

UC San Diego

UC San Diego Previously Published Works

Title

Online Liver Imaging Course; Pivoting to Transform Radiology Education During the SARS-CoV-2 Pandemic

Permalink

<https://escholarship.org/uc/item/3rq6k6f4>

Journal

Academic Radiology, 28(1)

ISSN

1076-6332

Authors

Elsayes, Khaled M
Marks, Robert M
Kamel, Serageldin
et al.

Publication Date

2021

DOI

10.1016/j.acra.2020.10.001

Peer reviewed



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Online Liver Imaging Course; Pivoting to Transform Radiology Education During the SARS-CoV-2 Pandemic

Khaled M. Elsayes, Robert M. Marks, Serageldin Kamel, Alexander J. Towbin, Ania Z. Kielar, Parth Patel, Victoria Chernyak, Kathryn J. Fowler, Sameh Nassar, Moataz A. Soliman, Aya Kamaya, Mishal Mendiratta-Lala, Amir A. Borhani, David T. Fetzer, Alice W. Fung, Richard K.G. Do, Mustafa R. Bashir, James Lee, Nikita Consul, Richard Olmsted, Avinash Kambadakone, Bachir Taouli, Alessandro Furlan, Claude B. Sirlin, Peggy Hsieh

Purpose: The SARS-CoV-2 pandemic has drastically disrupted radiology in-person education. The purpose of this study was to assess the implementation of a virtual teaching method using available technology and its role in the continuity of education of practicing radiologists and trainees during the pandemic.

Methods: The authors created the Online Liver Imaging Course (OLIC) that comprised 28 online comprehensive lectures delivered in real-time and on-demand over six weeks. Radiologists and radiology trainees were asked to register to attend the live sessions. At the end of the course, we conducted a 46-question survey among registrants addressing their training level, perception of virtual conferencing, and evaluation of the course content.

Results: One thousand four hundred and thirty four radiologists and trainees completed interest sign up forms before the start of the course with the first webinar having the highest number of live attendees (343 people). On average, there were 89 live participants per session and 750 YouTube views per recording (as of July 9, 2020). After the end of the course, 487 attendees from 37 countries responded to the postcourse survey for an overall response rate of (33%). Approximately (63%) of participants were practicing radiologists while (37%) were either fellows or residents and rarely medical students. The overwhelming majority (97%) found the OLIC webinar series to be beneficial. Essentially all attendees felt that the webinar sessions met (43%) or exceeded (57%) their expectations. When asked about their perception of virtual conferences after attending OLIC lectures, almost all attendees (99%) enjoyed the virtual conference with a majority (61%) of the respondents who enjoyed the virtual format more than in-person conferences, while (38%) enjoyed the webinar format but preferred in-person conferences. When asked about the willingness to attend virtual webinars in the future, (84%) said that they would attend future virtual conferences even if in-person conferences resume while (15%) were unsure.

Conclusion: The success of the OLIC, attributed to many factors, indicates that videoconferencing technology provides an inexpensive alternative to in-person radiology conferences. The positive responses to our postcourse survey suggest that virtual education will remain to stay. Educational institutions and scientific societies should foster such models.

Key Words: COVID-19; liver imaging; e-learning; education; radiologists; pandemic; teaching; residency; virtual learning.

© 2020 The Association of University Radiologists. Published by Elsevier Inc. All rights reserved.

Acad Radiol 2021; 28:119–127

From the Department of Diagnostic Radiology, The University of Texas MD Anderson Cancer Center, 1400 Pressler Street, Houston, TX, 77030 (K.M.E., S.N.); Naval Medical Center San Diego, CA, and Uniformed Services University of the Health Sciences, Bethesda, Maryland (R.M.M.); Clinical Neurosciences Imaging Center, Yale University School of Medicine, New Haven, Connecticut (S.K.); Department of Radiology, Cincinnati Children's Hospital; Department of Radiology, University of Cincinnati College of Medicine, Ohio (A.J.T.); Department of Radiology, University of Toronto, Toronto, ON, Canada (A.Z.K.); McGovern Medical School at UT Health, Houston, Texas (P.P.); Department of Radiology, Montefiore Medical Center, Bronx, New York (V.C.); Department of Radiology, University of California San Diego, San Diego, California (K.J.F., C.B.S.); Northwestern University, Chicago, Illinois (M.A.S., A.A.B.); Department of Radiology, Stanford University Medical Center, Stanford, California (A.K.); University of Michigan, Ann Arbor, Michigan (M.M.-L.); UT Southwestern Medical Center, Dallas, Texas (D.T.F.); Department of Radiology, Oregon Health and Science University, Portland, Oregon (A.W.F.); Department of Radiology, Memorial Sloan Kettering Cancer Center, New York, New York (R.K.G.D.); Department of Radiology, Duke University Medical Center, Durham, North Carolina (M.R.B.); Department of Radiology, University of Kentucky, Lexington, Kentucky (J.L.); Department of Diagnostic Radiology, Baylor College of Medicine, Houston, Texas (N.C., R.O.); Department of Radiology, Massachusetts General Hospital, Boston, Massachusetts (A.K.); Department of Radiology/Translational and Molecular Imaging Institute, Icahn School of Medicine at Mount Sinai, New York, New York (B.T.); Department of Radiology, University of Pittsburgh Medical Center, Pennsylvania (A.F.); Office of Educational Programs, McGovern Medical School at UT Health, Houston, Texas (P.H.). Received August 11, 2020; revised October 1, 2020; accepted October 1, 2020. The authors received no financial support for the research, authorship, and/or publication. The views expressed in this article are those of the author and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government. Dr. Marks is a military service member. This work was prepared as part of his official duties. Title 17, USC, § 105 provides that 'Copyright protection under this title is not available for any work of the United States Government.' Title 17, USC, § 101 defines a U.S. Government work as a work prepared by a military service member or employee of the U.S. Government as part of that person's official duties. **Address correspondence to:** K.M.E. e-mail: kmelsayes@mdanderson.org

© 2020 The Association of University Radiologists. Published by Elsevier Inc. All rights reserved.
<https://doi.org/10.1016/j.acra.2020.10.001>

INTRODUCTION

The SARS-CoV-2 pandemic has caused unprecedented disruptions to the health, social, and economic status of individuals at the local and global levels (1). The World Health Organization has reported more than 14 million cases and 593,000 deaths as of July 18, 2020 (2). In response, governments and public health authorities have enforced measures to slow transmission of the virus such as social distancing, air travel bans, limiting public gatherings, mask-wearing, and self-isolation (3). Medical schools have canceled many on-campus educational activities and shifted to remote learning models. To maintain the capacity of their workforce to care for hospitalized patients with COVID-19, hospitals have applied similar risk mitigation strategies, including temporarily halting elective procedures, a major source of revenue for hospitals, as well as enforcing social distancing within the workplace (4). For radiology, in many institutions, this has translated to limiting the number of trainees in reading rooms and lecture halls and potentially converting the readout to a virtual experience (4). Hundreds of scientific conferences, including many major radiology conferences, have been either canceled or switched to virtual models to abide by local public health authority recommendations. Additionally, financially strained institutions may experience a shortage of allocated funds to pay for these conference experiences (5). All projections of how and when this pandemic will end are speculative and dependent on the interplay of many factors (6). Therefore, the future of in-person educational activities remains uncertain.

Historically, adaptation to virtual conferences has been hampered by technological barriers and preference of in-person conferences (7). Teleconferencing technology has rapidly evolved over the past decade, and many reliable, advanced, and affordable platforms are now available (8). Given the technological nature of radiology, adaptation to a virtual environment may be easier than with other disciplines in medicine. In fact, there is precedence for virtual education in radiology. Remote conferencing has been implemented for radiology faculty and residents at the University of Arkansas over a two-year period and has shown that many participants valued the quality and convenience of this approach (7).

As a form of remote conferencing, webinars may reach a broader audience on both national and global levels with the participants attending sessions and interacting with the presenters in real-time. In response to the SARS-CoV-2/COVID-19 pandemic, we launched the Online Liver Imaging Course (OLIC) with a series of webinars to address potential barriers in liver imaging education amongst those involved in radiology. In this paper, we share the structure and outcomes of OLIC as well as discuss the potential of this model to offer a reproducible and convenient educational solution for radiologists worldwide.

METHODS

Course design

The OLIC was created with the mission of providing free, high-quality education, accessible worldwide to anyone interested in the topic of liver imaging. Our target audience included radiology trainees (residents and fellows) and practicing radiologists. The course director designed a comprehensive course of 28 online webinar lectures delivered in real-time via the internet over six weeks.

The webinars' content was carefully designed to cover a comprehensive list of topics crucial for practicing radiologists interested in liver imaging. Key themes included Liver Imaging Reporting and Data System (LI-RADS) (9), liver imaging techniques, the correlation between radiological and pathological findings in the liver, and image-guided therapies for hepatocellular carcinoma. Each webinar included one topic, but some topics were discussed over several webinars. The course director invited 28 liver imaging experts to speak as part of the series. Speakers were chosen based on their expertise in liver imaging; this expertise was indicated by track records of scholarly peer reviewed publications and previous involvement in teaching these topics at national and international conferences. Each webinar lasted for 60–80 minutes, was delivered as a didactic presentation by the speaker, and was followed by a live question-and-answer session. Questions were either written in the chatbox or asked by the attendees directly using the audio tools with permission from the moderator. At the end of the course, participants received a survey by email to evaluate the effectiveness of the sessions and solicit feedback to make improvements. To facilitate easy and open access to our OLIC presentations, and in response to high numbers of registrants, all lectures were recorded and uploaded to an online video stream (YouTube powered by Google; San Bruno, California).

Registration

A webinar series interest form was created using an online survey tool (SurveyMonkey; San Mateo, California). The interest form asked potential participants for their contact information and degree of interest in an online liver imaging course. The OLIC was advertised by the course director and speakers through direct emails to personal contacts involved in radiology education nationally and internationally, and on social media platforms such as Facebook and Twitter.

Technology

The webinars were delivered in real-time to attendees via the GoToMeeting platform (LogMeIn, Inc.; Boston, Massachusetts). The course director purchased a business plan account to manage the webinar series. This platform was selected as it met the requirements of being secure and affordable, allowed

speakers to share their screen, audio, and video; and allowed attendees to interact with the speaker via voice or a chat window. The business plan was selected as it allowed up to 250 attendees to join the webinar and provided advanced features such as annotation tools and cloud-based recording for later upload to YouTube.

An online marketing automation platform (MailChimp; Atlanta, Georgia) was used to send mass emails containing the webinar link to interested participants. The first webinar was held on April 20, 2020, and the course concluded on May 29, 2020.

Postcourse survey

A 46-question survey was designed and distributed using an online survey tool (SurveyMonkey; San Mateo, California). The questions were reviewed by the OLIC course director to verify the integrity and objectivity of the questions. Attention was made to ensure the survey was free of bias and contained language that was nonleading and easily interpretable by participants. The survey included questions regarding participants' level of training in radiology, type of medical practice, number of attended live or recorded sessions, perception of the usefulness of virtual conferencing, evaluation of each session, and several more items (see [Appendix 1](#) for a detailed list of

questions). The survey was distributed via email to all webinar participants. All questions, except one asking about the country of practice, were multiple-choice with single choice options. The online survey engine's built-in analytics were used for data analysis and chart generation. The origin countries of practice provided in responses were analyzed using Microsoft Excel to generate a map graph of attendees by location.

RESULTS

Attendance

We received 1434 responses to the interest form before the beginning of the course, with 98% (1434/1460) of respondents expressing their interest in the opportunity to attend. The first webinar had the highest number of live attendees (343 people), but it was noted that a number of interested participants were not able to attend these live sessions (see below: Challenges).

In order to ensure that each webinar was accessible to attendees who could not log in or who otherwise could not attend live, each session was recorded and made available on YouTube. On average, there were 89 live participants per session and 750 YouTube views per recording (as of July 9, 2020) ([Tables 1 and 2](#)).

TABLE 1. Course Topics, Speakers, and Participants/Webinar

| Session # | Date | Topic(s) | Max Participants |
|-----------|--------|---|------------------|
| 1 | 20-Apr | What's LI-RADS? History & Evolution | 343 |
| 2 | 21-Apr | LI-RADS: Overview of CT/MR algorithm and major features | 279 |
| 3 | 22-Apr | Malignant lesions that are not definitely HCC: LR-M | 274 |
| 4 | 23-Apr | LI-RADS: Tumor in Vein | 167 |
| 5 | 24-Apr | LI-RADS Ancillary features | 142 |
| 6 | 27-Apr | Pitfalls in Cirrhosis Imaging and User Errors in applying LI-RADS | 151 |
| 7 | 28-Apr | LI-RADS: HCC Treatment Response: from Concepts to Algorithms | 89 |
| 8 | 30-Apr | Present and Future of LI-RADS | 50 |
| 9 | 1-May | LI-RADS Case-based Review | 60 |
| 10 | 4-May | LI-RADS: Is There a Clinical Need? | 57 |
| 11 | 5-May | Management Implications of LI-RADS Categories | 57 |
| 12 | 6-May | LI-RADS Technical Recommendation | 45 |
| 13 | 7-May | Ultrasound Screening of Hepatocellular Carcinoma | 46 |
| 14 | 8-May | Contrast Enhanced Ultrasound of the Liver | 42 |
| 15 | 11-May | Imaging of Liver Iron Deposition and Steatosis | 71 |
| 16 | 12-May | Abbreviated MRI for HCC surveillance | 59 |
| 17 | 13-May | Liver MR Technique Related Pitfalls | 50 |
| 18 | 14-May | MR Imaging of Hepatic Adenomas: Subtypes and their Management | 48 |
| 19 | 15-May | Hepatocellular Carcinoma: LI-RADS Treatment Response after locoregional therapy | 43 |
| 20 | 18-May | Liver Directed Therapy for HCC | 39 |
| 21 | 19-May | Y90 Microspheres: State of the Science | 37 |
| 22 | 20-May | Cholangiocarcinoma: Current concepts | 42 |
| 23 | 21-May | Assessment of Pediatric Liver Tumors | 85 |
| 24 | 22-May | Liver malignancy masquerading as benignancy and how LI-RADS fits in | 38 |
| 25 | 26-May | Imaging Evaluation of Liver Transplantation | 51 |
| 26 | 27-May | Liver Transplantation: What Surgeons Expect from Radiologists | 38 |
| 27 | 28-May | The globalization of LI-RADS: roadmap and barriers to overcome | 31 |
| 28 | 29-May | Hepatocarcinogenesis: Rad./Path Correlation | 49 |

TABLE 2. YouTube Views Per Video (As of July 9, 2020)

| Video Title | Video Publish Time | Views |
|--|--------------------|-------|
| 1. What's LI-RADS? History & Evolution - Part 1. | 4/21/2020 | 2367 |
| 2. What's LI-RADS? History & Evolution - Part 2 | 4/21/2020 | 1260 |
| 3. LI-RADS: Overview of CT/MR algorithm and major features - Part 1 | 4/22/2020 | 1734 |
| 4. LI-RADS: Overview of CT/MR algorithm and major features - Part 2 | 4/22/2020 | 828 |
| 5. LI-RADS: Malignant lesions that are not definitely HCC: LR-M - Part 1 | 4/23/2020 | 1110 |
| 6. LI-RADS: Malignant lesions that are not definitely HCC: LR-M - Part 2 | 4/23/2020 | 558 |
| 7. LI-RADS; LR- Tumor In Vein (TIV) - Part 1 | 4/24/2020 | 709 |
| 8. LI-RADS; LR- Tumor In Vein (TIV) - Part 2 (Q&A). | 4/24/2020 | 461 |
| 9. LI-RADS Ancillary Features - Part 1. | 4/25/2020 | 695 |
| 10. LI-RADS Ancillary Features - Part 2 | 4/26/2020 | 369 |
| 11. Pitfalls in Cirrhosis Imaging and User Errors in applying LI-RADS - Part 1. | 4/28/2020 | 1631 |
| 12. Pitfalls in Cirrhosis Imaging and User Errors in applying LI-RADS - Part 2. | 4/28/2020 | 464 |
| 13. LI-RADS: HCC Treatment Response: from Concepts to Algorithms - Part 1. | 4/29/2020 | 537 |
| 14. LI-RADS: HCC Treatment Response: from Concepts to Algorithms - Part 2 | 4/29/2020 | 311 |
| 15. Present and Future of LI-RADS - Part 1. | 5/1/2020 | 326 |
| 16. Present and Future of LI-RADS - Part 2 (Q&A). | 5/1/2020 | 161 |
| 17. LI-RADS Case-based Review - Part 1. | 5/2/2020 | 625 |
| 18. LI-RADS Case-based Review - Part 2 (Q&A). | 5/2/2020 | 293 |
| 19. LI-RADS: Is There a Clinical Need? - Part 1. | 5/5/2020 | 273 |
| 20. LI-RADS: Is There a Clinical Need? - Part 2 (Q&A). | 5/5/2020 | 128 |
| 21. Management Implications of LI-RADS Categories - Part 1. | 5/6/2020 | 285 |
| 22. Management Implications of LI-RADS Categories - Part 2 | 5/6/2020 | 189 |
| 23. Ultrasound Screening of Hepatocellular Carcinoma - Part 1. | 5/7/2020 | 305 |
| 24. Ultrasound Screening of Hepatocellular Carcinoma - Part 2 (Q&A). | 5/7/2020 | 173 |
| 25. LI-RADS Technical Recommendation - Part 1. | 5/8/2020 | 288 |
| 26. LI-RADS Technical Recommendation - Part 2 (Q&A). | 5/8/2020 | 123 |
| 27. Contrast Enhanced Ultrasound of the Liver - Part 1. | 5/9/2020 | 266 |
| 28. Contrast Enhanced Ultrasound of the Liver - Part 2 | 5/9/2020 | 78 |
| 29. Imaging of Liver Iron Deposition and Steatosis - Part 1. | 5/12/2020 | 348 |
| 30. Imaging of Liver Iron Deposition and Steatosis - Part 2 | 5/12/2020 | 124 |
| 31. Abbreviated MRI for HCC surveillance - Part 1. | 5/13/2020 | 171 |
| 32. Abbreviated MRI for HCC surveillance - Part 2 | 5/13/2020 | 75 |
| 33. Liver MR Technique Related Pitfalls. | 5/14/2020 | 235 |
| 34. MR Imaging of Hepatic Adenomas: Subtypes and Their Management - Part 1. | 5/15/2020 | 365 |
| 35. MR Imaging of Hepatic Adenomas: Subtypes and Their Management - Part 2 | 5/15/2020 | 137 |
| 3. Virology and Immunology of COVID-19. | 5/17/2020 | 163 |
| 36. Hepatocellular Carcinoma: LI-RADS Treatment Response after locoregional therapy - Part 1 | 5/18/2020 | 302 |
| 37. Hepatocellular Carcinoma: LI-RADS Treatment Response after locoregional therapy - Part 2 (Q&A) | 5/18/2020 | 123 |
| 38. Liver Directed Therapy for HCC - Part 1 | 5/19/2020 | 175 |
| 39. Liver Directed Therapy for HCC - Part 2 | 5/19/2020 | 70 |
| 40. Y90 Microspheres: State of the Science - Part 1. | 5/19/2020 | 160 |
| 41. Y90 Microspheres: State of the Science - Part 2. | 5/19/2020 | 54 |
| 42. Cholangiocarcinoma: Current concepts - Part 1. | 5/20/2020 | 368 |
| 43. Cholangiocarcinoma: Current concepts - Part 2(Q&A). | 5/20/2020 | 143 |
| 44. Assessment of Pediatric Liver Tumors - Part 1 . | 5/21/2020 | 281 |
| 45. Assessment of Pediatric Liver Tumors - Part 2(Q&A) . | 5/21/2020 | 72 |
| 46. Liver malignancy masquerading as benignancy and how LI-RADS fits in-Part 1. | 5/22/2020 | 270 |
| 47.Liver malignancy masquerading as benignancy... - Part 2(Q&A) . | 5/22/2020 | 120 |
| 48. Imaging Evaluation of Liver Transplantation Part 1. | 5/26/2020 | 272 |
| 49. Imaging Evaluation of Liver Transplantation Part 2(Q&A). | 5/26/2020 | 136 |
| 50. Liver Transplantation; (What Surgeons Expect from Radiologists). Part 1. | 5/29/2020 | 192 |
| 51.Liver Transplantation; What Surgeons Expect from Radiologists. part2(Q&A). | 5/29/2020 | 136 |
| 52. The globalization of LI-RADS: roadmap and barriers to overcome. | 5/29/2020 | 107 |
| 53.Hepatocarcinogenesis; Rad./Path Correlation. | 6/12/2020 | 221 |
| Total Views | | 21367 |

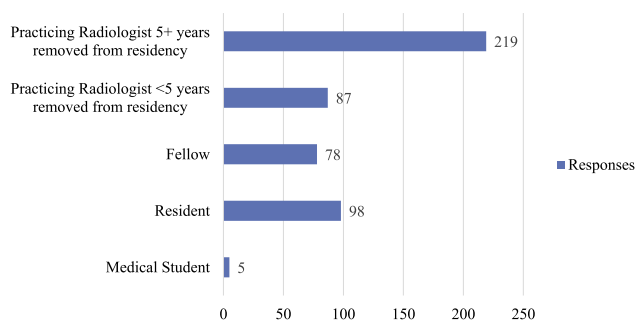


Figure 1. Post-course survey respondents' level of training. (Color version of figure is available online.)

Postcourse survey results

Demographics

The survey was sent to 1,460 registrants of the OLIC webinar series. There were 487 respondents to the survey for an overall response rate of 33%. The survey revealed that attendees joined from 37 countries and six continents with the largest percentage of attendees (28%) living in the United States (Fig 2). Approximately 63% (306/487) of participants were practicing radiologists while nearly all of the remainder 37% (181/487) of participants were either fellows or residents, if not medical students (Fig 1). Of the practicing radiologists, approximately 72% (219/306) had completed their residency training more than 5 years ago and 28% (87/306) finished their training less than 5 years ago.

Perception of OLIC

Responding to questions in this section was made optional for participants. As a result, a few respondents skipped some of the questions. The overwhelming majority, 97% (473/487), found the OLIC webinar series to be either somewhat or very beneficial; 82% (398/487) indicated that the information gained from the webinar series was very beneficial while 15% (75/487) stated that the information was somewhat beneficial (Fig 3).

There were 484 responses to the questions evaluating the course expectations. Essentially all attendees felt that the webinar sessions met 43% (207/484) or exceeded 57% (276/484) expectations. Only one respondent indicated that the series was not beneficial or did not meet their expectations (Fig 4).

We asked respondents to rate their perception of virtual conferences before and after February 2020, when the effects of the SARS-CoV-2 pandemic started to emerge. Of the 475 people who responded to this question, 11% (50/475) would not have considered virtual conferences before February 2020, 35% (168/475) would have considered but preferred in-person conferences, 35% (170/475) would have watched recorded lectures, and 18% (87/475) would have preferred virtual conferences occurring in real-time (Fig 5). When asked about their perception of virtual conferences after attending OLIC lectures, 61% (295/481) of the respondents enjoyed the virtual format more than in-person conferences,

while 38% (184/481) enjoyed the webinar format but preferred in-person conferences. Only 0.5% (2/418) respondents disliked the format (Fig 6).

Finally, participants rated their willingness to attend virtual conferences in the future, assuming that there can be a widespread resumption of in-person conferences. Of the 480 respondents, 84% (405/480) said that they would attend future virtual conferences even if in-person conferences resume while 15% (72/480) were unsure. Only 0.5% (3/480) indicated that they would not attend virtual conferences in the future (Fig 7).

DISCUSSION

The SARS-CoV-2 pandemic has severely disrupted traditional educational models throughout healthcare, particularly in-person learning both at one's institution, and attendance at regional, national, and global continuing medical education conferences. The new social distancing guidelines, restrictions on travel, and restrictions on academic mission funding pose challenges for radiologists as they try to educate themselves and also educate the next generation of radiologists. According to the Accreditation Council for Graduate Medical Education, the effect of the pandemic on imaging volumes and procedure mix could necessitate the need to lengthen the training of some radiology residents and fellows (10). This possible increased length in training combined with the persistent need for social distancing highlights the need to develop alternative educational approaches for teaching residents, fellows, as well as practicing radiologists.

As new approaches are developed, clinician-educators can leverage modern technology to expand the reach of their training programs at a low cost to the program and attendees. The costs of the course were limited mainly to subscriptions of the necessary online services and platforms; GoToMeeting business plan annual subscription costs \$192, SurveyMonkey annual plan is \$384, and the MailChimp plan costs \$50 per contacts per month. The total expenses were under \$1000 without considering the costs of other equipment such as personal computers, webcams, audio devices, and internet access subscriptions which are widely available nowadays and instructors used their own. Another significant cost reduction factor was that instructors did not get any financial compensation. Guest faculty at in-person conferences or meetings usually costs an average of \$2000–\$4000 to cover travel, food, and other expenses such as honoraria. In our course, speakers were generous to volunteer (11, 12). As a result, it was possible to offer the course for free both in real-time and on-demand through YouTube.

We found that the OLIC had a large international audience with nearly three-quarters of survey-responding attendees living outside of the United States. We are hopeful that courses like the OLIC can help to standardize educational opportunities across the world and mitigate existing global

■ Geographic locations of final survey respondents

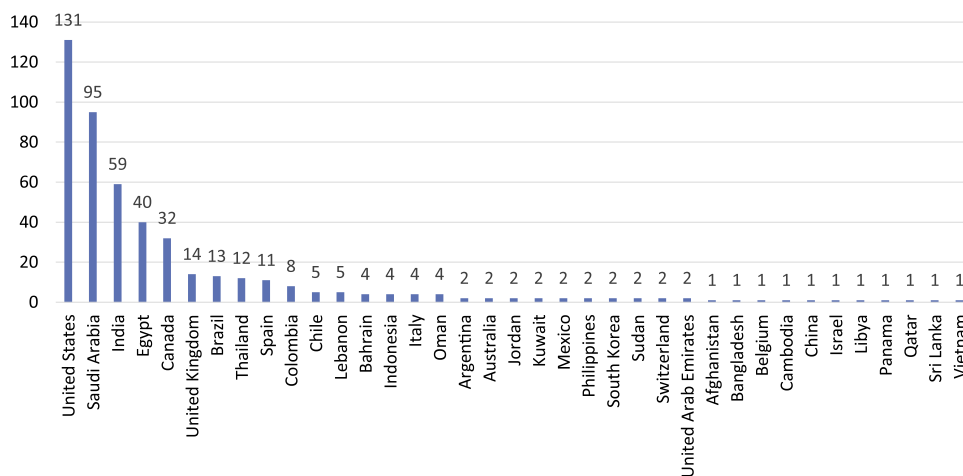
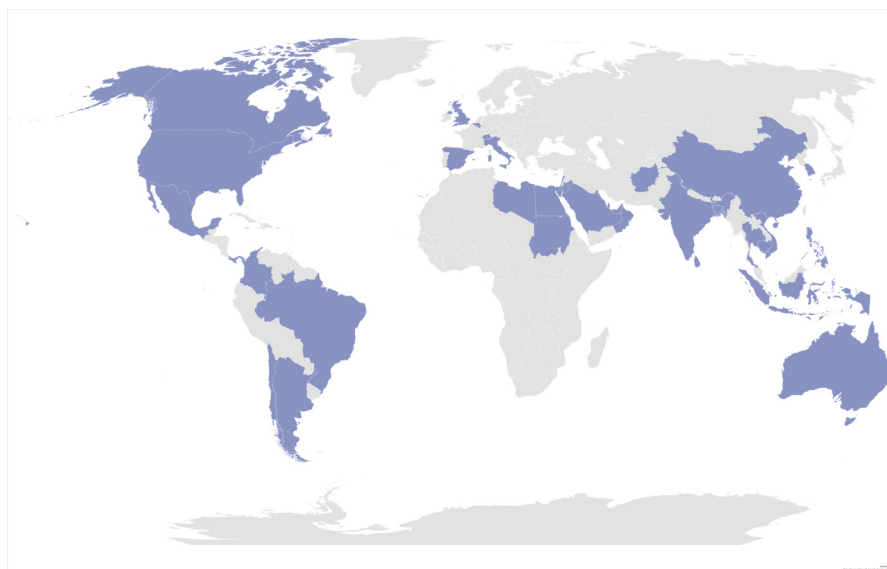


Figure 2. Post-course survey respondents by country of practice. (Color version of figure is available online.)

educational inequalities (13). We believe that the high number of registrants, real-time attendees, on-demand viewers, and positive response to the survey reflects the strength of our

faculty as well as the need for such a format. A further step would be seeking Continued Medical Education accreditation of the course material as enduring activities. While this

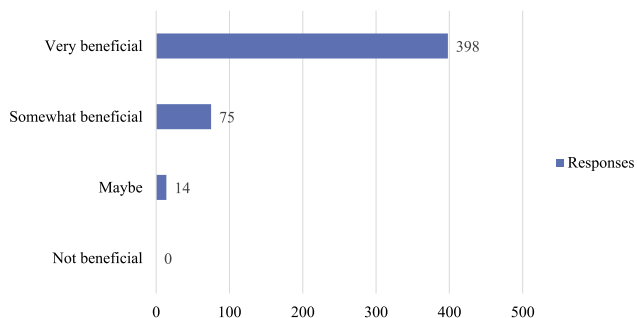


Figure 3. Post-course survey respondents' evaluation of the lecture series benefit in their future practice. (Color version of figure is available online.)

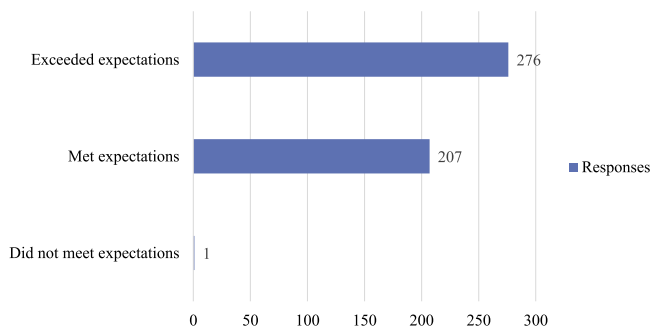


Figure 4. Attendees expectations of the lectures. (Color version of figure is available online.)

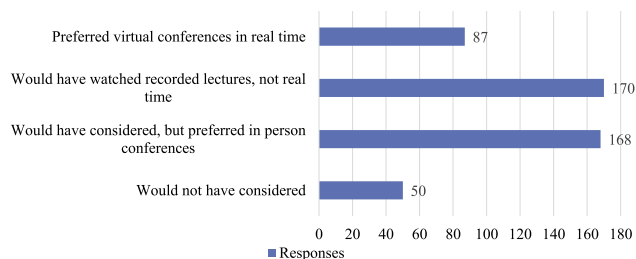


Figure 5. Post-course survey respondents' perception of virtual conferences before February 2020. (Color version of figure is available online.)

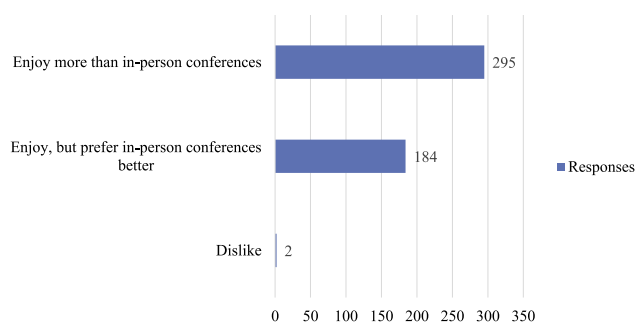


Figure 6. Post-course survey respondents' perception of virtual conferences after attending the online liver imaging series (OLIC). (Color version of figure is available online.)

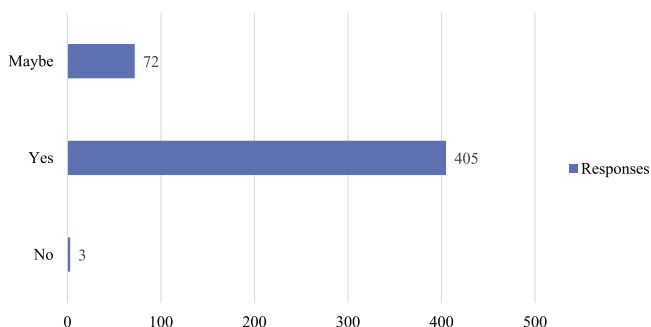


Figure 7. Post-course survey respondents' answers to the question "Assuming widespread resumption of in-person conferences, will you continue to attend virtual conferences in the future?". (Color version of figure is available online.)

would require extensive work and resources, it will maximize the benefit to radiologists who could use this credit to maintain their certification (14). We included one open-ended question asking if the respondents would change anything about the course. While the majority agreed that nothing should be changed, the requests mainly involved providing PDF handouts in future lectures. Some participants mentioned the timing was a challenge for them but making the course available on YouTube solved this problem. Regarding the course content, some participants suggested the inclusion of less LI-RADS lectures and more case discussions. Others commended the question and answer sessions and being able to directly interact with the speakers.

CHALLENGES

Despite sharing the link privately via direct emails with interested applicants, we had an unfortunate episode of a non-registrant interrupting and disturbing one of the lectures. Consequently, security precautions were put in place to avoid future disturbances. Thereafter, the webinars were password-protected and locked shortly after the presentation began. This makes it difficult for any potential hackers to be allowed in the webinar. Additional security measures included the manual assignment of host status, which allows screen-sharing and more control over the webinar, to the presenter(s) before the start of each webinar, and restricting the ability of other participants to share their screen. Following the implementation of these security measures, no further disturbances to the presentations took place after the initial incident. Participants were still able to interact with the course instructors as usual since questions and discussions go through the audio and chat channels, not through the screen-sharing option that was disabled for attendees.

Similar disruptive interruptions have been reported by users across multiple video conferencing platforms. As the SARS-CoV-2 pandemic progressed, the video conferencing platforms released multiple security updates helping users to avoid malicious interruptions (15). Furthermore, these platforms developed more tailored solutions for large webinars that make it easier to manage large numbers of attendees by disabling camera and screen sharing and offer more features such as a dedicated question and answer section and live polling that could enhance teaching.

Another challenge was the unexpectedly high number of registrants. The plan purchased for video conferencing allowed for a maximum of 250 attendees. Thus, nearly 100 attendees were not able to log-in and view the first session live. The number of attendees surpassed the account limits on two other occasions (webinars 2 and 3). However, there are more advanced webinar solutions tailored to such big numbers at an added cost. With early planning and resources, this problem could be practically addressed. Despite the high attendance rate at the beginning, numbers of live attendees started to drop towards the end of the course (Table 1). High dropout rates are a known phenomenon in online learning with the most common reason being the unexpected time of commitment by registrants (16). Since learners signed up for this course voluntarily, we can assume they might have reached their learning goals and hence shouldn't be considered as dropout (17). Another reason for the decline in attendance could be the availability of the recorded sessions on YouTube which could be accessed at the learner's convenience (18). The inclusion of incentives such as certificates of completion might help future projects if maintaining a high attendance rate is desired.

The lack of a control group limits the evaluation of the effectiveness of this model compared to standard instruction. Evaluation using a pre-test-post-test design was impractical because of limited preparation time, the statistical weakness of

this design, and the fact that it would have complicated the registration process given the large number of participants (19). However, further comparison studies of the videoconferencing and standard didactic instruction models could provide valuable insights to optimize future virtual radiology education.

CONCLUSION

The success of the OLIC indicates that videoconferencing technology can be used as an inexpensive, yet agile solution to address the educational needs of radiologists internationally. We believe that our success was due in part to having a committed course director, a well-defined curriculum, a cohort of experienced faculty, the effective use of social media as a marketing tool, and the utilization of multiple online tools for content consumption.

The positive responses to our post-course survey suggest that virtual education is here to stay, even in a postpandemic world. Educational institutions and scientific societies should consider directing resources to adapt and develop such models.

ACKNOWLEDGMENT

We would like to acknowledge the time and effort of our faculty. Their commitment to education helped to make the OLIC a successful event. Names are to be released after official acceptance of the manuscript.

REFERENCES

- Nicola M, Alsafi Z, Sohrabi C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *Int J Surg* 2020; 78:185–193. doi:10.1016/j.ijssu.2020.04.018.
- World Health Organization (2020) Coronavirus disease (COVID-19) Situation Report – 133. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200625-covid-19-sitrep-157.pdf?sfvrsn=423f4a82_2. Accessed June 25, 2020
- Kissler SM, Tedijanto C, Lipsitch M, et al. (2020) Social distancing strategies for curbing the COVID-19 epidemic. medRxiv 2020.03.22.20041079. <http://doi.org/10.1101/2020.03.22.20041079>.
- Alvin MD, George E, Deng F, et al. The Impact of COVID-19 on Radiology Trainees. *Radiology* 2020:201222. doi:10.1148/radiol.2020201222.
- Kalia V, Srinivasan A, Wilkins L, et al. Adapting Scientific Conferences to the Realities Imposed by COVID-19. *Radiol Imaging Cancer* 2020; 2: e204020. doi:10.1148/rycan.2020204020.
- Ng WL. To lockdown ? When to peak ? Will there be an end ? A macro-economic analysis on COVID-19 epidemic in the United States. *J Macroecon* 2020; 65:103230. doi:10.1016/j.jmacro.2020.103230.
- Shah CC, Deloney LA, Donepudi C, et al. Establishment of a Simple and Inexpensive Remote Radiology Conference. *J Am Coll Radiol* 2009; 6:884–885. doi:10.1016/j.jacr.2009.07.001.
- Lewis PJ, Catanzano TM, Davis LP, et al. (2019) Web-based Conferencing : What Radiology Educators Need to Know. 447–454. <http://doi.org/10.1016/j.acra.2019.05.017>.
- Elsayes KM, Kielar AZ, Chernyak V, et al. LI-RADS: a conceptual and historical review from its beginning to its recent integration into AASLD clinical practice guidance. *J Hepatocell Carcinoma* Volume 2019; 6:49–69. doi:10.2147/jhc.s186239.
- ACGME (2020) Special Communication to Diagnostic Radiology Residents, Interventional Radiology Residents, Subspecialty Radiology Fellows, and Program Directors. 1–4.
- Muroff LR. The anatomy of an outstanding CME meeting. *J Am Coll Radiol* 2005; 2:534–540. doi:10.1016/j.jacr.2004.10.005.
- Yablon CM, Wu JS, Slanetz PJ, et al. A Report on the Current Status of Grand Rounds in Radiology Residency Programs in the United States. *Acad Radiol* 2011; 18:1593–1597. doi:10.1016/j.acra.2011.08.015.
- Mollura DJ, Shah N, Mazal J. White paper report of the 2013 RAD-AID conference: I. In: *Journal of the American College of Radiology, Elsevier*; 2014:913–919.
- Davis LP, Olkin A, Donaldson SS. Continuing medical education in radiology: A glimpse of the present and of what lies ahead. *J. Am. Coll. Radiol.* 2005; 2:338–343.
- Achakulvisut T, Ruangrong T, Bilgin I, et al. Improving on legacy conferences by moving online. *Elife* 2020; 9. doi:10.7554/ELIFE.57892.
- Harju M, Virtanen I Interaction and Student Dropout in Massive Open Online Courses.
- Fini A. The technological dimension of a massive open online course: The case of the CCK08 course tools. *Int Rev Res Open Distance Learn* 2009; 10. doi:10.19173/irrodl.v10i5.643.
- Morris NP, Swinnerton B, Coop T. Lecture recordings to support learning: A contested space between students and teachers. *Comput Educ* 2019; 140:103604. doi:10.1016/j.compedu.2019.103604.
- Allen M (2017) The SAGE Encyclopedia of Communication Research Methods.

APPENDIX 1. POST-COURSE SURVEY QUESTIONS

- Q1. Your email address
 Q2. What is your specialty?
 Q3. If diagnostic radiologist, what is your sub-specialty?
 Q4. What is your level of training?
 Q5. In what country do you practice?
 Q6. If from the USA, what state? Please skip if not from USA.
 Q7. What type is your medical practice?
 Q8. How many of the sessions did you attend live?
 Q9. How many of the recorded sessions did you view?
 Q10. How did you find out about the lecture series?
 Q11. Did the lecture series meet your expectations?
 Q12. Will the information gained from the lecture series be beneficial in your future practice?
 Q13. Had you attended a real-time virtual conference before February 2020?
 Q14. What was your perception of virtual conferences before February 2020?
 Q15. What is your perception of virtual conferences after attending the liver imaging course lectures?
 Q16. Assuming widespread resumption of in-person conferences, will you continue to attend virtual conferences in the future?
 Q17. If you regularly attended in-person conferences in the past, will you attend them again if there will be virtual conferences with similar scientific/educational contents?
 Q18. What would you change about the lecture series?
- Evaluation of individual webinars**
- Q20. What is LI-RADS? History & Evolution
- Q21. LI-RADS: Overview of CT/MR Algorithm and Major Features
 Q22. LI-RADS: Malignant Lesions that are Definitely Not HCC
 Q23. LI-RADS: Tumor in Vein
 Q24. LI-RADS Ancillary Features
 Q25. Pitfalls in Cirrhosis Imaging and User Errors in Applying LI-RADS
 Q26. LI-RADS: HCC Treatment Response: From Concepts to Algorithms
 Q27. Present and Future of LI-RADS
 Q28. LI-RADS Case-Based Review
 Q29. LI-RADS: Is there a Clinical Need?
 Q30. Management Implications of LI-RADS Categories
 Q31. Ultrasound Screening of Hepatocellular Carcinoma
 Q32. LI-RADS Technical Recommendations
 Q33. Contrast Enhanced Ultrasound of the Liver
 Q34. Imaging of Liver Iron Deposition and Steatosis
 Q35. Abbreviated MRI for HCC Surveillance
 Q36. Liver MR Technique Related Pitfalls
 Q37. MR Imaging of Hepatic Adenomas: Subtypes and Management
 Q38. Liver Directed Therapy for HCC
 Q39. Y90: Microspheres: State of the Science
 Q40. Cholangiocarcinoma: Current Concepts
 Q41. Assessment of Pediatric Liver Tumors
 Q42. Liver Malignancy Masquerading as Benign
 Q43. Imaging Evaluation of Liver Transplantation
 Q44. Liver Transplantation: What Surgeons Expect from Radiologists
 Q45. The Globalization of LI-RADS: Roadmap and Barriers to Overcome
 Q46. Hepatocarcinogenesis: A Rad/Path Correlation