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Original Research

Specialist Physicians' Knowledge and Beliefs about Telemedicine: A Comparison of Users and Nonusers of the Technology

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ABSTRACT

Telemedicine as a technology has been available for nearly 50 years, but its diffusion has been slower than many had anticipated. Even efforts to reimburse providers for interactive video (IAV) telemedicine services have had a limited effect on rates of participation. The resulting low volume of services provided (and consequent paucity of research subjects) makes the phenomenon difficult to study. This paper, part of a larger study that also explores telemedicine utilization from the perspectives of referring primary care physicians and telemedicine system administrators, reports the results of a survey of specialist and subspecialist physicians who are users and nonusers of telemedicine. The survey examined self-assessed knowledge and beliefs about telemedicine among users and nonusers, examining also the demographic characteristics of both groups. Statistically significant differences were found in attitudes toward telemedicine between users and nonusers, but in many respects the views of the two groups were rather similar. Physicians who used telemedicine were aware of the limitations of the technology, but also recognized its potential as a means of providing consultation. Demographic differences did not explain the differences in the knowledge and beliefs of user and nonuser consultant physicians, although some of the differences may be explained by other aspects of the professional environment.

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INTRODUCTION

TELEMEDICINE TECHNOLOGY has been available since at least 1959,[1] but the rate of adoption of the technology as a means of providing health services has been slow. Its use remains concentrated in certain geographic areas, and is limited to a small percentage of the physician population. In the mid-1990s, it was thought that the capacity of telemedicine to increase access to healthcare would make it attractive to providers and patients alike, but the anticipated proliferation of telemedicine failed to materialize. This state of affairs was widely attributed to concerns about liability, interstate licensure of providers, and the unavailability of coverage. Medicare payment policy was viewed as a particularly important obstacle.[2–8]

Experience with telemedicine, however, suggested that factors other than these also might play an important role in constraining diffusion. In some interactive video (IAV) programs, even the availability of payment for specialist physicians to provide consultation failed to encourage wider participation. Attention subsequently turned to a number of human and organizational variables affecting the acceptance and dissemination of new technologies.[9–12] The reasons identified for nonuse of telemedicine are many: the equipment often is thought to be inconvenient or is inconveniently located,[13] sometimes the technology is unreliable,[13–15] many providers believe that their participation requires too much time,[13,16,17] reimbursement generally is inadequate or unavailable,[18] and the technology is considered by some to be not yet equivalent to in-person care.[18] There have, however, been no large-scale surveys of providers to assess their stated reasons for either embracing or avoiding the technology.

We were interested in determining what differences in attitudes and knowledge might distinguish users and nonusers of telemedicine. In this study of physician knowledge and beliefs about telemedicine, we hypothesized that specialist and subspecialist physicians who use telemedicine (1) are likely to be younger than nonusers, (2) are likely to be more recent medical school graduates, (3) have convenient access to telemedicine facilities, and (4) are earlier adopters of new technologies. Apart from these hypotheses, the study, which represents a preliminary exploration of why consulting physicians do, or do not, use telemedicine, was descriptive in nature.

MATERIALS AND METHODS

Sampling frame

The objective of the study was to examine the use of telemedicine among consulting physicians. The specialists and subspecialists included in the survey were recruited by two study sites: the University of Colorado at Denver and Health Sciences Center (UCDHSC), and the Center for Rural Health Research at the University of Nebraska Medical Center (UNMC). As described below, network and physician recruitment used slightly different approaches at the two sites. The data from the Colorado and Nebraska samples were aggregated for analysis.

Project staff at UCDHSC targeted 17 telemedicine networks for study recruitment. These networks were identified from the larger national sample of programs that participated in Grigsby and Brown's 1998 study of telemedicine activity.[5] From this sample, 17 relatively large networks that had been in operation for several years and had well-established IAV teleconsultation programs were targeted for recruitment. Of the nine networks that agreed to participate, eight were based in urban academic medical centers with affiliated, mostly rural, healthcare organizations. The ninth network was a private, nonprofit hospital.

For each participating network, permission to contact consulting physicians on hospital medical staff rosters was obtained from the head of the medical staff and the telemedicine administrator. Telemedicine users and nonusers were identified as such by the program administrator based on a history of use (or nonuse) of the available technology. Although recruitment employed administrator identification to classify physicians as users or nonusers of the technology, all study analyses were based on the physicians' self-report of

use. Consulting physicians then were sampled randomly from the lists of users and nonusers. Out of the 1,461 physicians targeted for recruitment from these nine networks, completed surveys were received from 544, a response rate of 37.2% for the UCDHSC sample.

Project staff at UNMC sent the survey to a total of 268 specialist physicians licensed to practice in the state of Nebraska. All physicians affiliated with Nebraska's largest telemedicine network (the Mid-Nebraska Telemedicine Network) were targeted for recruitment, as was a random sample of 1/3 of the remaining specialists in the state. Data for the 152 consulting physicians (56.7%) who responded to the survey were included with the UCDHSC data for analysis. As with the UCDHSC sample, users and nonusers were identified by self-report for analytic purposes.

Survey instruments and procedures

UCDHSC investigators sent paper-and-pencil surveys to all potential participants by regular mail. Surveys were completed between June 2001 and February 2003. The survey instruments also were made available for completion by means of a Web-based database. Up to two follow-up requests were sent by mail to individuals who were slow to respond (more than 2 weeks beyond the initial request and the first follow-up invitation). After two follow-up requests had been sent to providers with no response, project staff returned to the sampling pool and randomly selected additional individuals who had not previously been invited to participate. Physicians who took part in the survey received a small honorarium ($40) for their time, which was estimated at 15 to 30 minutes.

At UNMC, data collection began in July 2000 and continued through October 2000. An initial mailing was followed 1 week later with a postcard. In August, the survey was sent a second time to nonresponders. Follow-up phone calls and a final mailing of the complete survey were conducted a month later. Participants were not compensated for their participation.

For the analyses reported in this paper, two instruments were used: (1) a survey for specialist and subspecialist physicians who were telemedicine users (the Telemedicine User Survey), and (2) a survey for specialist/subspecialist physicians who were not telemedicine users (the Telemedicine Nonuser Survey).

Areas of investigation included the following: (1) demographic and practice information, (2) physician attitudes toward and knowledge of telemedicine, (3) perceived advantages for practice, (4) telemedicine and referral patterns, (5) perceived convenience/inconvenience of telemedicine, (6) effects of the technology on patients, (7) perceived financial investment, (8) concerns regarding malpractice and liability, and (9) reimbursement issues, especially related to Medicare. For all analyses, physicians were identified as users and nonusers based on self-reported utilization of telemedicine technology.

The majority of attitude and knowledge survey questions were presented on a four-point Likert scale: *strongly agree*, *agree*, *disagree*, and *strongly disagree*. Items were analyzed using the four-point scale, and subsequently were collapsed into dichotomous *agree/disagree* categories. We conducted descriptive analyses of the sample in addition to comparisons of users with nonusers. Analytic methods included measures of association (correlations), *t*-tests, *z*-tests, chi-square, and logistic regression. We controlled for multiple comparisons by using the Holm test.[19]

RESULTS

Response rate and description of the physician samples

The final sample reported in this paper consisted of 696 consulting physicians. Of these participants, 202 were users and 494 were nonusers of telemedicine. This sample size represents 40.3% of the physicians targeted for recruitment in the study across the two sites. In the UCDHSC sample, response rates were slightly higher among users (40.5%) than nonusers (35.9%). However, because project staff at the UNMC did not know in advance the user/non-user status of the physicians targeted

for enrollment in their sample, it is not possible to compute the response rate for users and nonusers across sites. Response rates were not significantly different statistically by specialty, although cardiology and dermatology were relatively overrepresented among the telemedicine users, as might be expected given that these specialties have typically been more frequent users of the technology.[5] Small group sizes and a large number of specialties limited our ability to detect differences across specialties. The distribution of physicians by specialty/subspecialty may be found in Table 1.

Demographic and practice characteristics of the sample are provided in Table 2. Across the sample, 21% of all respondents were female, and the median age was 48.0 years. The mean number of years practicing medicine was 18.4; the mean number of years practicing in the current community was 11.7; the mean number of years since medical school graduation was 21.8. None of these demographic variables was associated with a greater likelihood of using telemedicine, contradicting our first and second hypotheses. The only significant differences found were in practice site variables: a higher proportion of telemedicine users practiced in community health centers (6.5% vs. 1.4%, $p = 0.0007$), and a higher proportion of nonusers were in private practice (44.5% vs. 28.5%, $p = 0.0001$).

Users' experience with telemedicine

A series of survey questions asked physicians who had used telemedicine to report on their actual utilization experiences (see Table 3). Use of telemedicine technology was fairly modest among these physicians. On average, users in the sample had received nine referrals for teleconsultations in the preceding 6 months. Nearly 64% felt they had not used telemedicine enough to make it a regular part of their practices.

The most common uses of telemedicine identified by the 202 telemedicine-using specialist physicians were diagnosis (58%) and patient follow-up (53%). Less common uses included continuing medical education (40%), providing second opinions (28%), and chronic disease management (23%). IAV telemedicine was the modality most frequently used by specialist physicians (84%), which was expected in this sample as IAV was the predominant mode of the participating telemedicine networks. Thirty-two percent had used shared computer

Table 1. Distribution of Physicians in the Sample Groups by Specialty

	Telemedicine users		*Telemedicine nonusers*	
Specialty	n	*% of Total sample*	n	*% of Total sample*
Anesthesiology	1	0.50	2	0.41
Cardiology	28	13.86	23	4.67
Dermatology	14	6.93	16	3.25
Emergency medicine	5	2.48	21	4.27
Family practice	9	4.46	25	5.08
Internal medicine	3	1.49	11	2.24
Neurology	16	7.92	20	4.07
Obstetrics/gynecology	5	2.48	17	3.46
Occupational medicine	0	0.00	1	0.20
Oncology	8	3.96	37	7.52
Ophthalmology	0	0.00	18	3.66
Orthopedics	9	4.46	37	7.52
Pathology	2	0.99	4	0.81
Pediatrics	17	8.42	30	6.10
Preventive medicine	0	0.00	1	0.20
Psychiatry	20	9.90	62	12.60
Radiology	2	0.99	19	3.86
Rehabilitation medicine	6	2.97	7	1.42
Surgery	21	10.40	56	11.38
Other medical subspecialty	36	17.82	85	17.28
Totals	202		492[a]	

[a]Information about medical specialty was missing for two participants.

TABLE 2. DEMOGRAPHIC AND PRACTICE CHARACTERISTICS OF THE SAMPLE

Variable	*Users* (n = 202)		*Nonusers* (n = 494)	
Gender	Male	Female	Male	Female
	79.1%	20.9%	77.9%	22.1%
	Mean	*SD*	*Mean*	*SD*
Age	47.6	10.0	48.2	10.1
Years since medical school graduation	21.6	10.6	21.9	10.4
Years practicing medicine	18.1	10.9	18.5	11.6
Years practicing in community	12.1	9.5	11.5	9.8
Number of states in which physician practices	2.0	1.4	1.9	2.5
Number of patients in physician's practice	3,800		4,145	
	% Affirmative		*% Affirmative*	
Practice site = hospital	80%		71.5% (ns)	
Practice site = community health center	6.5%		1.4% ($p = 0.0007$)[a]	
Practice site = rural health clinic	4.5%		3.2% (ns)	
Private practice	28.5%		44.5% ($p = 0.0001$)[a]	

[a]These two variables are the only ones that remained significantly different at an equivalent $p \leq 0.05$ after the Holm test of significance was applied.

screen images (in real-time) while communicating by telephone. Only 20% had used store-and-forward telemedicine.

Access to telemedicine equipment, and the technical capabilities of the telemedicine system, play an important role in specialists' use of the technology. Although nearly half (48%) reported that technical problems with equipment occasionally interfered with consultations, nearly two-thirds (64%) stated that their use of telemedicine had increased over time. Only 14% indicated that the telemedicine system was rendered inconvenient by other activities using the system during times when the providers would like to offer services (e.g., administration, continuing education programs). Ninety-one percent reported adequate technical assistance during consultations, and 87% reported that the sound quality was adequate for clinical purposes—an especially important consideration. Although most participants were satisfied with the technical quality of telemedicine services, they were not satisfied with Medicare coverage for these services. Only about one-quarter (26%) of respondents agreed that Medicare reimbursement for telemedicine usage was adequate for their level of participation.

A substantial majority of consulting physicians indicated that the telemedicine technology available to them was well suited to the needs of their patients (74%), and reported that they were satisfied with the quality of patient care attainable through the use of telemedicine (83%). However, only a minority of respondents (38%) indicated that most of the cases on which they consult could be handled by means of telemedicine alone. Consistent with this, opinions varied on the effectiveness of telemedicine for patient examination and diagnosis. About one-third of respondents (32%) stated that they could conduct a thorough physical exam of the patient using telemedicine. Two-thirds (66%) reported that they found IAV telemedicine more acceptable for rendering second opinions or offering informal consultations than for diagnosing new patients. Although this group of 202 respondents classified themselves as users of telemedicine, nearly two-thirds (64%) stated that they do not use telemedicine frequently enough to make it a regular part of their practices.

Telemedicine knowledge reported by users and nonusers

Users and nonusers differed in their self-reported telemedicine knowledge. Users were

Table 3. Specialist Telemedicine Utilization ($n = 202$)

Variable	*% Who agree*
Most common uses of telemedicine	
Diagnosis	58.19
Follow-up	52.54
Continuing medical education	39.55
Second opinion	27.68
Chronic disease management	23.16
Type of telemedicine modality used	
Interactive video	83.52
Shared computer screen images with audio	32.39
Store and forward	19.89
Access to and technical capacity of telemedicine	
Access limited by other uses of system	13.66
Inconvenience greater than benefits	30.27
Telemedicine use has increased over time	63.48
Technical problems with equipment interferes with consultations	48.39
Sound quality adequate for clinical purposes	87.29
Adequate technical assistance available during consultations	91.16
Most of the consultations I do could be accomplished by using interactive video	38.33
Appropriateness of use with patients	
Satisfied with patient quality of care using telemedicine	82.94
Telemedicine technology available to me is well-suited to the needs of my patients	73.77
In most cases, I can conduct a thorough patient physical exam using telemedicine	31.58
Interactive video is more acceptable for second opinions or informal consultations than for diagnosing new patients	65.92
Reimbursement	
Current Medicare reimbursement rate for consultations is adequate for my level of participation	26.00
Regularity of use of telemedicine	
I do not use telemedicine enough to make it a regular part of my practice	63.74
Average number of times a patient has been referred for a telemedicine consultation in the last 6 months	9.15

more likely to describe themselves as "somewhat knowledgeable" or "knowledgeable" about telemedicine, whereas nonusers described themselves as "not at all knowledgeable" to "somewhat knowledgeable" about telemedicine ($p < 0.0001$; see Table 4). Significant differences ($p < 0.0001$) also were found in the extent to which respondents agreed with the statement, "I do not know enough about telemedicine technology and its applications to use it in my practice." Only 18.6% of users agreed with this statement, whereas 58.9% of nonusers agreed (OR = 0.15; CI = 0.11–0.24; $p < 0.0001$). Even among the users who agreed that they were knowledgeable, use of telemedicine was modest (an average of 7.1 times in the previous 6 months). Although the utilization rate was low even among knowledgeable physicians, it is important to note that the physicians included in this study had a limited number of referrals. The low rate of referrals makes it difficult to assess the relationship between knowledge and utilization rates.

The two groups differed with respect to their sources of information about telemedicine. Approximately 1 in 10 (9.8%) nonusers reported that *formal telemedicine training* was a source of information for them, as opposed to 21.5% of users ($p = 0.0001$). Nonusers (16.1%) were significantly more likely ($p < 0.0001$) to report *mass media* as a source of information than were users (1.5%). Users were significantly more likely ($p < 0.0001$) than nonusers to report that sources of information other than those listed in the survey were important to them (33% vs. 12.6%). Other sources mentioned included a local telemedicine program, physician mentors, and on-the-job training. Differences between

Table 4. Knowledge about Telemedicine, Users and Nonusers

Variable	*Nonusers* n = *494*	*Users* n = *202*	p *value*[a]
Knowledge source			
Colleagues	55.86%	56.50%	0.9324
Medical literature	34.94%	25.50%	0.0189
Formal telemedicine training	9.83%	21.50%	0.0001[a]
Medical or postgraduate training	11.72%	5.50%	0.0157
Grand rounds			
Mass media	16.11%	1.50%	0.0000[a]
Professional meetings/conferences	25.10%	17.00%	0.0211
Electronic media	15.90%	7.50%	0.029
Other sources #	12.55%	33.00%	0.0000[a]
Knowledge level about telemedicine 1 = not at all; 2 = somewhat; 3 = knowledgeable; 4 = very	1.84	2.53	0.0000[a]
Agree that "I do not know enough about telemedicine technology and its applications to use it in my practice"	58.93%	18.59%	0.0000[a]

[a]These variables were found to be significant at the $p \leq 0.05$ level after the Holm test of significance was applied.
Other sources of knowledge about telemedicine were reported as: local telemedicine program at my institution; name of a particular physician mentor; on the job learning; local hospital; informal conversations; reading ECHO; established a program for prison telemedicine use; consultation with a friend who makes telemedicine equipment; grant activities.

groups with respect to other sources of knowledge (e.g., colleagues, medical literature, medical or postgraduate training, professional association meetings and conferences, grand rounds, and electronic media) were not significant.

Beliefs about telemedicine reported by users and nonusers

Specialists were asked about their beliefs regarding telemedicine in several areas: patient care; time and convenience of telemedicine use; whether they considered themselves early adopters of technology; concerns about licensure, credentialing and malpractice; reimbursement; and other factors.

As illustrated in Table 5, a higher proportion of nonusers believe patients are likely to get better care in person than through telemedicine (85.2% vs. 71.1%, OR = 0.43, CI = 0.29–0.64, $p < 0.0001$). Respondents differed significantly in their beliefs about the necessity of a patient's presence for an adequate physical exam. Eighty-seven percent of nonusers thought a patient's physical presence was necessary for an adequate examination, whereas only 69.7% of users believed that the patient's presence was necessary (OR = 0.33, CI = 0.22–0.50, $p < 0.0001$) (see Table 6.) Nearly twice the proportion of users to nonusers would consider telemedicine for initial office visits, and more users than nonusers (72.9% vs. 58.2%, OR = 1.93, CI = 1.33–2.82, $p = 0.0006$) believe telemedicine might be effective for acute nonemergency care.

Time and convenience in telemedicine

Respondents differed in their beliefs about the time involved in telemedicine, and in the extent to which telemedicine was convenient. Statistically significant differences were found in respondents' willingness to put up with some inconvenience to use telemedicine, with their assessment of the convenience/inconvenience of telemedicine facilities, and with the importance of reduced travel time that telemedicine affords for specialist consultants. Users reported greater willingness to tolerate some inconvenience (OR = 2.88, CI = 2.02–4.10, $p < 0.0001$), that telemedicine facilities were convenient for their use (OR = 8.56,CI = 4.59–15.95, $p < 0.0001$), and that the ability to reduce their travel time by using telemedicine was important to their practices (OR = 2.97, CI = 1.90–4.63, $p < 0.0001$). There also was a significant difference in beliefs about the level

Table 5. Specialists' Beliefs about Telemedicine

Variable	*Nonusers* n = *494*	*Users* n = *202*	p *value*[a]
Beliefs about patient care			
Patient likely to get better in-person care	85.15%	71.07%	0.0000[a]
Would consider telemedicine use for follow-up care	62.00%	73.74%	0.0054
Telemedicine likely to be more effective for emergent care	43.76%	55.43%	0.0086
Telemedicine more likely to be effective for chronic condition management	87.34%	93.26%	0.0279
Would consider telemedicine for initial office visits	22.27%	46.47%	0.0006[a]
Telemedicine might be effective for postsurgical follow-up	57.05%	71.76%	0.0008
Telemedicine might be effective for acute nonemergency care	58.21%	72.93%	0.0006[a]
The patient's presence is necessary for an adequate physical exam	87.34%	69.70%	0.0000[a]
Time and convenience in use of telemedicine			
Use of telemedicine would not be an effective use of time	52.24%	38.97%	0.0021
Would put up with some inconvenience in order to use telemedicine	44.78%	70.00%	0.0000[a]
Telemedicine facilities are convenient for use	64.31%	93.91%	0.0000[a]
Scheduling telemedicine appointments would be disruptive to office routine	67.42%	48.94%	0.0000[a]
Reduced travel for consultants that is possible with the use of telemedicine is important	64.38%	84.29%	0.0000[a]
Early adopter of technology			
Respondent views self as an early adopter of technology	60.37%	77.66%	0.0030[a]
Concerns about licensure, credentialing, malpractice			
Concerned about liability issues if telemedicine is used	66.11%	50.00%	0.0001[a]
Use of telemedicine would increase the risk of malpractice suits	50.44%	28.79%	0.0000[a]
Credentialing and licensure issues discourage telemedicine use	70.35%	33.71%	0.0000[a]
Reimbursement			
Compensation for use of telemedicine should be on a par with in-person treatment	78.90%	64.74%	0.0003[a]
Other factors influencing use of telemedicine			
Use of telemedicine would expand network of colleagues	68.00%	44.62%	0.0000[a]
Colleagues influence use of such technologies as telemedicine	69.61%	48.99%	0.000[a]
Would use interactive telemedicine if it were available in their offices	66.95%	80.15%	0.0005[a]
Prefer use of store and forward over interactive telemedicine	38.44%	24.74%	0.0014[a]
Percent of patient population that provider believes could be treated using store and forward technology	23.33%	29.19%	0.0124
Percent of patient population that provider believes could be treated using interactive technology	25.22%	40.44%[a]	
Prefer interactive over store and forward technology where 1 = strongly agree and 5 = strongly disagree	3.20	3.55	0.0007[a]
Dislike loss of personal contact with patient that results from use of telemedicine	83.72%	65.50%	0.0000[a]
More research on telemedicine is needed	59.28%	37.37%	0.0000[a]

[a]These variables were found to be significant at the $p \leq 0.05$ level after the Holm test of significance was applied.

of disruption of office routine associated with scheduling telemedicine appointments, with nonusers more likely to see this as a problem than users (67.4% vs. 48.9%, $p < 0.0001$). These data provided support for our third hypothesis.

Early adoption of new technologies

More than three-quarters (77.7%) of users described themselves as early adopters of new technologies, whereas 60.4% of nonusers characterized themselves this way, a difference that remained significant ($p < 0.003$) after application of the Holm test, providing modest support for our fourth hypothesis.

Concerns about licensure, credentialing, and malpractice

The practice of medicine is governed by individual states' Medical Practice Acts. Physi-

Table 6. Likelihood of Telemedicine Use as a Function of Attitudes toward Telemedicine

Attitude statement	*Odds ratio*	*95% CI*	p *value*
Beliefs about patient care			
Would consider use of telemedicine use for application of initial office visit	2.28	2.08–4.41	0.0001
Telemedicine might be effective or is effective for chronic condition management	2.01	1.07–3.75	0.029
Telemedicine might be effective or is effective for postsurgical follow-up	1.91	1.30–2.81	0.0009
Telemedicine might be effective or is effective for nonemergency care	1.93	1.33–2.82	0.0006
I do not think an adequate physical examination can be conducted without the patient being present physically	0.38	0.22–0.50	0.0001
Time and convenience in use of telemedicine			
If interactive video were available in my office, I would use it	2.04	1.36–3.05	0.0005
I am willing to put up with some inconvenience for my patients to receive telemedicine services	2.88	2.02–4.10	0.0001
If I must present the patient for teleconsultation, current telemedicine equipment location is convenient for me	8.56	4.59–15.95	0.0001
I would use telemedicine if it allowed me to significantly reduce the time I spend traveling to other communities to see patients	2.97	1.90–4.63	0.0001
Early adopter of technology			
I am generally one of the first among colleagues to try new technologies	2.28	1.56–3.34	0.0001
Knowledge statement			
I do not know enough about telemedicine to use it in my practice	0.15	0.11–0.24	0.0001
Licensure, credentialing, and malpractice			
I am concerned with possible liability issues associated with use of telemedicine	0.51	0.37–0.72	0.0001
Use of telemedicine would increase my risk of being sued for malpractice	0.40	0.28–0.57	0.0001
Credentialing and licensure for telemedicine are burdensome/discourage use	0.21	0.15–0.31	0.0001

cians whose practices cross state lines typically are licensed by all states in which they practice. The use of telemedicine, which readily permits providers to see patients in many other geographic jurisdictions, has raised questions about licensure.[20–24] We asked physicians about their concerns regarding across-state-lines issues of licensure, credentialing, and malpractice. Significant differences exist in responses between specialists who use telemedicine and those who do not. A higher proportion of nonusers believed that credentialing and licensure issues discourage telemedicine use (33.7% vs. 70.4%, OR = 0.21, CI = 0.15–0.31, $p < 0.0001$). The same relationship held for individuals who reported concerns about liability issues if telemedicine is used (66.2% vs. 50.0%, OR = 0.51, CI = 0.37–0.72, $p < 0.0001$). Nonusers also were more likely to believe that the use of telemedicine would increase the risk of malpractice suits (28.8% vs. 50.4%, OR = 0.40, CI = 0.28–0.57, $p < 0.0001$). These results are summarized in Table 6.

Reimbursement

In response to a question about disparities between in-person care and teleconsultation, more nonusers than users (78.9% vs. 64.7%, $p = 0.0003$) agreed that compensation for telemedicine should be on a par with in-person treatment.

Other factors influencing the use of telemedicine

Several other beliefs are related to the use of telemedicine by specialist and subspecialist physicians. Although both users and nonusers

reported that they dislike the loss of personal patient contact that results from the use of telemedicine, a significantly higher proportion of nonusers endorsed this concern ($p < 0.0001$). A higher proportion of nonusers believed that the use of telemedicine would expand their network of colleagues ($p < 0.0001$). More nonusers also hold the opinion that colleagues influence their use of new technologies such as telemedicine ($p < 0.0001$), and that more research on telemedicine is needed ($p < 0.0001$). More users than nonusers reported that they would employ IAV telemedicine if it were available in their offices ($p = 0.0005$). Nonusers were more likely than users to favor the use of store-and-forward technology over IAV ($p = 0.0014$). No significant difference was found in the proportion of their patients that nonusers and users believe could be treated using store-and-forward technology (23.3% vs. 29.2%); by contrast, a significantly higher proportion of users believed that they could treat more patients in their practice with IAV telemedicine (40.4% vs. 25.2%, $p = 0.0007$).

DISCUSSION

The results of this survey suggest that demographic characteristics do not explain the use or nonuse of telemedicine. The only statistically significant demographic difference between the two groups was that more users practiced in public clinics and more nonusers were in private practice. Public clinics, including federally qualified health centers, community and migrant health centers, and even health clinics that serve the prison population might well depend on the use of telemedicine to serve their diverse and sometimes scattered populations. The proportion of users in such settings was nonetheless modest, under 10% of the reporting users. This lack of demographic differences between users and nonusers is in contrast with the conventional wisdom in telemedicine, which is that younger, more recent medical school graduates are likely to be users of telemedicine.

The results of the study indicate that users and nonusers differ somewhat in their self-reported knowledge and beliefs about telemedicine. Users were more likely to report being knowledgeable about telemedicine, and were more likely to perceive the potential advantages of telemedicine, and less likely to acknowledge barriers to its use. It may be that the perception of greater knowledge and greater endorsements of the advantages of telemedicine is a causal factor that predisposes physicians to use telemedicine. Alternately, the successful provision of teleconsultation services may lead specialists and subspecialists toward more positive perceptions of their knowledge and telemedicine's advantages. Because the study was correlational in nature, it is not possible to identify causation in the relationships under investigation.

Some differences between what users and nonusers know or believe about telemedicine may be explained by other aspects of their professional environments. The influence and role of colleagues seemed greater for nonusers, who reported that they depend on colleagues as a source of information and attitudes about topics such as telemedicine; users saw their colleagues as having less influence over their (the users') decision making. Nonusers also were more likely than users to believe that the use of telemedicine would increase their network of colleagues, a finding that runs counter to the conventional wisdom that expanding one's collegial network is an incentive for telemedicine use.

According to Berwick's[25] discussion of disseminating innovations in healthcare, in which he applies the work of Rogers[26] on diffusion of innovations, the first group to adopt an innovation ("innovators") represents a small proportion (2.5%) of the population under consideration; the second group to adopt an innovation (about 13.5% of the population) are referred to as early adopters. Across this sample, roughly two-thirds of participants described themselves as early adopters of technology. Telemedicine users were somewhat more likely than nonusers to describe themselves this way (albeit over 60% of nonusers described themselves as early adopters as well).

Although these findings may suggest a discrepancy between self-perception and behavior, it is likely that the threshold for identifying oneself as an early adopter is different

among physicians than among telemedicine researchers. Further, it may be reasonable to expect higher rates of participation by early adopters in this study than in the general population of physicians. Participants (both users and nonusers) may have self-selected into the study due to an interest in technology in general and telemedicine technology in particular. These findings may also suggest that a tendency toward early adoption of technology may not cut across all technologies. Participants may, in fact, be early adopters of some technologies, but not others.

The economic motivations for physician participation in telemedicine were explored to a limited extent in this survey. Respondents agreed that reimbursement of telemedicine services should be at least on a par with that for in-person care. Questions pertaining to the types of payers and their proportion in each physician's practice did not yield statistically significant differences. Other factors beyond reimbursement that likely need to be more fully considered in assessing a physician's economic motivation for participating in telemedicine include the location and convenience of the equipment, its availability and ease of scheduling, the age of the equipment, availability of technical support, and other factors that influence a physician's time expenditure. Physicians in private practice are less likely to use telemedicine than those practicing in other settings, especially public clinics, perhaps because they are not on a salary and telemedicine is perceived as an opportunity cost in many cases.

Access to and experience with the use of telemedicine appear to be factors in specialist utilization. In this sample, users of telemedicine were more likely than nonusers to report that their access to telemedicine facilities is convenient. The frequently cited barriers to telemedicine use (credentialing, licensure, and malpractice; inconvenience; disruption to office routines caused by telemedicine scheduling) were perceived as barriers by nonusers to a greater extent than by users. Likewise, users were more likely to report being knowledgeable about the use of telemedicine. However, it was noteworthy that substantial proportions of both groups cited these factors as problems. Some users even reported having too little knowledge of telemedicine to incorporate it into their practices. Perhaps telemedicine users are less likely than nonusers to be deterred by these variables because they believe in the utility of telemedicine. However, it also may be that these concerns do, in fact, influence the participation of users, who reported providing only a small number of teleconsultations. Perhaps users only participated in teleconsultation in cases where the limitations were perceived as nominal.

Users were open to a wider range of applications of telemedicine technology in patient care than nonusers. This may be because their experience with telemedicine has been more satisfying than has been the case for nonusers, or that past satisfaction with the technology predisposes them to have generally favorable expectations toward future use. The opportunity to use telemedicine in a convenient setting seems to be associated with a positive perspective on telemedicine's potential as an adjunct to their practice of medicine. Hands-on experience may be required to persuade clinicians of telemedicine's utility.

The Centers for Medicare & Medicaid Services (CMS) has sought, through demonstration projects and research studies, to determine whether telemedicine services should be reimbursed, and if so, whether the reimbursement rates should be comparable to those for in-person care.[20,21] The original Medicare payment waiver approved for CMS demonstration sites provided substantially less payment for providers who used telemedicine. The majority of respondents in this study, both users and nonusers alike, reported that current reimbursement remains a problem. Payers who want to encourage telemedicine utilization as one way to increase provider efficiency, reduce patient and provider travel, or for other reasons may need to reconsider their telemedicine reimbursement policies.

Dissemination of telemedicine technology at the present appears to be driven more by administrators on the supply side than from any intrinsic demand on the part of physicians or patients. Yellowlees[27] makes the case that a tendency exists for central bureaucracies—at different levels of the hierarchy—to decide that a telemedicine system can solve a range of delivery system problems. Such bureaucracies

then design and establish systems, often with little input from the prospective clinician–users about their preferences, knowledge, and beliefs about telemedicine. This top-down approach has contributed to dissatisfaction with and failure of some telemedicine systems. This is a critical finding, strongly suggesting that the potential users of telemedicine must be not only consulted prior to implementation of the technology, but significantly involved in the development of telemedicine programs and applications. Such involvement is likely to provide some of the incentive necessary for the establishment of routines of practice that may become habitual.

The results of this survey are particularly interesting on several counts. First, nonusers differ little from users on most demographic and practice variables. The major exception is that nonusers are more likely than users to be in private practice. This may reflect economic factors (e.g., capital expenditures and opportunity costs for private practitioners), or it may be that it is easier to use telemedicine technology when someone else (e.g., hospital administration) takes responsibility for establishing a system, especially one with convenient access.

Also of considerable interest was the fact that users and nonusers of telemedicine alike view the technology as having both potential advantages and downsides. Even after experience with the technology, many users have a tendency to view telemedicine as somewhat inconvenient, less effective than in-person care, and less than optimal. The recognition of limitations and barriers to telemedicine services may explain the relatively low utilization of telemedicine even among those who have adopted the technology. Telemedicine users nevertheless appear to find the technology of sufficient value that they are willing to take advantage of it.

Because they demonstrate association and not causality, the data do not provide a clear direction with regard to mechanisms for increasing telemedicine utilization by physicians. A qualitative analysis of data obtained from telemedicine administrators as part of a separate component of this same study[28] suggested that the issue is in part a function of habit. That is, physicians develop practice routines that are efficient, and changing these habitual routines involves at least temporary disruption of an efficient pattern of workflow, irrespective of attitudes, beliefs, and knowledge.[29]

Behavior may precede belief in this case, as suggested by social psychological research on persuasion.[30] Perhaps if physicians can be induced to use telemedicine on a regular basis, they will come to believe in its value, and in so doing, become more knowledgeable about it. The more convenient telemedicine is for users and the more exposure they have to the technology, the more familiar it will become. In conjunction with adequate reimbursement, over time the diffusion of telemedicine is likely to increase. As long as physicians feel no compelling need to use telemedicine, however, this process may occur slowly.

Although this study provides an important examination of knowledge and beliefs among users and nonusers of telemedicine, employing a large sample of physicians, the study has two important limitations. It is possible that physicians with particular interest in telemedicine and/or technology in general were more likely to complete and return the survey. Because we were not able to obtain information about those physicians who chose not to participate, we could not conduct formal analyses examining the potential for self-selection bias in this sample. If more technologically minded physicians participated in the study, this self-selection may have reduced the size of the differences between the groups of users and nonusers, and limited our ability to detect demographic differences between groups. In addition, because the study was correlational in nature, we were not able to identify causal relationships. Future research in this area should examine the causal impact that variables such as demographic characteristics, knowledge, and beliefs about telemedicine advantages and barriers may have on the use of the technology.

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