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ABSTRACT

This study examines the information sources used by practicing rural physicians in North Dakota to keep current with new information in their area of specialty. The hypotheses tested were: (1) there are more male than female rural practitioners in North Dakota; (2) rural physicians depend on printed material to fulfill regular need for information related to their practice; (3) rural physicians fulfill their information need by frequently using local medical reference libraries; (4) rural physicians have a demand for only a limited number and type of information from medical libraries; (5) a large number attend professional meetings and conferences to fill the void of face-to-face contact with colleagues; (6) utilization patterns vary significantly between general practitioners and specialists; (7) practitioners, who have recently taught medical students vary significantly in their mean score on the extent of information sources used; and (8) age of the rural physician has a significant effect on the extent of information used. Data were collected by a survey of 278 rural health care practitioners in North Dakota. The study used simple descriptive statistical analysis to test the first five hypotheses, and a multivariate technique, ANOVA, to test the last three hypotheses. Results yielded support for all hypotheses. More efforts should focus on bringing better machines (such as on-line computer searches and facsimile machines) and programs to rural physicians to meet their information needs. (KS)

PATTERNS OF INFORMATION TECHNOLOGY ADOPTION AMONG RURAL HEALTH PROVIDERS IN NORTH DAKOTA

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DRAFT

Patterns of Information Technology Adoption
Among Rural Health Providers in North Dakota

The technological revolution of the past few decades has affected every aspect of human life and its surroundings, especially the workplace. Work is becoming more and more specialized. This process has affected every profession, including medicine. Specialized jobs mean specialized skills and knowledge that need to be acquired, because technology is in constant flux. This paper examines the information sources used by practicing rural physicians in North Dakota to keep current with new information in their area of specialty.

The Impact of Technology in the Workworld

Extensive reorganization of the workplace has occurred due to profound impacts of rapidly changing technology. Technology is here defined as the 'complex interplay among various elements in the production process' (Ritzer and Walczak, 28:1986). The technological domain subsumes both material and non-material tools, knowledge and skills required for a particular task. New professions with new job roles, not conceived even a few decades ago, have emerged mainly due to rapid technological development and work specialization. According to the Bureau of the Census there were over 100 medical specialties in America. Physicians, nurses and nurses aides filled most of those specialized jobs.

Despite all these changes the minimum requirements to attend medical school and the actual years of training remains the same. Although state law requires

physicians and other health personnel practicing medicine to take more than 100 credit hours in continuing medical education (CME) before renewing their license to practice, it may, however, be argued that CME is not structured to ensure a physician with training comprehensive enough to cope with the constantly changing technology. It is, therefore, up to the discretion of medical professionals to keep current in their field of specialty through self-education.

Failing to adopt the newly emerging technologies and adapt with the changing norms of medical practices could mean not only a potential loss of patients and income, but threat of liability suits for malpractice. In addition to the problems associated with timely adoption of new technologies, the situation is further compounded by the proximity issues. This is especially true for physicians practicing in the "frontier" communities. These regions are so distanced from the central hub of the community of medical professionals that not only are physicians denied collegial support of their fellow practitioners, they also act as stumbling blocks for technological diffusion. It is this concern that prompted us to study rural physicians and their problems of accessibility to medical information. This paper addresses this issue by studying the information-seeking and use behavior of rural practitioners in North Dakota.

Information Support Systems

Systematic effort has been made to store and disseminate medical information of all types. Bold attempts by the medical community in association with public and private collaborations have been made to bring scientific information as fast and reliably as possible to the physicians wherever they

might be.

Three decades ago the biomedical discipline received a remarkable increase in monetary support for engaging in scientific research. The federal government implemented a policy to achieve breakthroughs in understanding the origin and eradication of certain diseases by investing heavily on basic research in biomedicine. As a direct consequence of this federal policy there has been an exponential growth of new knowledge in medical science. This quickly led to the problem of storing and efficiently disseminating the knowledge to the potential users. It was decided that the existing health sciences libraries will be restructured to accommodate the changes and build new libraries wherever necessary. The Association of American Medical Colleges (AAMC) in collaboration with the Medical Library Association (MLA) was instrumental in the passage of the Medical Library Assistance Act (MLAA) of 1965. This Act mandated the establishment of the National Library of Medicine (NLM) in Bethesda, Maryland and an information system network.

The information system network that evolved consisted of centralized and decentralized organizations at the national, regional and local levels. The network formed a hierarchy with The National Medical Library at the top linked with 11 Regional Medical Libraries (RML), (later reconfigured to 7). Some of these regional libraries are centralized organizations providing primarily regional services and management. Others were decentralized, later called Resource Libraries (RL), interacting mostly with the 100 or so medical school libraries. At the bottom of this hierarchy were some 500-600 local libraries called basic units or basic health sciences libraries (BHSLs). These small units are found in institutions such as hospitals, medical societies, and the like. A significant number of our respondents in our study represent the users of these

local units.

The regional and local medical libraries serve purposes similar to most general libraries but their attempts to build and sustain functional linkages between the libraries are unique. These libraries have constantly worked on ways to provide services more efficiently with easy access to requested information. The regional and local medical libraries have led the way in innovating electronic network systems that speeded up the process of information searches from local and remote sites at a reasonable cost to users. The electronic network provides on-line computer services. The first on-line retrieval system was introduced by adding an on-line version, called MEDLINE, to the MEDLARS (Medical Literature Analysis and Retrieval System) in 1971. MEDLARS was developed by NLM to 'produce its listing of the medical periodical literature, Index Medicus, via computer' (Bunting, 3:1987). There are more than twenty-five databases available on the NLM system, but MEDLINE is the most heavily used and well known. Regional and all local libraries have access to MEDLINE. All North Dakota medical libraries and hospitals have access to MEDLARS.

MEDLINE is a bibliographic database containing references to articles which have appeared in more than 3500 journals since 1966. Each reference to an article is referred to as a unit record or bibliographic citation and approximately sixty percent of the citations include author-generated abstracts of the articles (U.S Department of Health and NLM, 1989). Since 1988 MEDLINE database has been segmented into seven database files. The most currently reported file is called MEDLINE which contains about a million citations published between 1988 to present. The MEDLINE network has been extended to include other countries. This led to a phenomenal growth in the number of searches since its inception from a modest annual 25,000 to 2.6 million in 1985

(Bunting, 1987). Software programs for personal computers, such as GRATEFUL MED, have been developed for users to bypass the library and access the MEDLINE through modem on their own personal computers.

Recently a cost effective and faster alternative to the on-line MEDLINE system has been developed and distributed to most of the medical libraries. This is the MEDLINE on CD-ROM designed for the microcomputers. It contains information from the past 7-8 years in a read-only optical disc.

Information-Seeking and Adoption Behavior Models

Information-Seeking Model

Two models pertinent to information-seeking and adoption of innovation behavior are presented here. These models are heuristic devices included here for comprehending the information seeking and gathering behavior, and the rate of adoption of new information dissemination technology by the North Dakota rural health care practitioners. It is beyond the scope of this study to empirically test these models.

Figure 1 about here

Information-seeking and gathering process begins with the presence of a condition arising from an interaction between an individual and an external condition. For example, the situation where a physician diagnosing a patient faces an uncertainty state and feels the need for further information to fill the information void in him. As information involves any stimulus that reduces

uncertainty, need involves a recognition of the existence of this uncertainty (Atkins, 1973). This process is outlined in Figure 1.

Recognition of uncertainty, however, does not always lead to information-seeking because the seeker is faced with the decision to chose between the types or conditions of need. Needs can be categorized as "kinetic" or "potential". According to Childers (1975) needs can be kinetic (immediate) if they are directed toward satisfying a special problem. They are "potential" (deferred) if they "remain unconscious, hidden under layers of attitudes, impulses, and values." He goes on to add that information gathered based on potential needs "may never be put into action" (Childers, 1975).

Depending upon the type of perceived need an individual will eventually decide if he should follow up with actual information-seeking activity. He will have to make yet another decision. He decides to seek the needed information either internally or externally. Internal sources are individual generated information from such stimuli as experience and memory (Egan and Henkle, 1956). Internal sources are stored stimuli and was gathered and stored from previous communication with external stimuli. In a particular problem solving setting the needed information already existing is retrieved to the short-term memory and acted upon. All other information sources are categorized as external. The most common medium being literature. According to Krikelas (1983:15), "regardless of the purpose ..., a person must decide where to seek information. One ... of the following may be produced by that encounter: 1) a message that resolves the uncertainty might be found; 2) the search may produce no message; 3) as a result of the search, a refinement of the issue might occur; and 4) the searcher might be referred to another source."

Studies have repeatedly shown that when a person turns to external sources

of information, he strongly prefers human face-to-face contact (Glass and Norwood, 1959; Prentice, 1980). However, Krikelas adds, "... at some point individuals do turn to the literature for information; some may even initially choose that source" (Krikelas, 1983:15-16). It may be suggested that such a choice depends upon the degree of accuracy of information sought and the ease of information access. Once the information is gathered it is then put to use (Figure 1).

Adoption of Innovation Model

Closely tied with the information-seeking behavior is the adoption of innovative behavior. An innovation is, 'an idea, practice, or object that is perceived as new by an individual...' (Rogers, 1983). Thus the on-line MEDLINE system described above is an innovation.

Adoption of an innovation may occur due to the inherent attributes of the innovation. According to Rogers and Shoemaker (1971), the most important attributes that influence the adoption of an innovation are, relative advantage; compatibility; complexity; trialability; and observability. Relative advantage is the perceived advantage of the innovation compared to the present practice. Closely related to this attribute are issues of risk reduction, ease of use, technical expertise of the advisors, and the availability of the experts for interpersonal communication. The second attribute, compatibility, is the consistency of the innovation with the existing values, practices, and the needs of people. The third attribute, complexity, refers to the degree of difficulty involved in understanding or using an innovation. The fourth attribute, trialability, involves the degree to which the new technology can be used on an experimental basis. Finally, observability, an attribute of innovation is the

degree to which the user can actually observe the results of using that technology. For the information-seeking rural physicians adoptable innovation can range from non-material technology, such as new ideas of practicing medicine published in medical journals to material technology, such as computers for information retrieval or other equipments that have inherent innovative attributes.

Figure 2 about here

The adoption of innovation model, outlined in Figure 2, may be viewed as a system consisting of three major components and the relationships between them. In simple terms the model suggests that some external conditions have impact on the perceptions of the potential adopters. This impact in turn influences a behavioral outcome i.e. the adoption of innovation. Four important aspects of the external conditions should be taken into account. They are, the introduction of a new technology, the existing communication channels, the nature of the social system or the social context, and finally the extent of promotion efforts. Interactions between these subcomponents influence the potential adopter's perception about the attributes of the technology (described above). This, in the final analysis, is followed by the adoption of the innovation such as the MEDLINE system or a microcomputer.

Continuing Medical Education (CME)

If using the internal and external sources, such as personal collection of books and journals or the library, a major process in filling immediate information needs, CME may be viewed as the means to fulfill any knowledge gap that might have arisen from recent change in the technology.

Today CME is considered as one of the primary means to overcome any knowledge gap created by rapidly changing technology. CME is defined as, an intention 'to validate and expand the knowledge, skills, and attitudes of practicing physicians to promote efficient and effective patient care' (Covell, 1985). In this respect CME serves as an essential learning tool for rural physicians.

CME in the early 1900s was used as a form of remedial education to fill the gaps of formal education. In the 1960s major changes in the medical profession took place, especially, increased biomedical research, the opening of new medical schools through federal government funding, and an increase in medical specialization. There were concerns from both medical professionals and people outside it, "over the issue of lifetime certification and licensure; and scientific, clinical, and technical breakthroughs increased as to how physicians were going to be able to receive, digest, and use information" (O'Reilly, 1982). In the 1970s a key element to the CME system was added. This was the evaluating process to measure the success of CME. In the past decade CME was made mandatory in most states through the passing of legislative measures. Most state legislative measures require a physician to complete 120 credit hours of CME every three years for renewal of their practicing license. Today membership to medical specialty boards, such as American Board of Family Practice, require recertification every six years. As a part of that recertification, a physician has to complete 150 credit hours of CME over a three-year period. Although it has been argued by some that by making CME mandatory adverse results may have been produced (Wilbur, 1978), there is however, a general consensus that there is an absolute need for some form of continuing medical education for all practicing physicians.

Hypotheses Formulation

Drawing upon the preceding discussion on medical specialization, information technology, and related topics we have derived several hypothesis that we intend to test empirically using the 1988 survey of North Dakota rural physicians conducted by the Center for Rural Health, University of North Dakota School of Medicine. The hypotheses to be tested are as follows:

Hypothesis 1. There are more male than female rural practitioners in North Dakota. This is derived from the fact that proportionately there are more male than female doctors in the country. Competition for jobs will force male doctors to locate widely.

Hypothesis 2. Since there are few informed colleagues to consult with, rural physicians will depend on printed material to fulfill regular need for information related to their practice.

Hypothesis 3. Dependence on printed material will force the rural physicians to fulfill their information need by frequently using local medical reference libraries.

Hypothesis 4. Because rural medical institutions offer limited services rural physicians will have a demand for only a limited number and type of information from medical libraries.

Hypothesis 5. Since rural physicians do not have the opportunity to make frequent face-to-face contact or associate with medical professionals, a large number will attend professional meetings and conferences to fill that void.

Hypothesis 6. Utilization pattern, operationalized as the number of sources used for gathering medical information, will vary siginificantly between general practitioners and specialists.

Hypothesis 7. Practitioners, irrespective of their background, who have recently taught medical students will vary significantly in their mean score of the extent of information sources used.

Hypothesis 8. Age of the rural physicians has a significant effect on their extent of information sources used.

The major objective of this paper is to test the hypotheses developed above. Other related issues will also be addressed. Finally, in light of the findings, we will suggest some policy implications pertaining to access to

medical information by the rural health professionals.

Methods

The data for this paper come from an exploratory study conducted by the Center for Rural Health in 1989. The study was designed to examine the current rate of use and future needs of accessibility of institutional medical information retrieval system, by the rural health care practitioners. These professionals include family practitioners, family nurse practitioners, physician's assistants and specialists representing various medical fields, in North Dakota. A survey of all 278 rural health care practitioners, working in 53 rural hospitals and 80 rural clinics, was conducted via telephone interviews in January 1989. The survey yielded 214 (77.0 percent) completed interviews from physicians and nurse practitioners located throughout North Dakota, excluding the four metropolitan areas of Fargo, Bismarck, Grand Forks and Minot.

Analysis

Simple descriptive statistical analysis of the key variables achieves the first major objective of this study. The first five out of eight hypotheses will be tested using this analysis. Key variables to test these hypotheses include demographic information, educational and professional affiliation, types of information used, extent of information sources used, mode of continuing education, use of microcomputers and facsimile devices, and the satisfaction level of the practitioners with the accessibility and existing methods of medical information retrieval.

A multivariate statistical technique, ANOVA, is utilized to test the last

three hypotheses. This technique will examine the mean differences among subgroups and categories of the sample in terms of their extent of information sources used. ANOVA is used because it performs analysis of variance for factorial designs. Instead of doing multiple t tests (comparison of means of two groups), ANOVA allows interpretation by partitioning the total sum of squares into main effects (i.e. a single variable), multi order interaction effects (i.e. multiple variables), and residual sum of squares.

The dependent variable, EXTENT, describes the extent of sources used by the respondents. It was created by counting the number of sources listed by the respondents for gathering patient care information. The total number of possible sources ranged from 0 to 14. The unweighted sources included personal collection of medical books and documents, use of reference libraries, human sources through contacts with local and non-local colleagues, pharmaceutical representative and medical programs on the television. The higher the score on this variable the greater the number of sources used by the respondents. The independent variable SPECIAL describes two subgroups in the sample - general practitioners and specialist. For this analysis the family nurse practitioners and physician's assistants have been merged with the family practitioners to form one group called general practitioners. It was merged to avoid analysis problems arising from empty cells in the ANOVA tests. The second independent variable is a dichotomous variable called TAUGHT. The response to this variable is a simple yes or no to the inquiry if the respondent had taught medical students in the past two years.

Two ANOVA models are tested. The first model uses EXTENT as the dependent, and two categorical variables, SPECIAL and TAUGHT, as the independent variables. The second ANOVA model is a hierarchical model similar to the first one except

the covariate AGE (a continuous variable measuring the chronological age of the respondent) is added to test for significant differences when age is controlled for.

Results

The respondents in our study are predominantly male (83.2 percent). This finding supports hypothesis 1. The mean age of the respondents is 48 years with a standard deviation of 12. The overall age range from 30 to 84 years. Sixty one percent of the respondents are family practitioners and 13 percent family nurse practitioners. The remaining 39 percent identified themselves as specialists in various medical specialty. According to the North Dakota Medical Directory of 1989, comprised of 96 specialty groups in North Dakota (Medical Directory, 1989). It is estimated that there are more than 5 doctors for every 10,000 rural residents in North Dakota.

Although the practitioners are located in rural areas, most however, have not severed their relationship with the medical school. Fifty five percent of the respondents indicated having taught medical students sometime in the past two years. Forty seven percent of the respondents reported that they were currently affiliated with a medical school as a teacher or preceptor. This later category is almost all male and has a mean age of 48 years. Sixty percent of whom are general practitioners and the rest specialists from various fields. This affiliation with the medical school serves as one of the fundamental ways to stay current with the developments in the medical profession.

Information-Seeking Behavior

This study found that the rural physicians of North Dakota consider patient care information as the most important form of information need for their practice. This supports hypothesis 4. The study also found that multiple sources are used by the rural practitioners for gathering such patient care information. The most commonly cited source was a personal collection of books and journals. This was followed by reference library. This lends support to hypotheses 2 and 3. Consulting with local colleagues was the third most frequently used sources of patient care information.

Table 1 shows the complete list of sources mentioned by the respondents. Most respondents use personal collections and reference libraries as their major source of patient care information. This result is not consistent with studies of physicians' information-seeking behavior. Covell et al. (1985) reported that only 30 percent of physicians' questions on patient care during patient diagnosis are actually answered. The doctor will most likely consult with his peers in the vicinity for answers to his questions. Covell and his colleagues also reported that printed materials were rarely used as the primary source of the needed information under these circumstances. One reason why the practitioners in our study ranked personal collection of books and journals as number one source may be that there are very few colleagues around them to give meaningful response to their questions.

Table 1. Sources of Information by specialty.

Source	Gen. Prac. (104)	Spcl. (83)	FNPs (26)
Personal Collection	90 (87.4)	74 (89.2)	22 (84.6)
Reference library	70 (68.0)	53 (63.9)	18 (69.2)
Local colleagues	46 (44.7)	16 (19.3)	8 (30.8)
Non-local coll.	14 (13.6)	11 (13.3)	1 (3.8)
Newsletter	9 (8.7)	7 (8.4)	2 (7.7)
Courses/seminars	3 (2.9)	5 (6.0)	1 (3.8)
Meeting/conference	2 (2.0)	2 (2.4)	0 (0.0)
Audio/visual tapes	5 (4.8)	1 (1.2)	1 (3.8)
Computerized Dbase	1 (1.0)	5 (6.0)	0 (0.0)
Librarian	2 (1.9)	2 (2.4)	1 (3.8)
Pharmaceutical Rep.	1 (1.0)	0 (0.0)	2 (7.7)
Television programs	2 (1.9)	0 (0.0)	0 (0.0)
Other	6 (5.8)	10 (12.0)	2 (7.7)

Note: Figures in parentheses are the percentages.
Note: Items are not mutually exclusive.

Those who use reference libraries regularly for patient care information indicated checking out mostly the widely circulated and reputed medical journals. Some such journals include the Journal of the American Medical Association, New England Journal of Medicine, Journal of the American Academy of Family Physicians, American Family Practice, and the like (See Table 2). As Table 2 shows, there is no predominance of any one particular published source of information the respondents use. The diversity of the journals listed by the respondents quite clearly correspond to the interests of the general and family practitioners, family nurse practitioners, physician's assistant and specialists in various fields.

Table 2. Journals cited as most useful

Title	Percent
Journal of the American Medical Assoc.	24.3 (52)
New England Journal of Medicine	23.8 (51)
Journal of Am Academy of Family Practice	21.0 (45)
American Family Physician	15.4 (33)
Post Graduate Medicine	7.0 (15)
P.A. Journal	6.1 (13)
Emergency Medicine	5.1 (11)

Note: Figures in parentheses are the actual numbers.
Note: Items are not mutually exclusive.

Adoption of Innovation:

North Dakota health practitioners have indicated relying on the computerized database, including MEDLINE and other on-line system in the libraries, for patient care information, citation and requisition of reference materials.

The information gathering style found among the rural practitioners suggests that more than half (53 percent) of the practitioners have adopted the on-line computerized database retrieval system (See Table 3). Of that 53 percent only eleven percent do the computerized data base searches themselves, the remaining 89 percent requests the librarians to it for them. (see Table 3). Such a small number of hands-on users suggest heavy dependence on others for information retrieval. It may be, however, mentioned that only trained personnel are expected to do on-line searches. According to a research analyst from the Harley French Library of the Health Sciences at the University of North Dakota School of Medicine only fifteen percent of the hospitals in North Dakota have

a staff member who can perform on-line searches. Trained personnel may be expected to do the on-line searches, there is, however, no restrictions to do a personal on-line search as long as one has the logon authorization. It is also hard to believe that self-search is really that difficult to perform because most local and university libraries are switching over to electronic cataloging system and the system is fast becoming popular with even casual computer users.

Although more than half the rural North Dakota health providers have adopted the on-line database retrieval system, the fact remains that 46.72 percent are yet to adopt this technology. It may be mentioned that 18 percent of the respondents reported having no local library facility in and around their workplace. Additionally, among library users the study found ten percent indicating using only the collections on library shelves. The study also found that 36 percent of the North Dakota rural physicians do not use either the on-line computer database or the manual system. In other words they don't use the library system at all.

Respondents reported several key problems with their local libraries. Among the library users, fifty nine percent reported experiencing obstacles in their attempts to use the local library. Forty five percent complained that the library did not have adequate materials and 31 percent were not happy with the services provided.

More specific information on the adoption behavior of the rural practitioners is revealed when their use behavior of MEDLINE system or the use of GRATEFUL MED microcomputer software program for accessing the MEDLINE, and use of microcomputers and facsimile machine are examined.

Table 3. Adoption rate of library computerized information retrieval system by subgroups

Subgroups	Retrieval Mode OL	M	OLM	CO	MO	N	Total
Family Prac.	54 (47)	30 (47)	19 (45)	35 (49)	11 (50)	39 (51)	188(88%)
Specialists	52 (46)	24 (38)	19 (45)	33 (46)	5 (23)	26 (34)	159(75%)
FNPs	8 (07)	10 (16)	4 (10)	4 (06)	6 (27)	12 (16)	44(21%)
Total	114(53) (100%)	64(30) (100%)	42(20) (100%)	72(34) (100%)	22(10) (100%)	77(36) (100%)	

Search Legend

OL	On-line computer	CO	On-line computer only
M	Manual	MO	Manual only
OLM	On-line and Manual	N	None used

Note: Figures in the parentheses are percentages.
Note: Marginal percentages are calculated with N=213
Note: CO+MO+OLM=213; OL=CO+MO; M=OLM+MO.

An unexpectedly small number responded positively to the question of using the MEDLINE system. Only 34 percent of the respondents had actually used the MEDLINE services in the previous 12 months. This response is quite congruent with the fact that many of these rural practitioners depend very heavily on their personal collection of medical books and journals. Among those who used the MEDLINE services, used it for searching patient care information (71 percent), followed by a small number of those who reported using it for topical research.

About a quarter of the respondents reported using it for presentation preparation. A small number (16 percent) also indicated using it for lecture preparation. (See Table 4).

Table 4. Reasons for using MEDLINE services

Reason	Percent
Patient Care Information	70.6 (48)
Topical Research	25.0 (17)
Presentation Preparation	23.5 (16)
Lecture Preparation	15.9 (11)
Other	2.0 (2)

Note: Figures in parentheses are the actual numbers.
Note: Items are not mutually exclusive.

Utilization of Computer Technology

Microcomputers are yet to become popular with the North Dakota rural physicians. Fifty-one percent of the respondents said they had access to a microcomputer. While over half of them (56 percent) had it at home, 40 percent had it in their office. A few indicated using computers in the library and other locations (See Table 5). Less than half (47 percent) of the microcomputer users have a modem hooked up to their computers giving them the option to link up with a network system (library or otherwise).

Table 5. Location of microcomputers of respondents with access

Location	Percent
Home	55.6 (60)
Office	39.8 (43)
Library	6.5 (7)
Other	8.3 (9)

Note: Figures in parentheses are the actual numbers.
Note: Items are not mutually exclusive.

Clearly the lack of use of microcomputers is tied with the failure to perceive the potentials of this technology. This is very much reflected in the number and type of uses the owners and users of microcomputer reported. They are limited mostly to word processing. The majority of the microcomputer users do word processing on their machine. Others indicated using it for records management, database searches and billing. Only 7 percent said they use the microcomputers for accessing the MEDLINE system (see Table 6).

Facsimile machine, another modern device with high potentials, has not become popular with the rural North Dakota practitioners either. Only 24 percent of the respondents indicated access to a fax machine. While 61 percent of those with access to a fax machine reported using their machine to transmit and copy patient records, about a quarter use it for transmitting and copying business records, but 19 percent do not use it for any purpose.

Table 6. Microcomputer uses

Use	Percent
Word Processing	22.2 (24)
Records Management	16.7 (18)
Database Searches	16.7 (18)
Billing	14.8 (16)
Medline	4.6 (5)
Grateful Med	1.9 (2)
Electronic Mail	0.9 (1)
Other	26.9 (29)

Note: Figures in parentheses are the actual numbers.
Note: Items are not mutually exclusive.

Also of interest are the various ways in which the rural health professionals obtain continuing medical education. This information is provided in Table 7 below. A majority of the physicians regard scientific conferences (out-of-state and in-state) as important avenues for obtaining new medical knowledge. Obviously this also serves as the menas to associate with medical professionals. This finding supports hypothesis 5. Other methods of acquiring CME by the rural practitioners involve structured courses and accompanying tests, seminars and grand rounds and annual professional society meetings. Most practitioners use more than one method to acquire CME.

Table 7. Methods of acquiring continuing medical education (CME)

Method	Percent
Scientific Conferences (Out-of-State)	63.1 (135)
Scientific Conferences (In-State)	37.9 (81)
Various Courses & Tests	32.7 (70)
Seminars and Grand Rounds	28.5 (61)
Specialty/Society/Med. Assoc. Meetings	27.6 (59)
Subscriber of Self-Assessment Homestudy	21.5 (46)
Teaching Medical Students/Residents	4.2 (9)
Other	2.8 (6)

Note: Figures in parentheses are the actual numbers.
Note: Items are not mutually exclusive.

In light of the above findings it may be added that 71.3 percent of the respondents stated that they are satisfied with their current methods of gathering needed medical information. However, in response to a seperate question regarding their need for greater access to medical information, approximately one-half (50.2 percent) indicate such a need. Among fields, specialists indicate the most contentment, while family nurse practitioners and physician's assistants express the greatest amount of dissatisfaction with their information gathering methods.

Analysis of Variance (ANOVA) Models:

A recurring finding, alluded to above, involved respondents reporting using more than one source for gathering patient care information. The distribution of this variable is shown in Table 8.

Table 8. Frequency distribution of sources used.

No. of Sources	Percent
1	7.5 (16)
2	22.9 (49)
3	39.3 (84)
4	16.8 (36)
5	12.1 (26)
6	1.4 (3)
Total	214 100.0

Mean (3.075) Std Err (.078) Std Dev (1.14)

Note: Figures in the parentheses are actual numbers.

Tables 9 through 11 provide descriptive statistics, count and group mean, for the first model. The overall mean of the dependent variable is 3.10 (estimated with 5 missing cases) with a minimum value of 1 and a maximum of 6. It may be recalled that the dependent variable, EXTENT, describes the extent of information sources used by the respondents. It is created by counting the total number of unweighted sources listed by the respondents.

Tables 9 to 11 show that there are clearly differences in the means between the subgroups and categories. There is a very small difference in the means of the general practitioners and the specialists (see Table 9). However, there is a big differnce in the means of those who taught medical students and those did not. Those who taught tend to have a much higher mean (see Table 10). Table 11 is a contingency table that shows the interaction between the two variables SPECIAL and TAUGHT. Although there is very little difference in mean among

general practitioners, irrespective of their teaching background, specialists who have taught medical students tend to have a much higher mean than those specialists who have not taught. The ANOVA models test for the statistical significance of these differences in means. The results are summarized in Tables 12 and 13 and discussed below.

Table 9. Means of the subgroups in the SPECIAL variable

	SPECIAL
Specialty Group	Mean No. of Sources
General Practitioners	3.07 (127)
Specialists	3.13 (82)

Table 10. Means of the categories in the TAUGHT variable

	TAUGHT
Teaching Experience	Mean No. of Sources
Yes	3.24 (117)
No	2.91 (92)

Table 11. Comparison of means between the subgroups using the independent variables SPECIAL and TAUGHT

	TAUGHT	
	Teaching Experience	
	Yes	No
Specialty Group		
SPECIAL		
General Prac	3.10 (70)	3.04 (57)
Specialists	3.45 (47)	2.71 (35)

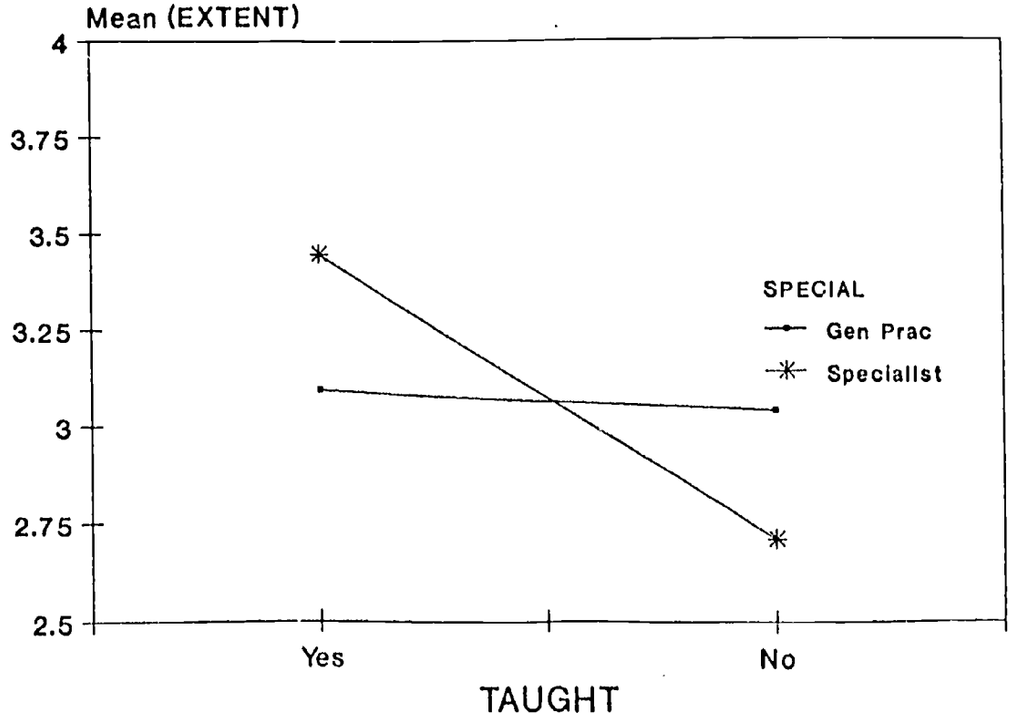
The first source of variation accounts for the main effects or the variations occurring between each of the subgroups and categories in the independent variables SPECIAL and TAUGHT. Regression technique was chosen for the analysis. This technique assesses all effects in the models simultaneously with each effect adjusted for all other effects in the model. Table 12 presents the results of the first ANOVA model. The overall main effects has a F ratio that is significant at .046 probability level. A close examination of Table 12 reveals that the significant difference is occurring from variable TAUGHT. It has a F ratio of 6.210 with a probability level of .013. This supports hypothesis 6. It is interesting to note that there are no significant differences among the general practitioners and specialists (SPECIAL) but there is a significant second-order interaction between SPECIAL and TAUGHT variables. This supports hypothesis 7. This significant interaction is plotted in Figure 3. General practitioners (family practitioners, family nurse practitioners and

physician's assistants) who may or may not have taught medical schools differ very little on their mean score. However, specialists who have taught medical school differ on their score from those specialists who have not taught.

Table 12. Test results for ANOVA Model 1

Source of Variation	Sum of Squares	DF	Mean Square	F Ratio	Significance of F
Main Effects	7.838	2	3.919	3.126	.046
TAUGHT	7.786	1	7.786	6.210	.013
SPECIAL	.008	1	.008	.007	.935
2-Way Interactions	5.457	1	5.457	4.353	.038
TAUGHT SPECIAL	5.457	1	5.457	4.353	.038
Explained	11.096	3	3.699	2.951	.034
Residual	256.990	205	1.254		
Total	268.086	208	1.289		

Figure 3. Significant interactions between SPECIAL and TAUGHT.



The second ANOVA model (Table 13), with the addition of age covariate, shows very little difference in the test results. The age covariate in itself has a significant effect on the model. This supports hypothesis 8. It also lowers quite appreciably the probability level of the overall explained variation in the model.

Table 13 Test results for ANOVA Model 2

Source of Variation	Sum of Squares	DF	Mean Square	F Ratio	Significance of F
Covariates	7.493	1	7.493	6.057	.015
AGE	7.493	1	7.493	6.057	.015
Main Effects	6.440	2	3.220	2.603	.077
TAUGHT	5.793	1	5.793	4.683	.032
SPECIAL	.409	1	.409	.331	.566
2-Way Interactions	4.704	1	4.704	3.802	.053
TAUGHT SPECIAL	4.704	1	4.704	3.802	.053
Explained	18.296	4	4.574	3.697	.006
Residual	243.724	197	1.237		
Total	262.020	201	1.304		

Discussion and Conclusion

This paper has examined the information-seeking and the adoption of information dissemination technology of North Dakota rural physicians. It has also sought their opinion about the adequacy of the existing information dissemination system and future needs in this area.

The study found that for immediate patient care information rural physicians of North Dakota depend mostly on personal collection of documents rather than face-to-face contacts with colleagues as suggested in previous studies. Previous studies reviewed in this context reported results from urban settings. In the rural areas, especially in the so called "frontier" areas where the population density is extremely low, and the hospitals and clinics are few and far between, colleagial contact is not as frequent.

General practitioners and specialists do not differ significantly as to the extent of sources they use for patient care information. However, when their teaching experience is controlled for specialists who have taught tend to use use a larger variety of sources of information than either the specialists who have not taught or the general practitioners.

A major finding of this study was that a very small number of respondents use any form of computerized database for either patient care or other purposes. It is quite clear that most physicians do not perceive these innovations as very useful for their mode of operation. Such perception may have arisen due to the inherent attributes of the technology discussed above. Our data also suggest that 36 percent of the North Dakota rural physicians do not use library services at all. Other factors associated with accessibility and availability of the needed information may have contributed to this situation. More than 35 percent did report experiencing obstacles such as inadequate library materials and services.

It is perplexing to note that so few rural physicians have adopted the microcomputers and fax machines. These machines have already proven to be essential tools for medical professionals. Millions of dollars are spent by software developers each year to develop programs for medical professionals.

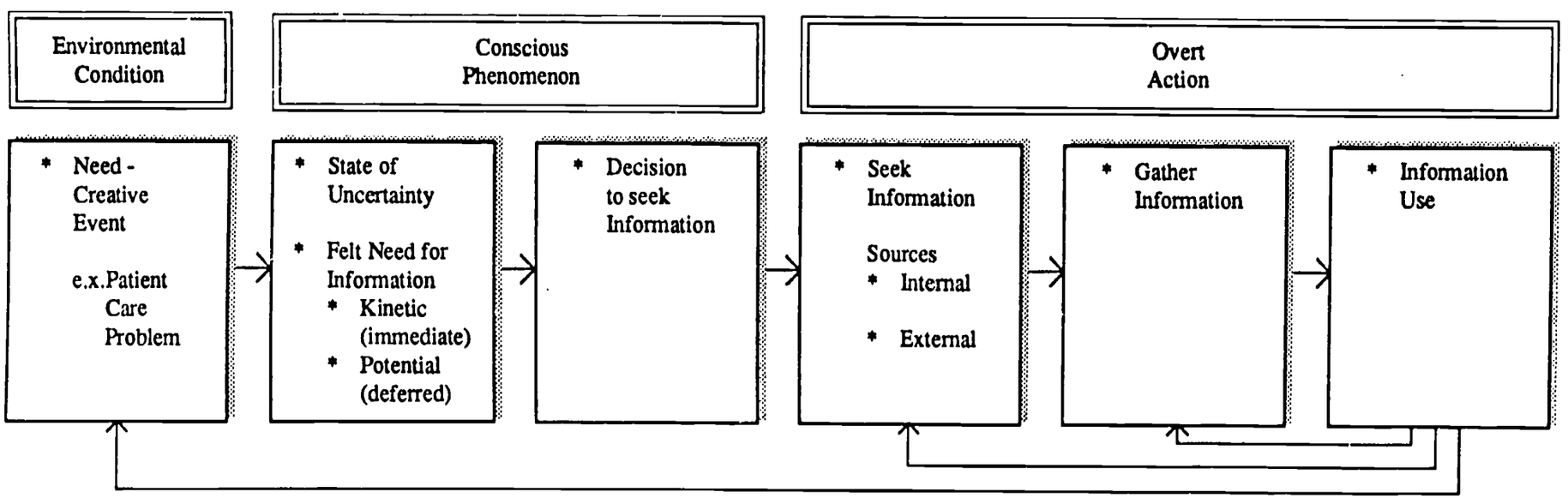
References to these software programs may be found in "Physicians & Computers", a physician's leading computer journal. One fails to comprehend why the rural physicians so remotely positioned would not take advantage of these machines. One also fails to understand why the fax machine, a device that can transport important documents almost instantaneously to remote areas at a reasonable cost, has not been adopted and given similar importance as the telephone. It is possible that the information needs of the rural physicians are not that demanding as one would expect. Even if the rural physicians are willing to try new machines and computer programs there simply is no impetus from the work environment they are in. Related to this line of argument is the fact that unilateral adoption of technologies such as fax machines do not mean much unless the person at the receiving end has adopted one too. This is an important attribute of this technology.

Since more than 47 percent of the physicians expressed the need for greater access to medical information it is only fair to say that more efforts should be diverted to bringing better machines and programs to the rural physicians so that they can fulfill their information needs. Assuring easy access to medical information is bound to ensure better health care.

APPENDIX

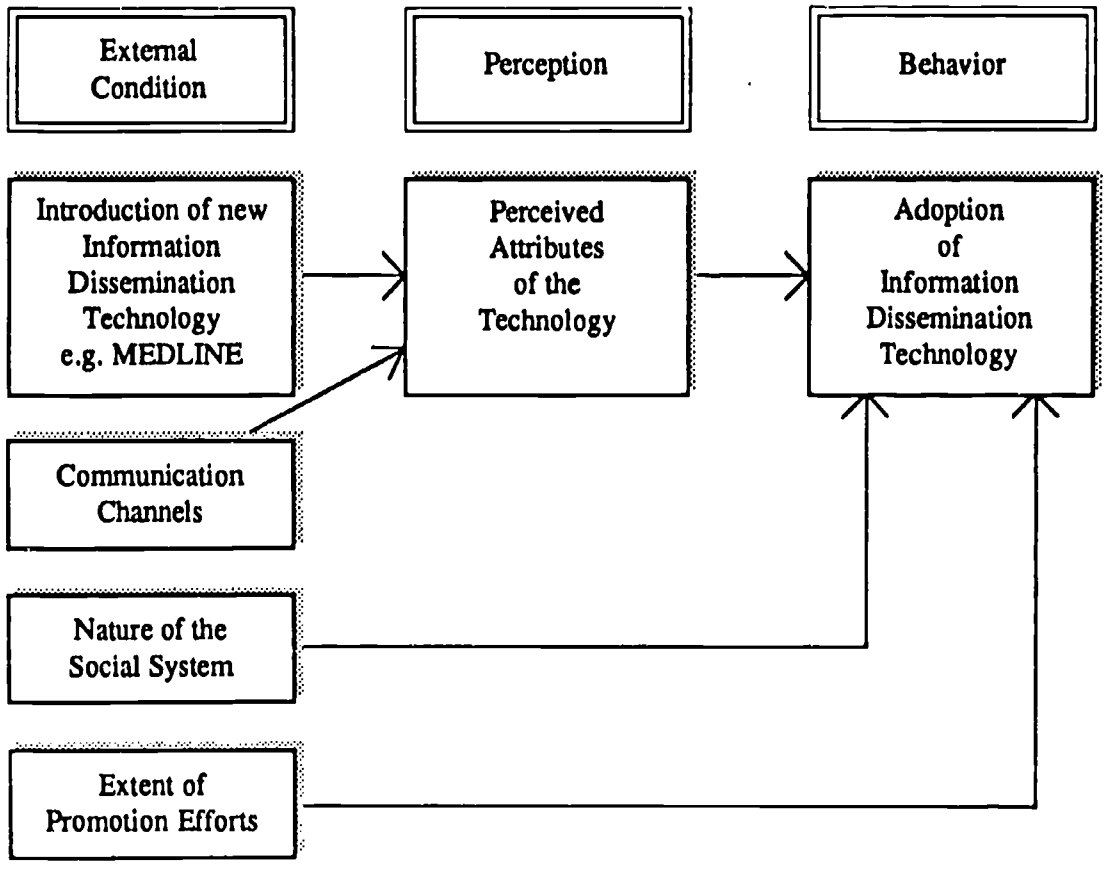
FIGURE 1.

INDIVIDUAL INFORMATION-SEEKING AND GATHERING MODEL



Adapted from James Krikelas. 1983.

FIGURE 2.
ADOPTION OF INNOVATION MODEL



Adapted from Rogers, 1983.

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