Evaluating the Impact of MEDLINE Using the Critical Incident Technique

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Abstract

An adaptation of the Critical Incident Technique for the evaluation of an online information system is described. 552 users of the National Library of Medicine's MEDLINE database, interviewed by telephone and responding to a highly structured set of open-ended questions, reported 1,158 incidents in which the results of a MEDLINE search was especially helpful (or not helpful) in carrying out professional activities. Systematic analysis of these "critical incidents" produced three comprehensive and detailed views of the purposes and outcomes of MEDLINE searches: (1) why information is sought from MEDLINE; (2) the impact of MEDLINE-derived information on medical decision-making; and (3) the ultimate outcome of having (or not having) the desired information on medical situations prompting a MEDLINE search. Results revealed that MEDLINE is used to satisfy a diversity of medical needs concerning patient care, the progress of biomedical research, the quality of education received by health professionals in training, the safety and effectiveness of health care institutions, the operation of the system of third-party reimbursement, for legal decisions, and for the knowledge of the public.

Of continuing concern for all providers of scientific and technical information is how to evaluate the impact of that information on the professional activities of our users. Does what we do "make a difference"?

The National Library of Medicine has addressed this issue through use of the Critical Incident Technique (CIT) to evaluate the impact of its MEDLINE database on the decisions and actions of health professionals. The results demonstrate the very practical value of MEDLINE in the biomedical community, and reveal considerable diversity in the clinical, research, educational, and administrative uses to which the information is put.

The Critical Incident Technique is a systematic approach to obtaining and analyzing reports of behaviors leading to successful or unsuccessful outcomes on a task or process. The evaluation technique was developed by John C. Flanagan in the 1940's in response to the need to identify the critical behaviors that determined success or failure of pilots on World War II bombing missions [1]. The method has been widely used since that time to define the skill requirements of various occupations, including a number of studies to define the requirements for effective performance in medical specialties [2].

We set about the task of translating this concept of collecting "critical incidents"--that is, collecting especially noteworthy instances in which background circumstances can be shown to lead to specific outcomes. In this case, we would be identifying the impact of MEDLINE-derived information on specific--especially noteworthy--medical situations that led to the need for the information.

Our adaptation of the methodology for an evaluation of an information system calls for gathering data through structured interviews with the actual users of the information, i.e., the "end user" and/or the search requestor if an intermediary actually executed the searches. Users are asked about their reason(s) for searching on a particular occasion, the immediate effects of the information they obtained on decision-making, and the outcome of having (or not having) the desired information on the medical situation prompting the search, e.g., the outcome for the patient in the case of clinical searches of MEDLINE.

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The sample is selected with a view to obtaining accounts of the widest range of possible users and impacts of the database. It is not necessary that the sample reflect the proportional representation of particular groups within the user community. For NLM's study, individual users of MEDLINE (65% of those interviewed) were selected from a random sample of MEDLINE subscriber records. Users of MEDLINE through library search services (35% of those interviewed) were selected to include users at a major health sciences center, as well as users of libraries in community hospitals. Of 1,169 health professionals invited, by letter, to participate in the study, 1,160 were contacted and, of these, 552 were interviewed, for an overall interview rate of 48%. Most of those interviewed (71%) were M.D.s or M.D./Ph.D.s. An additional 14% were Ph.D.s, with the remaining 15% consisting of dentists, nurses, other allied health practitioners, and attorneys.

During the course of interview sessions averaging 30 minutes in duration, respondents were asked to describe recent searches (i.e., the "incidents") that were especially effective or especially ineffective (i.e., "critical") in meeting a specific information need. A carefully structured set of open-ended questions was asked of each person, but with slight variations depending on whether the search was effective or ineffective, and whether or not the respondent was an end user. The following questions illustrate the interview protocols for end users describing effective and ineffective searches. Note that the questions are identical except for questions 1, 7, 8, and 9.

End-User Interview Protocol

1. Can you think of a recent instance in which the information you obtained through a MEDLINE search you conducted was especially helpful with your work? (FOR INEFFECTIVE SEARCHES: Have you had any recent experience in which you performed a MEDLINE search that was unsatisfactory or *not* helpful in getting information that you needed for your work?) Do you have a specific search in mind?
2. What was the situation that led you to do this search?
3. What specific information were you seeking?
4. Why did you choose to do a MEDLINE search instead of consulting some other information source you had available, such as textbooks, journals, or colleagues?
5. How did you carry out this search to get the information you needed?
6. What information did you obtain as a result of this search?
7. In what specific ways was this information helpful in your decision making? (FOR INEFFECTIVE SEARCHES: In what way was the search or its results unsatisfactory?)
8. (FOR INEFFECTIVE SEARCHES ONLY: What search results would have been more helpful in your decision-making?)
9. What was the impact on the situation of having this information? (FOR INEFFECTIVE SEARCHES: What was the impact on the situation of *not* having the information?)
10. What was the outcome of the situation?

In addition to these open-ended questions, several pre-coded questions were asked to learn about such variables as work setting, community size, method of accessing MEDLINE, and previous searching experience, among others.

In all, the study generated detailed accounts of 1,158 searches, spanning applications in clinical practice (43%), research (20%), education (20%), personal learning (7%), administration (6%), and a variety of other needs including medico-legal consulting (3%). Interviewees provided more numerous effective (86%) than ineffective (i.e., not helpful) incidents, despite efforts to encourage them to relate any unsatisfactory experiences with MEDLINE. Many individuals felt that the problems they encountered were due to their own inexperience rather than to system shortcomings.

Of the 494 searches that were motivated by information needs that arose in a clinical setting, 56% were related to the care of the physician's own patient, 28% to consultation they were providing on another M.D.'s patient, and 15% were related to a general class of patient

rather than any specific individual. The largest percentage of the searches reported addressed the care of hospital inpatients (48%). This was followed by office patients (33%), hospital outpatients (12%), and emergency room patients (2%), with the remaining 6% spread among a variety of other settings. (It should be noted that these percentages may, in part, reflect the composition of the sample and the specific elicitation of patient-care related incidents; and, therefore, should not be interpreted as population estimates). Abstracts of several of the search incidents are shown below:

A woman who had had a giant cell tumor removed from a metatarsal bone several years previously was found to have recurrent tumors in that foot. A physician assistant was asked to obtain a literature search because a consulting physician had suggested either amputation or removal of the tumors by osteotomy as treatment options. The attending physician needed to know the indications for amputation. They did not find an answer in their orthopedic journals and books, and needed to consult the oncology literature. At the medical school library, a MEDLINE search was requested. The articles obtained made it clear that amputation was not indicated if the recurrent tumors were not malignant on biopsy. The physician performed an osteotomy and biopsy, which was negative. The patient's foot was saved and she is doing very well.

A physician had a patient with pneumonitis due to a gram positive organism, who was being treated with cephalosporins. The treatment was ineffective, and the physician wanted to know just how effective cephalosporins are in pneumonitis therapy. The texts he consulted were out-dated, so he searched MEDLINE from home. He found several reference articles that specified which cephalosporins were effective against pneumonitis. For gram positive organisms, first and second generation cephalosporins are preferred, and for gram negative bacteria, second and third generation cephalosporins are the treatment of choice. He changed the patient's antibiotic to Ancef, one of the first generation forms. The patient recovered completely.

A physician specializing in infectious diseases in an urban private practice had a young patient who developed a brain abscess caused by a rare fungus, Pseudallescheria. The medical team needed to know the therapeutic recommendations, what others had done to treat the fungus, what agent they had used, how much they had used, and how often they had administered it. Because the information was not in textbooks, he searched MEDLINE from his office and discovered only 13 previously reported cases and that it was potentially fatal. Intravenous miconazole was reported as the best therapy. The patient received the proper antifungicide, at the proper dose for the proper length of time. She has survived for two years, and, although it is not known if the fungus will recur, her prognosis is good. The physician was certain that the search was critical in selecting the correct therapy.

The primary outcome of a CIT study is typically a detailed and structured inventory or taxonomy based on the interview responses, and is intended to provide baseline information for an ongoing program of research and development or evaluation. In NLM's study, three such inventories were developed, each looking at the searches from a different frame of reference: (1) why the information was sought from MEDLINE, i.e., the motivation for searching; (2) the immediate effect of the information on professional decisions and actions; and (3) the ultimate outcome on the situation of having (or not having) the desired information. Accounts of searches that were *not* effective in meeting the information needs were also analyzed in order to understand the reasons behind these unsuccessful searches.

In analyzing the data, each reported incident is broken down into discrete elements relating to each frame of reference. Then for each frame of reference, the search reports are physically sorted, combining those that are essentially the same and separating those that are different. The resultant categories are then organized into a hierarchy or outline, proceeding from the most specific to the more general. The collection and analysis of reports continues until

there are no more unique categories generated. The frequency of incidents in different categories will typically not be proportional to the actual frequency of occurrence of such events in the population from which they are drawn. Rather, the objective is to capture and categorize descriptions of all unique occurrences of antecedent conditions and outcomes representative of the situation under study. Each of the inventories provides at once a very comprehensive and very detailed view of the purposes and outcomes of MEDLINE searches.

To illustrate the taxonomies, one portion of the comprehensive inventory of MEDLINE's impact on medical decision-making (included here as Figure 1) shows the major categories within Patient Care. There is in fact additional detail for categories B, C, and E that is not included in the figure. This example shows that, within the area of patient care, users report instances in which information was critical to choosing the most appropriate diagnostic test; reaching the correct (or any) diagnosis; developing and carrying out a sound treatment plan, especially when faced with rare diseases or unusual combinations of conditions; monitoring and revising treatment plans as needed; maintaining a good physician-patient relationship; insuring adequate continuity of care; modifying health risk behaviors; and carrying out responsibilities with respect to medical benefits/reimbursements.

The results of this study are important to NLM in a number of ways. First, they have provided NLM with detailed evidence that MEDLINE is in fact used with a remarkable diversity of medical need and positive effect, particularly in the patient care setting. Based as it is on reports of actual experiences that have been systematically acquired and analyzed, the study has been useful for demonstrating the practical value of MEDLINE to potential users and policy makers. Results also provided an in-depth understanding of user motivations and needs that have been important for NLM's user training and product improvement activities. Results from the analysis of ineffective searches also have been helpful in suggesting areas for improvement of the database and the search system. Failure to use MeSH properly was a relatively common reason behind ineffective searches. Such problems are amenable to remedy by new user training techniques and by specific system enhancements.

For the medical informatics community as a whole, the successful adaptation of the CIT methodology to the evaluation of an online database provides the opportunity for other database developers and/or vendors to demonstrate the impact of their information services with their own user groups.

For further information on this study, the full technical report [3] is available from NTIS. The contributions of collaborators Sandra Wilson, Ph.D. and Norma Starr-Schneidkraut, Ph.D. of the American Institutes for Research, Palo Alto, CA, are gratefully acknowledged.

References

1. Flanagan, J.C. The critical incident technique. *Psychological Bulletin*, July 1954, 51(4), 327-358.
2. Hubbard, J.P., Levit, E.J., Schumacher, C.F., & Schnabel, T.G. An objective evaluation of clinical competence. *The New England Journal of Medicine*, June 24, 1965, 272(25), 1321-1328.
3. Wilson, SR; Starr-Schneidkraut, N; and Cooper, MD. *Use of the Critical Incident Technique to Evaluate the Impact of MEDLINE. Final Report*. Submitted to the National Library of Medicine, September 30, 1989, Contract No. N01-LM-8-3529. (NTIS Order Number PB90-142522, Price $39.95.)

Figure 1
Patient Care Segment of
Inventory of Impacts of MEDLINE on Medical Decision-Making

I. Patient care

A. Used the most appropriate diagnostic test

1. Used a previously unknown or unavailable diagnostic test or procedure
2. Used the most sensitive and specific diagnostic test(s) or workup for suspected condition
3. Performed or interpreted diagnostic test properly
4. Evaluated new laboratory test for adoption
5. Identified most appropriate test and where it could be performed

B. Recognized and properly diagnosed a medical problem or condition

1. Recognized existence of an abnormal or normal condition
2. Arrived at a differential diagnosis

C. Developed an appropriate treatment plan

1. Confirmed the appropriateness of therapy selected to treat a particular problem
2. Identified, evaluated, and chose an alternative to own approach to treatment of a problem
3. Adjusted proposed therapy to improve effectiveness
4. Selected a treatment plan appropriate to condition of individual patient
5. Minimized risks of treatment
6. Determined limits of own capacity to manage patient's problem and need for specialized care

D. Implemented treatment plan

1. Instituted prompt treatment of problem
   a. Began treatment earlier than otherwise possible
   b. Chose the correct priority for treatment(s) in an emergency situation

2. Provided appropriate monitoring of patient's condition
   a. Identified early symptoms indicative of a recurrence or exacerbation of a problem
   b. Determined appropriate method and frequency of monitoring for potential side effects

3. Evaluated and revised treatment plan as needed
   a. Identified a promising new treatment or variation when other options had proven ineffective
   b. Utilized a promising therapeutic agent not readily available in U.S.
   c. Chose a new treatment option, taking into account contraindications due to patient's condition
   d. Insured that all possible treatment options were explored in the case of a seriously disabling or life-threatening condition
   e. Determined nature and extent of others' previous experience with own improvised therapy

E. Maintained an effective physician-patient relationship

1. Provided explanation of condition to patient/family
2. Insured continuity of care for patient moving or traveling outside area

F. Provided assistance in modifying patients' health behaviors

G. Discharged responsibilities with respect to patient and third-party payors