Providing Evidence-Based Answers to Complex Clinical Questions: Evaluating the Consistency of Article Selection

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Abstract

Purpose
Health care providers must maintain familiarity with current biomedical evidence, but clinicians struggle to maintain their awareness of current research because of the demands of daily practice and the exponential growth of medical knowledge. Clinical information specialists (informationists), trained experts in reviewing and filtering the medical literature in response to complex clinical queries, may be able to assist practicing clinicians. This study compared informationists and two categories of physicians in their article selection in response to two complex clinical questions.

Method
The study was performed at Vanderbilt University Medical Center. A total of 15 faculty and staff from three groups were recruited (five general physicians, five physicians trained in research methodology, and five informationists). The participants reviewed two previously selected clinical questions, worked in focus groups to define the pertinent facet questions of the questions, and then ranked the articles by pertinence to the clinical questions.

Results
In general, both informationists and physicians trained in research methodology had a high degree of intergroup agreement for ranking article pertinence, while the generalists were less likely to agree on pertinent articles.

Conclusions
These findings suggest that informationists consistently select articles relevant to answering complex clinical queries and may assist practicing clinicians by providing information relevant to patient cases.

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The volume of medical knowledge embodied in biomedical literature continues to grow rapidly. Discourses on the amount of medical information available and its exponential growth are commonplace in the literature of information science and medicine. In 1976, Pauker estimated the amount of the "core of information in the subspecialties of internal medicine" to be two million facts.[1] Demonstrating expansion in the volume of published medical knowledge, in 1978 Durack stacked and weighed successively larger piles of consecutive years' volumes of *Index Medicus*.[2] Current data indicates that this body of knowledge continues to grow; Medline, which now includes more than 14 million references, added over 500,000 in 2002 and more than 525,000 in 2003.[3]

Although clinicians have an obvious imperative to maintain their level of awareness about current research to sustain high-quality patient care, the realities of day-to-day practice often preclude their spending adequate time investigating every clinical question. Research about the impact of and barriers to evidence-based medicine (EBM) and its core tenet of "conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients"[4] has demonstrated the inability of practicing physicians to keep up with the expanding corpus of medical knowledge.[5–8] Ely has identified the poor coverage of resources and the lack of information synthesis as two major obstacles to successful evidence-seeking.[5] Furthermore, studies indicate that, although physicians often encounter multiple questions during daily practice, many questions generated from patient care may never be pursued or answered.[7] These findings illustrate that it is simply not feasible for most practicing physicians to devote adequate time to clinical queries.

To help meet the clinicians' need for timely and up-to-date evidence-based medical information at the point of care, the Eskind Biomedical Library at Vanderbilt University Medical Center (VUMC) has developed an innovative program called the Clinical Informatics Consult Service (CICS).[9] The CICS model provides librarians with advanced training in research design, biostatistics, and clinical and information sciences so they can serve as both information experts and medical knowledge providers. Once integrated into clinical teams, CICS librarians search the biomedical literature and interpret retrieved articles to provide information about complex medical questions. Analyzing the biomedical literature to identify and present the best examples

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of each available viewpoint in response to clinician queries, CICS librarians carefully point out conflicting data and opinions when a clear consensus is lacking. This service represents a working clinical model of the "informationist" concept recently discussed by Davidoff and Florance and others.[10] In preliminary, small-scale evaluations, clinicians consistently rated the CICS librarians highly on their ability to interpret the literature and provide relevant and useful information.[9] Similarly, other investigators noted positive results concerning librarians' ability to identify relevant material.[11–13] Since its inception in November 1996, the CICS program has trained 19 informationists.

We tested the hypothesis that CICS librarians are well equipped to interpret and filter articles retrieved from the literature in response to complex clinical questions. This study evaluated consistency in identifying and ranking pertinent biomedical articles for addressing complex clinical questions for three groups (informationists, methodologists, and generalists, described below). We also quantified the participants' self-assessed familiarity with searching and analyzing the biomedical literature.

Method

The design and methods for this investigation were approved by the VUMC's Institutional Review Board (IRB Protocol #03–0286).

Design

We prospectively compared the approaches taken by three groups for selecting and interpreting pertinent medical articles in response to two complex clinical questions that arose from patient care episodes at VUMC. Adapted from Giuse's previous work,[14] we defined "pertinent articles" as those "containing information that is likely to answer the clinical question." Outcomes included the participants' baseline self-assessment data, qualitative pertinence factors identified through small focus-group sessions, and ranking agreements for article pertinence.

Setting and participants

The VUMC in Nashville, Tennessee includes the Vanderbilt Schools of Medicine and Nursing and a 658 bed private academic hospital with affiliated clinics that together provided primary and subspecialist care for 37,867 inpatient visits, 71,402 emergency department visits, and 698,960 outpatient visits in 2002. Within VUMC, the Eskind Biomedical Library (the Library) serves as a single point of contact for individuals who need either information or access to the expertise of a medical informationist (the CICS librarians). In addition to print volumes, the Library provides access to an extensive digital library of electronic journals, books, databases, and other resources. The Library also houses a unique collection of rare books, manuscripts, photographs, and historical documents that reflect the histories both of the medical center and of medicine. The medical informationists at the Library participate in rounds throughout VUMC, including the medical, trauma, surgical, neonatal, and neurosurgical intensive care units (ICU).

In the Spring of 2003, we recruited 15 full-time VUMC faculty or staff based on their background, interest, and willingness to participate in the study. The participants were five general physicians in active clinical practice at VUMC (generalists), five physicians with specific formal advanced training in epidemiology, biostatistics, or research methodology who participated in both clinical research and in active practice at VUMC (methodologists), and five experienced clinical CICS librarians (informationists) from the Library.

Selection of questions

From a pool of complex questions previously received by the CICS librarians, we selected ten that we judged to be complex and of significant clinical impact for the study. Based on previous work,[15] we defined "complex questions" as those that, when initially explored by the CICS librarians, had no clear consensus answer presented by the biomedical literature, or those that required the CICS librarian to address a number of facet questions. A senior clinician in VUMC's Department of Biomedical Informatics then selected two of these questions for the study: (1) "Does the use of an insulin drip for strict glucose control help to prevent infectious complications in critically ill patients?" (insulin question, which originated in the surgical ICU) and "Can you describe the prognosis of upper extremity deep vein thrombosis, focusing particularly on the incidence of associated pulmonary embolism?" (UEDVT question, which originated in the trauma ICU).

Facet questions

Participants met in small focus groups to discuss and identify important facets of the two complex clinical questions that articles from the biomedical literature needed to address to be considered pertinent. During the focus groups, we asked participants to think aloud, to build on the comments of others rather than criticize their points, and to reach a consensus on the facet questions implied by the complex clinical questions. We condensed the observers' notes into a list of key consensus facet questions for each of the two complex clinical questions.

Baseline data collection

Participants completed a seven-item questionnaire that asked for demographic data, including years of clinical experience, formalized training in epidemiology or related fields, and self-rated knowledge of topics related to research design and biostatistics. We also asked participants to rate their clinical knowledge and experience related to the two complex clinical questions, including whether they had previously researched either of the topics.

Article selection and pertinence assignments

Because the intent of the study was not to assess variability in searching (i.e., finding articles from an article database like PubMed), which has been well explored by other investigators,[16] CICS librarians developed a consensus on the best search strategy for each of the two questions. Given the nature of the complex clinical questions and the targeted search strategies employed, only 57 citations were initially retrieved in response to the insulin question and 86 for the UEDVT question. Articles about other topics that were clearly not relevant (e.g., an article initially retrieved in response to the UEDVT question studied the association of hematomas with the site of subcutaneous heparin administration). In addition, letters and editorials were excluded, unless they added information (e.g., clarification of points in the article, delineation of methodologic strengths and weaknesses, clinical applicability). Based on this search strategy, the CICS librarians identified 37 articles, 12 for the insulin question and 25 for the UEDVT question.

Participants each received a packet containing both the 37 full-text articles and the lists of consensus facets for each of the two complex clinical questions. Each

participant selected up to five of the provided articles they believed was pertinent to answering each of the two questions. Participants assigned relevance rankings for each article they selected based on a seven-point Likert-type scale: one relevance ranking for overall pertinence to the main question and one relevance ranking for each of the consensus facets.

Analysis

We assessed rater agreement using polychoric correlations. Although kappa is often used to represent agreement, it has been the source of some criticism.[17] Polychoric correlation, which provides a measure of agreement in a well-known form, is not subject to the problems that plague kappa.[18,19] All agreement analyses were performed on the Fisher *r*-to-*z* transformed correlations. We used randomization tests for the tests of correlations due to the nonnormal distributions and relatively small sample sizes, and tested differences between cohorts using analysis of variance followed by Bonferroni-adjusted pairwise comparisons. We performed analyses using the SAS statistical package (version 8.1 SAS Institute, Inc., Cary, NC) and the R programming language.[20]

Results

All 15 participants completed the study by finishing the questionnaire, interacting in the focus groups, and selecting and ranking articles for pertinence. Generally, participants' years in practice or time spent in basic research did not differ. Methodologists reported more formalized training and self-rating of comfort, understanding, and use of topics related to research design and biostatistics than did either informationists or generalists. The groups did not differ in their prior experience with or knowledge of the insulin or the UEDVT questions. Informationists were more comfortable answering both the insulin and the UEDVT question than were generalists ($p < .05$). The participants' baseline characteristics are summarized in Table 1.

Article selection

In the small focus groups, the participants defined seven key consensus facet questions for each clinical question (see List 1). Participants selected 11 of the 12 insulin question articles and 16 of the 25 UEDVT question articles as pertinent. Overall agreement was significantly different between the two questions, with higher agreement on the insulin question ($r = 0.75$) than the UEDVT question ($r = 0.19$), $p < .05$. There were no significant differences among groups for either question, although there was a trend towards higher within-group agreement for informationists and methodologists than for generalists. These results are shown in Table 2.

The articles for which there was widespread agreement among the groups (insulin question articles 1–5 and UEDVT question articles 1–6) represent the larger prospective and retrospective studies related to each question. Articles outside of this core of agreement represent a wider range of study design and methodological quality. For the insulin question, infrequently selected articles included two letters (articles 9 and 11) commenting on the more commonly selected articles and a report of four patients treated with subcutaneous insulin rather than an intravenous insulin infusion (article 10). Article 6, selected by two informationists only, examines the antiinflammatory effect of intensive insulin therapy and posits this influence as a possible reason for reduced morbidity and mortality.

In identifying pertinent articles for the UEDVT question, the generalists selected five articles that the other groups did not (articles 12–16). Article 12, which was selected by three generalists, was a recent review article that covered diagnosis and

Table 1

Responses of 15 Participants to Baseline Demographics and Self-Assessed Comfort Questions, Vanderbilt University Medical Center, 2003

Characteristic	Participant category: Informationist ($n = 5$)	Methodologist ($n = 5$)	Generalist ($n = 5$)	*P*
Years in practice	n/a	6.0	10.4	Not significant
% Time spent in patient care	n/a	34%	64%	Not significant
% Time spent in clinical research	n/a	62%	22%	Not significant
No. with advanced methodology training	0/5	5/5	0/5	< .001
Self-assessed comfort with methodology (1–5)*	3.6	4.7	4.0	< .01
Self-assessed statistical test understanding (1–5)*	1.7	4.0	1.9	< .001
Self-assess comfort with statistical test use (1–5)*	1.6	4.1	1.8	< .001
Does the use of an insulin drip for strict glucose control help to prevent infectious complications in critically ill patients?				
Self-assessed prior knowledge about question*	2.0	2.8	1.8	Not significant
Self-assessed comfort answering question*	3.4	3.0	1.8	< .05
Can you describe the prognosis of upper-extremity deep vein thrombosis, focusing particularly on the incidence of associated pulmonary embolism?				
Self-assessed prior knowledge about question*	2.0	2.6	1.8	Not significant
Self-assessed comfort answering question*	3.4	2.8	1.8	Not significant

* Range of 1 (low) to 5 (high).

List 1

Facet Questions for Two Complex Clinical Questions Identified by 15 Participants in Focus Groups for Selecting Pertinent Articles, Vanderbilt University Medical Center, 2003

Insulin question: Does the use of an insulin drip for strict glucose control help to prevent infectious complications in critically ill patients?

1. Does tight control of blood glucose impact outcome (i.e., mortality)?
2. If tight control of blood glucose does impact outcome, is it due to the prevention of infection?
3. How tightly does blood glucose need to be controlled in the acute critical care setting? What is an "acceptable" range?
4. In which critically ill patient populations has management with an insulin drip been shown to reduce infectious complications?
5. What are the risks and possible adverse effects associated with use of an insulin drip?
6. Is management with an insulin drip useful in diabetic critically ill patients only, or in nondiabetic critically ill patients as well?
7. Is the insulin-drip protocol feasible/reproducible in a real-world clinical setting?

UEDVT question: Can you describe the prognosis of upper-extremity deep vein thrombosis (DVT), focusing particularly on the incidence of associated pulmonary embolism?

1. Is UEDVT as likely as lower-extremity DVT (LEDVT) to cause PE or other clinically significant complications?
2. Are UEDVTs life-threatening compared with LEDVTs?
3. Does the risk/severity of PE vary with the etiology of the UEDVT or the patient's underlying medical condition?
4. Does the size of the clot, size of the vessel, or location within the upper extremity impact the risk and/or severity of associated PE?
5. Is the risk/severity of PE different if the UEDVT is symptomatic vs. discovered during screening/surveillance scans?
6. How often does UEDVT occur in combination with LEDVT?
7. Is treatment of UEDVT necessary? If so, what is the appropriate agent/dosage/administration/duration?

management of thromboembolic disease of the upper extremities. Articles 13–16, each selected by one general clinician, represent a wide range of topics, including a summary of four cases of effort-induced upper extremity thrombosis in athletes (article 16), a discussion of the incidence of UEDVT in association with pacemaker devices (article 15), and two retrospective studies (article 13 and 14) reviewing the rates of UEDVT diagnosis. Interestingly, the generalists did not select article 7, a large retrospective study with an extensive literature review.

Table 2

Articles Selected by Three Groups of Participants for Two Clinical Questions, with Mean Agreement (Standard Deviations), Vanderbilt University Medical Center, 2003

	Articles selected by participant category		
Question and Article #	Informationist	Methodologist	Generalist
Insulin question			
1	XXXXX	XXXXX	XXXXX
2	XXXXX	XXXXX	XXXX
3	XX	XXXX	XXX
4	XXXXX	XXXXX	XXX
5	XX	XX	XXXX
6	XX		
7		XX	X
8		XX	X
9			X
10			X
11			X
Agreement (SD)	0.83 (0.15)	0.82 (0.15)	0.59 (0.28)
UEDVT question			
1	XXXXX	XXXX	XX
2	XXXX	XXXX	X
3	XXXX	XX	XXXX
4	XX	X	XX
5	XX	XX	X
6	XX	XX	XXX
7	XX	XXX	
8	X	XXXX	X
9	X	X	X
10		X	X
11		X	X
12			XXX
13			X
14			X
15			X
16			X
Agreement (SD)	0.45 (0.28)	0.25 (0.35)	−0.13 (0.26)

Overall pertinence and facet pertinence

We calculated average pertinence score for each facet question by participant and group averages with standard deviations. For the articles addressing the insulin question, the overall pertinence rankings were high for all groups (mean = 5.7, SD = 0.9). Across the question's facet questions, pertinence ratings were lowest for the facet question: "What are the risks and possible adverse effects associated with use of an insulin drip?" with a mean rating of 2.7 (SD = 1.0). Ratings across the other facet questions were all similar.

For the articles addressing the UEDVT question, pertinence rankings for the overall pertinence were high for all groups (mean = 5.7, SD = 1.3). There was more variability in pertinence ratings for the UEDVT question's facet questions, suggesting that this clinical question may have been more complex. Across facet questions and all groups, ratings were low for three: "Does the size of the clot, size of the vessel, or location within the upper extremity impact the risk and/or severity of associated PE?" (mean = 2.7, SD = 1.6), "Is the risk / severity of PE different if the UEDVT is symptomatic vs. discovered during

screening/surveillance scans?" (mean = 2.6, SD = 1.1) and "How often does UEDVT occur in combination with LEDVT?" (mean = 2.5, SD = 0.7). Methodologists assigned relatively lower pertinence rankings compared with generalists and informationists for three of the seven facet questions.

Discussion

For years, EBM visionaries have emphasized the necessity of integrating evidence from biomedical research into both the processes of patient care and educating clinical trainees.[4] Medical centers, too, are increasingly recognizing that the use of evidence in clinical practice could eliminate variability and reduce costs.[21] Given the complexities of managing the large volumes of medical knowledge, health care providers need to optimize the methods of information delivery to take full advantage of the insight that information resources offer.[7] As part of multidisciplinary teams, informationists are uniquely positioned to assist clinicians in bridging the gap between current medical literature and the time pressures of patient care. Librarians in some institutions have already begun to adopt the crucial new roles of knowledge worker and informationist,[22] equipped to handle the information needs of rounding teams and to provide clinicians with tools for accessing and managing information more effectively.

Although all three groups (informationalists, generalists, and methodologists) assessed themselves as having high levels of comfort with reviewing the biomedical literature and with identifying study questions and design, only the methodologists professed high levels of confidence in identifying bias, generalizability, and applicability of studies to patients. Likewise, methodologists had more advanced postgraduate training in biostatistics, epidemiology, and research design and were more likely to report understanding of the appropriate use of individual statistical tests and methods than were informationists and generalists.

In this study, informationists and methodologists displayed greater consistency in selecting pertinent articles than did generalists, and the informationists' article selection and pertinence ratings approximated those made by the methodologists. The spread among the general clinicians suggests lower levels of agreement about article selection within this group. Generalists often selected review articles as the most pertinent, consistent with prior explorations showing the practicing physicians' prefer summary articles that can be quickly read.[7] We speculate that consistency in article selection results from the combination of training in and experience with filtering articles, an ability to identify the strengths and weaknesses of individual study designs, and from an adequate fund of knowledge in the subject area the articles represent.

Our results are consistent with similar studies of clinical medical librarians (CMLs). Focusing on the relevance of CML-provided information, Claman[11] and Staudt et al[12] found that most information was considered pertinent to the case at hand. Haynes found comparable relevance rates by librarians and clinicians experienced in searching,[16] and a 1993 University of Pittsburgh study reported that clinical librarians recognized and selected articles that were at least as useful as those clinicians selected on their own.[13]

Our study has some limitations. First, given the small sample size and the nonrandom nature of participation, it is possible that the participants were not representative of the populations from which they were drawn, leading to a selection bias and potentially limiting the generalizability of the results. The small sample may also have reduced the observed effect size; repeating the study with more participants could lead to greater differences between the informationists and the generalists in their agreement on relevance rankings for articles. The small sample size also limited our ability to perform quantitative analyses of the facet questions. Second, our study was performed at an academic health care facility housing a large medical library and a mature clinical informationist's training program, which also limits the study's generalizability. It is possible that organizations with limited resources devoted to information retrieval services would be unable to replicate our findings. Third, this study did not compare article selection and pertinence ratings against a gold standard, and therefore we cannot assess the participant cohorts' accuracy. We are unaware of any confirmed gold-standard method for selecting pertinent articles. Potential standards, including opinions of experts in the subject area queried by the complex clinical questions or the consensus of a large number of practicing clinicians, remain unproven and are likely difficult to implement. Establishing a gold-standard method for assessing pertinence in article selection is a potentially fruitful direction for future research on clinical informationists.

Conclusion

Research has demonstrated that providing quality patient care requires clinicians to maintain a high degree of familiarity with current medical evidence. The exigencies of clinical practice limit clinicians' pursuit of evidence-based answers to questions that arise during patient care. Surrogate professionals who specialize in information acquisition and delivery and filtering biomedical literature may enhance the delivery of evidence relevant to clinical practice. Clinical information specialists with appropriate training in librarianship, synthesizing biomedical literature, research design and biostatistics, and with experience rounding on clinical teams are such adequately equipped surrogates who can select relevant evidence that addresses specific clinical information needs. In our study, informationists identified medical articles relevant to complex medical questions as reliably as did physicians trained in clinical research. As others have pointed out,[10] integrating clinical-information specialists into patient care teams is feasible, results in improved information delivery, and may help enhance the quality of patient care.

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Teaching and Learning Moment

Following Orders

"I got the ABG!" I proudly announce to my resident. "Need help with anything else?" It's a Saturday night and I am a third-year medical student on my medicine rotation.

"Jane and Cindy may need some help in room 304 with their LP," he replies. "Wear gloves though, he's end-stage HIV positive. It will be a good learning experience." I feel my pulse quicken in anticipation of danger. *I'll show that I can handle it,* I think to myself.

On the bed lies a very ill man with his hospital gown riding up to his chest. He is writhing in pain and screaming. One resident tries to hold his hands and feet in place while another is chasing a moving target with a long spinal needle. They see me and smile, and then ask me to help them hold him down. My thoughts are racing. *This is my learning experience? My medical education is about forcing people into submission? Okay, just do what you're told.* Within seconds I have his wrists secured between his knees, while pushing his head down to his chest. He is overpowered and still. The residents exclaim, "Perfect position!" and start reprepping his skin with iodine. The patient's eyes focus on my face. I bend down and apologize, "Sorry. We have to do this." He looks away. *Apology not accepted. Is this the right thing to do?*

The needle penetrates his skin and resurrects his will to fight. He is cursing, spitting, and screaming for us to stop. "Please don't move," I say calmly as I continue to restrain him. *C'mon*, I am silently screaming at the residents, *hurry up!* Five minutes feel like hours, and the residents continue to fail at drawing the fluid from the patient. I want to object. *Overpowering this remnant of a man feels wrong, but it is my duty to continue. Or is it? These senior residents know what's best for the patient. They taught me about foremost respect for autonomy in their lecture last week. He must not have capacity to refuse the procedure. Or does he?*

I am silent. The residents are exhausted and frustrated. *Don't say anything. If you speak up they can turn on you. They evaluate you. If you can't handle this, they will not teach you any more procedures.*

I am silent. Another scream with drops of spit hitting my face. That's it. They must stop. I know the residents expect me to be enthusiastic, respectful, and obedient. *You shouldn't say anything critical, condescending, or threatening. Don't embarrass the residents in front of the patient or each other. How do you make them think about it without them thinking you made them think about it?* I suddenly realize the solution to my dilemma. *You are a student. Ask a naïve question*: "What do we expect the analysis of the fluid to show?"

The question drowns in a double sigh of relief. They got the fluid, finally. "Hold steady, Mr. Johnson." He closes his eyes and his muscles weaken. The procedure is finished. He lies peacefully in the bed, almost smiling, on a brief vacation from hell. "I am sorry it took so long, but the fluid should be very helpful for the diagnosis," I say to him gently. *I am sorry I cared about being a good medical student more than about you,* I confess silently. He slowly turns to look at me. "Please let me be, Doctor," he utters.

I walk out, wishing he never said that. What I did today was not the work of a doctor. While contemplating a diplomatic dissent I lost the chance to intervene—a good learning experience indeed.

This essay is dedicated to my wife, Betsy, for her love and support. I also wish to thank all those who taught me to question their orders.

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