busy workflows, and capture structured and standardized data.

The Epic EHR [2] platform supports creation of structured data entry systems (SDES), which allows users and developers to create customized templates to match their clinical workflows and to maximize data completeness and structure [3]. Templates can be adjusted to physician preference based on encounter specific variables such as diagnosis, complaint, or findings, in order to create structured data narratives. The integration of unstructured free text with coded, discrete data fields has the potential to facilitate data capture directly from physicians while allowing freedom of expression, as well as providing structured data to support reuse of clinical information for quality assurance and clinical research analysis [4]. SDES also support standardization for sharable data among EHR systems and ease in reporting, thus demonstrating meaningful use.

Using discrete data fields in clinical documentation has many potential advantages, but acquisition of data directly from clinicians remains one of the largest obstacles to leveraging the EHR for secondary use. The process and products for documenting clinical care occupy a critical intersection among the diverse domains of patient care, clinical informatics, workflow, research, and quality [1]. Structured data entry can be time-consuming, and its adoption varies widely among different end users. Clinicians are pressed for time and often are unwilling to assume the data entry burden unless receiving significant returns for their efforts [5]. Negative impact on physician productivity is a major barrier to EHR implementation and acceptance [6]. Since much of the responsibility for capturing structured clinical data has fallen to the physician at the point of care, the amount of time required for documentation has increased provider frustration associated with using EHRs [7]. Clinicians are reluctant to switch from natural prose to templates in clinic documentation because of the increased accuracy, reliability in identifying patients with given diseases, and greater understandability to healthcare providers reviewing patient records [8]. Systems optimized to acquire structured data from healthcare providers often have idiosyncratic, inflexible, or inefficient user interfaces, and place the burden of data entry in a structured format on a busy healthcare provider, rather than leveraging specific computer programs to extract the data from the clinical narrative [1].

Developing and optimizing the architecture of SDES is essential for future secondary research using EHR data. Collecting research data without compromising the clinician's commitments to patient care is a promising step toward decreasing research costs, increasing patient-centered research, and speeding the rate of new medical discoveries. With this goal in mind, four general steps have been proposed to deliver a complete, accurate, and usable SDES: 1) Establish a clinical advisory committee for creating clinical protocols and EHR standards; 2) Identify the "deal breakers" for structured data entry with specific attention to physician resistance; 3) Identify the workflows to facilitate data entry capture; and 4) Identify the technology platforms necessary for seamless integration [7].

Reasons for physician resistance to SDES can be multifactorial. Acceptance of information technologies research has generated many competing models and the operationalization of user acceptance is perspective-dependent [9]. Venkatesh *et al.* [10] created the Unified Theory of Acceptance and Use of Technology (UTAUT) after reviewing and empirically comparing eight competing models. They noted that four constructs play significant roles as direct determinants of user acceptance and usage behavior: *performance expectancy, effort expectancy, social influence,* and *facilitating conditions* [10]. Three other constructs, *attitude toward using technology, self-efficacy,* and *anxiety,* may play indirect roles in determining user acceptance and behavior.

Determining factors affecting physician adaptation of SDES will support appropriate and targeted interventions to mitigate physician resistance. Employing a UTAUT-derived questionnaire to identify issues and to improve early adoption rates, we examined physician perspective on the use of Epic Smartforms CDES format.

Methods

The study was conducted in a large tertiary academic pediatric healthcare system located in Southern California providing pediatric medical services in San Diego, southern Riverside, and Imperial counties. In 2010, the healthcare system began a phased implementation of the Epic EHR, which included inpatient, ambulatory, billing, and research modules, across the entire healthcare system. In fall 2013, the healthcare system began an optimization phase for the Epic ambulatory module, responding to end-users' expressed desires for increased functionality and user-friendliness. Conducted over a three-to-fourth month period, and led by an information technology project manager, the optimization phase was broken into three specific processes, tailored to each medical division. The approach incorporated content gathering, observation, and training with significant input and feedback from the clinical end users. The primary goals of the optimization phase included increased efficiency and end-user satisfaction through improved EHR chart design, reducing time navigating to locate data in the electronic record, and increased ease of documentation with reduced dependence on free text. An ambulatory optimization committee (AOC) was responsible for oversight of the entire process across the participating medical divisions. The AOC's overarching goal was to use the resulting data to build collaborative, research-ready data marts for ongoing outcomes research within the healthcare system's diverse pediatric population.

A key component of the initiative was the promotion of Smartforms for patient encounter data capture. Smartforms were built for each individual medical specialty based on the instructions of the specialty's medical informatics champion. The Smartform format could be based on chief complaint, symptomatology, or diagnosis. Multiple queries with possible responses could be created throughout the sections of the clinic note with the purpose of capturing data while allowing for output directly into actual documentation (Figures 1 and 2).

In spring 2014, the authors designed a UTAUT-modeled, multi-section questionnaire based on previous EHR research and the work of Duyck et al. [9] in order to measure physician and surgeon perspectives regarding structured data entry and the use of Smartforms (Appendix 1). The paper questionnaire was distributed to specialty physicians and pediatric surgeons participating in Smartform optimization training before the Smartform implementation. In addition to demographic questions such as age, years of training, medical specialty, and whether an individual was a physician or surgeon, the questionnaire addressed attitudes and expectations regarding Performance and Effort Expectancy, Social Influence, Facilitating Conditions, Attitudes toward Technology, Self-Efficacy, Anxiety, Voluntary Use, and Behavioral Intention. Respondents were asked to measure their level of agreement ranging from complete agreement to complete disagreement using a seven-item Likert scale. The responses were captured with both summary means for the nine different areas of interest as well as scores for all of the individual items. This study met the exempt category following institutional review board review.

Questionnaires were double-entered and verified. SPSS version 21 [11] was used to test initial associations of demographic and attitude variables using *chi*-square for categorical data as well as independent sample *t*-tests and analysis of variance for continuous variables. Statistical significance was set at *p*-value less than .05. Once summary mean differences were identified, subscale responses were examined for differences among groups.

Results

A total of 25 participants completed surveys. Eleven were female, and participants ranged in age from 32 to 78 ($M = 43$, $SD = 7.40$). The respondents were on average 11 years post-training. Pediatric specialties included urology, pulmonology, hematology/oncology, orthopedics, and otolaryngology, and represented 12 specialty physicians and 13 pediatric surgeons. Table 1 summarizes the respondents' demographic characteristics.

Female respondents were on average ten years younger than male respondents (female: $M = 39.6$, $SD = 4.61$; male: $M = 49.0$, $SD = 12.63$; $p = .03$), although there was no significant difference in mean age between physicians and surgeons. Mean scores of the main categories of interest demonstrate a primarily positive attitude toward and perception of Smartform use (Table 2).

Respondents under 40 were significantly more likely to strongly agree there were the necessary facilitating conditions for Smartforms compared to those over 40 ($p = .02$). There were significant differences in intent and expectancy between specialty physicians and pediatric surgeons, with pediatric surgeons significantly less positive about the effect of Smartforms on Performance ($p = .01$); in less agreement about Social Influence ($p = .02$); and in more agreement that use of such forms was voluntary use ($p = .02$). There were no significant differences when employing analysis of variance to look at differences in means regarding Expectancy, Influence, Conditions, Attitudes, Self-Efficacy, Anxiety; Voluntary Use; or Intention by gender.

The impact of being a more recent graduate who was 10 years or fewer years post training compared to those more than 10 years post training was examined, to test the hypothesis that more recent trainees were likely to have had more EHR exposure and therefore more comfort with the EHR. There were no significant differences between the groups in their attitudes and perceptions. Once the summary mean differences were identified, specific items were examined for their contribution to the differences. Table 3 demonstrates that pediatric surgeons were less likely to agree that Smartforms increase productivity ($p = .02$) and chances of a raise ($p = .01$).

Pediatric surgeons were also less likely than physician specialists to feel that people who influence them ($p = .02$) or who individuals whom they consider important within the administrative hierarchy will have an effect on their use of structured data entry ($p = .03$). In contrast, specialty physicians were more likely than pediatric surgeons to feel that the use of Smartforms is compulsory ($p = .04$) or required ($p = .04$).

Discussion

The analysis identified there was not significance variance in results when examining the potential effect of age, gender, or years since completion of formal training on attitudes and behaviors toward Smartforms. Significant differences emerged when comparing the responses by physician versus surgeon. While both groups were generally positive about the adoption of the structured template, the surgeons were in less positive structured data entry would improve their productivity. The surgeons felt they would have more say and more flexibility regarding any adoption of a structured approach than the specialty physicians did.

Several possible factors could account for the differences between the specialty physicians and pediatric surgeons, including the differences in clinical workflow, workload, and training. The two groups are members of different academic divisions, which may result in different perceptions regarding the need to adopt a structured approach and a different emphasis on outcomes research. These findings are in agreement with Scheepers *et al.* [12], who identified and measured different personality type clusters according to specialty field. The differences may reflect differences in computer skills required to enter medical information while also interacting in the work environment [13]. The findings reinforced the barriers associated with EHR implementation in general such as the need for tech support, technical concerns, and insufficient time, and workflow challenges [14, 15].

Behavioral intent is usually the greatest predictor of overall adaptation to new technology [10]. There can be variability in the direct and indirect effects on behavioral intent. Duyck *et al*. examined user acceptance of a picture archiving and communication system implemented in Ghent University Hospital Radiology Department in Belgium [9]. They found that performance expectancy and facilitating conditions were important for predicting acceptance, while social influence and effort expectancy were not. Their study was performed in a heterogeneous population of 19 radiologists and 37 technologists, a survey response rate of 59.6%, compared to this study's 100% response rate. Effort expectancy in this study showed high values of agreement with behavioral intent, demonstrating a belief in being able to use Smartforms effectively and planning to proceed with their use in the future. These findings support the theory that one of the main barriers to structured data entry is the amount of extra work or effort that is required on the part of the end user.

This report of perceptions of specialty physicians and surgeons in during an EHR optimization phase contains feedback from one pediatric institution, which is a limitation. The small physician and surgeon groups do not have the required power to do a rigorous analysis of potential covariates noted in other studies such as cost and resistance to changing work habits [14]. Moreover, the participant specialty physicians and pediatric surgeons were a subgroup of the many clinicians who use the EHR and structured reporting in the institution. The attitudes reflected in this study may differ among primary care providers as well as other specialty physicians and surgeons, especially given competing factors such as time with patients, ongoing patient relationship, divisional leadership goals, and participation in research, all of which may be significant covariates regarding acceptance and utilization.

Conclusion

The mean scores of the nine constructs demonstrated primarily positive attitudes toward SDES, which should be reinforced and further strengthened. As SDES are designed and implemented, it is important to note that there may need more emphasis on available training and facilitation for those who are more advanced in their careers in order to facilitate conditions needed to embrace SDES. These findings indicate a significant difference in attitude between pediatric surgeons and specialty physicians, which should be considered during any SDES implementation. SDES adoption is more likely among pediatric surgeons if there is sufficient attention paid to ensure performance will not be adversely affected. Implementation of SDES program are much more likely to be successful of SDES adoption is discipline-targeted and presented with the context of that disciplines workflow rather than a uniform approach.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

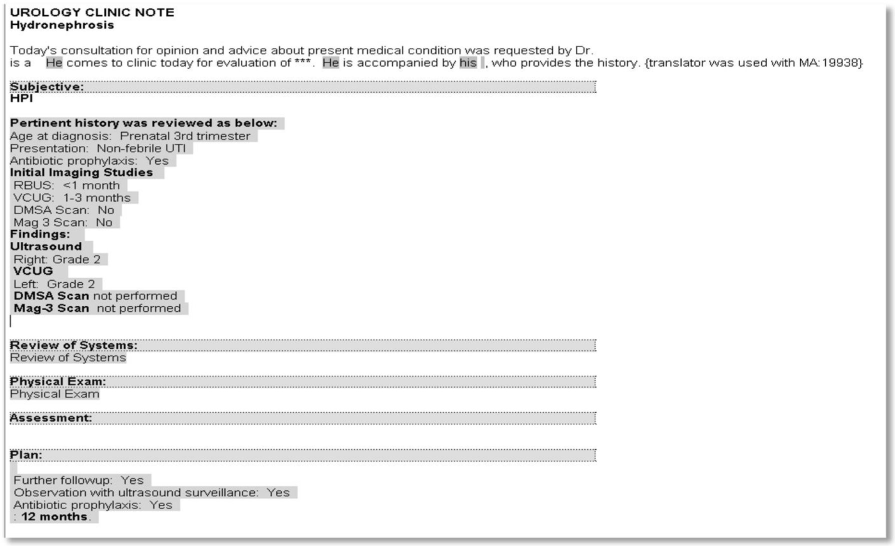
This project was supported in part by grant number K99/R00 HS022404 from the Agency for Healthcare Research and Quality. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality.

References

1. Rosenbloom ST, Denny JC, Xu H, Lorenzi N, Stead WW, Johnson KB. Data from clinical notes: a perspective on the tension between structure and flexible documentation. J Am Med Inform Assoc. 2011; 18(2):181–186. DOI: 10.1136/jamia.2010.007237 [PubMed: 21233086]
2. Epic Electronic Health Record [Computer software]. Madison, WI: Epic;
3. Rosenbloom ST, Miller RA, Johnson KB, Elkin PL, Brown SH. Interface terminologies: facilitating direct entry of clinical data into electronic health record systems. J Am Med Inform Assoc. 2006; 13(3):277–288. DOI: 10.1197/jamia.M1957 [PubMed: 16501181]
4. Johnson SB, Bakken S, Dine D, Hyun S, Mendonça E, Morrison F, … Stetson P. An electronic health record based on structured narrative. J Am Med Inform Assoc. 2008; 15(1):54–64. DOI: 10.1197/jamia.M2131 [PubMed: 17947628]
5. Gilbert JA. Physician data entry: providing options is essential. Health Data Manag. 1998; 6(9):84–6. 88, 90–92.
6. Leu MG, O'Connor KG, Marshall R, Price DT, Klein JD. Pediatricians' use of health information technology: a national survey. Pediatrics. 2012; 130(6):e1441–1446. DOI: 10.1542/peds.2012-0396 [PubMed: 23166335]
7. Murray, T., Berberian, L. The importance of structured data elements in EHRs. Computer World. 2011 Mar. http://www.computerworld.com/article/2470987/healthcare-it/the-importance-of-structured-data-elements-in-ehrs.html
8. Marill KA, Gauharou ES, Nelson BK, Peterson MA, Curtis RL, Gonzalez MR. Prospective, randomized trial of template-assisted versus undirected written recording of physician records in the emergency department. Ann Emerg Med. 1999; 33(5):500–509. [PubMed: 10216325]
9. Duyck P, Pynoo B, Devolder P, Voet T, Adang L, Vercruysse J. User acceptance of a picture archiving and communication system. Applying the unified theory of acceptance and use of technology in a radiological setting. Methods Inf Med. 2008; 47(2):149–156. [PubMed: 18338086]
10. Venkatesh V, Morris M, Davis G, Davis F. User acceptance of information technology: toward a unified view. MIS Quart. 2003; 27(3):425–478. DOI: 10.2307/30036540
11. IBM Corp. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp; Released 2012
12. Scheepers RA, Lombarts KM, van Aken MA, Heineman MJ, Arah OA. Personality traits affect teaching performance of attending physicians: results of a multi-center observational study. PLoS One. 2014; 9(5):e98107.doi: 10.1371/journal.pone.0098107 [PubMed: 24844725]
13. Boonstra A, Broekhuis M. Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. BMC Health Services Research. 2010; 10:231. http://doi.org/10.1186/1472-6963-10-231. [PubMed: 20691097]
14. Kruse CS, Kristof C, Jones B, Mitchell E, Martinez A. Barriers to Electronic Health Record Adoption: a Systematic Literature Review. Journal of Medical Systems. 2016; 40(12):252.doi: 10.1007/s10916-016-0628-9 [PubMed: 27714560]
15. Ben-Zion R, Pliskin N, Fink L. Critical Success Factors for Adoption of Electronic Health Record Systems: Literature Review and Prescriptive Analysis. Information Systems Management. 2014; 31(4):296–312. DOI: 10.1080/10580530.2014.958024

Figure 1.

Smartform template obtained from the RCHSD Epic installation.



UROLOGY CLINIC NOTE
Hydronephrosis

Today's consultation for opinion and advice about present medical condition was requested by Dr.
is a He comes to clinic today for evaluation of ***. He is accompanied by his , who provides the history. {translator was used with MA:19938}

Subjective:
HPI

Pertinent history was reviewed as below:
Age at diagnosis: Prenatal 3rd trimester
Presentation: Non-febrile UTI
Antibiotic prophylaxis: Yes
Initial Imaging Studies
RBUS: <1 month
VCUG: 1-3 months
DMSA Scan: No
Mag 3 Scan: No
Findings:
Ultrasound
Right: Grade 2
VCUG
Left: Grade 2
DMSA Scan not performed
Mag-3 Scan not performed

Review of Systems:
Review of Systems

Physical Exam:
Physical Exam

Assessment:

Plan:

Further followup: Yes
Observation with ultrasound surveillance: Yes
Antibiotic prophylaxis: Yes
: **12 months**.

Figure 2.

Smartform output into clinical documentation obtained from the RCHSD Epic installation.

Table 1

Descriptive Characteristics of Study Population

	Physician Specialist		Surgeon		Total		
Characteristic	***n***	**%**	***n***	**%**	***n***	**%**	χ^2
Age (years)							
< 40	3	30	5	39	8	35	
40–49	5	50	4	31	9	39	0.90
≥ 50	2	20	4	31	6	26	
Gender							
Female	5	46	6	46	11	46	0.00
Male	6	55	7	54	13	54	
Department							
ENT	0	0	4	31	4	16	
Hematology/Oncology	6	50	0	0	6	24	
Orthopedics	0	0	4	31	4	16	24.38**
Pulmonary	6	50	0	0	6	24	
Urology	0	0	5	39	5	20	
Major							
Biology	5	63	6	60	11	61	
Chemistry	1	13	1	10	2	11	4.63
Zoology	0	6	2	20	2	11	
Other	2	25	1	10	3	17	
	M	*SD*	*M*	*SD*	*M*	*SD*	*t*
Age (years)	43.00	7.40	45.70	12.70	44.50	11.82	−0.60
Number of years post-training	9.30	7.71	11.80	14.90	10.63	11.82	−0.50

Note. ENT = Ear, Nose, and Throat; *M* = Mean; *SD* = Standard Deviation. Some percentages do not add up to 100 because of rounding and missing data.

** $p \leq .001$.

Table 2

Mean Attitude Responses

	Age							Group				
	<40		40–49		≥ 50			Physician Specialist		Surgeon		
Construct	***M***	***SD***	***M***	***SD***	***M***	***SD***	***t***	***M***	***SD***	***M***	***SD***	***t***
Performance expectancy	2.69	0.65	3.36	1.87	4.17	1.21	1.96	2.52	1.00	3.96	1.52	7.71*
Effort expectancy	2.00	0.77	3.06	1.57	3.29	1.27	2.24	2.29	1.13	3.08	1.42	2.31
Influence	3.22	1.41	3.03	1.48	3.35	0.49	0.11	2.63	1.38	3.81	0.95	6.01*
Facilitating conditions	2.00	0.56	3.00	0.80	3.00	0.85	4.73*	2.92	0.75	2.33	0.83	3.25
Attitude technology	3.06	2.13	3.28	1.52	4.21	1.03	0.88	2.94	1.70	3.88	1.43	2.29
Self-efficacy	2.07	1.01	3.03	1.86	3.13	1.15	1.15	2.18	1.17	2.98	1.55	1.87
Anxiety	5.53	1.71	4.94	1.07	4.42	1.08	1.22	5.42	0.89	4.75	1.56	1.68
Voluntary use	3.03	1.67	3.69	1.29	3.13	0.90	0.59	3.88	1.21	2.69	1.12	6.43*
Behavioral intention	1.58	0.66	2.30	2.15	2.44	0.86	0.13	1.69	1.11	2.28	1.67	1.06

Note. M = Mean; *SD* = Standard Deviation.

* $p \le .05$

Table 3

Subscale Analysis Physician Specialist and Surgeon Responses

Subscale Item	Physician Specialist		Surgeon		
	M	*SD*	*M*	*SD*	*t*
Performance Expectancy (PE)					
Find Smartforms useful in job	1.92	0.99	2.85	1.86	−1.54
Smartforms enable tasks more quickly	2.00	1.04	3.08	1.80	−1.81
Smartforms increase productivity	2.17	1.12	3.69	1.84	−2.53*
Smartforms increase chances of raise	4.00	2.13	6.23	1.54	−3.02*
Social Influence (SI)					
People who influence think should use	2.25	1.22	3.62	1.45	−2.54*
People important think should use	2.25	1.22	4.00	2.31	−2.34*
Senior management helpful	3.17	1.80	4.42	1.51	−1.85
Hospital supported Smartforms	2.83	1.80	3.08	1.38	−0.38
Facilitating Conditions (FC)					
Have necessary resources	2.58	1.08	2.25	1.06	−0.38
Compatible with other systems	3.25	1.06	2.62	1.04	1.51
Assistance available	2.92	1.08	2.17	1.34	1.51
Voluntary Use (VOL)					
Helpful but not compulsory	4.08	2.23	2.54	1.20	2.18*
Boss does not require	4.25	2.22	2.62	1.12	2.35*
Superiors expect me to use	3.08	2.23	3.15	1.46	−0.09
Use of Smartforms voluntary	4.08	2.19	2.46	1.71	2.07*

Note. *M* = Mean; *SD* = Standard Deviation. The complete physician questionnaire can be found in Appendix 1.

* $p \leq .05$