

Educational Technology Integration and Distance Learning in Respiratory Care: Practices and Attitudes

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INTRODUCTION: Educational technologies have had an important role in respiratory care. Distance learning via postal correspondence has been used extensively in respiratory care, and Internet-based distance learning is now used in the training of respiratory therapists (RTs), clinical continuing education, and in baccalaureate degree and higher programs for RTs and educators. **OBJECTIVES:** To describe the current scope of respiratory care educational technology integration, including distance learning. To investigate online research potential in respiratory care. **METHODS:** A probabilistic online survey of United States respiratory care program directors was conducted on educational technology practices and attitudes, including distance learning. A parallel exploratory study of United States respiratory care managers was conducted. **RESULTS:** One-hundred seventy-seven (53%) program directors participated. One-hundred twenty-eight respiratory care managers participated. For instructional purposes, the respiratory care programs heavily use office-productivity software, the Internet, e-mail, and commercial respiratory care content-based computer-based instruction. The programs use, or would use, online resources provided by text publishers, but there is a paucity. Many program directors reported that their faculty use personal digital assistants (PDAs), often in instructional roles. 74.6% of the programs offer no fully online courses, but 61.0% reported at least one course delivered partially online. The managers considered continuing education via online technologies appropriate, but one third reported that they have not/will not hire RTs trained via distance learning. Neither group considered fully online courses a good match for RT training, nor did they consider training via distance learning of comparable quality to on-campus programs. Both groups rated baccalaureate and higher degrees via distance learning higher if the program included face-to-face instruction. Online distance-learning participatory experience generally improved attitudes toward distance learning. There was a good match between manager RT expectations in office-productivity software and program instructional practices. **CONCLUSIONS:** Educational technologies have an important role in respiratory care. Online distance learning for baccalaureate and higher degrees in respiratory care is promising. Online distance learning in respiratory care must include face-to-face instruction. Distance-learning deployment in respiratory care will require resources. A follow-up probabilistic survey of United States respiratory care managers is needed. Online surveys conducted for respiratory care are promising, but neither less expensive nor easier than conventional means. *Key words:* educational technology, distance education, instruction technology, professional education, computer-assisted instruction, teaching methods, education techniques, respiratory care. [Respir Care 2007;52(11):1510–1524. © 2007 Daedalus Enterprises]

Introduction

Educational technologies have played an important role in the training of respiratory therapists (RTs) and in their continuing in-service education for about 4 decades.¹ Technologies employed in the field of respiratory care (RC) in

an educational role began with computer-managed tutorials, drill and practice programs, and branching-logic clinical simulations.² These were sometimes authored and pro-

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duced in-house, but were more commonly purchased from commercial vendors.^{1,2} Educational technologies have continuously evolved and now include various types of generic presentation applications, such as Microsoft PowerPoint, sophisticated spreadsheet and database applications, and more recently, a multitude of Internet-based technologies for developing and deploying instruction. Online distance learning, still a relatively new frontier, has been the subject of intense, even frantic, development worldwide,^{3,4} and a compelling education topic in the field of RC.^{5,6} Various technologies, such as personal digital assistants (PDAs), ubiquitous in the business world and often carried by RC managers and teachers, are also finding limited educational roles. But technology integration in teaching, particularly in the field of RC, has been sporadic and chaotic, with technology-biased teachers and administrators embracing often expensive technologies without due attention to issues of efficacy and pedagogy.¹

A clear picture of educational technology integration in the field of RC, and attitudes toward traditional and emerging educational technologies such as online education, in both initial training and continuing education roles, have not been described. In 1999, in a study restricted to one state, Becker and Gibson⁷ identified a compelling aspect of distance learning in RC, that practicing RTs wanted assurance that a baccalaureate degree earned via distance learning would be valued by their employers, and this has not been adequately addressed in the literature. A subsequent national study conducted in 1999 by Becker⁸ found that most managers favored some use of distance learning for graduate degrees, but that study did not directly address online programs. A study by Boone and Jones-Boggs⁹ of United States RC program directors reported that 30% indicated that their program offers some form of distance learning, and that this is almost exclusively Web-based, but distance learning deployment and other aspects of technology integration in teaching in the field of RC have not been established in adequate detail. Technology integration in teaching in RC clinics, for continuing education, staff training, and patient education, is not meaningfully addressed in the literature.

We conducted Internet-based national surveys of RC educators and managers to begin to assemble a picture of current practices and attitudes, toward distilling a vision of educational-technology integration and distance learning in the field. This research comprises a probabilistic survey of United States RC program directors and an exploratory study of United States RC managers. The surveys were deployed September through October 2006.

Research Objectives

The primary objective of the research was to determine how RC presently employs technology in teaching roles,

including distance learning, how teachers and managers perceive these practices, and to reveal potential elements of a long-range vision of educational-technology integration for the field. A secondary objective was to evaluate the potential of survey research conducted online in the field of RC.

Methods

Online surveys were constructed and deployed with online survey software (Zoomerang, MarketTools, San Francisco, California) and servers for 2 target populations: RC program directors and RC managers. Both survey instruments consisted of about 35 items and aimed for a respondent completion time of < 15 min (confirmed with pilot testing).^{10,11} The survey instruments consisted primarily of yes-or-no, single-choice, multiple-choice, and multiple-choice Likert-scale items, which were primarily fixed-response and mandatory. Many items also included optional input for comments on fixed-response items, and there were 2–3 open-ended, optional entry items for comments. Items were grouped by technology category.^{10,12} The 2 survey instruments were designed to be parallel inasmuch as differences between the 2 vocational groups permitted. Both instruments were pilot tested by ≥ 2 members of each target population, and refined for format and content based on user feedback.^{11–13} The survey instruments were proofread and refined by an information-design professional to ensure appropriate reading level, item clarity, item specificity, appropriate emphasis,¹⁰ proper formatting, plain language, and readability.¹¹ The survey instruments can be accessed at http://www.spsu.edu/htc/rc_2006/edtech_rc06.htm. The survey technology was set to decline multiple submissions from the same Internet-protocol address, to reduce duplicate submissions. As an incentive to participate in the surveys,^{11,13} respondents who completed them were provided access to a summary of preliminary findings for their respective target populations.

Data from the surveys were entered into statistical analysis software (Minitab 14, Minitab, State College, Pennsylvania). Categorical data were analyzed with the chi-square test. Fisher's exact test was used to confirm the chi-square for 2-by-2 tables with categories with small expected frequencies ($n < 5$).¹⁰ Likert-scale items were first analyzed as categorical data, by combining "very much so" and "moderately so" (or equivalent) responses for the positive category, and "somewhat negative" and "not at all so" (or equivalent) for the negative category. These 3-by-2 table chi-square results were confirmed with the *t* test, with Likert-scale responses analyzed as interval data (value 1 = highly negative, through value 5 = highly positive). In all 3 statistical measures, a *p* value of < 0.05 was deemed to indicate a significant difference.¹⁰

The responses to open-ended questions on educational technology and distance learning provided rich qualitative data that amplified and explained the survey responses. Thematic qualitative analysis was performed to identify patterns of order that emerged from the data.¹⁴ Responses were coded and categorized, and saturation of data revealed dominant themes.

Respiratory Care Program Director Survey

A probabilistic online survey was conducted of the population of United States RC program directors. Published lists of RC programs were obtained online from the Web sites of the National Board for Respiratory Care (<http://www.nbrcc.org>), the Committee on Accreditation for Respiratory Care (<http://www.coarc.com>), and the Commission on Accreditation of Allied Health Programs (<http://www.caahep.org>). Program institution names and program-director e-mail addresses were gathered from all 3 lists. Because copious inaccuracies and omissions were found in all three, the lists were merged to cast the widest possible net to identify all current RC programs. The study was not restricted to programs presently accredited. Where e-mail addresses were not published, an Internet search of the target program's Web site was conducted to obtain the RC program director's e-mail address. Where this was not successful (e-mail addresses not published on institution Web site), the target program was contacted via telephone. In cases of different e-mail addresses for a single program director, a first choice database e-mail was selected on a "best guess" basis (e-mail with oldest distinguishing elements was discarded, such as e-mail addresses that ended in the ".us" suffix or that did not include the ".edu" suffix). This process yielded an initial e-mail address database of 341 target respondents.

The e-mail database was uploaded to a mass-e-mail application (GroupMail 5, Infacta, Bellingham, Washington), and a preliminary survey notice of invitation was e-mailed individually to all the target addresses. This was to prompt respondent targets to expect the formal survey invitation, and to test the e-mail address database to improve survey response rate.^{15,16} The e-mailed invitation is the functional equivalent of a cover letter in a postal survey, and provides information on researcher identity and contact information, information on how respondents are identified, aims of the study, potential benefits or harm, and what will happen to data collected.¹²

The preliminary e-mail to the target population resulted in 95 e-mail notifications of delivery failure (e-mail "bounces") and 2 notifications of e-mails rejected by intranet firewall systems. One program director elected to opt out of the study. Internet searches and telephone queries replaced 93 of the inaccurate e-mail addresses. Three e-mail address errors could not be corrected. Eleven re-

cipients of the preliminary e-mail, who identified themselves as faculty but not program directors, provided current e-mail addresses for their program directors. The net result was that the target population e-mail database was refined to include a total of 335 probable respondent e-mail addresses ($N = 335$). Six days after the initial survey notification, the preliminary survey message was e-mailed individually to 100 corrected program-director e-mail addresses.

Seven days after the initial preliminary survey announcements, the survey invitation was e-mailed individually (via the GroupMail 5 application) to the database of 335 target e-mail addresses. An announcement that the survey was underway was simultaneously posted to the American Association for Respiratory Care (AARC) Education Section e-mail list, which invited the program directors who did not receive an e-mail invitation to e-mail the research team for instructions to participate. Seven program directors responded to that posting and were invited to participate (it was presumed that these respondents did not receive e-mailed invitations, due to e-mail-address or technical errors, and so did not constitute an addition to the target population).

Program directors who chose to participate in the survey accessed a consent form uniform resource locator (URL) provided in the survey invitation e-mail (by clicking on the URL in the e-mail message or by copying the URL text and pasting it into an Internet browser). The consent form Web page provided information on the purpose of the study, participant expectations, time requirements, risk potential, confidentiality and anonymity, identity of principal investigator, and institutional review board contact information.¹¹ Both the e-mail invitation and consent form attempted to identify educational technology integration as a topic of common interest in potential respondents, to promote participation.¹¹ The survey Web site was closed after 10 days.

The research procedures followed were in accordance with the institutional research review board of Southern Polytechnic State University, and with the Helsinki Declaration of 1975, as revised in 1983.

Respiratory Care Manager Survey

A nonprobabilistic online exploratory survey was conducted of United States RC managers. A survey invitation was posted to the AARC Management Section e-mail list. The invitation directed potential participants to a consent form Web page, which was identical in format and operation to the equivalent consent form for program directors (described above). A follow-up invitation was posted to the same list after 10 days. The survey invitation included a request that participants forward the invitation to one or more RC managers in their acquaintance. We e-mailed a similar survey invitation to about 20 RC managers in var-

Table 1. Respondent Demographics

	<i>n</i>	%
Respiratory Care Program Directors	177	100
Program Type		
Entry	7	4
Advanced	155	88
Both Entry and Advanced	15	9
Respiratory Care Managers	128	100
Facility Type (predominant)		
Acute Care	107	84
Extended Care	4	3
Home Care	1	1
Other*	16	13
Facility Size		
Large (≥ 200 beds)	69	54
Medium (100–199 beds)	26	20
Small (< 200 beds)	32	25
Not applicable	1	1
Respondent's Position		
Department Manager	97	76
Technical Director	13	10
Supervisor	6	5
Other†	12	10
Highest Academic Degree		
Associate	34	27
Bachelor's	60	47
Master's	28	22
Doctorate	0	0
Certificate or other	6	5

*Long-term acute care, subacute, rehabilitation, or specialty

†Associate director, assistant director, project coordinator, or education director

ious geographic areas of the United States. A request to enlist RC managers in the survey was posted once on the AARC Education e-mail list. In all direct and mailing-list postings, respondents were invited to forward the survey invitation to one or more RC managers. This survey technique is known as “snowballing” and is generally recognized as a legitimate tactic in convenience sampling for exploratory surveys.^{10–12} Survey access procedures, respondent instructions, and informed consent were handled similarly to the survey of program directors. The survey Web site was closed after 20 days, when responses dwindled to < 5 per day.

Results

Table 1 presents the demographic survey data. Table 2 presents the calculated statistical data on the program directors. Table 3 presents the calculated statistical data on the RC managers. Figure 1 presents the selected compar-

ative data from the 2 studies. Figure 2 presents selected data from the survey of program directors. Figure 3 presents selected data from the survey of RC managers. (Complete tabular data from the survey is available at http://www.spsu.edu/htc/rc_2006/edtech_rc06.htm.)

Respiratory Care Program Director Survey

There were 187 respondents to the survey. Data from 8 respondents with incomplete surveys were excluded. Data from 2 respondents who identified themselves as director of clinical education, rather than program director, were excluded. The survey yielded 177 viable response sets ($n = 177$), which is a response rate of about 53%.

Technology Integration. The programs reported heavy faculty use of generic commercial software (such as PowerPoint) for instruction. 98.3% of program directors reported faculty skill levels in office-productivity tools (eg, word processing and spreadsheets) as moderate or high, and similarly high student requirements to use such tools in course work. All program directors reported program use of e-mail, most (89.3%) use e-mail in an instructional role, and a substantial number (58.8%) employ e-mail listservs (automated e-mail distribution technology). All programs reported regular faculty access to the Internet and 99.4% use the Internet for instructional preparation. Nearly all programs (99.4%) provide Internet access for students. Few of the program directors (7.3%) reported an instructional role for podcasting technology.

58.8% of program directors reported that at least one person in the program uses a PDA, which is about the same as reported PDA use among medical professionals (45–85%).¹⁷ Of those, 58.7% use a PDA in an instructional role. Instructional PDA applications reported by program directors are presented in Table 4.

Nearly all (98.3%) of the program directors reported that they use, or would use if available, online resources provided for RC textbooks. Asked to identify the most needed technologies related to instruction, the program directors reported a pressing need for instructional resources from RC text publishers, especially including high-quality content modules for WebCT and Blackboard (online course-management systems). Also frequently mentioned was access to high-quality streaming video presentations on RC procedures, a repository of online didactic presentations, an online database of RC practice examination items, and access to classroom wireless technology.

Distance Learning. 74.6% of the programs delivered no fully online courses, and 51.4% of the programs plan to offer no such courses within 2 years. 21.5% of the

Table 2. Calculated Statistical Data on Respiratory Care Program Directors (Probabilistic Study)

		Response Category (n)		Chi-square (p)	
Initial training of RTs is a good match for courses delivered entirely online					
		Agree	Disagree		
Respondent had taken a college level course delivered entirely online	Yes	7	63	0.130	
	No	9	98	(0.719) DF 1	
		Agree	Disagree		
Respondent had earned a degree in or was enrolled in a program delivered entirely or substantially online	Yes	5	31	1.292	
	No	11	130	(0.256) DF 1	
RC degree (initial training of RTs) via distance-learning programs (online, postal, or other) is of comparable quality and value to traditional on-campus programs					
		Agree	Neutral	Disagree	
Respondent had taken a college level course delivered entirely online	Yes	20	13	37	5.121
	No	16	24	69	(0.077)* DF 2
Respondent had earned a degree in or was enrolled in a program delivered entirely or substantially online	Yes	13	5	18	8.522
	No	21	32	88	(0.014) ^{†‡} DF 2
Degrees other than RC (bachelor's to doctorate) earned in distance learning programs with no face-to-face elements are of comparable quality and value to similar on-campus programs					
		Agree	Neutral	Disagree	
Respondent had taken a college level course delivered entirely online	Yes	40	12	18	14.006
	No	31	29	47	(0.001) ^{†‡} DF 2
Respondent had earned a degree in or was enrolled in a program delivered entirely or substantially online	Yes	26	4	6	19.400
	No	45	37	59	(< 0.001) ^{†‡§} DF 2
Program type	Fully online	71	41	65	34.391
	Partially online	111	47	19	(< 0.001) ^{†‡} DF 2

*Significant via 2-sample *t* test[†]*p* < 0.05 via chi-square test[‡]Confirmed via 2-sample *t* test[§]Frequency less than 5 in less than 25% of cells probably does not invalidate *p* value

DF = degrees of freedom

programs reported offering 1–4 courses delivered totally online. 4.0% of programs reported offering ≥ 5 courses delivered totally online. 16.9% of the programs offer courses via satellite video or videoconferencing technology. Few of the programs (8.5%) offer distance-learning courses provided by other institutions. 61.0% of the programs reported offering at least one course

delivered partially online, and 28.8% reported ≥ 5 such hybrid courses.

39.5% of the program directors had taken a fully online college course, and 20.3% had earned a degree in an on-line program.

The program directors did not consider courses delivered entirely online to be a good match for initial training

Table 3. Calculated Statistical Data on Respiratory Care Managers (Nonprobabilistic Study)

Response Category (n)			Chi-square (p)		
Initial training of RTs is a good match for courses delivered entirely online					
Agree			Disagree		
Respondent had taken a college level course delivered entirely online	Yes	4	24	0.627	
	No	21	79	(0.428) ^{**†} DF 1	
Agree			Disagree		
Respondent had earned a degree in or was enrolled in a program delivered entirely or substantially online	Yes	4	15	0.033	
	No	21	88	(0.856) ^{**†} DF 1	
RC degree (initial training of RTs) via distance-learning programs (online, postal, or other) is of comparable quality and value to traditional on-campus programs					
Agree			Neutral	Disagree	
Respondent had taken a college level course delivered entirely online	Yes	11	5	12	2.679
	No	26	31	43	(0.262) [‡] DF 2
Respondent had earned a degree in or was enrolled in a program delivered entirely or substantially online	Yes	8	3	8	2.556
	No	29	33	47	(0.279) [‡] DF 2
Degrees other than RC (bachelor's to doctorate) earned in distance learning programs with no face-to-face elements are of comparable quality and value to similar on-campus programs					
Agree			Neutral	Disagree	
Respondent had taken a college level course delivered entirely online	Yes	15	4	9	7.051
	No	28	32	40	(0.029) ^{†‡§} DF 2
Respondent had earned a degree in or was enrolled in a program delivered entirely or substantially online	Yes	12	2	5	9.097
	No	31	34	44	(0.011) ^{†‡§} DF 2
Program type	Fully online	43	36	49	31.041
	Partially online	78	37	13	(< 0.001) ^{‡§} DF 2
Respondent had hired or would hire an RT trained via distance learning	Yes	34	32	20	41.637
	No	3	4	35	(< 0.001) ^{‡§} DF 2

*Fisher's exact test for 2-by-2 tables was used to confirm chi-square test results for small frequencies

†Frequency less than 5 in less than 25% of cells probably does not invalidate p value

‡Confirmed via 2-sample t test

§p < 0.05 via chi-square test

||Frequency less than 5 in less than 25% of cells may invalidate p value

DF = degrees of freedom

of RTs (91.0% margin of error [ME] \pm 4.2%), and this was so regardless of whether they had taken a fully online college-level course (chi-square 0.130, p = 0.719) or had

earned a degree in a fully or substantially online program (or were enrolled in such a degree program) (chi-square 1.292, p = 0.256). However, nearly all (96.6% ME \pm 2.5%)

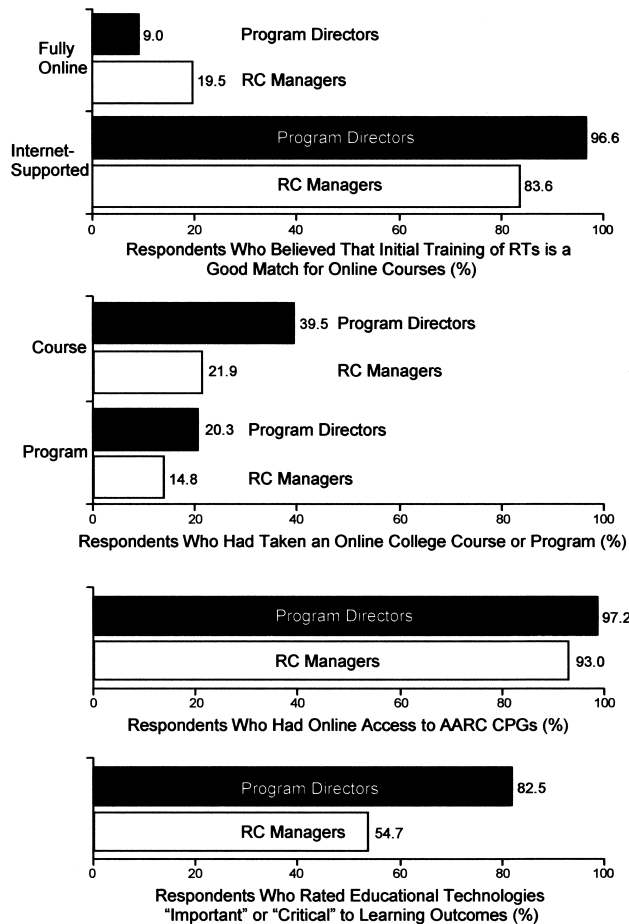


Fig. 1. Selected comparative data. RC = respiratory care. AARC = American Association for Respiratory Care. CPG = clinical practice guideline.

the program directors considered the initial training of RTs to be a good match for courses supported by the Internet.

By a wide margin (t test $p < 0.001$), the program directors reported that they do not consider RC degrees in the initial training of RTs earned via distance learning to be of comparable quality to traditional on-campus programs (19.2% positive, 20.9% neutral, 59.9% negative). However, program directors who had taken a fully online college course rated RC distance-learning programs as comparable in value in higher (significantly via t test but not via chi-square) proportions (28.6% positive, 18.6% neutral, 52.9% negative) (chi-square 5.121, $p = 0.077$, whereas via t test $p = 0.016$). Program directors who had earned a degree in or were enrolled in an online college-level (completely or substantially) online distance-learning program rated RC distance-learning programs as comparable in value in significantly higher proportions (36.1% positive, 13.9% neutral, 50.0% negative) (chi-square 8.522, $p = 0.014$, confirmed via t test, $p = 0.006$).

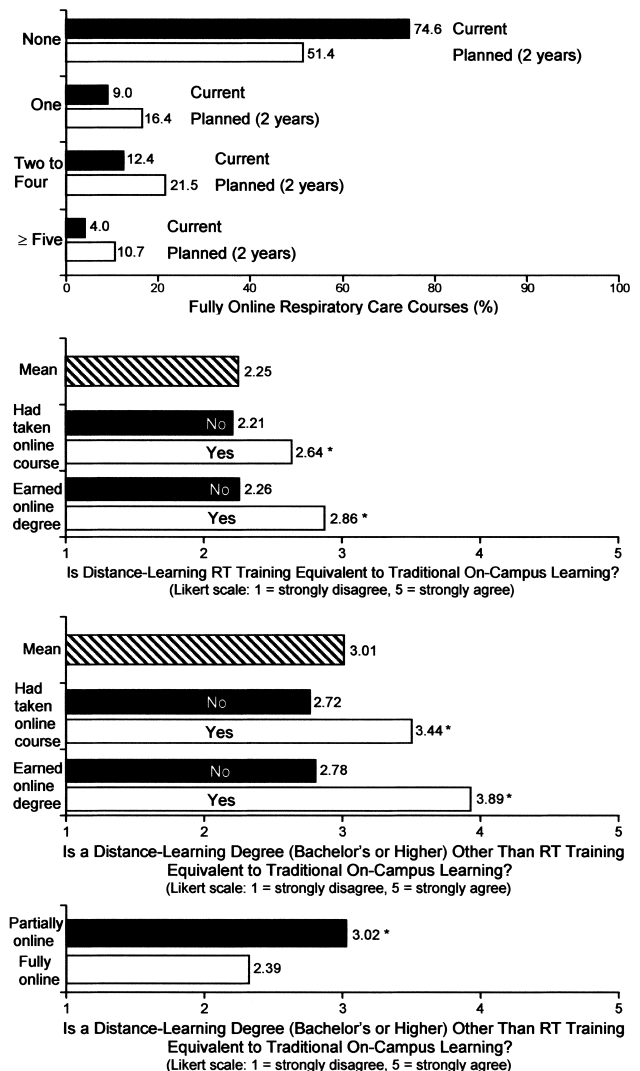


Fig. 2. Survey responses from respiratory care (RC) program directors. RT = respiratory therapy.

Overall, the program directors were approximately split (40.1% positive, 23.2% neutral, 36.7% negative) on the question of whether degrees other than RC (baccalaureate or higher) earned in distance-learning programs with no face-to-face elements are of comparable quality and value to on-campus programs. However, the program directors who had taken a fully online college course rated such distance-learning programs as comparable in value in significantly higher proportions (57.1% positive, 17.1% neutral, 25.7% negative) (chi-square 14.006, $p = 0.001$, confirmed via t test, $p < 0.001$), as did the program directors who had completed or were enrolled in a college-level (completely or substantially) online program (72.2% positive, 11.1% neutral, 16.7% negative) (chi-square 19.4, $p < 0.001$, confirmed via t test, $p < 0.001$). The program directors rated degrees other than RC (baccalaureate or higher) earned in distance-learning programs with some

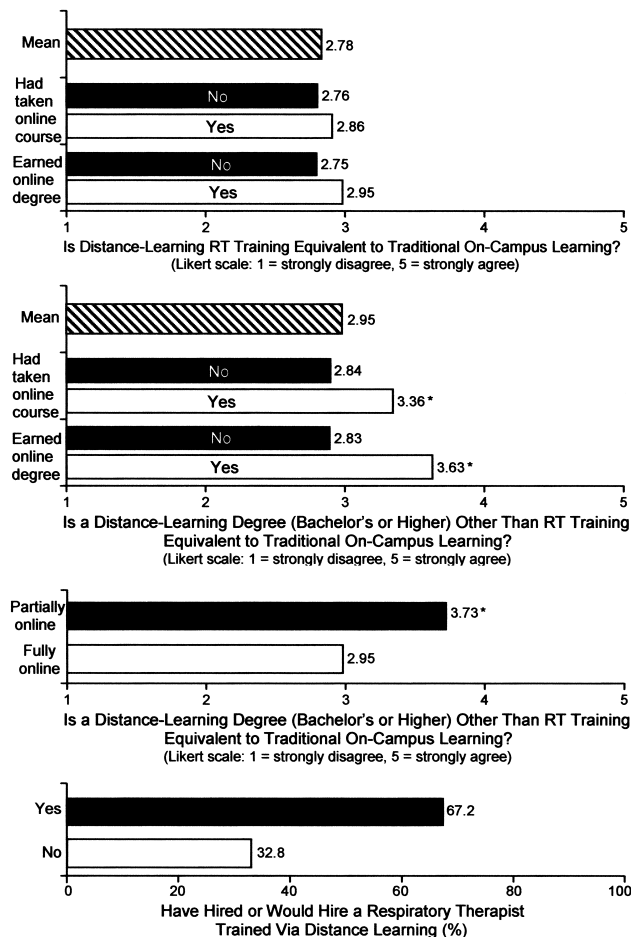


Fig. 3. Survey responses from respiratory care (RC) managers. RT = respiratory therapy.

Table 4. Instructional Applications of Personal Digital Assistants Reported by Respiratory Care Program Directors

Clinical competency and performance documentation, using generic spreadsheet and database tools, as well as commercial technology (eg, DataArc)
Student database management, including attendance
Grade keeping
Classic clinical instructional devices (arterial blood gas values, digital radiographs)
Student laboratory tracking
Content presentations
Bedside clinical notes
Bedside clinical calculations
Clinical schedules
Lecture notes
Use with clinical simulators

face-to-face elements significantly higher than such degrees earned entirely online (chi-square 34.4, $p < 0.001$, confirmed via t test, $p < 0.001$).

Respiratory Care Managers

One-hundred forty-one respondents participated in the survey. Data from 13 respondents with incomplete surveys were excluded, resulting in 128 viable response sets ($n = 128$).

Technology Integration. The managers assessed their skill with office-productivity software similarly to the program directors: 95.3% indicated a moderate to high skill level. The managers' expectations of these skills in RT hires were mixed: 26.6% reported a low expectation.

35.2% of the managers reported development of clinical instructional Web sites for RC staff, and 14.8% reported development of instructional Web sites for patients. Most managers (83.6%) participate in professional online discussions such as e-mail listservs and blogs. Most of the managers (96.9%) consider Internet technologies such as Web-casts appropriate for providing continuing education. 10.3% of the managers reported an instructional role for podcasting technology.

40.6% of the RC managers reported using a PDA in their work, which is somewhat less than the reported rate of PDA use among medical professionals (45–85%¹⁷). Of those, only 3.1% of the managers reported using a PDA in an instructional role. PDA applications reported by the managers included reference use, such as to *The Merck Manual* and *Physicians' Desk Reference*, and for clinical competency management, such as Advanced Cardiac Life Support training coordination and records. The managers also reported using PDAs as an interface with commercial respiratory management systems, for notes on new drugs, and for recording notes on employee performance.

Distance Learning. 21.9% of the managers had taken a fully online college course, and 14.8% had earned a degree in an online program (see data at http://www.spsu.edu/htc/rc_2006/edtech_rc06.htm).

Similarly to the program directors, the managers did not consider courses delivered entirely online to be a good match for the initial training of RTs (80.5% ME \pm 6.8%), and that was so regardless of whether they had taken a fully online college-level course (chi-square 0.63, $p = 0.43$) or had earned a degree in a fully or substantially online program (or were enrolled in such a degree program) (chi-square 0.03, $p = 0.86$). For each, Fisher's exact test was used to confirm the chi-square test results for small frequencies ($n < 5$). The majority (83.6% ME \pm 6.5%) of the managers considered the initial training of RTs to be a good match for courses supported by the Internet.

By a significant margin (t test $p = 0.046$), the managers reported that they do not consider RC degrees in the initial training of RTs earned via distance learning to be of com-

parable quality to traditional on-campus programs (28.9% positive, 28.1% neutral, 43% negative). Unlike the program directors, the managers who had taken a fully online college course rated RC distance-learning programs as comparable in value in somewhat (but not significantly) higher proportions (39.3% positive, 17.9% neutral, 42.9% negative) (chi-square 2.68, $p = 0.26$, confirmed via t test, $p = 0.7$). Again, unlike the program directors, the managers who had earned a degree in or were enrolled in an online (completely or substantially) college-level distance-learning program rated RC distance-learning programs as comparable in value in somewhat (but not significantly) higher proportions (42.1% positive, 15.8% neutral, 42.1% negative) (chi-square 2.57, $p = 0.28$, confirmed via t test, $p = 0.5$).

Overall, and similarly to the program directors, the managers were approximately split (33.6% positive, 28.1% neutral, 38.3% negative) on the question of whether degrees other than RC (baccalaureate or higher) earned in distance-learning programs with no face-to-face elements are of comparable quality and value to on-campus programs. However, the managers who had taken a fully online college course rated such distance-learning programs as comparable in value in significantly higher proportions (53.6% positive, 14.3% neutral, 32.1% negative) (chi-square 7.05, $p = 0.03$, confirmed via t test, $p = 0.05$), as did the managers who had completed or were enrolled in a college-level (completely or substantially) online program (63.2% positive, 10.5% neutral, 26.3% negative) (chi-square 9.1, $p = 0.01$, confirmed via t test, $p = 0.008$). The managers rated degrees other than RC (baccalaureate or higher) earned in distance-learning programs with some face-to-face elements significantly higher than such degrees earned entirely online (chi-square 31.04, $p < 0.001$, confirmed via t test, $p < 0.001$).

Two thirds (67.2%) of the managers reported that they have hired or would hire RTs trained via distance learning. However, the managers who did not consider RT training via distance learning to be of comparable quality and value to traditional on-campus programs were significantly less likely to report that they had hired or would hire RTs trained via distance learning (chi-square 41.64, $p < 0.001$, confirmed via t test ($p < 0.001$)).

Qualitative Findings

For most items, the responses from the program directors and the RC managers were similar in content and tone. Six dominant themes in the comments in both surveys were identified:

1. Distance learning in RC is appropriate for experienced RTs seeking continuing education and for advanced degrees. Representative comments:

"The hands-on experiences, both in the laboratory and clinic, are important, and tricky to accomplish at a distance."

"Must be carefully monitored. The clinical competency issues are still not resolved."

"We have students participating in our program from a large geographic area. The use of the Internet to facilitate information distribution and limit student travel to campus is essential. . . . The use of educational technology is no substitute for the bedside patient care experience."

"I think advanced courses are appropriate, but face-to-face learning with hands-on professors for entry-level and initial courses is crucial to patient care."

"Hands-on is still needed. Bachelor of science programs could heavily use technology."

"For those who have experience and are going back to get their credential, I think there is a place for online, but there still needs to be some classroom time."

"I believe it is a bad idea all together. No amount of frequently-asked-questions or help files can ever accomplish the face-to-face necessity of initial training."

"Distance learning in the early phases of a hands-on profession has *no* place at all."

Representative dissenting opinions:

"The distance-learning graduates I have seen have excellent clinical skills and a higher-than-average pass rate for the RRT examination."

"From personal experience I have found online instruction to be of high quality while providing convenience. Important in our current society, it also saves gas."

"Our students enrolled in distance learning have done well, but state they prefer instructors face-to-face."

"Educational technology or distance learning is the future of RC education. I for one would like to improve my educational-technology skills and help my students improve in these skills as well."

2. Distance learning in RT training is appropriate in a supportive role; online RC courses are best done in a partially online, hybrid approach.

"I think there is a place for training of RC online, but not entirely online. There needs to be a mix of online and classroom, especially for those that don't have any experience in RC."

"I support nontraditional distance learning via the Internet but believe *some* on-site education and/or clinical stationing is imperative."

"I have no problems with supporting materials or classes that are not core classes being online. As RC is a hands-on profession that is highly technical as well as highly medically oriented, it is absolutely not appropriate to have an entire program online. I would not hire anyone that would graduate from that type of program."

"Hybrid courses are perfect: they allow students to access didactic content after class, so they spend less time

taking notes and more time listening; the notes are already available online. These courses can utilize quizzes, testing, and homework in didactic classes.”

“Technology should extend the classroom and not replace the classroom.”

3. For initial RT training, face-to-face interaction is essential in developing affective (behavioral) skills and attitudes.

“Health care itself demands certain social skills and a high level of contact with other people. This cannot be developed online.”

“I feel that human-to-human interaction is very important in developing the positive and proactive assets of a therapist.”

“The face-to-face contact and student-to-patient contact are invaluable for the preparation of even the most media-savvy RC students. The use of educational technology is no substitute for the bedside patient care experience.”

“When you are lecturing face-to-face with your student, there is a dialog and nonverbal behavior that cannot compare when using distance education. It is called distant for a reason.”

4. Distance learning in RC is important for rural facilities and for working RTs seeking further education.

“Online programs are a great benefit to small rural facilities that do not have the financial ability to send their employees to traditional education.”

“Essential for advanced degrees in very rural areas.”

“Continuing-education units provided online are a large resource for rural facilities.”

“One of my supervisory staff received her RRT to bachelor of science via the Internet, through our local university bachelor of science program. Another one is currently enrolled. Excellent education. They can work full-time and still go to school.”

5. Distance learning has a place in RC for some applications and some learners.

“Community college students need more face-to-face input. Just a handful could succeed in an online course.”

“I did my respiratory degree through a distance program before they had online. As long as you have a good preceptor and can get clinical time, it can be a good way to do it. The same can be said of online courses.”

“The person needs to be a motivated, goal-driven, self-starter to succeed.”

“For someone who has a family and wants to change careers, a distance program is a great alternative.”

6. Distance learning deployment in RC will require resources and training. This theme was primarily found in the comments of program directors, who frequently expressed a sense that faculty and programs are currently enthusiastic but not endowed with the technology or online teaching acumen to effectively deploy online courses.

“We do not have the financial resources to invest in the educational technology necessary to bring state-of-the-art technology either to our program or the college. There is a huge disparity in the money available to universities for this purpose, as compared to community college.”

“With the right resources, distance learning could rival traditional schools.”

“Our students are becoming more and more technology-savvy and we instructors must be at or above their level!”

“Teaching via interactive video and online education is significantly different than classroom teaching and demands a different instructional skill set and behavior.”

“It is not the technology but the knowledge of how to use the technology that I need.”

“It’s time RC educators demanded online content from the textbook publishers.”

Discussion

This section provides summative and interpretive detail, and a context for understanding and applying the study’s quantitative and qualitative findings. First, the limitations of the research are explored, including a strongly indicated need for a follow-up, probabilistic survey of RC managers. Next, educational technology integration is discussed, including its continuing importance in RC and the match between programs and RC managers regarding widely used computer software. This study’s findings on distance learning in RC are compared to previous studies reported in the literature, including prevalence of the various types of distance learning, program director and manager preferences regarding distance learning, the strong finding of an expectation of some classroom study in distance-learning courses, a widely held skepticism regarding initial RT training via distance learning, and other topics. A number of recommendations based on this study and related to educational technology and distance learning are proposed. The potential for online research, as was used in this study, is explored in detail, including expense, advantages and disadvantages, technology, and lessons learned. Finally, the need for further research indicated by this study is explored, such as the need to better distinguish distance learning via postal correspondence from distance learning conducted via the Internet.

Survey Limitations

The present study’s survey of program directors was deployed to a small, closed, and well-defined population, and enjoyed a satisfactory response rate of about 53%. This is higher than a published and related 2005 RC online survey study that reported a 29% response rate,⁹ and this is probably due to using before-and-after survey e-mail messages, and to more rigorous correction of bounced

e-mail addresses. However, the companion survey of RC managers is a nonprobabilistic study of a population that is much larger and poorly defined. While the data are interesting, they cannot be considered to be of the same quality and validity as data from the probabilistic survey of program directors. As such, direct comparisons between the 2 surveys should be viewed with this important qualification in mind. As invitations were via e-mail and responses were via the Internet, respondents to the survey of RC managers may have had a pro-technology bias. This is further suggested by a finding that of these manager respondents, 81.2% reported that they subscribe to the AARC Management Section listserv. Even so, the data from the exploratory survey of RC managers parallel that of the probabilistic survey of program directors, and that of a similar study conducted in 1999.⁸ The exploratory survey of RC managers indicates the need for a secondary, formal, and more extensive follow-up probabilistic survey on the same research questions, to verify the exploratory survey's findings, and perhaps reveal other aspects of educational technology integration in RC, particularly in the case of distance learning.

Technology Integration

The present study confirms the important role of educational technologies in RC, particularly in RC training programs. 82.5% of the program directors and 54.7% of the managers indicated that educational technologies play an important or critical role in terms of learning outcomes. Nearly all the program directors and many of the managers reported use of commercial instructional software for RC (eg, clinical simulations, content tutorials, drill and practice programs). Most of the program directors (97.2%) access clinical practice guidelines online, as do 93.0% of the managers.

The managers' expectations about RTs' competence in office-productivity tools, such as word processors, spreadsheets, and presentation software (73.4% ranked the expected skill level as moderate to high) seem to be well-matched by the program directors' assessment of the importance of graduate competence (92.7% rated these as of moderate or high importance) and by relatively high program requirements that students use these tools.

The data indicate a good match between the managers' skill level with office-productivity software, the managers' expectations about RTs' skill levels, and program design, in that most of the programs reported that students are required to produce work with word-processor (96.0%) and presentation applications such as PowerPoint, and many are required to also use spreadsheets and databases. The program directors and managers reported similar skill levels in office-productivity applications (nearly 100% reported moderate to high skill); however, we may be cau-

tioned that there is cause to expect adult users to overestimate skill levels in these applications.¹⁸

Presentation software such as PowerPoint seems to be universally employed in both programs and clinics (for departmental instructional needs and patient education). Although not originally developed for an instructional role, its advantages of utility and ease of use make it an attractive educational technology.¹ Educators can adopt instructional strategies that use PowerPoint in more learner-centered, as opposed to instructor-centered, ways.¹⁹

Distance Learning

This study confirms Boone's findings that about one third of RC programs are delivering distance-learning courses, and that these are predominantly Internet based.⁹

The distinct preference of the program directors for advanced degree programs that are partially rather than fully online might be considered professional-educator bias from faculty of traditional on-campus programs, but this was mirrored by a similar preference among the managers. This study confirms Becker's finding that RC managers gave greater support to graduate programs that include some classroom study.⁸ The program directors and managers reported that they themselves had earned degrees via distance-learning programs in approximately equal proportions (20.3% and 14.8%, respectively). This study approximates Becker's⁸ findings of high support for distance learning (baccalaureate degree or higher) delivered partially online, but we find a much lower recommendation for fully online programs. However, the lack of consistency and precision in terminology related to distance learning is likely to have contributed to this disparity. Overwhelmingly, the comments by both program directors and managers were dubious of fully online courses and programs in the initial training of RTs, but were often enthusiastic about courses supported by the Internet for initial training, or partially online hybrid courses for RTs.

RC programs appear to be exploring the potential of providing Internet support to traditional courses, and deploying hybrid courses (delivered partially online). 96.6% of the program directors confirmed the pedagogical advantages in this, in keeping with the literature on best practices in online instruction,^{3,9,20,21} although deployment of such courses in RC programs lags somewhat behind (39.0% of the programs deliver no partially online courses).

The question that Becker and Gibson⁷ revealed as important to RTs considering pursuing a degree via distance learning—that a degree earned via distance learning would be valued by employers (current and prospective)—is answered by the mixed results in the present exploratory study of RC managers. About one third (33.6%) responded that they considered distance-learning baccalaureate and higher degrees earned with no face-to-face elements to be

of comparable quality to traditional on-campus programs, 28.1% were neutral on the topic, and 38.3% would not consider such degrees comparable to traditional campus work. The managers were somewhat more generous responding to the same question on distance-learning courses that include some face-to-face elements (60.9% favorable, 28.9% neutral, 10.1% negative). One third (32.8%) of the managers reported that they had not or will not hire RTs trained via distance learning, which is a comparable but somewhat lower proportion than Becker reported.⁸ The managers who did not consider RT training via distance learning to be of comparable quality and value to that of traditional on-campus programs appeared to match that opinion with their hiring practices; 83.4% of that subset reported that they have not or would not hire RTs trained via distance learning.

Becker⁸ postulated that attitudes toward distance learning would improve as RC managers became familiar with current online technologies and instructional practices, which permit rapid feedback and high levels of interactivity, as compared to the more familiar postal correspondence model in RC. The present study generally supports this expectation in the program directors but not in the managers. The program directors' attitudes were significantly more positive toward distance learning in initial RT training if the respondents had personal distance-learning experience. But this was not mirrored in the managers, whose attitudes improved, but not significantly. However, attitudes toward distance learning for baccalaureate or higher degrees other than RC when the respondents had either taken a fully online course or enrolled in a substantially online program were significantly higher in both groups.

Both the program directors and the managers reported substantial experience with online courses and degree programs. Becker⁸ found that, in 1999, 8.9% of managers reported prior distance learning experience. The present study found that 21.9% of managers had taken a fully online college course and 14.8% had earned an online degree (see the data at http://www.spsu.edu/htc/rc_2006/edtech_rc06.htm), which indicates that distance learning currently plays an important role among management level RTs in RC clinics. However, this may be a manifestation of a pro-technology bias in this online exploratory survey.

The program directors viewed baccalaureate and higher degrees earned entirely via distance learning somewhat more positively than did the managers (40.1% favorable, 23.2% neutral, 36.7% negative). This may indicate greater familiarity with the pedagogical implications of distance learning, a vocational bias, or both. Clearly, this important aspect of the research should be further explored with a national probabilistic study of RC managers.

Recommendations

The present surveys suggest several potentially important recommendations on educational technology use in RC:

- Program directors should demand rich online resources from textbook publishers. Online resources for texts in RC have not reached the level of sophistication seen in other fields. These can include downloadable syllabi templates, tips for instructors, high-quality PowerPoint presentations with figures and illustrations taken directly from companion texts, online case studies, interactive online tutorials and exercises, self-assessment exercises, access to learning communities, and other useful resources.

- Few of the managers reported clinical development of instructional Web sites for staff or for patients, and this suggests an important opportunity to deploy Internet technologies in cost-effective but meaningful ways. The Internet has become known as the "biggest medical library in the world,"²² and customized, high-quality online informational and instructional resources developed by the clinics may find a surprisingly large and eager audience.²³

- An interesting finding regarding PDAs was that the program directors reported a higher adoption rate than did the managers (58.8% vs 40.6%, respectively), and this suggests a possibly important direction for technology integration in the clinics. Innovative clinical applications of PDAs in RC have been reported in the literature, including drug-reference literature and dosage aids, critical care calculations, automated clinical documentation, quality monitoring and billing.^{24,25}

- Several program directors commented that they needed high-quality topical instructional modules for use on online course platforms such as WebCT and Blackboard. These are time-consuming to create, as are stand-alone computer-based-instruction applications, and the field would do well to implement an organized system to share such products.

- Few of the program directors or managers indicated that they use Internet technologies to access subject-matter experts. For example, a course on ventilator management might invite the author of their text or a well-known expert in another state to present a live but distant class and participate in discussion. A clinic in Nebraska might virtually trade in-service training with a clinic in Texas, sharing their subjects of expertise.

Internet Survey Research

Apparent advantages of rapid survey deployment and instantaneous responses at little cost were offset by unanticipated technical obstacles. These included a high incidence of e-mail address failures, which made maintenance of a current e-mail database of RC program directors dif-

ficult. Our experience confirms recent literature on Internet surveys,^{15,16} that expected cost and time savings from technology deployment, as opposed to telephone or postal surveys, may be offset by disproportionate increases in labor costs to correct e-mail-address database errors. Indeed, correcting bounced e-mails required on average about 10 minutes of tedious labor each, which cost approximately 2 full days of researcher time. Our experience does not support the purported cost-effectiveness of online research claimed by some authors.¹¹ Successive surveys of the same closed population of program directors, having created and groomed the e-mail database, would be less tedious and more efficient. The annual subscription cost of the survey technology (about \$200) must also be included in cost planning. Self-administered surveys and automated data collection and computation proved to be a major advantage of the online surveys. They eliminate the need for tedious, often expensive, labor for data entry, and reduce data-entry error. Data analysis is available the moment the survey closes, and the researchers may choose to monitor data trends, plus response trends, as the survey progresses. Our experience confirms the rapid reception of survey responses with online survey technology reported in the literature.¹¹ It may be that the optimal survey methodology for RC is a hybrid approach that uses postal invitations and follow-up reminders but directs respondents to a survey URL for data collection.

A technical advantage of online survey technology, compared to paper-based methods, is the capability of automated "skip-logic" (also known as "transparent branching navigation").¹¹ Thus, it is simple to automatically direct the user to appropriate follow-up questions, based on respondent input. For example, respondents who indicated that they used a PDA would encounter a short series of follow-up questions on the topic, but respondents who responded negatively would skip those questions. This is difficult to achieve with paper-based surveys, and causes respondent confusion and data-entry errors.

The Zoomerang online survey technology proved to be robust, albeit with occasional server lapses during survey design. It was relatively simple to use, flexible (many survey item types and formatting styles), and efficient (ability to copy and paste items, and to create survey templates for faster development). A previous effort to deploy similar surveys was aborted due to another commercial provider's server failure. Data analysis is a major strength of this technology, which permits flexible, fast cross-tabulation of data with graphical and numerical presentation. However, we detected numerous, but usually minor, errors in calculated percentages. Researchers may download raw data in common spreadsheet/database file types to be uploaded by spreadsheet or statistical applications. An option to provide password-protected online access to preliminary survey data for respondents seemed to be effective to

provide incentive to complete the surveys. Seventy-four of the program directors (41.8%) chose to review the preliminary data, as did 42 of the managers (32.8%).

The response rate (53%) for the RC program director survey is comparable to that of general postal mail surveys¹⁵ and somewhat higher than the response rate reported by other medical online survey researchers.²⁶ RC may be a special case in online research, as our positive experience indicates that RC program directors and managers are singularly enthusiastic about education and technology innovations, and are therefore eager and diligent survey participants toward the best interests of their field.

A technical limitation of online survey research is the difficulty of assuring participant eligibility and authenticity.^{11,15,27} Anyone who finds their way to the survey instrument Web site can potentially complete the survey. Participant eligibility error is an issue in nearly all types of surveys (postal, telephone, and online) with the possible exception of personal interview surveys. In this research, this was minimized by directly e-mailing survey invitations to a selected group and by posting invitations on private professional listservs, as opposed to linking the survey to a permanent Web site. We also minimized the time window when the instruments were available (it would be difficult to locate the Web pages with popular Internet search engines).

As with all forms of survey research, the data are self-reported and may not accurately reflect actual behaviors.¹³ In this research, participants were assured of anonymity and confidentiality of responses, and this may be expected to improve data accuracy.

A pitfall of online surveys where participants are invited via direct e-mail is that, whereas bounced e-mails signal an e-mail address error via return e-mail, the absence of such a warning does not necessarily indicate a valid e-mail address. In other words, some e-mails sent to presumed potential participants in the sample frame database may not have reached the addressee, and the researcher probably would not be aware of that.

Whereas the population of RC program directors was found to have universal access to the Internet and e-mail, the same cannot be determined by this research for the population of RC managers. The managers would necessarily have had e-mail and Internet access to have participated in the survey, but it is possible that a large number of clinics prohibit this with firewall technologies (complete or selective online blocking by the intranet administrator). Again, this may have biased the survey findings in this study of clinical managers, in favor of respondents who are technology supporters.

Finally, a limitation of anonymous online survey research, which became apparent as the results were analyzed, is that it does not facilitate further probing of qualitative responses, because the respondents are intentionally

not identified. This might be addressed in future research by asking willing respondents to disclose e-mail addresses, which could be linked to responses, for qualitative follow-up purposes. It might also be necessary to conduct online quantitative and qualitative studies separately.

Further Research

Again, the need for a follow-up, probabilistic survey on a national scale of RC managers is strongly indicated by this research. These surveys revealed specific needs for survey item refinement and expansion, as well as important lessons learned in online research methodology, and these will be well applied to further similar studies to reveal the distance-learning topic in more detail and to track educational technology adoption trends. For example, research designed to more clearly distinguish attitudes toward postal correspondence distance learning in RC versus online technologies is clearly in order.

Conclusions

RC managers and educators have embraced educational technologies, including Internet technologies, and consider these to fulfill an important role. RC educators have judiciously integrated mainstream office-productivity tools into the curriculum by requiring students to prepare assigned papers using a word processor, and this is in keeping with the recommendations of current technology-integration literature.^{1,28} Educators could enhance this type of practical technology integration in teaching by similarly requiring students to use mainstream spreadsheets and database applications in their course work, and this is supported by the current level of use of these tools by RC managers. RC educators should collectively demand the scope and quality of online supportive text resources that are available to some other fields.

Perhaps singularly important in this study is that substantial numbers of RC program directors and managers have themselves taken courses and earned degrees via distance learning, and that this has mildly improved attitudes toward distance learning in initial RT training (significant in program directors but not in managers), and, more dramatically, in non-RC bachelor's and higher education (significant in both groups). Also important is the finding of substantial numbers of RC programs currently deploying courses supported by the Internet, and the strong perception across both groups that this is a sound instructional practice.

The survey finding of the prevailing perception among RC program directors and managers that fully online courses are a poor fit for the specific case of initial training of RTs, as individual courses or as programs, is important, and richly supported by anecdotal comments, some em-

phatic and compelling. While it may be tempting to dismiss the research finding of a substantial negative perception of fully online courses in RT training as broad unfamiliarity with current best practices in distance learning, it must be noted that this negative opinion did not extend generally to advanced degrees beyond initial RT preparation. The data indicate a distinction in opinion regarding online instruction as a poor match for initial RT training, and distance learning education with no face-to-face elements for non-RC baccalaureate or higher degrees. This should serve as an important plank in a vision for technology integration for the field: that Internet-supported coursework is a promising goal in RC training, but that deployment of fully online courses and programs should be carefully considered. In both the program directors and the managers there was a clear expectation of face-to-face elements in distance-learning programs.

The correspondence-school stigma is a persistent issue in distance learning, and this is especially true of the field of RC.⁶ RC was an early, aggressive adopter of correspondence distance learning in the training of RTs, no doubt due in part to the commercial potential of meeting pressing RC manpower needs in this way, and long before the sophisticated, collaborative, media-rich pedagogies and technologies of present online courses in higher education were developed. The negative distance-learning image persists in RC, indicated by this research, and it must be addressed by earnest online program developers in RC. Both program directors and managers submitted compelling questions and issues, such as the imperative to address affective aspects of RT training, and the necessity of rigorous clinical assessment.

RC presently employs educational technologies in a wide range of roles, in both RT training programs and clinics, using a variety of commercial applications and instructional tools developed in-house. While RC program directors and managers are cautious regarding the role of fully online courses and programs in the training of RTs, they are enthusiastic about employing online distance-learning technology in a supportive role. RC managers support and use distance learning technologies for continuing education. This study suggests a number of specific elements toward a long-range vision of educational technology for RC and emphasizes the essential nature of face-to-face instruction in distance learning for RT preparation. Finally, the study shows that online surveys in the field of RC are viable, although attended by unique challenges and limitations.

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