

Residency Education

Synchronous Distance Learning as an Effective and Feasible Method for Delivering Residency Didactics

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Background and Objectives: *Providing effective multisite didactic teaching in residency programs remains a challenge. There is limited evidence regarding the educational equivalency of the traditional and distance learning methods for delivery of didactics. We introduced a synchronous two-way audio and video Internet-transmitted distance learning methodology in two sites. The study assessed both residents' satisfaction and knowledge gain at the face-to-face lecture site as compared with the distance learning site.* **Methods:** *The study was conducted over 1 year at the Wayne State University family medicine residency program, involving all 36 residents. Seventeen distance learning sessions were conducted, and the results from the lecture and distance learning sites were evaluated.* **Results:** *The didactic sessions were rated highly by both groups, with no significant differences on the resident satisfaction survey. The distance learning method was received positively by learners. The residents in both groups scored higher on posttests compared to the pretests, and there was no statistical difference in knowledge gain between the lecture and the distance learning group.* **Conclusions:** *Synchronous interactive instructor-led distance learning is an effective method for delivering residency didactics at more than one site. The new technology is well accepted by learners and is a promising approach to multi-site education.*

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Didactic conferences are important components of residency training, but delivering them efficiently and effectively is a challenge for many programs when learners are located in multiple sites. Residents and faculty may expend valuable time traveling from remote sites to a centralized location for conferences, often facing an inefficient return trip, as well.

Distance learning technologies have been proposed as a method for addressing these problems. There are two main formats for distance learning experiences: directed study and instructor-led events. Directed study learning experiences are asynchronous, self-study modules. They rely on a structured plan that directs the learner through experiences without real-time interaction with the instructor. CD-ROM-based tutorials, paper-based correspondence, traditional homework assignments, and Web-based "click-to-learn" modules are examples of this learning format.¹ Instructor-led events are synchronous and offer real-time learning. Not only

do all learners have the opportunity to communicate directly with the lecturer, but they also view learning content simultaneously with the lecturer. Instruction is highly interactive in synchronous events, since there is the capability to react to real-time environments and adapt the flow of learning to meet the needs of learners at a particular time.

While the Internet has been used fairly widely in the implementation of higher education distance learning experiences, most of these efforts have been conducted in an asynchronous manner.¹ Synchronous methods are more difficult to implement. However, several examples of real-time distance learning experiences have been reported. All reports include learners' subjective responses to the experiences. Medical education distance learning programs that have proven satisfactory to learners have occurred in continuing medical education series,^{2,3} medicine and cardiology grand rounds presentations,⁴ pediatric cardiology residency didactics,⁵ surgery education for first-year medical students,^{6,7} and first aid instruction for health professionals taught by emergency medicine faculty.⁸ While participants found these experiences acceptable, none of these studies measured learning effectiveness. Similarly, in family medicine graduate medical education, a Texas family

medicine program⁹ reported satisfied residents in a two-way interactive videoconferencing program that included didactic conferences across three separate teaching practices, but the investigators did not measure residents' learning.

Both learner satisfaction and educational equivalency between on-site and remote-site experiences have been demonstrated in occupational therapy¹⁰ and medical informatics for health professionals.^{11,12} However, we found only one other study measuring both learner satisfaction and education equivalency in graduate medical education. An Arkansas program¹³ evaluated two-way interactive video technology for occasional delivery of lectures on special topics to family medicine residents at the home program location as well as several remote locations. While residents' learning was equivalent in both the remote and home-based groups, attitudes of learners toward the program's distance learning methodology declined significantly after the experience.

Our objective was to assess both participant satisfaction and equivalency in educational effectiveness across sites of the synchronous distance learning program we developed at Wayne State University.

Methods

In the Wayne State University Department of Family Medicine, we implemented a distance learning program to electronically deliver didactic conferences to residents at a remote site simultaneously with live delivery at our home site. Prior to that, the residency program had traditional delivery of the didactic curriculum with a lecturer and audience in one location. The sessions occurred every Wednesday afternoon. Residents evaluated the lecture topic and the presentation using a 10-item evaluation form. Some residents found it very time consuming and inconvenient to commute to the central location for conferences; therefore we decided to add another remote site and introduced the distance learning concept. Our methods were reviewed and approved by the Wayne State University Human Investigation Committee.

Sample

The study population consisted of all 36 resident physicians from the Wayne State University/Detroit Medical Centers Family Practice Residency Program. We studied a total of 17 presentations broadcast between January and December 2002, delivered during the regularly scheduled conference time on Wednesday afternoons. Residents rotated between the different sites depending on their schedules and rotation assignments; thus, the population at each location differed at each session (Table 1).

Locations

We conducted sessions at two sites. One was our Northwest Detroit administrative residency location

and the second was a conference room at Huron Valley-Sinai Hospital in Commerce Township, Mich. These locations are 24 miles apart. Each site served as the traditional classroom or distance learning site, depending on the instructor's location.

Measurements

We evaluated both residents' satisfaction and knowledge gain with each session.

Table 1

Number of Participants, by Site and Presentation Topic

<i>Presentation Topic</i>	<i># of Residents at Site of Lecture</i>	<i># of Residents Participating From Remote Sites Distance Learning</i>	<i>Total</i>
Abdominal pain	0*	16	16
Anxiety disorder	13	5	18
Bartholin cyst, PID, STD	10	4	14
Eating disorder in children and adolescents	13	8	21
Ethics in family medicine	6	10	16
Fatigue	9	7	16
First-trimester bleeding	4	11	15
Healthy child: conception to age 2	10	18	28
Hernia	5	13	18
Medical and surgical diseases of the gallbladder	4	10	14
Multiple sclerosis	8	5	13
Patient satisfaction/practice management	5	10	15
Poisons/toxins, overdose	5	12	17
Smoking cessation	15	4	19
Team player/behavioral science	10	5	15
Thrombocytopenia	6	13	19
Thyroid disorders	10	6	16
Total	133	157	290

* Evaluations were lost at this site

PID—pelvic inflammatory disease
STD—sexually transmitted disease

Satisfaction Evaluation. At the end of each lecture session, each resident was asked to complete an attitude questionnaire, which included 18 statements regarding the instructor, didactic topic content, and the distance learning experience. Respondents were asked to indicate on a 5-point Likert scale their agreement (a score of 5) or disagreement (a score of 1) with each statement on the questionnaire (Table 2). There was also an opportunity for residents to write comments.

Knowledge Evaluation. This evaluation tool consisted of identical pretests and posttests on the subject matter, provided by the presenter. Each consisted of eight to 11 questions that evaluated the residents' knowledge. The tests specifically assessed the objectives of each didactic session. The pretests and posttests were matched using an anonymous numeric identifier.

Educational Design

Seventeen lectures were evaluated. All were part of the formal didactic curriculum for the family medicine residency. Topics addressed adult medicine, care of

surgical patients, care of women, care of children and neonates, preventive medicine, behavioral science, and mental health. Lecturers were given guidelines regarding the nature of the electronic conferencing ("e-conferencing") experience, asked to provide approximately 10 questions for the pretest and posttest, and asked to bring a disk with their presentation in a PowerPoint format at the time of the presentation. Residents' attendance in our residency program is mandatory at all didactics if rotational schedule allows.

E-conferencing Design

The distance learning method we chose was synchronous interactive Internet-based transmission of PowerPoint slide presentations with audio connection via a telephone line. Both locations had T-1 Internet connection. We used an external company that provided a server on which to transmit and coordinate the conferences. At each site we needed only a simple technology, consisting of a computer and a digital projector. At each site, a physician faculty member coordinated the session, administered the evaluation forms and

Table 2

Residents' Satisfaction Evaluation of the Didactic Sessions

Question	Site Group	n	Mean	Mann-Whitney P Value
The objectives of the session were communicated clearly.	Lecture	79	4.77	.16
	Distance	100	4.67	
The instructor met the objectives established for the session.	Lecture	79	4.72	.72
	Distance	100	4.69	
The instructor was well prepared and presented information in a logical manner.	Lecture	80	4.73	.98
	Distance	98	4.71	
The instructor was knowledgeable in the topic area.	Lecture	80	4.74	.53
	Distance	98	4.69	
I would recommend this instructor for future sessions.	Lecture	80	4.76	.27
	Distance	98	4.66	
The content of the session was relevant to my professional needs.	Lecture	80	4.78	.14
	Distance	100	4.67	
The session helped me identify knowledge and skills I will need to effectively function in my chosen profession.	Lecture	80	4.74	.09
	Distance	100	4.60	
The level of difficulty of the material presented was appropriate for my level of training.	Lecture	80	4.74	.19
	Distance	99	4.62	
My understanding of the subject matter was enhanced.	Lecture	80	4.71	.29
	Distance	100	4.60	
I would recommend this session to others.	Lecture	80	4.78	.12
	Distance	98	4.66	
Overall, I would rate the session as excellent.	Lecture	80	4.76	.06
	Distance	98	4.62	

tests, and solved problems when technological difficulties arose. These faculty received training consisting of one-on-one instruction about steps for connecting to and using the e-conferencing Web site.

The lectures occurred once per month during the regular residency didactics time period on Wednesday afternoon. Each session had three components: (1) a 30-minute pretest consisting of about 10 questions per lecture to be presented, (2) three 45-minute lectures, each of which was followed by a 15-minute question-and-answer and discussion session, and (3) a 30-minute period for taking the posttest and completing the evaluation. Residents and lecturers chose a site based on geographic proximity to their rotation or office location. Presenters of the three lectures for a given session might all be together at one location; alternatively, they might be split between the two sites. Because lectures could be transmitted from either site at each session, residents sometimes were in both a remote location and face to face with an instructor during a single distance learning session.

Data Analysis

Residents' Satisfaction Questionnaire Responses. Comparisons of the responses by group (lecture versus distance learning) were made using the Mann-Whitney U test. Additionally, distance learners were instructed to answer a set of questions relevant only to the distance learning sites. These questions were summarized descriptively.

Knowledge Test Scores. Pretest and posttest scores were used to evaluate learning. We made overall comparisons among time points and also stratified these comparisons by lecture site using a paired *t* test. To test for any variation in changes of scores between groups, the total change was calculated between pretest and posttest scores, and the averages for each learning site were compared using an independent *t* test. Pretest and posttest comparisons between lecture groups were also made for each test period, again using an independent *t* test.

Results

Residents' Satisfaction Questionnaire Responses

There were no significant differences in the residents' satisfaction survey results between distance learners and site learners (Table 2). In general, the lectures seemed to be very well received by both groups, with means ranging from 4.60 to 4.78.

Residents who participated in lectures at the distance sites rated the sessions favorably (Table 3). On the residents' ratings of seven aspects related to distance learning features on a 5-point Likert scale that ranged from "1=strongly disagree" to "5=strongly agree," three median values were 5, one was 4.5, and the remaining three

Table 3

Residents' Evaluation of the Distance Learning Experience—Distance Site Survey

Question	<i>n</i>	Mean	SD
The distance learning technology was implemented effectively for today's didactic session.	84	4.44	0.87
Distance learning methods are as effective as traditional classroom methods for the delivery of didactic topics.	84	4.13	1.14
Distance learning methods are as effective as traditional classroom methods for learning the material delivered in the didactic topics.	84	4.17	1.10
Distance learning methods are as effective as traditional classroom methods for sustaining adequate student-instructor interaction.	84	4.13	1.10
As a resident, distance learning is an important method for delivering didactic conference.	82	4.37	0.84
I prefer distance learning to the traditional classroom method.	82	3.74	1.32
I would recommend distance learning to other residents as a method to receive didactic lecture.	82	4.20	1.10

SD—standard deviation

were 4.0. Residents thought that the distance learning technology was implemented effectively and viewed distance learning as an important method for delivering didactic conferences. Residents recorded that they would recommend distance learning to other residents, and they believed that distance learning methods are as effective as traditional classroom methods for the delivery of didactic topics. While the residents felt that the distance learning site was equal to the traditional classroom, they did not prefer it (mean 3.74).

Knowledge Test Scores

There was no significant difference in improvement in test scores by learners at the lecture site when compared to that of learners at distance sites (0.15 versus 0.15, $P=.61$). Distance learners achieved higher mean values on both the pretests (0.61 versus 0.53, $P=.005$) and posttests (0.78 versus 0.68, $P=.001$) (Table 4). Both groups showed a significant increase in their test scores (Table 5). The lecture site group test score increases were significant from pretest to posttest (0.53 versus 0.69, $P<.001$). The same changes occurred in the distance group's test scores (0.63 versus 0.77, $P<.001$).

Table 4

Residents' Knowledge Gain Assessed
by Using Pre- and Post-lecture Test Results
at the Distance Learning and Lecture
Sites—Independent Samples Test

Test	Site Group	n	% Correct	P Value
Pretest percent correct	Lecture	130	53.4	.005
	Distance	142	61.2	
Posttest percent correct	Lecture	104	68.1	.001
	Distance	125	77.6	
Difference (posttest–pretest)	Lecture	101	15.2	.922
	Distance	114	14.9	

Table 5

No Difference in Residents' Knowledge
Gain at Distance Learning and Lecture
Sites—Paired Samples Test

Site Group	Test	n	Mean	P Value
All	Pretest percent correct	215	58.2	.000
	Posttest percent correct		73.2	
Lecture site	Pretest percent correct	101	53.4	.000
	Posttest percent correct		68.6	
Distance site	Pretest percent correct	114	62.5	.000
	Posttest percent correct		77.4	

Discussion

This study assessed the influence of traditional versus virtual environment on residents' knowledge gain from a lecture and their attitude toward the experience. Notably, the objectives of the didactics seemed to be met regardless of where or in what fashion the resident physicians experienced the lectures, and both methods were equally effective. The power of our study to detect a difference between a mean of 4.75 in the lecture group and a mean of 4.65 in the distance group was only 18%. Assuming the effects were equivalent in the two groups, e-conferencing appears to be a cost-effective teaching method considering the time savings and minimal equipment necessary.

Residents' satisfaction with the distance learning experience was high, and their learning was equivalent with distance learning and in-person lectures. An important benefit of the synchronous delivery of the lecture is the opportunity for discussion and asking questions during and at the end of the lecture. Residents were comfortable using the telephone microphone to communicate with the speaker. Our results on learner satisfaction measures were contrary to the Arkansas program findings,¹⁰ in which residents characterized the distance learning as "annoying" and "distracting," noting that it "turned off" some of them. Additionally, rather than finding that interactivity was equivalent across the Arkansas program sites, residents at the home site at which the lecturers were present asked more questions and were more interactive with the instructors than were the remote groups. To address remote-site participants' dissatisfaction, program organizers concluded that design and delivery of presentations could be improved with instructor training and experience. Most other studies on distance learning satisfaction,²⁻⁹ however, confirm our findings that, in general, learners accept new distance learning technology positively.

We needed to address several barriers in introducing the technology in our program.

First, our faculty needed to develop the skills to coordinate the sessions and troubleshoot on site. We would strongly recommend that each site designate one person, preferably a faculty physician, to be thoroughly trained in use of the system and have computer skills sufficient to improvise and problem solve on site. We provided a back-up computer, LCD projector, and telephone set at each location to be able to avoid delays from unexpected technical difficulties.

Second, in our pilot efforts, we found that in our residency location, our Internet bandwidth of 56k caused us to be unsuccessful because of the slow transmission of PowerPoint slides with complex images. We addressed the problem by installing a T-1 line in this location. In spite of that, we would advise instructing the speakers that the speed of the slide transmission via Internet causes a slight delay from the real-time view. Uncomplicated slides with simple backgrounds and fewer pictures are transmitted more quickly to the remote location, eliminating possible time lag between slide transmission and audio presentation.

Also vital for the success of the sessions was adequate audio transmission, requiring high-quality telephone speakers. Sound characteristics and size of the room need to be taken into account, and need for additional microphones must be evaluated.

A third barrier was the fact that some lecturers were not accustomed to using a PowerPoint digital format for their lectures; this limited the number of speakers available to participate in the distance-learning sessions. Speakers may need to be reminded to interact frequently with the remote site learners and encourage them to participate in discussions. The majority of the speakers had very positive experiences. They did not need much training or additional preparation. Most shared that once the lecture started, they became less conscious of the fact that there was a remote site, and they simply delivered the information in their usual way. Initially we invited only our faculty to be

presenters at the distance learning sessions, and after we became more confident in the equipment use, we extended the invitation to outside speakers.

Our study has several limitations. The study was conducted in two sites of a single residency program, thus its applicability to other programs needs to be evaluated. At some sessions, attendance was low due to residents' attendance at required rotations or time off for vacations or other purposes. We collected incomplete data for some evaluation items due to residents' failure to answer all evaluation items.

In conclusion, although distance learning courses are rapidly expanding on the Internet, there have been little data to support their use in the field of medicine. In our study, we found interactive e-conferencing to be acceptable for use in residency didactics. The saving of faculty and residents' time and travel appears to offset the technical difficulties encountered in introducing this new technology. Future applications include involving more than two sites and other residency programs from the same or other disciplines. Sharing faculty resources to provide the required didactic component in residency training programs can be accomplished through wider use of distance learning methods. Our experience is encouraging, and we hope other educators will join in continuing to develop this form of multi-site education.

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REFERENCES

1. www.weblearning.com. Accessed August 16, 2004.
2. Allen M, Sargeant J, MacDougall E, Proctor-Simms M. Videoconferencing for continuing medical education: from pilot project to sustained programme. *J Telemed Telecare* 2002;8(3):131-7.
3. Callas PW, Ricci MA, Caputo MP. Improved rural provider access to continuing medical education through interactive videoconferencing. *Telemed JE Health* 2000;6(4):393-9.
4. Allen M, Sargeant J, MacDougall E, O'Brien B. Evaluation of videoconferenced grand rounds. *J Telemed Telecare* 2002;8(4):210-6.
5. Finley JP, Beland MJ, Boutin C, et al. A national network for the tele-education of Canadian residents in pediatric cardiology. *Cardiol Young* 2001;11(5):526-31.
6. Gul YA, Wan AC, Darzi A. Use of telemedicine in undergraduate teaching of surgery. *J Telemed Telecare* 1999;5(4):246-8.
7. Gul YA, Wan AC, Darzi A. Undergraduate surgical teaching utilizing telemedicine. *Med Educ* 1999;33(8):596-9.
8. Chi CH, Chang I. Real-time telemedicine for teaching a first-aid course. *J Telemed Telecare* 2002;8(1):36-40.
9. Crump WJ, Tessen RJ, Montero AJ. The department without walls. Acceptability, cost, and utilization of interactive video technology. *Arch Fam Med* 1997;6(3):273-8.
10. Jedlicka JS, Brown SW, Bunch AE, Jaffe LE. A comparison of distance education instructional methods in occupational therapy. *J Allied Health* 2002;31(4):247-51.
11. Hersh WR, Junium K, Mailhot M, Tidmarsh P. Implementation and evaluation of a medical informatics distance education program. *J Am Med Inform Assoc* 2001;8(6):570-84.
12. Hersh W, Junium K, Mailhot M, Tidmarsh P. Implementation and evaluation of a distance learning introductory course in medical informatics. *Med Inform* 2001;10(part 2):1023-7.
13. Lewis YL, Bredfeldt RP, Strode SW, D'Arezzo KW. Changes in residents' attitudes and achievement after distance learning via two-way interactive video. *Fam Med* 1998;30(7):497-500.