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PRIMARY CARE GUIDELINES ON CONSULTATION PRACTICES: THE EFFECTIVENESS OF COMPUTERIZED VERSUS PAPER-BASED VERSIONS

A Cluster Randomized Controlled Trial Among Newly Qualified Primary Care Physicians

Jukkapekka Jousimaa
University of Kuopio

Marjukka Mäkelä
STAKES/FinOHTA

Ilkka Kunnamo
Finnish Medical Society Duodecim

Graeme MacLennan
University of Aberdeen

Jeremy M. Grimshaw
Ottawa Health Research Institute

Abstract

Objective: To compare the effects of computerized and paper-based versions of guidelines on recently qualified physicians' consultation practices.
Methods: Two arm cluster randomized controlled trial. Physicians were randomized to receive computerized or textbook-based versions of the same guidelines for a 4-week study period. Physicians' compliance with guideline recommendations about laboratory, radiological, physical and other examinations, procedures, nonpharmacologic and pharmacologic treatments, physiotherapy, and referrals were measured by case note review.

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Results: There were 139 recently qualified physicians working in 96 primary healthcare centers in Finland who participated in the study. Data on 4,633 patient encounters were abstracted, of which 3,484 were suitable for further analysis. Physicians' compliance with guidelines was high (over 80% for use of laboratory, radiology, physical examinations, and referrals). There were no significant differences in physicians' consultation practices in any of the measured outcomes between the computerized and textbook group.
Conclusion: Guidelines are a useful source of information for recently qualified physicians working in primary care. However, the method of presentation of the guidelines (electronic or paper) does not have an effect on guideline use or their impact on decisions. Other factors should be considered when choosing the method of presentation of guidelines, such as information-seeking time, ease of use during the consultation, ability to update, production costs, and the physicians' own preferences.

Keywords: Guidelines, Primary health care, Computer-assisted decision support

Clinical information can be defined as "the commodity used to help make patient care decisions" (22). Doctors constantly need to update their knowledge and skills. Although about a third of doctors' time is spent recording and synthesizing information (11), the clinicians have limited time for educational activities (17). Covell and colleagues (3) reported that the observed information needs of 47 internists clearly exceeded their self-perceived needs. Further, only a third of the physicians' self-reported information needs were met during the patient visit. During the time of this study, electronic information retrieval media were not readily available at physicians' offices in most countries, and the usability of paper-based information sources was seriously limited by the age of textbooks in the office, poor organization of journal articles, inadequate indexing of books and drug information sources, lack of knowledge of an appropriate source, and the time required to find the desired information.

Gorman and Helfand (9) found that only 2 of 12 factors were significant predictors of whether primary care physicians pursued new information: the physician's belief that a definitive answer existed, and the urgency of the patient's problem. The authors concluded that medical information systems must be shown to have direct and immediate benefits to solving the problems of patient care if they are to be widely used by practitioners.

The development of clinical practice guidelines has been stimulated by the need to improve patient care outcomes, reduce variability in practice, and control costs in health care (21). However, the existence of evidence-based guidelines does not guarantee their adaption in clinical practice. While practitioners' attitudes toward guidelines are generally positive (16;20), there remains uncertainty about the most effective ways of their implementation (18). The use of computers for implementing guidelines is encouraged by the rapidly developing features of personal computers such as easy data storage and retrieval, graphical user interfaces, network connections, and the possibility to link individual patient data to the database. Computerized guidelines have potential advantages over paper-based guidelines relating to information management, speed of retrieval, and ease of access within the consultation.

The sources of information to assist practitioners' decisions have been presented as a "4S" hierarchical structure (10). In this model, the original "studies" are at the base, "syntheses" (systematic reviews) are the next step, followed by "synopses" of the studies, such as evidence-based journal articles, and evidence-based information "systems" are at the top. Information seekers should start looking at the highest level available to solve the specific problem. The ultimate goal of these systems would be to link the specific patient's circumstances to the relevant information integrating the electronic medical record to the research evidence. Currently, existing systems do not reach this level but rather are evidence-based electronic textbooks such as UpTo Date (19) and Clinical Evidence (2).

The Physician's Desk Reference and Database (PDRD) (13;14), now re-named Evidence-Based Medicine Guidelines (EBMG) (6), is a collection of Finnish clinical practice guidelines designed to assist primary care physicians in daily practice decisions. It contains over 1,100 guidelines written by general practitioners in cooperation with experts from other specialties. The first PDRD computer version was published in 1989, and it is updated three times yearly. The textbook version has been published since 1992 and is revised biannually. The CD-ROM contains additional databases (e.g., full issues of two Finnish medical journals, laboratory databases, picture collections, etc.). The computer and textbook versions use similar indexing systems. Practically all Finnish health centers provide one or both versions for the daily use of the practitioners. Therefore, we had a unique opportunity to compare the use of either computerized or book form of a comprehensive and well-established set of guidelines that was already popular and well-known by Finnish physicians and medical students.

Since the guidelines in the textbook and electronic version are the same, we studied whether the electronic presentation of the guidelines would have any effect on how much evidence is sought and used, and whether the form of presentation of the guidelines would have any measurable effect on the physicians' consultation behavior. We included only recently qualified physicians in this study to eliminate the effect of differences in computer literacy and different levels of medical expertise in the study groups.

METHODS

Recruitment and Randomization

In Finland, newly qualified physicians undertake a further 2-year training period, which includes at least 6 months working in primary health care and 6 months in hospital. During this time, the physicians work independently and are responsible for their own clinical decisions. For the purposes of this study, we identified newly qualified physicians who would work in a Finnish health center for at least 2 months during the study period from February 1998 until September 1999.

There were 512 medical students who graduated from the five Finnish medical schools in 1998. We attempted to contact all these students prior to graduation by telephone or letter to ask them to participate in the study. Students agreeing to participate in the study were randomized centrally using computer-generated numbers to receive either computerized or textbook-based guidelines. Students who declined to participate were asked for their reasons for nonparticipation.

Interventions

Physicians in the computer group were given the latest CD-ROM version of the guidelines. Physicians with access to a computer in the consultation room were given a copy of the CD-ROM to be installed on their consultation room computer. If the physicians did not have access to a computer in the consultation room, they were provided with a laptop computer with pre-installed guidelines during the study period. Physicians in the textbook group were given the latest version of the textbook guidelines. Prior to the study, the participating physicians agreed not to use the other version of the guidelines if it was available in the health center, but they could use any other source of information, such as medical journals, books, and colleague consultations.

Data Collection and Analysis

Data were collected not earlier than during the second month of the physicians' assignment to the health center to allow the physicians to adapt to the daily routines of the health center.

Participants were asked to identify, on a daily printout of patient contacts, any consultation during which they searched for information to support patient care from any information source (information-searching consultation). They were also asked to complete a brief questionnaire for each information search about the reason for the search, the main sources of information searched, whether they had found the information they were searching for, and whether they complied with the information. Data were collected for 1 month, or until a maximum of 50 information-searching consultations were included.

The patient records were collected and photocopied from information-searching consultations and the preceding consultations with a different patient, which did not include information searches ("non–information search consultation"). Using this method, the physician could not know during the consultation that the non–information-searching consultation was also going to be analyzed. All patient identification data were deleted from the photocopies in the health center. The anonymous patient records were then evaluated by one author (JJ, experienced primary care physician) blinded to the study group (computer or textbook, information searching or non–information searching consultation). Nine elements of care were evaluated: laboratory examinations, radiologic examinations, physical examination, other examinations (for example, endoscopy), procedures, nonpharmacologic treatments, pharmacologic treatments, physiotherapy, and referrals. All consultations were classified using the ICD-10 disease classification system. Review criteria based upon the guidelines were developed by a consensus process by three researchers (JJ, IK, MM) for the 99 most common separate diagnoses. For other diagnoses, compliance with the guidelines was checked manually on a case-by-case basis. Noncompliance with the guidelines was classified into four categories (none, minor, major, serious) according to their clinical significance. This classification was later dichotomized to complying (none or minor) or not complying (major or serious).

Statistical Methods

The physician was the unit of randomization and inference. We analyzed the data using adjusted chi-squared tests, which account for the clustered nature of the data (5).

RESULTS

Participating Physicians

We were able to contact 386 of 512 medical students by phone or mail, of whom 209 were eligible to participate in the study (Figure 1). Of the eligible physicians, 139 (66.5%) agreed to join the study, and 130 completed it. The baseline characteristics of both study groups were similar (Table 1).

Patient Records and Questionnaires

In the textbook group, there were 2 to 50 information-searching consultations per physician (mean, 18.7; median, 18.0) and in the computer group, 3 to 50 (mean, 19.3; median, 15.5). Fifty-seven physicians used a laptop computer (mean searches, 19.8/physician) and nine physicians used a desk computer provided by the health center (mean searches, 16.2/physician). During the study, 4,633 photocopies of patient records were collected, 2,408 of which were from information-searching consultations and 2,225 from other consultations (Figure 1). Of these, 1,149 patient records could not be evaluated for physician performance because two or more different symptoms had been presented by the patient during the same consultation, patient encounters were unsuitable for analysis (health checks or complicated psychosocial problems), or there was insufficient information in the notes to judge compliance. The predetermined review criteria covered 2,813 of the 3,484 (81%) evaluated cases.

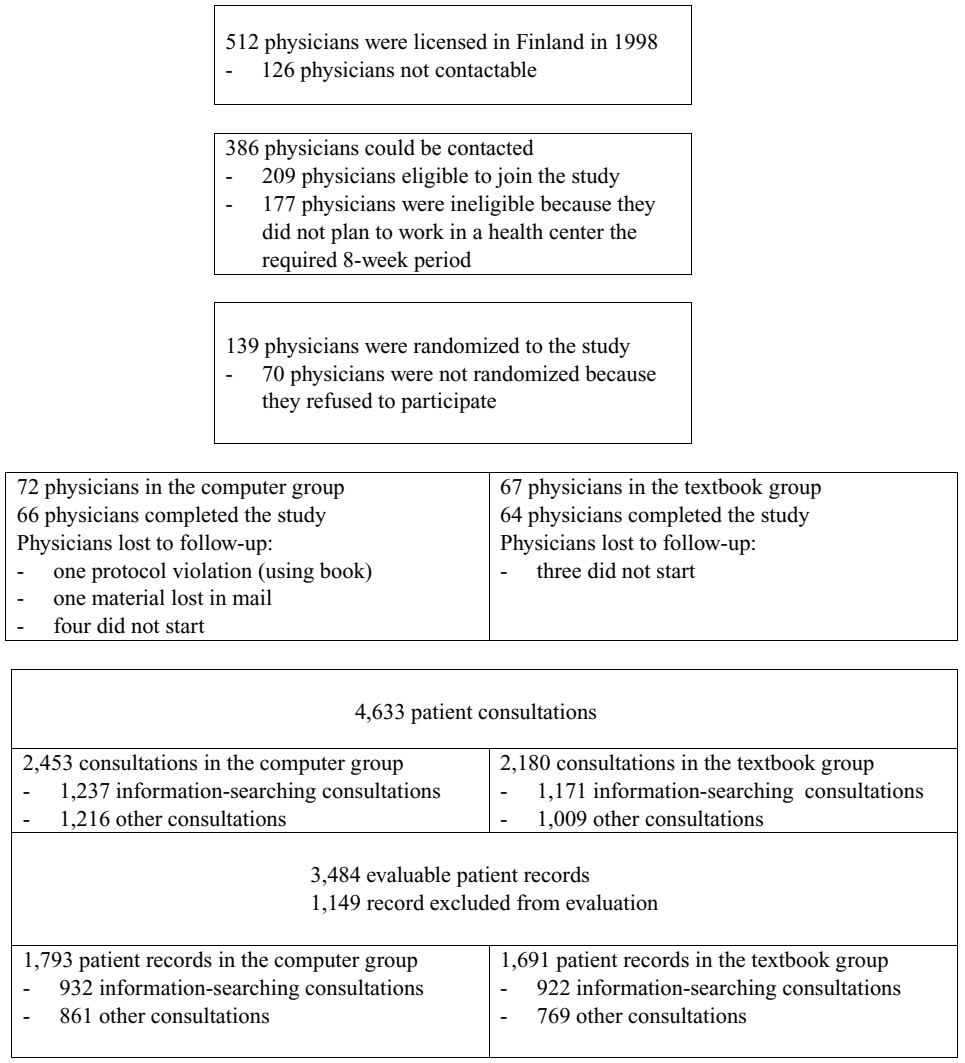

Figure 1. Flow chart of the study.

A total of 2,402 completed questionnaires from information-searching consultations were obtained for further analysis, and six questionnaires were missing.

Characteristics of Information-searching Consultations

In both groups, the guidelines were the most common source of information used, with direct consultations with colleagues in health center and hospital ranking second and third, respectively. The most common reasons for information searches were treatment and diagnostic advice (Table 2). There were no statistically significant differences between the groups in the proportion of successful searches where the physician found relevant information or physicians' self-reported compliance with the information (Table 3).

A total of 338 diagnoses were classified in the information-searching consultations and 212 diagnoses in the others. The 10 most common diagnoses in either group are presented in Table 4. Six of the 10 most common diagnoses in information-searching consultations were also among the 10 most common diagnoses in other consultations. Upper respiratory

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Table 1. Baseline Characteristics of the Study Physicians

	Computer group	Textbook group
n	72 (66)[a]	67 (64)[a]
University		
Helsinki	15 (20.8%)	15 (22.4%)
Kuopio	11 (15.3%)	13 (19.4%)
Oulu	14 (19.4%)	11 (16.4%)
Tampere	18 (25.0%)	14 (20.9%)
Turku	14 (19.4%)	14 (20.9%)
Gender		
Male	22 (30.6%)	18 (26.9%)
Female	50 (69.4%)	49 (73.1%)
Age		
Mean	27.3	26.9
Experience in health center		
Months, mean	6.3	5.4
Type of health center		
Urban	37	33
Rural	29	31
Previous experience with PDRD guidelines[b]		
Textbook	4.6	4.7
Computer	2.4	2.5
Searches, mean[c]		
Males	19.2	14.8
Females	19.4	20.1

Age, experience, and health center type were calculated from 130 physicians who finished the study.
[a]The number of physicians who completed the study is in parentheses.
[b]Estimated as 5-point Likert scale where 1 = no experience at all and 5 = daily use of the guidelines prior to the study.
[c]Differences between males and females are not significant.

Table 2. Physicians' Self-reported Reasons for Searches and Information Sources

	Computer group	Textbook group
n = 2,402 questionnaires (6 were missing)	1,232	1,170
Main reason for search		
Diagnostic advice	439	460
Treatment advice	540	491
Follow-up advice	84	79
Other advice	152	119
No answer	17	21
Main information source		
PDRD comp./book	871	844
Local guideline	5	8
Book	50	37
Medical journal	10	0
Pharmaceutical book	64	44
Healthcenter colleague	137	146
Hospital colleague	46	67
Other	29	19
No answer	20	5

All p values between the groups were nonsignificant (chi-square test).

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Table 3. Physicians' Self-reports About Results of Information Searches and Compliance with the Obtained Advice ($n = 2402$)

	Computer group		Textbook group		ICC
	All searches n = 1,232	PDRD searches n = 871	All searches n = 1,170	PDRD searches n = 844	
Did the searches find relevant information?					
All answers	1215	867	1136	836	0.20
All information found	883 (72.7%)	614 (70.8%)	797 (70.2%)	580 (69.4%)	
Information, partially found	267 (22.0%)	198 (22.8%)	292 (25.7%)	220 (26.3%)	
Information not found	65 (5.3%)	55[a] (6.3%)	47 (4.1%)	36[a] (4.3%)	
Did the physician comply with the information?					
All answers	1,145	814	1,098	806	0.39
Agreed	755 (65.9%)	483 (59.3%)	728 (66.3%)	488 (60.5%)	
Partially agreed	358 (31.3%)	302 (37.1%)	359 (32.7%)	308 (38.2%)	
Did not agree	32 (2.8%)	29[a] (3.6%)	11 (1.0%)	10[a] (1.2%)	

[a]There was not a significant difference between computer and textbook group PDRD searches in terms of finding the information or complying with it (chi-square test).

Table 4. Ten Most Common Diagnoses in Information Searching and Other Consultations

Ten most common diagnoses in information-searching consultations (2,408 consultations, 338 diagnoses)				Ten most common diagnoses in non–information-seeking consultations (2,225 consultations, 212 diagnoses)	
Diagnosis	Cases	Computer group	Book group	Diagnosis	Cases
1. Hypertension	56	19	37	1. Upper respiratory infection	119
2. Bronchial asthma	46	32	14	2. Middle ear infection	97
3. Ankle and foot injuries	39	19	20	3. Sinusitis	89
4. Carpal and hand injuries	37	21	16	4. Bronchitis	83
5. Middle ear infection	35	26	9	5. Hypertension	67
6. Low back pain	34	16	18	6. Low back pain	63
7. Adult type diabetes	31	12	19	7. Skin biopsy	47
8. Vertigo	29	9	20	8. Bronchial asthma	44
9. Bronchitis	29	19	10	9. Tonsillitis	44
10. Painful knee	28	10	18	10. Carpal and hand injuries	43

tract problems were uncommon in information-seeking consultations (with the exception of middle ear infections) and common in the other consultations.

Comparison between the Computer and Textbook Groups

In general, compliance was good for common elements of consultations (over 80% for use of laboratory, radiology, physical examinations, and pharmacologic treatments and referrals). Guideline compliance was similar in both study groups (based upon both information-searching and other consultations) (Table 5). The proportion of noncompliant decisions that were considered to be clinically important (major or serious) was also similar in the two groups: 47.4% (407/859) in the computer guidelines group compared with 46.3% (349/753) in the textbook group. A retrospective power calculation was done, adjusting for clustering using an intracluster correlation coefficient (ICC) of 0.015 and an average cluster size of 27. With 3,484 patients in total, we had 80% power to detect a 3% difference between the computer and textbook groups for the common elements of the consultation at the 5% significance level.

Table 5. Consultation Decisions Compliant with Guidelines

	Number of relevant consultations	Number of relevant consultations compliant with guidelines (%)	Odds ratio (95% CI)[a]	ICC
Laboratory examinations				0.015
Computerized group	1,640	1,481 (90.3%)	1.07	
Textbook group	1,529	1,372 (89.7%)	(0.79, 1.44)	
Radiological examinations				0
Computerized group	1,604	1,504 (93.8%)	1.09	
Textbook group	1,518	1,416 (93.3%)	(0.81, 1.46)	
Physical examinations				0.015
Computerized group	1,610	1,494 (92.8%)	0,74	
Textbook group	1,545	1,461 (94.6%)	(0.51, 1.06)	
Other examinations				0.021
Computerized group	314	235 (74.8%)	0.71	
Textbook group	307	248 (80.8%)	(0.43, 1.17)	
Procedures				0
Computerized group	196	152 (77.6%)	0.77	
Textbook group	171	140 (81.9%)	(0.43, 1.36)	
Physiotherapy				0.195
Computerized group	98	77 (78.6%)	0.88	
Textbook group	103	83 (80.6%)	(0.34, 2.32)	
Nonpharmacologic treatment				0.058
Computerized group	92	80 (87.0%)	0.73	
Textbook group	122	110 (90.2%)	(0.22, 2.41)	
Pharmacological treatment				0.010
Computerized group	1,654	1,391 (84.1%)	0.85	
Textbook group	1,568	1,350 (86.1%)	(0.67, 1.09)	
Referrals				0.002
Computerized group	1,684	1,619 (96.1%)	1.13	
Textbook group	1,578	1,508 (95.6%)	(0.79, 1.63)	

[a]Using Clustered Woolf Method (4).

Log Files Collected from the Computer Group

To check the concordance of self-reported searches with actual searches, a part of the computerized group had a log file–producing function in their program, and this log file was collected when the study period ended. Forty-five of the 66 physicians in the computer group had the software to produce a log file, and these files were returned from 41 physicians. One file was empty, and thus the contents of 40 files could be analyzed.

There were cases when the physician had reported PDRD use, but there was no such evidence in the computer log file. However, these cases were rare: no cases with 20 physicians, one case with six physicians, two to six cases with seven physicians, and 14 cases with one physician. Additionally, there were six log files with totally different searches from questionnaire reports. The number of searches in these log files was small (1–4/log), which suggests that the physicians could have worked in many consultation rooms and used more than one computer, or collected the log file by misunderstanding before the study started. However, the possibility of false search reports cannot totally be excluded in these six cases.

Calculated from the log files, the mean searching frequency from PDRD was 41.9 searches per 4-week study period, which means that approximately two searches were done during every working day. Counted from the physicians' self-filled questionnaires, the mean

of searches was only 15.3 searches per 4-week period, and so only 36.5% (15.3/41.9) of the searches would really have been reported. However, this estimate is not quite valid because the maximal number of searches to be reported was limited to 50, and some searches were obviously started for general information-searching purposes and not to solve patient-specific questions.

DISCUSSION

Principal Findings

The textbook and computerized guidelines were frequently used and were the most common source of information in both study groups.

The observed searching frequency was similar to our previous study (15) on more experienced physicians' use of the guidelines. However, the main search topics were interestingly different. In the previous study more experienced physicians commonly searched for dermatologic articles and information on rare infections newly qualified doctors searched for information on common primary care problems. Only, but in this study and diabetes treatment were among the ten most common searching topics in both studies. In the previous study, female users did more searches than the males, but in this study there was no difference in either the computer or the book group.

In this study, respiratory infections (upper respiratory infections in general, middle ear infection, sinusitis and bronchitis) were the most common patient problems in the non–information-searching consultations, but in this group only middle ear infections were among the 10 most common topics of information searches. A possible explanation could be that the doctors could have become familiar with these common diseases in the health center before this study began.

The compliance rate with the guidelines was high across all common elements of the consultation. Less than half of the noncompliant decisions were considered to be major, and very few were potentially harmful to the patients. The "major but not potentially harmful" category of noncompliant decisions included, for example, prescibing antihistamine-containing drugs for common cold. We did not observe statistically significant differences between the computerized and textbook group in terms of compliance to any of the evaluated elements of the consultation.

Results from Previous Studies

The assumption that when research evidence is made available, it is accessed and applied by practitioners, is largely discredited (7). A review of 11 studies evaluating the effectiveness of disseminating educational materials, including clinical practice guidelines, audiovisual materials, and electronic publications, found no statistically significant improvements in practice (8). There have been very few evaluations comparing the relative effectiveness of computerized and paper-based guidelines. In a recent study, 162 residents were randomly assigned to study from Internet-based or print-based guidelines for care after acute myocardial infarction (1). The immediate post-test scores were similar in both study groups, but the on-line tutorial users spent less time studying, had therefore greater learning efficacy and also higher satisfaction. However, after 4 to 6 months, knowledge had decreased to the same extent in both groups. The dissemination of guidelines through intranet did not bring any benefits compared with paper-based guidelines in a study among 16 internal medicine and family practice clinicians (13 physicians, 2 nurse practitioners, and 1 physician assistant) (12). The time required to complete the task was longer with intranet guidelines (6.7 minutes intranet versus 5.7 minutes paper-based), and the tasks completed with paper guidelines had a significantly higher number of perfect scores than those completed with the

intranet (59% intranet, 85% paper). There was no significant difference in the reported ease of use.

Strengths and Weaknesses

This study has noteworthy differences compared with many other guideline studies: we studied a collection of guidelines that covered most problems in everyday primary care practice instead of a single guideline, and the study guidelines were distributed to virtually every health center throughout the country. Indeed we could not use a "no guidelines" control group because of the popularity of the PDRD; instead, we decided to study whether using the computerized version would have any measurable additive benefit to consultation practices.

We included only recently qualified physicians to eliminate the effect of different experiences and attitudes toward computer use. As the PDRD guidelines cannot be the only source of information in the consultation room, we also included other sources of information and non–information-searching consultations in the analysis. The non–information-searching consultations were analyzed together with information-searching consultations because previous consultations could have influenced the decisions within the group. As we wanted to eliminate the effect of variable experience with computer use, the generalizability of the results of this study to more experienced groups of physicians remains unclear.

POLICY IMPLICATIONS

This study suggests that, at this time, the method of presentation of guidelines does not significantly influence their effectiveness in practice. Other factors should be considered when choosing the method of presentation of guidelines, such as information retrieval times, ease of use during the consultation, ability to update, production costs, and physicians' preferences. The implementation of computerized guidelines may need more training and investment in computer hardware. However, once computers are readily available and routinely used within consultations, the computerized version offers many advantages such as easy updating, low production costs, possibility to include other databases and audiovisual material, the possibility of linking computerized guidelines to decision support systems, and the ability to monitor the guideline use.

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