The Use of New Technologies by Rural Family Physicians

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Background. Although office procedures that involve special training and office equipment are often performed by a specialist in an urban setting, they are increasingly being performed by family physicians in rural settings. This study documents the prevalence of four such procedures in rural family practice: flexible sigmoidoscopy, cardiac stress testing, colposcopy, and nasopharyngoscopy. Individual and community characteristics of physicians who perform each of the procedures are compared with those of physicians who do not.

Methods. Data were collected on office technology and the characteristics of physicians, their practices, and their communities through telephone interviews with 403 randomly selected, rural family physicians and general practitioners in eight states. Descriptive and univariate analyses were used.

Results. Flexible fiberoptic sigmoidoscopy was performed by 57% of the physicians in our sample. The presence of another physician in the group or in the community who performed this procedure increased the probability of a rural physician performing it. Being male, recent licensure, board certification, and patient volume were also positively associated with the performance of this procedure.

Conclusions. This study found evidence of a collegial effect among rural physicians and of a significant number of rural physicians seeking postresidency training in new procedures.

Key words. Ambulatory care; diffusion of innovation; physicians, family; primary health care; rural health; sigmoidoscopy; colposcopy; exercise test. (*J Fam Pract 1994; 38:479-485*)

The rapid diffusion of medical technology in recent years has had an impact on health services in rural areas. Rural hospitals have acquired technologies, such as computed tomography (CT), magnetic resonance imaging (MRI), and diagnostic ultrasound, often as mobile units, that were available only in tertiary care settings 10 to 15 years ago. The technological advances that have occurred in the hospital have been so dramatic, and sometimes so costly, that they have overshadowed the advances in ambulatory settings. Family physicians locating in rural areas are bringing with them the training and knowledge necessary to employ a number of new office-based technologies. Flexible fiberoptic sigmoidoscopy, colposcopy, exercise stress testing, fetal monitoring, diagnostic ultrasound, upper gastrointestinal endoscopy, colonoscopy, and electrosurgical units now complement laboratory and diagnostic equipment in the offices of many primary care physicians practicing in rural areas.

This paper presents data on the prevalence of technologies being used in rural general and family practice physicians' offices, with special attention to primary care office procedures that involve an investment of training time and the purchase of specialized equipment. These procedures include flexible fiberoptic sigmoidoscopy, colposcopy, cardiac stress testing, and nasopharyngoscopy. The factors addressed in the analysis include community needs, provider competition with and consumer access to other physicians employing the technology, and individual physician characteristics.

Submitted, revised, December 31, 1993.

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ISSN 0094-3509

Background

The bulk of the research regarding the diffusion of medical technology involves hospitals. There is extensive literature documenting the correlates of MRI and CT acquisition, as well as the diffusion of a variety of technology-intensive services, such as organ transplants. One theory of technology diffusion, advanced by Luft et al,[3] emphasizes the potential importance of non-price-competition among neighboring hospitals. Other studies have found that hospitals with a greater scope of services are more likely to adopt new technologies.[4,5]

Studies of technology adoption by physicians in the ambulatory care setting have been less concerned with technologies involving specific pieces of equipment and more concerned with innovative behavior, as evidenced by the incorporation of new procedures, drugs, or treatment regimens into practices. Freiman[6] surveyed 484 physicians to determine how many new diagnostic or therapeutic procedures they had added to their practices in the previous 12 months. He found that rural solo practitioners adopted the fewest new procedures. Age was associated with an increase in innovative behavior up to age 50, followed by a decrease. Board certification was a significant predictor of innovation.

The influence of colleague interaction on physicians' technology adoption decisions has been documented in previous studies.[6–8] Coleman and associates[7] found that individual characteristics as well as frequency of contact with other physicians correlated with the date of adoption of a new drug. Weiss and co-workers[8] followed an approach similar to that of Coleman and colleagues, focusing on the adoption of two new prescribing practices by 200 office-based pediatricians. Discussion with a colleague was the most important source of information leading to a change to a new regimen. Physicians relied particularly on local subspecialists to advise them before they changed practice habits. Other significant factors included board certification, group as opposed to solo practice, teaching, subscriptions to medical publications, younger age, and greater patient volume.

Although many studies emphasize the importance of colleagues as a source of information about a new procedure or technology, they do not explicitly address the influence of potential patient volume on adoption. In many small rural communities, the need for a procedure can be met by a single physician. However, if there is no physician in the community offering the procedure, two alternatives remain. The patient may travel to a distant provider for the procedure, an option that risks permanent loss of that patient to another physician. Alternatively, the travel distance may discourage patients from seeking care at all. "Access effect" is the increased probability that a physician will offer a procedure not being performed by any other physician in the community.

While studies of hospital technology adoption have focused on hospital competition, a similar phenomenon may be observed among physicians: family physicians may feel they have to offer a level of technology similar to that of other physicians in the practice area or risk being perceived as low-quality providers. Simply knowing that a colleague has started performing colposcopy may stimulate other physicians to learn the procedure. Whether the motivation is "competitive" or "collegial," this effect tends to counteract the access effect. The "collegial/competitive effect" is the increased probability that a family physician will offer a procedure that is also performed by another physician in town. In this study, the competitive factor was considered stronger if this effect was observed only when another physician not in the same group offered the procedure; the collegial factor was considered stronger if same-group and other-group physicians both produced this effect. Thus, the effect of other physicians on the probability that a rural family physician will offer a technological procedure becomes an empirical question. A positive correlation is evidence of a stronger collegial or competitive effect, and a negative correlation is evidence of a stronger access effect.

The four procedures addressed in this study were all limited to specialists when they were introduced, but have become, to varying degrees, part of the practice of primary care physicians. A physician practicing in a rural community may invest time and money in adopting new procedures, out of both a concern for patient access and a perceived opportunity for increased revenues as the only provider of that service in the community. If there is a specialist available in the community who performs the procedure, a generalist may be less likely to make such an investment. In this circumstance, patient access is not the issue. The specialist may be perceived as having better training or better skills as a result of performing the procedure more frequently, and therefore, the opportunities to generate revenue for the family physician's practice may be more limited. "Specialist effect" is the decreased probability that a family physician will offer a procedure when there is a specialist in the community who already offers it.

We also expect to observe among rural physicians a phenomenon similar to the relation between technology adoption and the scope of services among hospitals.[4,5] The extent to which physicians are technologically oriented may be determined by observing whether they have incorporated other technologies or procedures into their practices. As indicators of this technological propensity, we used the blood chemistry analyzer, the hematology analyzer, and the tympanometer, as well as one

outpatient surgical procedure, vasectomy. We hypothesized that each of the four procedures under study would be positively associated with the presence of these indicators.

Methods

Rural family and general practice physicians in Washington, Oregon, Idaho, Montana, North Dakota, South Dakota, Minnesota, and Iowa were identified using the American Medical Association's (AMA) Physician Masterfile. This file includes members and nonmembers of the AMA as well as graduates of foreign medical schools. We used the *American Medical Directory,* 32nd edition, which publishes masterfile information by geographic location, to produce a sampling frame of 2602 family and general practitioners in the eight states in our study. This list was based on the most current information from the masterfile as of May 1990. From this list, we selected a random sample of 400 physicians and a second sample of 200 to be used as replacements should we be unable to locate some of the original 400 or find that some had retired or relocated. A sample of 400 is sufficient to distinguish mean differences of not less than ± 5 % with a 95 % confidence interval (CI).

Physicians with practices located in metropolitan statistical areas were considered urban and not included in the sample. Telephone surveys were completed during the fall of 1991, with a 90.5% response rate among physicians who were located and determined to be appropriate for the study. Four types of respondents had to be replaced: those who had retired, those no longer in family or general practice, those who had left the area, and those in a group practice from which another respondent had already been selected. Survey respondents were asked to report various demographic information as well as details of their practices with respect to a list of technologies and procedures.

In addition to descriptive statistics, *t* tests and chi-square analyses were used to compare respondents who were performing each of the four procedures with those who were not. Logistic regression was used to determine the impact of access, collegial/competitive, and specialist effects, and physician and practice characteristics on the adoption of one technology, flexible sigmoidoscopy.

Results

Descriptive Analysis

Table 1 presents descriptive characteristics of the 403 rural physicians surveyed, as well as data on the preva-

Table 1. Characteristics of Family Practice and General Physicians (N = 403) Who Do and Do Not Perform Four Office Procedures

	Performs Procedure?							
	Flexible Sigmoidoscopy		Colposcopy		Cardiac Stress Testing		Nasopharyngoscopy	
Physician Characteristics	Yes (n = 228)	No (n = 175)	Yes (n = 80)	No (n = 323)	Yes (n = 108)	No (n = 295)	Yes (n = 19)	No (n = 384)
Female (%)	3.9	13.7*	10.0	7.7	4.6	9.5	5.3	8.3
Board certified (%)	85.5	53.7*	85.0	68.4*	86.1	66.4*	89.5	70.8
Years in practice	15.3	21.3*	13.8	18.9*	14.6	19.1*	15.7	18.0
Age (%)†								
<40 years	33.3	17.7	42.5	22.6	36.1	23.1	31.6	26.3
40–49 years	37.7	29.1	33.8	34.1	38.9	32.2	42.1	33.6
50–59 years	15.4	17.7	16.3	16.4	11.1	18.3	15.8	16.4
≥60 years	13.6	35.4*	7.5	26.9*	13.9	26.4*	10.5	23.7
Solo practice (%)	25.4	43.4*	26.3	35.0	23.1	36.9*	21.1	33.9
Population of community where respondent practices (in 1000s)	9.8	11.6	10.1	10.7	9.8	10.9	12.9	10.5

*P < .01.

†*Significance levels are based on 8-cell chi-square using all four age categories.*

Table 2. Effects of Other Physicians and Patient Characteristics on the Performance of Four Office Procedures by Family and General Physicians

Characteristic	Performs Procedure?							
	Flexible Sigmoidoscopy		Colposcopy		Cardiac Stress Testing		Nasopharyngoscopy	
	Yes (n = 228)	No (n = 175)	Yes (n = 80)	No (n = 323)	Yes (n = 108)	No (n = 295)	Yes (n = 19)	No (n = 384)
Physician								
In group where other FP/GP does procedure (%)	67.1	27.4*	41.3	11.5*	59.3	17.3*	31.6	2.9*
In town where other FP/GP does procedure (%)	53.9	26.9*	25.0	12.7*	41.7	15.3*	5.3	1.6
In town where specialist does procedure (%)	58.8	61.1	52.5	54.5	37.0	48.1†	26.3	46.4
Patients								
Over age 50 (%)	46.0	46.5						
Abnormal Pap smears found per month (n)			2.77	1.61*				
Patients seen per day (n)	29.1	26.9†	29.8	27.7	29.3	27.7	32.1	28.0†

*P < .01.
†P < .05.
FP/GP denotes family physician, general practitioner.

lence of the four procedures studied. Fifty-seven percent of the physicians sampled reported that they had performed a flexible sigmoidoscopy within the past year. Twenty percent reported that they had performed a colposcopy within the past year or had been trained in the procedure and planned to offer it within the next year. Approximately 27% were doing cardiac stress testing, and fewer than 5% were performing nasopharyngoscopy.

Consistent with previous studies, we found that board-certified physicians were more likely to perform each of the four procedures and that solo practitioners were less likely to do so. Physicians in solo practices comprised only one third of the rural family and general practitioners in the sample, suggesting that group practice has become a more typical organizational structure for rural family and general physicians in our sample. We also found that physicians who were performing these procedures had been in practice fewer years, supporting our hypothesis that changes in residency training over the past decade would affect adoption of these procedures. Nevertheless, the average number of years in practice for physicians who were performing each of these procedures was relatively high (15.3 for flexible sigmoidoscopy), indicating that many rural physicians have developed proficiency through continuing medical education. The importance of residency training is more clearly supported by a consistent pattern across all four procedures of a higher proportion of physicians under age 40 who offer these services.

Table 2 presents an analysis of the effects of other physicians on technology adoption. For all four procedures, there is evidence that physicians in a group practice or in the community who perform a given procedure produce the collegial/competitive effect. In each case, physicians who reported that they currently perform a procedure were more likely to report that another physician in the group and in the community also performs the procedure. The access effect was not observed for any procedure. That is, there is no evidence that the lack of another physician in the group or in the community who performs the procedure increases the probability that a physician will adopt it. With the exception of nasopharyngoscopy, there was no appreciable difference between the influence of those who perform a procedure and those who do not on whether a specialist in the group or in the community is available to perform the procedure. These hypothesized effects were also analyzed for flexible sigmoidoscopy using multivariate methods.

Table 2 also presents data on two indicators of need. We asked respondents to estimate the percentage of their patients who were over age 50. Recent recommendations have targeted the 50- to 75-year age group for colorectal cancer screening with flexible fiberoptic sigmoidoscopy.[9] The results indicate that population need, as we have defined it, is not significantly associated with the performance of flexible sigmoidoscopy. Similarly, we created an indicator of the need for colposcopy by multiplying a respondent's reported percentage of Papanicolaou (Pap) smears that are abnormal by average total Pap smears per

Table 3. Availability of Four Technologies in Rural Communities of 403 Family and General Physicians

Variables	Flexible Sigmoidoscopy	Colposcopy	Cardiac Stress Test	Nasopharyngoscopy
% of family physicians who practice in community where no physician performs procedure	9.2	34.7	19.1	50.1
Average number of miles patient must travel to receive procedure when not available locally	29.8	40.4	36.4	50.0

month. This indicator is the number of abnormal Pap smears each respondent could be expected to see in 1 month. This indicator of need was significantly associated with colposcopy adoption ($P < .01$). For flexible sigmoidoscopy and nasopharyngoscopy, we found that the number of patients seen per day was associated with adoption of the procedure. This reinforces Weiss's finding that greater patient volume was associated with the adoption of new procedures, although the causal relationship is unclear.[8]

Physicians who did not perform a procedure and reported that no one in the group or the community performed it were asked how far a patient would have to travel to obtain that service. Since these are all diagnostic procedures unlikely to be used in emergency situations, traveling some distance for such care would not necessarily have a detrimental effect on patient health. However, some patients may perceive travel as a barrier, and therefore choose not to seek care, decreasing the chances for early detection of disease. Such a choice would seem particularly likely in the case of flexible sigmoidoscopy when used as a screen for colorectal cancer. If there is no presenting problem, travel is more likely to be perceived as a deterrent, particularly for a procedure known to be unpleasant. The percentage of physicians reporting that their patients had to travel to have access to each procedure is presented in Table 3, along with the average distance traveled.

Table 4 presents several indicators that compare the communities where the procedure is not available with those where it is. Approximately 9% of the communities surveyed had no physician performing flexible sigmoidoscopy. These communities are significantly smaller than those where this procedure is available ($P < .01$). The average distance from these communities to the nearest area where flexible sigmoidoscopy was available was 30 miles. Approximately 35% of the communities had no physician performing colposcopy. Compared with communities where colposcopy was available, those where it was not available were smaller, had a lower physician-to-population ratio, had fewer physicians on the medical staff of the local hospital, and were less likely to have a surgeon. The average distance to obtain a colposcopy in another community was 40 miles.

Some physicians may enjoy learning new procedures and take pride in being able to offer a wide range of services. One outpatient surgical procedure and three pieces of office equipment, two of which are used for laboratory bloodwork, were used as indicators of a physician's propensity to adopt new technologies and procedures. The relation between these indicators and the

Table 4. Characteristics of Rural Communities of 403 Family and General Physicians, by Availability of Technology

Community Characteristics	Flexible Sigmoidoscopy		Colposcopy		Cardiac Stress Testing		Nasopharyngoscopy	
	Available	Not Available	Available	Not Available	Available	Not Available	Available	Not Available
Mean population (n)	11363	3405*	13755	4386*	12653	3431*	16056	4993*
Mean population per physician (n)	1195	1312	1075	1463*	1134	1459*	1024	1393*
Active physicians on local hospital staff (n)	31	37	36	20*	31	30	41	20*
Local hospital has active surgeon on staff (%)	95.8	92.3	97.2	92.0†	96.3	92.2	99.5	91.2*

*$P < .01$.
†$P < .05$.

Table 5. Indicators of Technology Predilection in 403 Family and General Physicians, by Performance of Four Office Procedures

Indicators	Performs Procedure?							
	Flexible Sigmoidoscopy		Colposcopy		Cardiac Stress Testing		Nasopharyngoscopy	
	Yes (n = 228)	No (n = 175)	Yes (n = 80)	No (n = 323)	Yes (n = 108)	No (n = 295)	Yes (n = 19)	No (n = 384)
Performs vasectomies (%)	65.8	34.3*	71.3	47.4*	68.5	46.1*	63.2	51.6
Has tympanometer (%)	60.5	40.0*	67.5	47.4*	60.2	48.5†	78.9	50.3†
Has blood chemistry analyzer (%)	57.9	48.0†	53.8	53.6	63.9	49.8†	52.6	53.6
Has hematology analyzer (%)	60.1	48.0†	63.8	52.6	68.5	49.8*	68.4	54.2

*$P \leq .01$.
†$P \leq .05$.

performance of each of the four procedures is presented in Table 5. Performing vasectomy was associated with all procedures except nasopharyngoscopy. Having a tympanometer was associated with all four procedures. The two pieces of laboratory equipment were each associated with the performance of flexible sigmoidoscopy and cardiac stress testing. Table 5 lists data that support the contention that the acquisition of procedural skills and technologies by physicians is an indication that they will acquire additional skills and technologies. Some physicians are more technologically oriented than others.

Multivariate Analysis

The descriptive analysis suggests that adoption of an office-based technology is influenced by a collegial/competitive effect. Likewise, there is an association between physician-specific characteristics, such as the number of other technologies and procedures the physician currently offers and technology adoption. Additional physician characteristics that appear positively related to technology adoption are being male, years in practice (as indicated by the year of licensure), board certification, and group practice.

To determine whether these effects are present while controlling for other variables, we used logistic regression, with the dependent variable being whether the respondent performed flexible sigmoidoscopy. All effects were confirmed by multivariate analysis. In addition, the "specialist" effect, which was not detected in the univariate analysis (Table 2), was marginally significant in the logistic regression ($P = .01$). When there was a specialist in the group or in the community who offered the procedure, our respondents were less likely to offer it.

Discussion

We found that flexible sigmoidoscopy was being performed by 57% of the rural family physicians surveyed, while only 9% of our respondents lived in a community where this procedure was not available. We conclude that this procedure is generally available in rural areas. Based on a 1986 survey, Buckley and colleagues[10] reported that 29% of a national sample of family physicians performed flexible sigmoidoscopy. Although this study reported on physicians in both urban and rural practices, it seems reasonable to conclude that there has been an increase in the prevalence of this procedure by family physicians in recent years.

Flexible sigmoidoscopy was introduced into residency training in family practice in the early to mid-1980s, following a series of studies that established its value in primary practice.[8,9,11–13] In 1986, Rodney[1] reported that flexible sigmoidoscopy or limited colonoscopy was being taught in 75% of the accredited family practice residency programs in the United States. By 1991, Crump and Phelps[14] reported that 100% of family practice and 92% of internal medicine programs provided training in flexible sigmoidoscopy.

Twenty percent of our respondents were actively performing colposcopy or had been trained and planned to become active. There is also a growing interest in colposcopy in the residency setting. In 1991, Gordon[15] surveyed family practice residency training programs and found that 59% offered training in colposcopy. Forty percent of the programs that did not offer such training were planning to offer it in the near future.

Since the average number of years in practice for physicians who offer these procedures is relatively high and these procedures have been added only recently to residency training, it appears that significant numbers of rural family physicians have obtained postresidency train-

ing in the procedures. In our sample, one third of family physicians who perform flexible sigmoidoscopy learned the procedure in a formal continuing medical education (CME) setting, and one half of those performing cardiac stress testing had learned it either in a CME setting or from a colleague. This finding highlights the efforts of the American Academy of Family Practice to develop and provide procedural training. The finding that greater patient volume is associated with the adoption of each of the four procedures in this study indicates that a heavy workload does not deter family physicians from learning new procedures.

Our finding that the presence of another family physician in the group or the community who performs a procedure increases the probability that a physician will perform it may be interpreted as evidence of a collegial or competitive effect. Since family physicians are unlikely to engage in a technological "arms race" with physicians in their own group, the finding regarding other physicians in the group supports the collegial interpretation. While it is likely that the influence of physicians in the community but not in the respondent's group is an indication of a competitive effect, it is possible that local circumstances may lead to collegial relations between physicians in the same community who are not partners, a phenomenon that would also explain the observed effect. There is no evidence of an access effect, ie, rural family physicians do not appear to learn a new procedure because no one else in town offers it.

The effect of a specialist in the community who performs a given procedure is an issue of particular interest. Recent discussions of an "interspecialty war" over endoscopy highlight the efforts of procedurally oriented family physicians regarding the acquisition of new skills and technologies.[16] In our univariate analysis we found that the presence of a specialist in the respondent's community had no effect on a respondent's performance of flexible sigmoidoscopy. However, controlling for the effect of other variables, the multivariate analysis showed a trend in favor of this effect. Family physicians were slightly less likely to perform flexible sigmoidoscopy if there was a specialist in the community who performed the procedure.

The inclusion of the four procedures examined in this study in family practice residency programs and our finding that many family physicians have developed proficiency in these procedures through CME programs suggest that these procedures will continue to diffuse into rural family physicians' offices. This study provides an analysis of the factors that influence the rural primary care physician to perform these technological procedures, but future research is needed to address the clinical consequences of this dissemination.

Acknowledgments

This research was supported by the Northwest Area Foundation, St Paul, Minnesota, grant no. 90–97.

The authors gratefully acknowledge the skill and persistence of Colleen King and her staff in collecting telephone interview data.

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