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Impact of Knowledge Resources Linked to an Electronic Health Record on Frequency of Unnecessary Tests and Treatments

Kenneth Goodman, MD; Roland Grad, MD, MSc; Pierre Pluye, MD, PhD; Amy Nowacki, PhD; John Hickner, MD, MSc

Dr. Goodman: Associate Director, Center for Continuing Education, Cleveland Clinic;
Dr. Grad: Associate Professor, McGill University;
Dr. Pluye: Associate Professor, McGill University;
Dr. Nowacki: Quantitative Health Sciences, Cleveland Clinic;
Dr. Hickner: Chair, Department of Family Medicine, Vice Chair for Research, Cleveland Clinic.

ABSTRACT

Introduction: Electronic knowledge resources have the potential to rapidly provide answers to clinicians' questions. We sought to determine clinicians' reasons for searching these resources, the rate of finding relevant information, and the perceived clinical impact of the information they retrieved.

Methods: We asked general internists, family physicians, and clinical nurse practitioners to complete the Information Assessment Method (IAM) survey after searching 1 of 2 electronic knowledge resources linked in the electronic health record. IAM stimulates reflection on the relevance, cognitive impact, use, and potential health outcomes of retrieved clinical information.

Results: Forty-two clinicians rated 502 searches (mean 12, range 1–48) and reported finding information 75% (n = 375) of the time. The most common reasons for searching were to address a clinical question (411, 82%) and for curiosity (75, 15%). In 68% of the rated searches (341), participants indicated they would use the retrieved information for at least 1 patient. In 31% (157) of rated searches, clinicians expected the retrieved information to benefit the patient by avoiding an unnecessary or inappropriate treatment, diagnostic procedure, or preventive intervention.

Conclusions: Searches in electronic knowledge resources frequently yield relevant information that may benefit the patient by, for example, avoiding an inappropriate diagnostic procedure or treatment. Knowing that searches for answers to clinical questions can result in patient health benefits should intensify efforts to encourage clinicians to pursue answers to their questions.

Keywords: electronic knowledge resources, Information Assessment Method, electronic health record, reflection on practice

INTRODUCTION

In the course of their work, physicians often have questions about how to take care of their patients, but many questions go unanswered.[1] Ely and colleagues found that for every 10 patients seen in a primary care practice, approximately 3 questions arise.[2] While physicians do not pursue answers to most of these questions, good answers probably exist for many of them.[2,3] Many barriers to pursuing answers to clinical questions have been identified, such as believing that an answer does not exist.[4] It appears that when clinicians pursue answers to their questions, they rely most heavily on their colleagues for answers.[5]

Electronic knowledge resources—otherwise known as online clinical information retrieval systems and hereafter referred to as knowledge resources—are increasingly used by clinicians, residents, and students to search for clinical information in the course of patient care. These knowledge resources, which may be used at the point of care or for general reference, include text documents, images, or sound and provide synthesized information from databases that merge clinical practice guidelines, electronic journals, computerized synopses, and medical Web sites. In theory, these tools should help clinicians provide evidence-based health care.[6–8] Given ready access to evidence-based knowledge resources, generalist physicians can more easily pursue answers to questions as they arise in practice.[9] However, it is unclear that use of these knowledge resources has a positive influence on the clinician, with less than one third of observational studies showing a positive influence and a small number of experimental studies yielding modest results.[8–11]

Previous studies have demonstrated that patient health benefits are associated with searches for information because they can help physicians avoid unnecessary diagnostic tests or treatments. Westbrook et al examined how the use of one knowledge resource potentially influenced daily practice and the delivery of care.[12] In her study, 23 (27.4%) of 85 searches were associated with patient health benefits such as "improvements in medication use or management of complications, differential diagnosis, and identification of effective treatment for drug interactions."[12(p239)] In regards to avoiding unnecessary treatments, clinicians indicated that retrieved information helped reduce blood transfusions in the management of postpartum hemorrhage.

In a cross-sectional survey, Rothschild et al studied the use of a hand-held computer-based pharmacological resource. In his study, 61% (n = 1501) of physicians reported that drug look up helped prevent three or more adverse drug reactions over the 4-week data collection period.[13] Lindberg et al

used the critical incident technique to gather reports from 552 US physicians who received answers to their clinical questions from librarians using MEDLINE.[14] Of the searches categorized as impacting professional activity, 8% (40/455) minimized or reduced the number of unnecessary treatments and procedures and 6% (31/455) reduced or avoided the risks or side effects of treatment.[14] Richwine et al interviewed physicians who indicated that retrieved information from a virtual medical library contributed to avoiding a hospital ad- mission, additional tests and procedures, medication errors, and litigation.[15]

The Information Assessment Method (IAM) is a recently validated instrument developed to systematically document reflections of health professionals on the value of retrieved clinical information.[16] In a prospective longitudinal study of clinical information retrieved by family physicians from one knowledge resource, the content validity of all IAM items was demonstrated.[17] This study also showed that IAM can capture the use of research-based information in medicine, opening the door to further study of associations between retrieved clinical information and patient health.[18]

IAM systematically documents the value of retrieved information using four constructs: relevance, cognitive impact, use for a specific patient, and any expected patient health benefits[16] (see EXHIBIT 1). The survey utilizes branching logic which permits, for example, only those indicating they would use the information for a specific patient to answer what the expected benefits of that information might be.

Electronic health record (EHR) systems are being designed to incorporate links to frequently used resources for answering clinical questions. One study evaluated the EHR- linked knowledge resources for point-of-care searching.[11] In that study, Del Fiol et al confirmed that info buttons in the EHR are effective in helping clinicians answer questions at the point of care. A Cochrane review found that no studies have utilized a validated questionnaire (such as the IAM) to objectively measure outcomes of searching for clinical information using EHR-linked knowledge resources.[19]

The purpose of this study was to evaluate the use of knowledge resources linked in the EHR and to access physicians' perception of the impact of such use. Our research questions were: (1) Why do clinicians search for information using electronic knowledge resources? (2) How often do they find relevant information? (3) What patient benefits are anticipated by the clinician when retrieved information is perceived as relevant to a specific patient and used (or will be used) for that patient?

METHODS

The population addressed by this study included the primary care physicians, internal medicine residents, and nurse practitioners practicing at the Cleveland Clinic. Recruitment of physicians into the

study began with presentations to community family and internal medicine physicians during their quarterly meetings and to residents during their monthly morning rounds. Family medicine residents and general nurse practitioners were not offered this initial presentation due to scheduling difficulties.

An e-mail study invitation was sent approximately 1 month after these presentations to 278 family medicine physicians, family medicine residents, general internal medicine physicians, general internal medicine residents, and general nurse practitioners. The announcement contained general study information, information about the electronic resources to be used, and notification that the study would be limited to the first 44 providers indicating their interest. The study was capped at 44 participants due to funding and other resource limitations. The opportunity to be entered into a drawing for an Apple iPad was used as an incentive to participate; participants were required to submit a minimum of 12 searches to be eligible for the drawing.

The first 44 providers consenting to take part in the study were sent an e-mail including a link to a demographics survey, the study protocol, and general information on use of the two knowledge resources utilized in the study; DynaMed and UpToDate (hereafter referred to as "study resources"). We choose UpToDate as it was as resource well known to Cleveland Clinic providers and DynaMed as it was being offered on a trial basis. Both study resources are clinical reference tools designed to be used during patient care and for continuing education. We limited the study knowledge resources to these 2 for simplicity, as we had to establish links to each in our EHR.

Participants were instructed that both resources would be available throughout the study through the EHR. Although the study was not designed as a comparison of these resources, given differences in familiarity (participants were familiar with UpToDate, but not Dynamed), it was our intent to encourage providers to utilize DynaMed during the trial period permitted during the study. Due to concern that some might use only the more familiar resource, a crossover design was implemented. Participants were instructed to initiate their searches using the study resources as follows: In the first 6 weeks of the study, one half of the participants were instructed to initiate searches with DynaMed and one-half UpToDate; in the second 6 weeks, participants crossed over and were instructed to utilize the other resource first. Once weekly, participants received an e-mail with their study ID number, a reminder of which study resource they were to be using first, and links to educational material about both study resources.

During the 12-week study period, participants were asked to complete an IAM questionnaire (EXHIBIT 1) after their first search of the day and for others when possible. Surveys were to be based solely on their initial search of a particular topic with the designated study resource. If clinicians did not find the required information in their initial search, they were instructed to rate that search and then permitted to use any available knowledge resource (study resource or other) as needed for patient care.

We did not track when searches were performed (before, during, or after patient care), nor could we record the total number of searches initiated.

Clinicians used a modified version of the IAM questionnaire to rate their searches (EXHIBIT 1). A direct link to IAM was provided as a hyperlink in the EHR. IAM was modified for this study by adding the following items: a free text field to enter the study participation number, a place to indicate the resource being evaluated, a free text question asking for a description of the clinical search, a place to record the resource utilized if the respondent did not find the information in the initial search, and a question regarding impact. The branching nature of the survey was left intact.

We analyzed the data on participants and their rated searches with descriptive statistics: means, standard deviations and ranges for continuous variables and counts and percentages for categorical variables. Frequencies and percentages for the responses to each survey question are reported with respect to the total number of searches initiated.

This study was evaluated by the IRB at the Cleveland Clinic and classified as exempt.

RESULTS

TABLE 1 provides demographic information about the participants. Two of the 44 participants did not rate any searches and were excluded from the analysis. Thirty of the 42 remaining participants (72%) were general internists or general internal medicine residents with all participants seeing patients a mean of 47.2 hours each week. Fourteen (33%) reported baseline use of electronic resources greater than or equal to 5 times each day.

TABLE 2 summarizes survey completion rates by specialty and gender. Seventy-three percent (365/502) of the surveys were submitted by general internists and general internal medicine residents. Distributions of survey completions were quite uniform despite one outlier (one participant submitted 48 rated searches) explaining the large standard deviations for subgroups containing this participant. Medians closely approximate the means, however, and thus are not reported. The majority of participants completed approximately a dozen surveys; thus, our results are not dominated by a few.

TABLE 3 summarizes the survey results. Of the 502 total searches rated using IAM, the most common reasons for searching were to address a clinical question (411, 82%) or for curiosity (75, 15%). Clinicians indicated they found some information in their initial search 75% (n = 375) of the time. Clinicians indicated the retrieved information was relevant or partially relevant 71% of the time (n = 358) and felt they would use, or possibly use, the information for at least 1 patient 68% of the time (n = 341). Clinicians indicated the retrieved information was expected to have the following health benefits: 31% (n = 157) indicated the information helped them avoid an unnecessary or inappropriate treatment,

diagnostic procedure, or preventive intervention; 27% (n = 135) stated the information increased patient knowledge about health or health care; and 13% (n = 64) indicated it increased patient acceptability of treatment.

Not all participants were presented all survey questions due to the branching logic; as a result, only 341 were given the opportunity to answer the final question regarding expected health benefit. Of the 341 who did complete that question, 46% (157) indicated that the retrieved information helped them avoid an unnecessary or inappropriate treatment, diagnostic procedure, or preventive intervention. That is, if the clinician found relevant information that was or would be used for a specific patient, nearly one half of the time, the clinician reported avoiding an unnecessary or inappropriate diagnosis or treatment.

DISCUSSION

In this study, clinical searches were performed using 2 knowledge resources linked in the EHR. Although we did not document the exact timing of participants' searches (before the patient visit, in the examination room, after the office visit), the knowledge resources and IAM survey were accessed through the EHR, presumably at some time during patient care hours. Using IAM, clinicians reported that 71% of searches yielded relevant or partially relevant information for a specific patient. For 2 in 3 searches, clinicians expected the retrieved information would help them avoid an unnecessary or inappropriate treatment, diagnostic procedure, or preventive intervention. While other health benefits were expected, this was the most frequent benefit observed in our study. In line with previous studies, the finding of "avoiding something unnecessary" is particularly important if we want to move toward addressing a long-standing problem for clinical medicine—namely, the "overuse" of tests and procedures.

Although physicians in other studies have reported that their clinical searches benefit patients, there is insufficient evidence in terms of objectively documented patient health benefits to support the value of electronic retrieval of health care information by clinicians.[12] Thus, a logical next step in evaluating the value of knowledge resources is to objectively investigate reports of patient health benefits.

When expected health benefits can be verified, we believe the "number needed to benefit from information" (NNBI) should be considered as an outcome measure in future studies. Analogous to "number needed to treat," the NNBI associates the number of searches for clinical information and patient health benefits.[20] The NNBI is defined as the number of patients for whom clinical information needs to be retrieved for one to benefit. A low NNBI can be used to encourage doctors to search for information, as well as provide justification for better information retrieval. In a Canadian study of 16 family medicine residents using the IAM, residents searched for 7 patients to observe benefits for 1; NNBI = 7.20 In

contrast to this mixed methods study, which scrutinized 84 searches through interviews guided by IAM ratings, we analyzed rated searches utilizing only quantitative survey data.

In our study, clinicians indicated that in 31% of rated searches the retrieved information was expected to provide a health benefit by avoiding an intervention that may be inappropriate or unnecessary. This would suggest an NNBI of approximately 3. However, this NNBI is likely underestimated (the lower the NNBI, the better) as unsuccessful searches are more likely to be unrated compared to successful searches and the expected health benefits were not verified. In the study by Pluye et al, residents were interviewed about "expected" benefits they reported using IAM.[20] That study found that not all "expected" benefits were truly observed. We therefore urge caution until further research can verify that expected health benefits are indeed observed in practice.

Targeted searches for clinical information can play an important role in the lifelong learning of clinicians.[21] Our study used IAM to facilitate reflection on practice using resources linked in the EHR. When clinicians reflect on clinical information they retrieved for a specific patient, they are thinking about their actions in a context of reflection on practice.[22] Leung et al have proposed a reflective learning framework for CME that includes 4 cognitive processes and 12 cognitive tasks.[23] By way of illustration, these tasks are concerned with identifying relevant information and applying information in practice. Several cognitive tasks are represented by items within the IAM questionnaire, which asks physicians to reflect on the relevance of the retrieved clinical information and the effect of this information on them or their practice. Leung et al studied family physicians who used the IAM to rate clinical information delivered as e-mail alerts. The potential for the IAM to facilitate reflection on practice is potentially greater in the search context. This is because rated searches were most frequently done to address clinical questions for a specific patient, making it more likely that reflection on action was being stimulated as physicians worked through its structured questionnaire.

There are several limitations to this study. First, because our participants were not randomly selected, it is possible their search skills and motivation was greater than the average provider at our center. As our main outcome measure was subjective and self-reported, it is conceivable that some physicians may have overestimated the benefits of information they retrieved. To objectively verify outcomes, a follow- up study is planned to evaluate and correlate what doctors specifically say they avoid with a review of the electronic health record for the specific patient for whom the search was performed. In addition, we need to carefully evaluate if avoiding an action is truly beneficial for the patient.

Our ability to document searches was limited to those that were rated. Thus, our data do not provide a comprehensive picture of all searches performed during the study period. This limitation likely resulted in a reporting bias where physicians may have been more likely to rate their successful searches.

Many physicians are not well trained to effectively utilize knowledge resources.[4] As we provided no formal training to physicians, searches performed with an unfamiliar knowledge resource may have resulted in greater initial difficulty in finding answers to clinical questions. As this study was performed using 2 knowledge resources, evaluations of other resources may yield different results.

Our results indicate that when stimulated by questions that arise during the course of patient care, targeted searches for information can produce several positive outcomes at the levels of clinical practice and patient health outcomes. We need to develop a better understanding of how and when physicians use targeted searches, with what results, and how we can support and facilitate this important dimension of physician learning.

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DISCLOSURE

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LESSONS FOR PRACTICE

- In 68% (345/502) of searches using knowledge resources linked in the electronic health record, health professionals reported that the retrieved clinical information was used (or would be used) for a specific patient.
- In about 1 of 3 rated searches, clinicians expected that retrieved information would benefit their patients by, for example, avoiding an inappropriate diagnostic procedure or treatment.

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TABLES AND FIGURES

TABLE 1. Participant Demographics (*n* = 42)

age, years, mean (range)	37.6 (24 − 71)
patient care, hours/week, mean (range)	47.2 (14 − 80)
Speciality	
family medicine	8 (19%)
family medicine resident	3 (7%)
general internal medicine	15 (36%)
general internal medicine resident	15 (36%)
general nurse practitioner	1 (2%)
Baseline frequency of electronic resource usage	
≥ 5 times/day	14 (33%)
1-4 times/day	17 (41%)
1 time/week	9 (21%)
1 time/month	2 (5%)

TABLE 2. Number of Rated Searches* by Clinician Type

	mean (sd)	min	max	Total
all participants	12.0 (8.2)	1	48	502 (100%)
men	13.7 (10.6)	1	48	273 (54%)
women	10.4 (5.0)	1	19	229 (46%)
family medicine	14.8 (4.0)	12	23	118 (23%)
family medicine resident	3.3 (2.1)	1	5	10 (2%)
general internal medicine	13.3 (11.5)	1	48	199 (40%)
general internal medicine resident	11.1 (5.8)	1	24	166 (33%)
general nurse practitioner	9.0 (0)	9	9	9 (2%)

*Clinicians rated searches using the Information Assessment Method survey. sd = standard deviation

TABLE 3. Summary of Selected Information Assessment Survey Responses

	% Based on Total Surveys Initiated	
(3) Why did you do this search for information? (check all that apply)	*n* = 502	
To address a clinical question/problem/decision about a specific patient	411	82%
To search in general or for curiosity	75	15%
To fulfill an educational or research objective	66	13%
To look up something I had forgotten	68	14%
To share information with a patient/caregiver	44	9%
To exchange information with other health professionals (e.g., colleague)	27	5%
To manage/delegate/coordinate/monitor tasks with other health professionals	7	1%
(5) With regard to any of your objectives, did you find the information in your initial search?		
Yes	375	75%
No	127	25%
(7) What was the IMPACT of this information on you or your practice? (check all that apply)		
I learned something new	201	40%
This information confirmed I did (am doing) the right thing	126	25%
My practice is (will be) changed and improved	115	23%
I am reassured	98	20%
I am reminded of something I already knew	91	18%
I am motivated to learn more	57	11%
I am dissatisfied	4	1%
There is a problem with this information	0	0
I disagree with the content of this information	0	0
This information is potentially harmful	0	0
Question not prompted[a]	127	25%
(8) For searches that DID change or improve your practice, check all that apply:		

It changed my treatment plan	112	22%
It altered my diagnostic work up	64	13%
It changed my differential diagnosis	41	8%
Question not prompted[a]	127	25%
(10) Was the information relevant for at least one of your patients[a]?		
Totally relevant	311	62%
Partially relevant	47	9%
Not relevant	11	2%
Missing data/ incomplete survey	6	1%
Question not prompted[a]	127	25%
(11) Will or did you use this information for at least one patient?[b]		
Yes	319	64%
Possibly	22	4%
No	13	3%
Missing data/ incomplete survey	4	1%
Question not prompted[a]	144	29%
(12) If you do expect health benefits, what are these benefits? (check all that apply)[c]		
Avoiding unnecessary/inappropriate treatment/diagnostic procedure/preventive intervention	157	31%
Increasing patient knowledge about health or healthcare	135	27%
Increasing patient acceptability of treatment/diagnostic procedure/preventive intervention	64	13%
Preventing disease/health deterioration (including acute episode of chronic disease)	58	12%
Improving patient health functioning/resilience (i.e., how well the patient faces difficulties)	21	4%
Other	10	2%
Question not prompted[a]	161	32%

[a] This question prompted if answered "Yes" to question 5

[b] This question prompted if answered "Totally relevant" or "Partially relevant" to question 10

[c] This question prompted if answered "Yes" or "Possibly" to question 11

EXHIBIT 1. Electronic Resource Study Survey (study participants only)

Please complete the survey below. Thank you!	
1. Participant Study ID #	_____
2. Please select the resource that you utilized FIRST and are currently evaluating.	DynaMed UpToDate
3. Why did you do this search for information? (check all that apply)	To address a clinical question/ problem/ decision about a specific patient To fulfill an educational or research objective To search in general or for curiosity To look up something I had forgotten To share information with a patient/caregiver To exchange information with other health professionals (e.g., colleague) To plan, manage, coordinate, delegate or monitor tasks with other health professionals
4. What is the specific clinical question and/or search term you were researching? Please copy and paste or type a short response.	
5. With regard to any of your objectives, did you find the information in your initial search (DynaMed or UpToDate)?	Yes No
6. If you did NOT find an answer with your INITIAL search (DynaMed or UpToDate), please check other resources that you used:	DynaMed UpToDate PubMed Medline Google Google Scholar No other resource Other
6a. If other, please specify	_____

7. What was the IMPACT of this information on you or your practice? (check all that apply)	My practice is (will be) changed and improved. I learned something new. I am motivated to learn more. This information confirmed I did (am doing) the right thing. I am reassured. I am reminded of something I already knew. I am dissatisfied. There is a problem with this information. I disagree with the content of this information. This information is potentially harmful.
8. For searches that DID change or improve your practice, please check all that apply.	It changed my differential diagnosis. It altered my diagnostic workup. It changed my treatment plan. None of the above. N/A.
10. Was the information relevant for at least one of your patients?	Totally relevant Partially relevant Not relevant (This choice will end this survey.)
11. Will or did you use this information for at least 1 patient?	Yes Possibly No (This choice will end this survey.)
12. If you do expect health benefits, what are these benefits? (check all that apply)	Increasing patient knowledge about health or health care Avoiding unnecessary or inappropriate treatment, diagnostic procedure or preventive intervention Increasing patient acceptability of treatment, diagnostic procedure or preventive intervention Preventing disease or health deterioration (including acute episode of chronic disease)

	Improving patient health functioning or resilience (i.e., how well the patient faces difficulties) Other
12a. If Other, please specify.	_____
13. Optional additional comments (trouble with resource, other)	