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COVID-19 SCIENTIFIC COMMUNICATION — BRIEF REPORT

Variable Effect of the COVID-19 Pandemic on Radiation Oncology Practices in the United States

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Purpose: Early in the pandemic, the American Society for Radiation Oncology surveyed physician leaders at radiation oncology practices in the United States to understand how the field was responding to the outbreak of COVID-19.
Methods and Materials: Surveys were repeated at multiple points during the pandemic, with a response rate of 43% in April 2020 and 23% in January 2021. To our knowledge, this is the only longitudinal COVID-19 practice survey in oncology in the United States.
Results: The surveys indicate that patient access to essential radiation oncology services in the United States has been preserved throughout the COVID-19 pandemic. Safety protocols were universally adopted, telehealth was widely adopted and remains in use, and most clinics no longer deferred or postponed radiation treatments as of early 2021. Late-stage disease presentation, treatment interruptions, shortages of personal protective equipment, and vaccination barriers were reported significantly more at community-based practices than at academic practices, and rural practices appear to have faced increased obstacles.
Conclusions: Our findings provide unique insights into the initial longitudinal effect of the COVID-19 pandemic on the delivery of radiation therapy in the United States. Downstream lessons in service adaptation and improvement can potentially be guided by formal concepts of resilience, which have been broadly embraced across the US economy.

Introduction

In the United States in 2021, 1.9 million new cancer cases were estimated to be diagnosed.[1] More than half of these patients will be treated with radiation therapy.[2] Early in the COVID-19 pandemic, the American Society for Radiation Oncology (ASTRO) began to survey physician leaders at radiation oncology practices in the United States to understand how the field was responding to the outbreak.[3] Surveys were repeated at multiple points during the pandemic. To our knowledge, this is the only longitudinal COVID-19 practice survey in oncology in the United States.

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Research data are stored in an institutional repository and will be shared upon request to the corresponding author.

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Methods and Materials

Surveys were emailed to all US radiation oncologists from the ASTRO membership directory who had self-identified as department leaders with the position of medical director. Surveys were designed to assess practice demographics, safety measures, patient volume, financial effect, treatment delays, and vaccination barriers. Consent was obtained, and data were deidentified. Responses were collected April 16-30 and June 11-25, 2020, and January 15 to February 7, 2021; trends were compared across timepoints. Comparisons were made between community-based and academic practices, between freestanding and hospital-based clinics, and between clinics with ZIP codes in large metropolitan areas (ie, population ≥1 million people), smaller metropolitan areas (ie, population <1 million), or nonmetropolitan areas, using categories created from the US Census–based Rural-Urban Continuum Codes.[4] The significance of those differences was evaluated by Pearson's χ^2 test, the Fisher exact test, the Student t test, and analysis of variance; $P < .05$ was considered statistically significant.

Results

At the beginning of the pandemic in the United States, 222 of 517 physician leaders (43%) responded from community (65%) and academic (34%) practices. In early 2021, 117 of 509 physician leaders (23%) responded from community (55%) and academic practices (44%). Full demographics are provided in Table 1.

Throughout the entire survey period, 100% of practices remained open. Patient volumes dropped in 73% of clinics; on average, visits were down 21% (range, 5%-75%) in early 2021. All clinics continued to use enhanced safety protocols to protect patients and staff through early 2021; 73% experienced reduced staffing at some point and 7% closed a satellite location. In early 2021, 15% of surveyed centers continued postponing treatment for low-risk diseases, down from 92% of centers in April 2020. Only 12% of centers reported deferring new patient visits in early 2021, down from 75% in April 2020. At the beginning of the pandemic, deferrals were most common for low-risk prostate cancer (88%) and early-stage breast cancer (73%), and least used for cervical, vaginal, and pediatric cancers (each 1.4%) (Fig. 1, Table 2).

Status of care in community and academic practices in early 2021 is summarized in Table 3. Community centers reported more patients presenting with advanced disease (81% vs 45%, $P < .001$) and treatment interruptions (77% vs 56%, $P = .018$) than academic practices. Community centers experienced more shortages of personal protective equipment (PPE) (50% vs 23%, $P = .003$), less telemedicine adoption for new patients (38% vs 75%, $P < .001$), lower vaccine access (61% vs 41%, $P = .035$), and increased vaccine hesitancy among staff (72% vs 41%, $P = .001$) and patients (59% vs 42%, $P = .065$).

The use of telemedicine for new patient consults was more common for clinics located in larger communities (75% in metropolitan areas ≥1 million vs 38% in metropolitan areas <1 million vs 21% in nonmetropolitan areas, $P < .001$). Compared with metropolitan clinics, practices in more rural areas reported greater vaccine hesitancy from staff (46% in metropolitan areas ≥1 million vs 62% in metropolitan areas <1 million vs 90% in nonmetropolitan areas, $P = .002$). Compared with hospital-based clinics, freestanding clinics reported increased PPE shortages (57% vs 30%, $P = .006$) and barriers to vaccine access (65% vs 57%, $P = .07$). Most practice leaders (87%) reported increased social or financial patient hardship during the pandemic.

Discussion

The ASTRO COVID-19 surveys provide incomplete but unique insight into how the pandemic has affected our field's practice and product. How could we leverage these insights to better prepare for future disruptions, regardless of scale or scope?

All commercial sectors of the US economy have confronted this question during the pandemic. Many, particularly the financial services, logistics, and retail industries, have turned to organizational and system resilience theories to respond to the shocks to their operations.[5,6] Resilience in this context refers to an organization or system's capacity to withstand and recover from adverse disruptions. Structured concepts of resilience have found a natural home in software and engineering fields but have been increasingly used to assess adaptive behaviors of natural and human ecologic systems, including health care systems operating in unpredictable environments.[7,8] A body of literature has emerged to evaluate health system adaptation to the COVID-19 pandemic according to models of resilience at the national[9,10] and global[11,12] levels, accompanied by efforts by the World Health Organization and the Organization for Economic Cooperation and Development to provide international best practice recommendations to sustain resilient health system performance during and after COVID-19.[13-15]

Drawing actionable connections from such efforts to the delivery of radiation therapy in the United States requires a framework relevant to our providers, payors, policymakers, and patients. Studies outside our field published early in the pandemic understandably focused on models of preserving COVID-19 care delivery in the face of abrupt demand/resource imbalance. A more holistic construct relevant to short and long-term priorities of radiation oncology can be applied from the work of Béné et al,[8] which leverages published experience in international development to expand from a simple model of preserving baseline expectations of care "into a more elaborated concept which embraces the ability not simply to bounce back but also to adapt and to transform." In this "3-D Resilience framework," the innate capacity of a care delivery system to "absorb" a shock is just the first in a series of responses which can evolve into a capacity to "adapt" (modify current behavior) and "transform" (fundamentally modify future behavior) as warranted

Table 1 Characteristics of radiation therapy practices across survey waves

Variable	April 2020	June 2020	January 2021 to February 2021
Number	222	159	117
Practice type, n (%)			
Academic	76 (35.7)	55 (34.6)	52 (44.8)
Community-based	137 (64.3)	99 (62.3)	64 (55.2)
Community size, n (%)			
Metropolitan area with ≥1 million residents	116 (53.0)	82 (51.9)	60 (51.7)
Metropolitan area with <1 million residents	76 (34.7)	58 (36.7)	37 (31.9)
Nonmetropolitan area	27 (12.3)	18 (11.4)	19 (16.4)
Practice location, n (%)			
Hospital-based	153 (70.2)	108 (67.9)	80 (68.4)
Freestanding/satellite clinic	65 (29.8)	50 (31.4)	37 (31.6)
US region, n (%)			
West	45 (20.5)	32 (20.1)	20 (17.1)
Midwest	55 (25.0)	45 (28.3)	32 (27.4)
South	73 (33.2)	47 (29.6)	37 (31.6)
Northeast	47 (21.4)	35 (22.0)	28 (23.9)
Radiation oncologists on staff, mean (SD)	6.2 (7.5)	6.7 (7.2)	8.1 (9.8)
Radiation therapists on staff, mean (SD)	15.6 (17.9)	15.4 (16.6)	18.5 (19.2)
Cancer cases treated in 2019, mean (SD)	1086.1 (1287.9)	1161.3 (1232.3)	1256.7 (1511.8)
Patients currently on treatment, mean (SD)	69.9 (75.7)	71.8 (79.6)	86.1 (89.5)
Percentage of patients at time of survey compared with typical patient volume, mean (SD)	68.3 (16.5)	69.9 (17.3)	85.0 (15.6)
Reasons for decrease in patient volume, n (%)[*,†]			
Delays/deferrals for certain diseases	155 (82.0)	94 (71.2)	64 (54.7)
Fewer referrals	153 (81.0)	113 (85.6)	69 (59.0)
Other	30 (15.9)	13 (9.8)	12 (10.3)
Telemedicine in use, n (%)[*]			
For routine surveillance visits	165 (74.3)	119 (74.8)	100 (85.5)
For patients currently on treatment	33 (14.9)	17 (10.7)	18 (15.4)
For new patient consults	(not asked)	(not asked)	63 (53.8)
Telemedicine is new for the practice, n (%)	198 (89.2)	141 (88.7)	(not asked)
Scheduling for new patient visits, n (%)			
Deferring some but not all new patient visits	168 (75.7)	43 (27.0)	14 (12.0)
No change	53 (23.9)	116 (73.0)	103 (88.0)
Not accepting new patients	1 (0.5)	0 (0.0)	0 (0.0)
Staffing reductions, n (%)[*]			
Due to reduced patient visits	107 (48.2)	74 (46.5)	34 (29.1)
Due to effect of pandemic on family care responsibilities	60 (27.0)	32 (20.1)	57 (48.7)
Due to staff transfer to other clinical areas	34 (15.3)	22 (13.8)	20 (17.1)
Due to staff COVID-19 illness	23 (10.4)	17 (10.7)	66 (56.4)
No staff reduction	67 (30.2)	65 (40.9)	33 (28.2)
Staff hiring was affected by pandemic, n (%)	(not asked)	92 (57.9)	47 (40.2)

(*Continued*)

Table 1 (*Continued*)

Variable	April 2020	June 2020	January 2021 to February 2021
Estimated revenue decrease due to pandemic, n (%)‡			
1-10%	10 (5.3)	16 (12.2)	19 (21.1)
11-20%	45 (24.1)	40 (30.5)	37 (41.1)
21-30%	80 (42.8)	42 (32.1)	19 (21.1)
31-40%	20 (10.7)	13 (9.9)	5 (5.6)
41-50%	9 (4.8)	11 (8.4)	4 (4.4)
>51%	23 (12.3)	9 (6.9)	2 (2.2)
Revenue will increase	0 (0.0)	0 (0.0)	4 (4.4)
Shortages/limited access to resources, n (%)*			
PPE (eg, N95 masks, gowns, gloves)	152 (68.5)	93 (58.5)	45 (38.5)
Medical hand sanitizer	94 (42.3)	55 (34.6)	24 (20.5)
Nasopharyngeal swabs	56 (25.2)	21 (13.2)	10 (8.5)
Anticancer drugs	3 (1.4)	7 (4.4)	(not asked)
Other supportive care drugs	8 (3.6)	8 (5.0)	(not asked)
None of these	48 (21.6)	55 (34.6)	68 (58.1)

Abbreviations: PPE = personal protective equipment; SD = standard deviation.
* Respondents could select multiple answers.
† Only asked of respondents who noted a decline in patient volume.
‡ Only asked of respondents who noted a decline in practice revenue.

by the severity of hardship. In the case of radiation oncology, the initial "absorption" (ie, treatment cancellations, satellite clinic closures, and machines or time slots dedicated to COVID-19-positive patients) and "adaptation" (ie, creation of treatment deferment guidelines, infection control protocols, and novel use of telehealth) may eventually give way to "transformation" (ie, broadened use of hypofractionation, hybrid in-person/virtual care platforms, and/or shared care models with primary care physicians or midlevel providers).

Given the continuing pandemic activity resulting from new variant strains of COVID-19, the potential need for COVID-specific transformation remains relevant. More likely, slow-rolling external "shocks" to our field originating in parallel from payors (ie, value-based payment models and price transparency requirements) and patients (ie, growth of consumerism and expectations of on-demand access) will create realities necessitating transformation. The rapid, intensive behavioral changes captured by the ASTRO COVID-19 surveys highlight professional flexibility and commitment that can be leveraged for preemptive growth—growth we will require regardless of COVID-19. Specific findings from the surveys that merit closer inspection through the lens of resilience come from 5 areas of concern: (1) patient

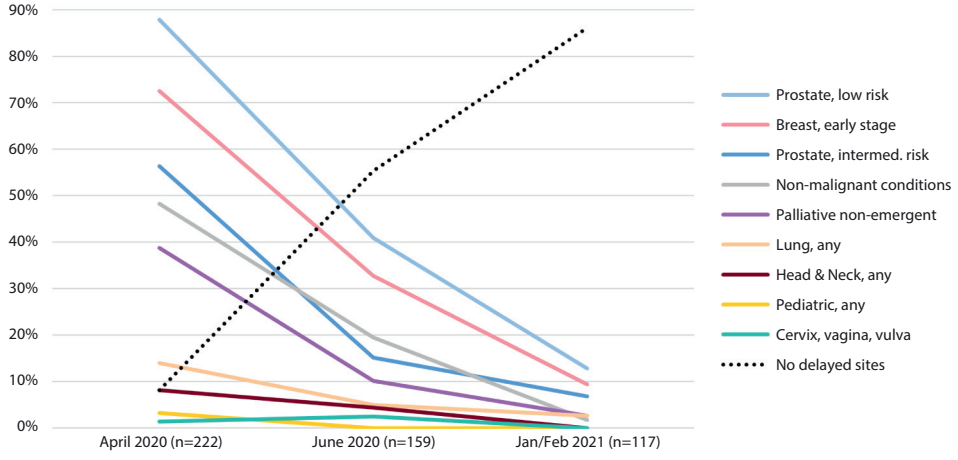

Fig. 1. Radiation treatments deferred owing to the COVID-19 pandemic over time by cancer type.

Table 2 Pandemic-driven postponements for radiation therapy by cancer type and over time

Site, n (%)	April 2020 (N = 222)	June 2020 (N = 159)	January 2021 to February 2021 (N = 117)
Breast, early stage	161 (72.5)	52 (32.7)	11 (9.4)
Breast, locally advanced	6 (2.7)	5 (3.1)	0 (0)
Lung, SCLC	4 (1.8)	4 (2.5)	1 (0.9)
Lung, NSCLC early-stage SBRT	30 (13.5)	8 (5)	2 (1.7)
Lung, NSCLC locally advanced	4 (1.8)	4 (2.5)	1 (0.9)
HN, early-stage definitive	7 (3.2)	5 (3.1)	0 (0)
HN, locally advanced definitive	4 (1.8)	4 (2.5)	1 (0.9)
HN, postoperative adjuvant	13 (5.9)	6 (3.8)	0 (0)
CNS, low-grade glioma	74 (33.3)	17 (10.7)	4 (3.4)
CNS, high-grade glioma	6 (2.7)	3 (1.9)	0 (0)
CNS, GBM	5 (2.3)	4 (2.5)	0 (0)
GI, esophageal/gastric	8 (3.6)	4 (2.5)	0 (0)
GI, pancreas	11 (5)	5 (3.1)	0 (0)
GI, liver	7 (3.2)	3 (1.9)	1 (0.9)
GI, rectal	12 (5.4)	5 (3.1)	1 (0.9)
GI, anal	6 (2.7)	3 (1.9)	0 (0)
Prostate, low risk	195 (87.8)	65 (40.9)	15 (12.8)
Prostate, intermediate risk	125 (56.3)	24 (15.1)	8 (6.8)
Prostate, high risk	54 (24.3)	10 (6.3)	2 (1.7)
Bladder	9 (4.1)	3 (1.9)	0 (0)
Sarcoma	5 (2.3)	4 (2.5)	0 (0)
GYN, cervical	3 (1.4)	3 (1.9)	0 (0)
GYN, uterine	15 (6.8)	4 (2.5)	0 (0)
GYN, vagina/vulva	3 (1.4)	4 (2.5)	0 (0)
Palliative, nonemergent	86 (38.7)	16 (10.1)	3 (2.6)
Palliative, emergent	4 (1.8)	4 (2.5)	0 (0)
Oligometastatic SBRT (<5 sites)	33 (14.9)	7 (4.4)	1 (0.9)
Cutaneous, melanoma	4 (1.8)	3 (1.9)	0 (0)
Cutaneous, nonmelanoma	54 (24.3)	18 (11.3)	3 (2.6)
Nonmalignant conditions	107 (48.2)	31 (19.5)	2 (1.7)
Lymphomas and leukemia	10 (4.5)	4 (2.5)	0 (0)
Pediatric, high-grade CNS	3 (1.4)	0 (0)	0 (0)
Pediatric, low-grade CNS	7 (3.2)	0 (0)	0 (0)
Pediatric, solid tumor	3 (1.4)	0 (0)	0 (0)
Pediatric, leukemia/lymphoma	3 (1.4)	0 (0)	0 (0)
No delayed sites	18 (8.1)	88 (55.3)	99 (84.6)

Abbreviations: CNS = central nervous system; GBM = glioblastoma; GI = gastrointestinal; GYN = gynecological; HN = head and neck; NSCLC = non-small cell lung cancer; SBRT = stereotactic body radiation therapy; SCLC = small cell lung cancer.

Table 3 Challenges created by the COVID-19 pandemic across academic and community-based radiation oncology practices

Challenge(reported in February 2021)	All practices (N = 117), n (%) "true"	Academic practices (N = 52), n (%) "true"	Community practices (N = 64), n (%) "true"	*P* value
Patients are presenting with more advanced cancers.	76 (65.5)	23 (45.1)	52 (81.3)	<.001
Patients have experienced radiation treatment interruptions.	78 (66.7)	29 (55.8)	49 (76.6)	.018
Shortages or limited access to personal protective equipment are a problem.	45 (38.5)	12 (23.1)	32 (50)	.003
Access to the COVID-19 vaccine has been a barrier.	61 (52.6)	21 (41.2)	39 (60.9)	.035
Vaccine distrust/unwillingness has been a barrier for staff.	68 (58.6)	21 (41.2)	46 (71.9)	.001
Vaccine distrust/unwillingness has been a barrier for patients.	60 (52.2)	21 (42)	38 (59.4)	.065

access to treatment, (2) telemedicine, (3) treatment delays, (4) treatment interruptions, and (5) the variable effect on different types of practices.

Patient access to treatment

Our surveys indicate that patient referral access to essential radiation oncology services in the United States was preserved during the pandemic, suggesting successful absorption of initial shock and preservation of expected baseline function. All survey respondents indicated that their practice system remained open throughout the pandemic and that patients continued to have access to radiation therapy. Despite keeping system-wide facilities open, however, 73% of practices experienced staffing shortages at some point, and 7% of respondents said their system closed one or more satellite facilities.

Telemedicine

Patient access also was sustained through the widespread adoption of telemedicine services (an "adaptive" capability demonstrated by most medical disciplines). By early 2021, more than 8 in 10 radiation oncology practices reported using telemedicine for routine surveillance visits, and more than 5 in 10 for new patient consults—despite 9 in 10 respondents noting that telemedicine was not used by their practice before the pandemic.

Treatment delays

Although all responding radiation therapy centers continued to provide services, caveats should be noted. First, although clinics stayed open, radiation treatments were still delayed for many patients. At the height of US lockdowns in April 2020, up to 9 in 10 practices were delaying radiation therapy for patients with lower-risk cancers, most commonly early-stage breast and low/intermediate-risk prostate cancers. Reported delays for these lower-risk cancers fell to 15% of practices by early 2021, however.

Treatment interruptions

Additionally, although patients were able to access treatment, the surveys indicate that completing those courses of treatment was more challenging than before the pandemic. Two-thirds of respondents in early 2021 reported that their patients had experienced radiation treatment interruptions. This disruption represents a potentially serious threat to treatment quality and cancer outcomes, and it merits dedicated study at both institutional and population levels to identify "adaptation" and "transformation" strategies to prevent treatment quality degradation during crisis events, particularly in vulnerable patient populations already at high risk for such events.[16]

Variable effect on different types of practices

The ASTRO COVID-19 surveys suggest the pandemic had an uneven effect across radiation oncology practices, with potentially greater relative strain shouldered by community-based centers with less absorptive capacity for shock. Treatment interruptions, PPE shortages, and vaccination barriers were significantly more common at community-based practices than at academic practices. Access to primary care and cancer screening services upstream of radiation therapy may also have been disproportionately compromised in community settings, given the larger proportion of such providers who reported an increase in patients presenting with more advanced cancers (81.3% vs 45.1%, $P < .001$). Differences also were observed between clinics in larger metropolitan and more rural areas, as well as in freestanding clinics compared with hospital-based clinics. Such heterogeneity reflects the fragmented, decentralized organization of American health care, and the social diversity of our country.

The severity and dynamics of disruptive events like COVID-19 are expected to vary widely across facilities serving different populations with differing treatment resources. Adaptive and transformative resilience practices required by each center promise to be just as varied, making standardized guidelines and outcome measures challenging to

implement. A question for ASTRO and the field to consider will be whether preparation for future disruption events should be organized at the community or regional level, so that resilience can be fostered by pre-existing collaborations and action plans shared by complementary partner institutions. It has been recognized that collaboration and shared learning among diverse partners,[13] including patients and their families,[17,18] fosters resilient care systems.

The limited participation in these web-based surveys restrict interpretation and generalizability of these results. Survey response rates decreased over time, from 43% in April 2020 to 23% in January 2021. Additionally, leaders of larger practices (ie, those with larger numbers of staff and patients, as reported in Table 1) continued to respond across time, which may bias our results toward the experience of those practices.

There also were limitations with the sampling frame. The ASTRO membership directory is estimated to include 90% to 93% of practicing US radiation oncologists, and members can self-identify as leaders with the position of medical director of their departments/practices. Thus, the ASTRO list of medical directors may not represent every practice medical director in the United States. Our respondents reported a total of 1376 and 948 radiation oncologists under their leadership in 2020 and 2021, respectively. The US Department of Health and Human Services estimated a total 5338 radiation oncologists in the United States as of 2017.[19] Accordingly, approximately 25.7% and 17.8% of US radiation oncologists are estimated to be represented from our sample in 2020 and 2021, respectively.

Conclusions

Although limited in scope and detail, the ASTRO COVID-19 surveys are the only longitudinal pandemic practice survey in American oncology. We observed that patient access to radiation therapy has been preserved throughout the pandemic. Safety protocols were universally deployed, telehealth was widely embraced, and most clinics no longer deferred treatment in early 2021. More late-stage disease presentation, treatment interruptions, PPE shortages, and vaccination barriers, however, were reported by community-based practices than academic practices, and rural practices appear to have faced increased obstacles relative to urban centers. These findings provide an imperfect but unique observation of COVID-19's real-world effect on the delivery of radiation therapy in the United States. Downstream lessons in service adaptation and transformation can potentially be guided by formal concepts of resilience, which promise to serve the field well in an age of rapid, unpredictable change.

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