Accurate Interpretation of HRCT in the Diagnosis of IPF

A Personalized, Simulation-Based Training Program

Outcomes Summary

Activity Dates: December 31, 2014 – December 31, 2015

Website: http://www.hrcteducation.org/

Prepared by National Jewish Health

EXECUTIVE SUMMARY

Accurate Interpretation of HRCT in the Diagnosis of IPF was developed by leading expert faculty in radiology and pulmonology from National Jewish Health. The interactive, case-based online training program provided valuable, pertinent education to radiologists and pulmonologists from around the United States with an interest in IPF. Of the 912 physicians who registered for the CME activity, 313 completed the web-based course, including 209 Radiologists and 104 Pulmonologists for a significant 34 percent completion rate.

The Program Chair, Dr. Jonathan Chung, will be submitting an article to the *American Journal of Roentgenology* on this activity. The purpose of the submission is to describe our HRCT educational program, determine the short-term learning effect of the activity, and identify poor performance cases to pinpoint areas of weakness in diagnostic acumen on HRCT.

Highlights:
- **75%** of radiologists and **62%** of pulmonologists stated they intended to incorporate different diagnostic strategies into patient evaluation as a result of this CME activity.
- **100%** of all participants stated that the activity was presented in an objective manner and free of commercial bias.
- **98%** of radiologists and pulmonologists reported that the activity provided new ideas or information they expect to use.
- **84%** of all learners were very to extremely likely to make changes in their practice as a result of what they learned from this CME activity.
- In a 45-day follow-up survey, **80%** of participants indicated that they retained the knowledge and competency learned from this CME activity
- In a 45-day follow-up survey, **98%** indicating that this activity provided them with new ideas and information that they will use in their current practice.

"Interpretation in the diagnosis of IPF has inter and intra reader variation, thus there is a strong need for continued education related to the screening and diagnosis of IPF for pulmonologists and radiologists." –Dr. Jonathan Chung, Activity Chair

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Project Overview
Accurate diagnosis of idiopathic pulmonary fibrosis (IPF) is essential to identify patients who are potential candidates for newly approved drug therapies. High-resolution CT (HRCT) scanning is a critical step in the evaluation of patients with suspected IPF, because it can help to distinguish IPF from other interstitial lung diseases. In the appropriate clinical situation, the presence of key features of IPF on HRCT of the chest can confirm the diagnosis of IPF and obviate the need for surgical lung biopsy.

This case-based, interactive activity utilizes actual, complete HRCT image sets from patients with IPF and lung diseases frequently mistaken for IPF. Clinical information, image sets and pulmonary function data are incorporated into the cases to simulate real-world clinical practice, emphasizing the importance of a multidisciplinary approach to IPF.

Learning Objectives
Upon completion of this educational activity, participants will be able to:
1. Define the CT categories of "Definite usual interstitial pneumonia (UIP)", "Possible UIP", and "Inconsistent with UIP", as described by the ATS/ERS criteria
2. Differentiate the above three categories of UIP on high-resolution chest commuted tomography (HRCT) images
3. Differentiate traction bronchiolectasis from honeycombing on HRCT
4. Recognize common diffuse interstitial lung disease patterns which can mimic UIP/ IPF

Target Audience
This activity was designed to meet the educational needs of radiologists, pulmonologists and other physicians involved in the diagnosis and care of patients with IPF.

Accreditation
National Jewish Health designated this enduring material for a maximum of *4.0 AMA PRA Category 1 Credits^{TM}*. This course met the American Board of Radiology's criteria for a self-assessment activity in the ABR Maintenance of Certificate program and is designated for 4.0 SA-CME Credits.

In order to receive credit, participants must complete the pre-test, view the activity, review and answer case-based questions on 20 cases, and complete the post-test and evaluation form. Statements of Credit were awarded upon successful completion of the post-test with a passing score of 60%, and evaluation form.

Faculty

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Personalized, Interactive Website: How It Works

After a pre-activity test assessment, participants were grouped into two levels and received an individualized series of instructional cases and immediate feedback designed to improve their HRCT interpretation skills. Each case consists of complete HRCT image datasets with PFT and patient history. Complete datasets were used to simulate real-life clinical practice. Six questions relating to axial distribution, zonal distribution, honeycombing, ground glass opacity (GGO), and diagnosis are asked for each case. After answering the questions for each case, participants view a video case review of the case they just went through and compare their own HRCT interpretations to those of an expert radiologist. Immediate grading of each question provided real-time feedback on answers to the case based questions. Informative mini-lectures by faculty presenters could be viewed at any time during the program. After the first 10 cases, participants were reassessed and grouped into three levels based on their weakest areas for the remaining 10 instructional cases. Users were provided up to four feedback points on their weakest HRCT interpretation areas throughout the activity. Once participants completed all of the cases, they were presented

with a post-activity test including 23 multiple-choice questions and three simulated cases with 6 related questions each. Upon completion of the post-activity test and evaluation, participants received credit for the program.

When the online program was launched there was a high percentage of learners not passing the post-test. After evaluating the post-test questions and cases, adjustments were made to them and the pass rate was lowered from 70% to 60%. Interpretation of HRCT and diagnosis of IPF is complex and variable and we did not want to frustrate learners, many of whom spent many hours on the educational activity. Lowering the pass rate improved the rate of completions.

Statistical Methods

Descriptive statistics about the number of users, their levels of completion of the activity, and their specialties and degrees were tabulated. Pre-test scores were calculated at the percent of the correct answers out of the 20 pre-test questions. Post-test scores were similarly calculated as the percent correct out of the 23 post-test questions and the 18 post-test case questions combined. Descriptive statistics were used to qualitatively assess if there were any differences in the users who completed the activity and those who dropped out/failed to complete the activity. Similarly, descriptive statistics for post-test scores and changes in the post-test score were calculated overall, as well as by specialty and levels of difficulty assigned after the pre-test and first 10 cases.

A paired t-test was used to determine if subjects had significant improvements in test scores before and after the educational activity. Multiple linear regression was used to determine the factors associated with the post-test score while controlling for the pretest score. The pre-test score, whether or not a user was a radiologist, the level assigned after the pre-test, and the level assigned after the first 10 cases were included as predictors in the model. All statistical tests were performed at the 0.05 significance level.   Lastly, the proportions of subjects answering each pre and post-test question correctly were tabulated in order to help identify questions that may be unclear or confusing.

Wilcoxon tests were used to evaluate differences between radiologists and pulmonologists for the ordinal answers, and Fisher's exact test was used for unordered categorical outcomes.

Level 1 Outcomes – Participation

Website Traffic Analysis - www.hrcteducation.org

- Total Unique Visits – 12,758
- Average minutes per visit – 5:47 minutes (2:29 min. for new visits and 14:35 min. for returning)
- Number of registered learners: 912
- Number of activity learners who completed entire activity but not the post-test: 330
- Number of entire activity completers: 313
- Number of certificates issued: 301

Of the 912 learners who signed up for the activity, 64.5% completed the pre-test, and 34.3% completed the post-test (Table 1). Of those who completed the pre-test, 76.3% went on to complete the post-test. Once a user had completed the first 10 cases of the activity, they became much more likely to complete the activity, with 90.7% of users who completed the first 10 cases completing the post-test as well.

Table 1: Learners Completing Different Portions of the Activity

	Number of Users	Percent of Users that Signed Up (N=912)	Percent of Users that Completed Pre-Test (N=410)	Percent of Users that Completed First 10 Cases (N=345)	Percent of Users that Completed Last 10 Cases (N=330)
Registered for Activity	**912**	-	-	-	-
Began Pre-Test	588	64.5%	-	-	-
Completed Pre-Test	410	45.0%	-	-	-
Began First 10 Cases	410	45.0%	100%	-	-
Completed First 10 Cases	345	37.8%	84.1%	-	-
Began Last 10 Cases	345	37.8%	84.1%	100%	-
Completed Last 10 Cases	330	36.2%	80.5%	95.6%	-
Began Post-Test	318	34.9%	77.6%	92.2%	96.4%
Completed Post-Test	**313**	34.3%	76.3%	90.7%	94.8%

Of the 912 participants who signed up for the activity, 50.2% were radiologists and 46.5% were pulmonologists. However, of those that completed the pre-test, 61.2% were radiologists and 37.8% were pulmonologists, indicating that **pulmonologists dropped out of the activity at higher rates than radiologists during the pre-test** (Table 2). Drop off rates for this activity were not surprising considering the length and complexity of the program. We only include radiologists and pulmonologists in our discussion since such a small number attendees from other specialties completed the activity and we do not have specifics on those specialties.

Table 2: Learner Specialties by Completion Category (% (N))

	Users that Signed Up (N=912)	Users that Completed Pre-Test (N=410)	Users that Completed First 10 Cases (N=345)	Users that Completed Last 10 Cases (N=330)	Users that Completed Post-Test (N=313)
Specialty: Radiology	50.2% (458)	61.2% (251)	64.1% (221)	64.5% (216)	66.8% (209)
Pulmonology	46.5% (424)	37.8% (155)	34.8% (120)	32.8% (110)	32.3% (101)
Internal Medicine	1.0% (9)	0.2% (1)	0.3% (1)	0.3% (1)	0
Family Practice	0.1% (1)	0	0	0	0
Other	2.2% (20)	0.7% (3)	0.9% (3)	0.9% (3)	1.0% (3)
Degree: MD	92.0% (839)	93.2% (382)	93.3% (322)	92.5% (310)	94.2% (295)
DO	3.9% (36)	4.1% (17)	4.3% (15)	4.2% (14)	4.5% (14)
Other	4.1% (37)	2.7% (11)	2.3% (8)	1.8% (6)	1.3% (4)

Radiologists tended to have higher pre-test scores and were more often assigned to level 2 after the pre-test than other users (Table 3). It does not appear that those who scored poorly on the pre-test were the ones that dropped out of the activity – pre-test scores for subjects that completed the activity are not significantly different from those who did not complete the activity (estimated difference of 0.05 points, p=0.97).

Case example. Learners select Axial, HRCT, Prone, Expiratory, or Coronal to see the related scan images and answer questions.

Table 3: Levels Assigned After the Pre-test and First 10 Cases (% (N))

	Level After Pre Test		Level After First 10 Cases		
	Level 1	*Level 2*	*Level A*	*Level B*	*Level C*
Users that Completed Pre-Test (N=410)	52.2% (214)	47.8% (196)	-	-	-
Radiologist (N=251)	48.2% (121)	51.8% (130)	-	-	-
Pulmonologist/Other (N=159)	58.5% (93)	41.5% (66)	-	-	-
Users that Completed First 10 Cases (N=345)	51.6% (178)	48.4% (167)	68.4% (236)	28.4% (98)	3.2% (11)
Radiologist (N=221)	48.4% (107)	51.6% (114)	70.6% (156)	26.7% (59)	2.7% (6)
Pulmonologist/Other (N=124)	57.3% (71)	42.7% (53)	64.5% (80)	31.5% (39)	4.0% (5)
Users that Completed Last 10 Cases (N=330)	52.4 (173)	47.6% (157)	68.2% (225)	28.5% (94)	3.3%(11)
Radiologist (N=216)	49.1% (106)	50.9% (110)	70.4% (152)	26.9% (58)	2.8% (6)
Pulmonologist/Other (N=114)	58.8% (67)	41.2% (47)	64.0% (73)	31.6% (36)	4.4% (5)
Users that Completed Post-Test (N=313)	52.1% (163)	47.9% (150)	69.0% (216)	28.1% (88)	2.9% (9)
Radiologist (N=209)	48.8% (102)	51.2% (107)	70.3% (147)	26.8% (56)	2.9% (6)
Pulmonologist/Other (N=104)	58.7% (61)	41.3% (43)	66.3% (69)	30.8% (32)	2.9% (3)

Level 2 Outcomes – Satisfaction

Attendees indicated that they were very satisfied with this CME activity.

- **100%** of all participants stated that the activity was presented in an objective manner and free of commercial bias.
- **98%** of radiologists and pulmonologists reported that the activity provided new ideas or information they expect to use.

Likert Scale: 1=Unsatisfactory 5=Excellent	Average
Compared to other educational activities in which you've participated in the past year, how would you rate this activity?	4.66
How effective will the information you learned during this activity be in helping you improve your skills or judgment?	4.67

Overall, attendees found the case-based format very effective for learning HRCT interpretation, as seen through these comments:

- "Very helpful to have immediate feedback, repetition and follow-up explanations."
- "This was awesome! I think I finally understand this topic after many years of practice."
- "As a pulmonologist, this is the first CME activity that allowed me to view entire CT scans. Amazing."
- "Seeing examples and considering differentials are essential."
- "The format mimics daily case interpretation."
- "Very effective, particularly the emphasis on strong teaching points which were then reiterated several times to drive the point home."
- "Terrific learning experience."
- "Illustrates how interpretation is not black and white."
- "Very effective. The cases were very good examples of the different disease processes."

Activity

Below is information on what has been completed and what is left to complete, as well as a view of your results from the different levels of the program. As you work through the different levels of the program, you will receive feedback and scoring on different categories of interpreting HRCT imaging. You are encouraged to view the educational videos prior to working through the cases and can view them at any time during the program. Progress in the program is tracked and you can stop and start the program as needed until the program is complete.

It is recommended that participants view the short educational videos developed by expert faculty to provide information on IPF and the interpretation of HRCT in the diagnosis of IPF.

VIEW EDUCATIONAL VIDEOS

Want to know how you answered a particular question? Just click on the view report card link and you'll see how you answered a given question and whether or not it was correct.

VIEW REPORT CARD

Take Pre-Test BEGIN SCORED RESULT

Take Cases 1-5 Test BEGIN SCORED RESULT

Take Cases 6-10 Test BEGIN SCORED RESULT

Take Cases 11-15 Test BEGIN SCORED RESULT

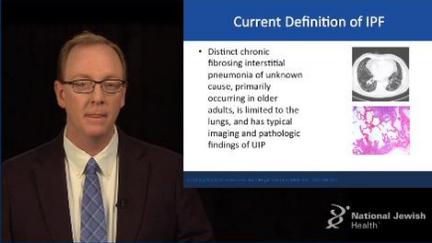**Take Cases 16-20 Test** BEGIN SCORED RESULT

Take Post-Test BEGIN SCORED RESULT

Final Steps

Participants can track their learning at their own pace throughout the activity.

Teaching Videos

Idiopathic Pulmonary Fibrosis: An overview of interstitial lung diseases and idiopathic pulmonary fibrosis (IPF) with definitions, diagnostic algorithm, and cases for demonstration.

Background Imaging: Classification of idiopathic interstitial pneumonias and diagnostic criteria for usual interstitial pneumonia (UIP).

Distribution: How to describe the CT distribution of pulmonary disease in the craniocaudal and axial planes.

Teaching videos cover diagnostic criteria, honeycombing and GGO, CT distribution, background imagining and an overview of IPF. These topics are reemphasized throughout the entire activity. The videos can be viewed at anytime for additional review.
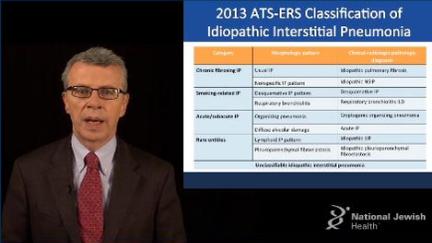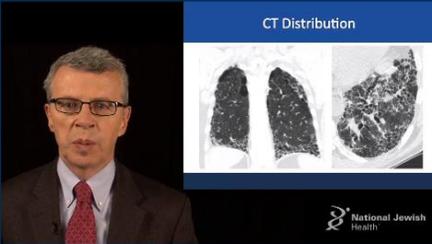
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Level 3 and 4 Outcomes – Learning and Competence

87.5% of participants that completed the educational activity scored 70% or higher on the post-test.   There was an overall increase of 8.2% in correct responses from pre- to post-test. Both an increase in correct responses from pre-to post-activity, as well as a high rating that the learning objectives were met indicates a marked knowledge gain. On a 5-point Likert Scale ranging from Excellent to Unsatisfactory, participants ranked the degree to which each learning objective was met:

Learning Objective	Out of 5
Define the CT categories of Definite UIP, Possible UIP, and Inconsistent with UIP	4.74
Differentiate the 3 categories of UIP on HRCT images	4.67
Differentiate traction bronchiolectasis from honeycombing on HRCT	4.42
Recognize common diffuse interstitial lung disease radiographic patterns that can mimic UIP/IPF	4.39

Using multiple linear regression to determine the factors associated with the post-test score, we find that higher pre-test scores were significantly associated with higher post-test scores. However, higher pre-test scores were also associated with smaller increases in the score from pre- to post-, as users that already had high scores had less room for improvement. On average, controlling for pre-test score, radiologists had 3.02 points greater increases in test scores than other users.

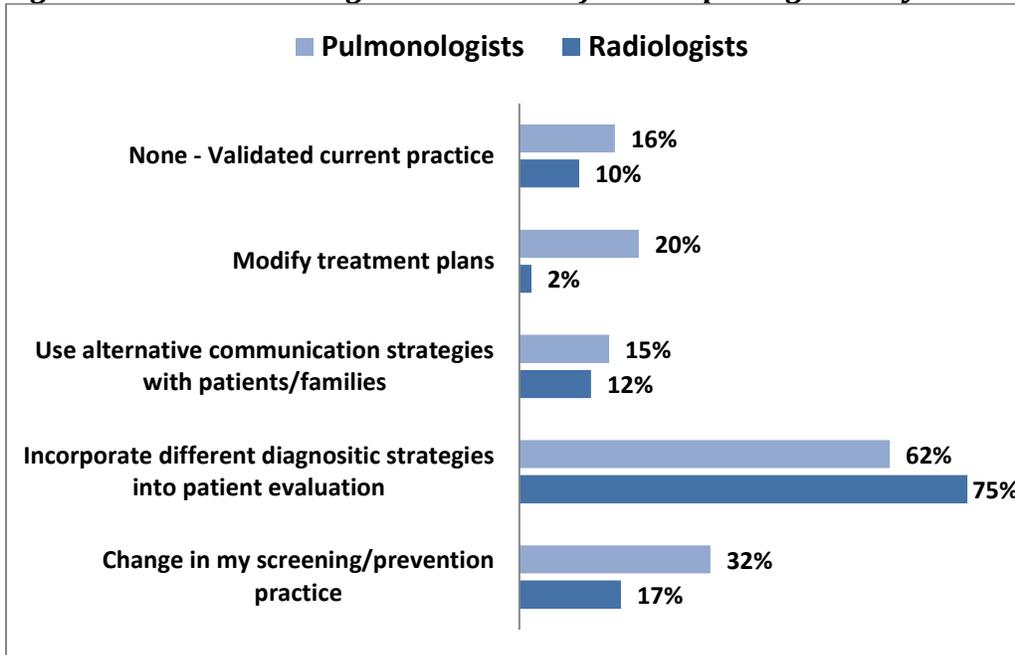## Level 4 Outcomes – Competence (Intent to Change)

Eighty-four percent (84%) of all learners were very to extremely likely to make changes in their practice as a result of what they learned from this CME activity.
Radiologists and pulmonologists differed in how they thought they would incorporate the course information into their practices. Pulmonologist users are more likely to change screening practices and modify treatment plans, while radiologists are more likely to incorporate different diagnostic strategies (Figure 1). Some of the "Other" free text included:

- Improved interpretation skills
- Improve structured HRCT reporting
- More scrutiny of HRCTs, especially in interpreting radiographic patterns of UIP
- Change radiology reports
- Better screening of UIP/IPF patients
- Change radiology report terminology
- Improve my diagnostic performance
- Be more definitive in diagnosis of UIP

- Increase my accuracy in diagnosing or ruling out UIP
- Make better diagnoses

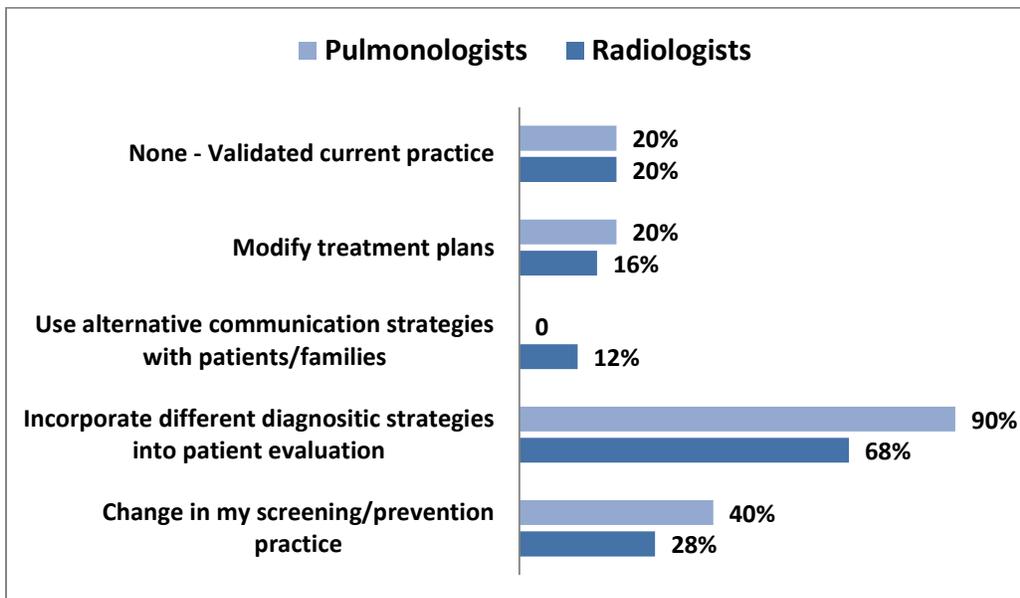*Figure 1: Intended Changes to Practice After Completing Activity - Evaluation*

(n=301)

A very impressive 75% of radiologists and 62% of pulmonologists stated they intended to incorporate different diagnostic strategies into patient evaluation as a result of this CME activity. This highlights improvement in physician competency and clearly meets the overall purpose of the activity to educate physicians on the HRCT interpretation to accurately diagnose IPF.

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Level 5 Outcomes – Self-reported Performance

A follow up survey was emailed to completers a month to 45 days after the activity. Pulmonologists reported incorporating different diagnostic strategies into patient evaluation at a higher percentage than in the post-activity survey, while more radiologists modified treatment plans than intended. A true comparison of intended changes to actual changes is limited by the small sample of the post-activity evaluation. **However, the intent to change and the actual reported change of participants related to diagnostic strategies and screening practices directly ties to the learning objectives and specific criteria of HRCT interpretation.**
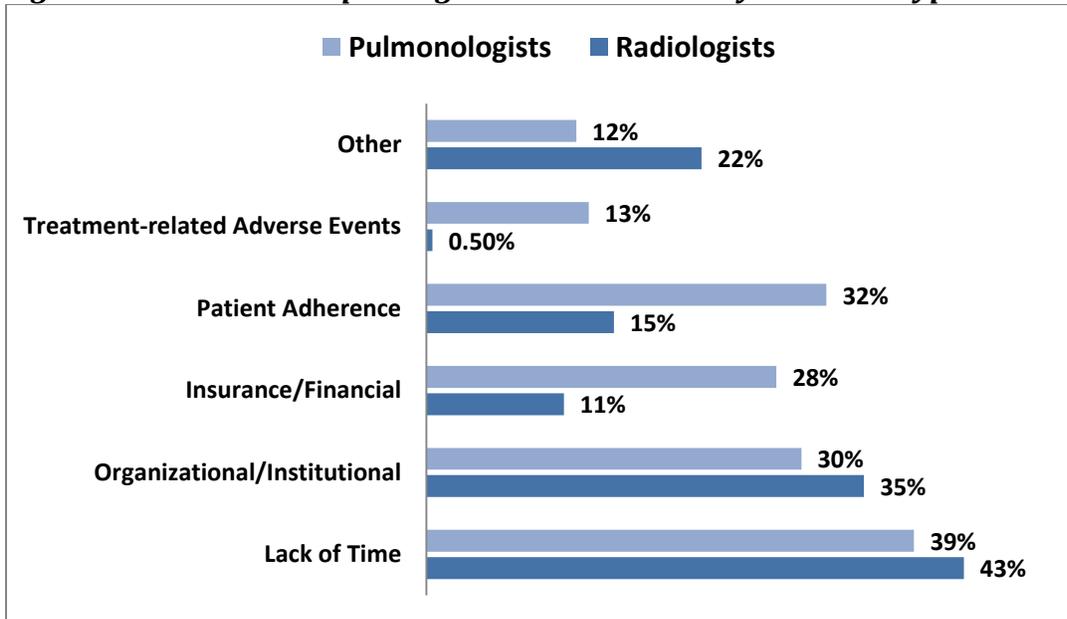

Pulmonologists ■ **Radiologists**

	Pulmonologists	Radiologists
None - Validated current practice	20%	20%
Modify treatment plans	20%	16%
Use alternative communication strategies with patients/families	0	12%
Incorporate different diagnositic strategies into patient evaluation	90%	68%
Change in my screening/prevention practice	40%	28%

(n=35)

Eighty percent (80%) of those who participated in the 45-day follow-up survey indicated that they retained the knowledge and competency learned from this CME activity with 98% indicating that this activity provided them with new ideas and information that they will use in their current practice.

Barriers to Improving Patient Outcomes

The two participant groups also identified different barriers to improving patient outcomes in their practices. The majority of radiologists consider lack of time and internal issues with their organization their biggest barriers, where pulmonologists identified lack of time and patient adherence as theirs. Notably, pulmonologists find that financial/insurance barriers significantly impact their patient outcomes more than radiologists (Figure 2).

Figure 2: Barriers to Improving Patient Outcomes by Attendee Type

(N=301)

"Other" free text comments for barriers include:
- HRCT underutilized in my hospital
- Lack of clinical information from providers
- Access to respiratory physician opinion/discussion
- Adequate radiology help
- Lack of history on x-ray request
- Lack of truly effective therapy
- Need for succinct online current reference

Areas of Ongoing Educational Need

Participant's answers to specific questions indicate a need for additional education in the areas of air trapping and differentiating categories of UIP. **Learners reported needing further and consistent instruction and reinforcement on reading HRCT.** "Interpretation in the diagnosis of IPF has inter and intra reader variation, thus there is a strong need for continued education related to the screening and diagnosis of IPF for pulmonologists and radiologists." –Dr. Jonathan Chung, Activity Chair

Thank you for your support!