Compliance with Fleischner Society Guidelines for Management of Small Lung Nodules: A Survey of 834 Radiologists[1]

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Purpose: To determine the familiarity of radiologists with the Fleischner Society guidelines for management of small lung nodules and to assess whether their decisions for nodule management are consistent with these recommendations.

Materials and Methods: Institutional review board exemption was granted for this electronic survey, which was sent to a sample of 7000 radiologists randomly selected from the Radiological Society of North America (RSNA) directory. Three clinical scenarios for nodule management were presented. Information about policies and guidelines for nodule management, awareness of published guidelines, and respondent demographics was obtained. Associations between these parameters and management recommendations were assessed by using a χ^2 test. Respondents were also asked about tube current settings for routine chest computed tomographic examinations and those performed solely for nodule follow-up.

Results: Of 834 respondents (response rate, 11.9%), 649 (77.8%) were aware of the Fleischner Society guidelines and 490 (58.8%) worked in practices that employed them or similar guidelines. Management selections were consistent with the Fleischner guidelines in 34.7%–60.8% of responses for the three scenarios. A significantly higher rate of concordance was associated with awareness of the Fleischner guidelines, presence of written policies based on them, a teaching practice setting, practice in a group with at least one member having chest radiology fellowship training, and fewer than 5 years of experience practicing radiology ($P < .05$ for all associations). The spectrum of tube current settings used was similar between the subgroups of respondents who were aware and those who were unaware of the Fleischner guidelines.

Conclusion: Among survey respondents, there was high awareness and adoption of the Fleischner guidelines, but radiologists showed varying degrees of conformance with these recommendations. Future efforts are necessary to bridge the gap between awareness and implementation of these evidence-based guidelines.

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Small (≤4 mm) pulmonary nodules have become a routine finding on computed tomographic (CT) scans in adults and present a dilemma for treating these patients (1). Until recently, the standard recommendation was to closely follow such incidentally detected nodules at frequent intervals for a period of 2 years; this recommendation required considerable health care resources and resulting in substantial radiation exposure (2).

On the basis of collective evidence that suggests that a varying but substantial number of such nodules are benign (3–5), the Fleischner Society issued a set of practical guidelines in 2005 for the management of very small pulmonary nodules that are incidentally detected during the course of CT examinations performed for purposes other than lung cancer screening ("Guidelines for Management of Small Pulmonary Nodules Detected on CT Scans: A Statement from the Fleischner Society," subsequently abbreviated in this manuscript as "Fleischner guidelines") (6). Although these guidelines are frequently accessed electronically (7), the degree to which they have been implemented in general radiology practice is unknown. Thus, the purpose of our study was to survey a large group of radiologists to determine their familiarity with the Fleischner guidelines and to assess whether their decisions for small pulmonary nodule management are congruent with the guidelines.

Materials and Methods

This retrospective study qualified for exempt status according to our hospital's institutional review board.

Survey Methods

In December 2008, an electronic survey was sent to a sample of 7000 radiologists throughout the United States to evaluate their current management strategies for the incidental discovery of a noncalcified nodule of 4 mm or smaller at chest CT examinations performed outside of research settings.

To achieve a sample of radiologists who were exposed to similar health care and medical-legal environments, we limited our survey recipients to radiologists practicing in the United States. Survey recipients were randomly selected from the entire 2007 membership directory of the Radiological Society of North America (RSNA). Questionnaires were sent to the e-mail address of every fourth individual in the directory. If this individual's address was not in the United States or an e-mail address was not provided for this member, the next person in the directory was selected to receive the questionnaire.

As shown in Appendix E1 (online), the survey included a variety of questions devoted to policies and guidelines for management of incidentally detected nodules. Respondents were also asked whether they were familiar with the Fleischner Society and American College of Chest Physician guidelines for the management of pulmonary nodules. These specific guidelines were selected because they represent the two major evidence-based nodule management guidelines published in the radiology and clinical literature within the past 5 years (1,6). Respondents were also asked whether they used a written policy for incidentally detected nodules in their practices and whether such a policy was internally developed or was based on guidelines published in the literature.

The survey included three clinical scenarios in which a small (≤4-mm) noncalcified nodule was incidentally detected. The following scenarios have been used in two previously published surveys (8,9) and are generally considered to be an accepted method for assessing radiologists' practice patterns in the management of noncalcified nodules.

Scenario 1: a young patient (<40 years of age).

Scenario 2: a patient 40 years of age or older with minimal or absent smoking history and no previous malignancy.

Scenario 3: a patient 40 years of age or older with a history of smoking or other known risk factor for malignancy but with no prior history of malignancy.

For each of these scenarios, respondents were asked to choose from among the following six management options for initial follow-up: *(a)* Nothing, nodule not mentioned in the report. *(b)* Nothing, nodule mentioned but no follow-up recommended. *(c)* Short-term CT follow-up (3–6 months). *(d)* Intermediate-term CT follow-up (12 months). *(e)* Recommend biopsy or surgical resection. *(f)* Nodule considered malignant or metastatic, no biopsy needed.

Additional survey questions related to the basic demographic information of respondents (including geographic location, type, and size of practice; presence of one or more fellowship-trained thoracic radiologists in the practice group; and years of practice

Advance in Knowledge

- There is high awareness and implementation of the Fleischner Society guidelines for the management of small lung nodules, but radiologists showed varying degrees of conformance with these recommendations.

Implication for Patient Care

- Full implementation of the Fleischner Society guidelines can potentially reduce the number of follow-up CT examinations, thus decreasing radiation exposure and health care costs.

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See also the editorial by McMahon in this issue.

experience), the perceived prevalence of incidentally detected nodules at routine CT examinations, the percentage of CT examinations performed solely for the purpose of nodule follow-up, and the CT tube current settings used for routine and follow-up CT examinations. The rationale for the latter questions was to determine whether respondents followed the recommendation of the Fleischner guidelines for using a low-dose technique for CT examinations performed solely for the purpose of nodule follow-up.

Statistical Analysis

For each scenario, the Fleischner guidelines were consulted to determine the "appropriate" management response. For scenarios 1 and 2, the appropriate response was no recommended follow-up (options *a* or *b*). For scenario 3, the appropriate response was intermediate-term follow-up (option *d*).

All statistical analyses were performed by using commercially available software (MedCalc, version 9.4.2.0; MedCalc, Mariakerke, Belgium). Normally distributed data were expressed as means ±1 standard deviation, and skewed distribution data were expressed as medians with upper and lower quartiles. Proportions were calculated and expressed as percentages. Comparisons between proportions were performed by using a χ^2 test, with all *P* values Bonferroni corrected. Statistical significance was set at the $P < .05$ level.

Results

Of the 7000 radiologists sent an electronic survey questionnaire, 834 (11.9%) responded. Tables 1 and 2 summarize the demographic information and work environment settings of the survey respondents.

Awareness of Published Guidelines

Of the 834 respondents, 649 (77.8%) were aware of the Fleischner guidelines. As shown in Table 3, higher rates of awareness of the Fleischner guidelines were reported among respondents with the following characteristics: *(a)* teaching hospital practice setting, *(b)* fewer than 5 years of experience practicing radiology, and *(c)* at least one member of their practice group having fellowship training in thoracic radiology.

Table 1

Demographic Data for 834 Respondents

Variable	No. of Respondents	Percentage of all Respondents*
Geographic distribution		
Northeast	239	28.7
Southeast	199	23.9
Central	165	19.8
West	116	13.9
Pacific	115	13.8
Granulomatous disease endemic in region?		
Yes	396	47.5
No	438	52.5
Practice setting		
Outpatient	101	12.1
Hospital	275	33.0
Both	458	54.9
No. of radiologists in group		
≤5	127	15.2
5–10	173	20.7
11–20	225	27.0
21–30	122	14.6
>30	187	22.4
Years of practice experience		
<5	66	7.9
5–9	156	18.7
10–19	309	37.1
≥20	303	36.3

* Percentages may not add up to 100% because of rounding.

Policy for Management of Small Nodules

Of the 834 respondents, 417 (50.0%) worked in practices that used the Fleischner guidelines, 73 (8.8%) worked in practices that used other available guidelines (eg, American College of Chest Physician guidelines), and 40 (4.8%) worked in practices that used an internally developed written policy. The remaining 304 (36.5%) respondents worked in practices that had no written policy (percentages may not add up to 100% because of rounding). Because the other guidelines used by respondents were similar to the Fleischner guidelines for management of small nodules, these 73 respondents were grouped together with the 417 respondents who worked in practices that used the Fleischner guidelines for comparison with the subgroups of respondents whose practices used either an internally developed written policy or no written policy.

Responses to Clinical Scenarios

Management selections were consistent with the Fleischner guidelines for 507 (60.8%) of 834 respondents in scenario 1, for 334 (40.0%) respondents in scenario 2, and for 289 (34.7%) respondents in scenario 3 (Table 4).

As shown in Figures 1–4 and Tables E1–E5 (online), several factors were associated with a higher rate of concordance of management selections with the Fleischner guidelines for one or more clinical scenarios. These included the following: awareness of the Fleischner guidelines, presence of written policies based on the Fleischner guidelines or similar guidelines, teaching hospital practice setting, practice in a group with at least one member with fellowship training in

Table 2

Practice Environment of 834 Respondents

Variable	No. of Respondents	Percentage of All Respondents*
Percentage of chest CT studies showing small nodules		
<25	360	43.2
26–50	329	39.4
51–75	116	13.9
>75	29	3.5
Percentage of chest CT examinations performed solely for follow-up of small nodules		
<10	579	69.4
10–25	212	25.4
26–50	37	4.4
51–75	6	0.7
>75	0	
No. of screening chest CT examinations per year		
0	244	29.3
1–50	298	35.7
51–100	93	11.2
101–200	71	8.5
201–300	34	4.1
>300	94	11.3
Written guidelines		
Fleischner or similar	490	58.8
Internally developed	40	4.8
None	304	36.5
Teaching hospital?		
Yes	113	13.5
No	721	86.5
One or more chest fellowship–trained members in group?		
Yes	245	29.4
No	589	70.6

* Percentages may not add up to 100% because of rounding.

Table 3

Awareness of Fleischner Guidelines among 834 Respondents

Group	Aware of Guidelines (%)	Unaware of Guidelines (%)
All respondents	77.8 (649/834)	22.2 (185/834)
Teaching hospital	89.4 (101/113)	10.6 (12/113)
Private practice	75.7 (546/721)	24.3 (175/721)
Chest fellowship training (at least one member in group)	88.6 (217/245)	11.4 (28/245)
No fellowship-trained radiologist in group	73.3 (432/589)	26.7 (157/589)
Fewer than 5 years of experience	84.8 (56/66)	15.2 (10/66)
20 Or more years of experience	71.9 (218/303)	28.1 (85/303)

Note.—Data in parentheses were used to calculate the percentages.

chest radiology, fewer than 5 years of experience practicing radiology, and a higher percentage of chest CT examinations with one or more small nodules.

There were no statistically significant differences in responses to the clinical scenarios on the basis of other factors, including the geographic location of the respondent (including regions in which granulomatous disease was endemic, $P = .292–.982$), practice environment (hospital, clinic, or both; $P = .295–.932$), and percentage of CT examinations performed solely for follow-up of small lung nodules ($P = .540–.977$).

CT Tube Current Settings

As shown in Table 5, almost half of the respondents did not know the tube current settings used for routine and follow-up chest CT examinations at their facilities. Of those who knew the tube current settings used, the spectrum of responses was similar for the subgroups of respondents who were aware and those who were unaware of the Fleischner guidelines. Moreover, the range of reported tube current settings was similar for both routine and follow-up examinations, suggesting that a low-dose technique was not routinely used for examinations performed solely for the purpose of nodule follow-up.

Discussion

Four years after the publication of the Fleischner Society guidelines for management of small pulmonary nodules detected at CT, our survey shows that nearly 80% of the responding radiologists are aware of the guidelines and 50% work in practices that have incorporated these or similar guidelines into their written policies. Despite these relatively high rates of awareness and adoption, we found that radiologists showed varying degrees of conformance (34.7%–60.8%) with these recommendations when asked to select management options for clinical scenarios in which a small nodule is incidentally detected at CT.

Although our results suggest that there is a relatively large gap between awareness and implementation of the Fleischner guidelines among radiologists, we emphasize that conformance is higher than that reported with evidence-based guidelines among nonradiologist physicians for a variety of indications (10–12). For example, in a survey of internists regarding the American Thoracic Society guidelines for the treatment of community-acquired

Figure 1

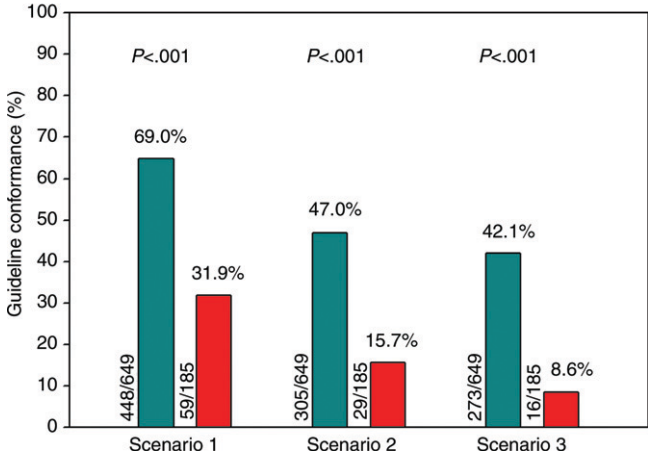

Figure 1: Bar graph shows percentages of radiologists among 834 survey respondents who were aware (teal) and those who were unaware (red) of the Fleischner guidelines for three clinical scenarios. Numbers are given as ratios of the raw numbers (bottom left of bar) and percentages (top of bar) with respective *P* values for pairwise comparisons (top of graph). Because the number of respondents was different between subgroups, percentages do not add up to 100%. Conformance with the Fleischner guidelines was significantly higher in all three scenarios among those who were aware of them than among those who were not.

Figure 2

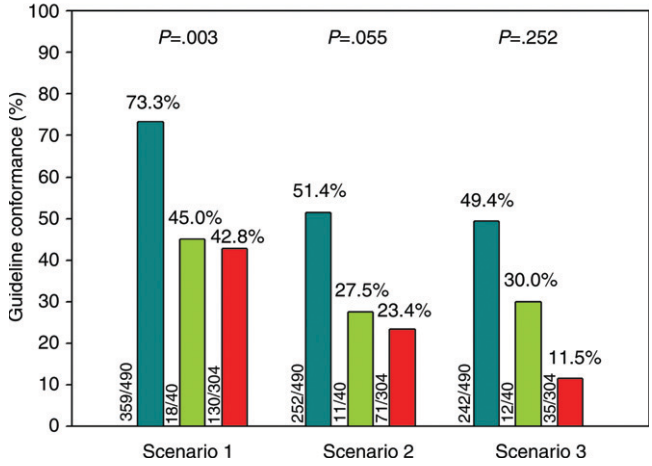

Figure 2: Bar graph shows Fleischner guideline conformance among 834 radiologists who incorporated the guidelines into a written policy for nodule management (teal), those who had internally developed written policies (lime), and those with no written policy at all (red). Numbers are given as ratios of the raw numbers (bottom left of bar) and percentages (top of bar) with respective *P* values for pairwise comparisons (top of graph). Because the number of respondents was different between subgroups, percentages do not add up to 100%. Conformance with the Fleischner guidelines was highest in all three clinical scenarios among those who incorporated them into a written policy for nodule management, but this was statistically significant only for scenario 1.

pneumonia (10), 80% of respondents were aware of the guidelines and 48% reported being "influenced" by them, but only 20% actually used them.

Because the Fleischner guidelines were designed to standardize the management of small nodules incidentally detected at CT and to reduce the overuse of short intervals (eg, 3 months) in follow-up CT studies, it is important to determine which factors may potentially enhance compliance. Such compliance has the potential to reduce the number of unnecessary follow-up CT examinations, in accordance with scientific evidence that shows that the follow-up of very small nodules prior to 1 year is unproductive, even among smokers at high risk for lung cancer (4). In our study, we found several factors that were associated with a higher rate of concordance of management selections with the Fleischner guidelines. These included awareness of the Fleischner guidelines, the presence of written policies based on the Fleischner or similar guidelines, a teaching hospital practice setting, practice in a group with at least one member with fellowship training in chest radiology, fewer than 5 years of experience practicing radiology, and a higher percentage of chest CT examinations with one or more small nodules.

Table 4

Overall Clinical Recommendations for Follow-up among 834 Responses

Recommendation	Scenario 1*	Scenario 2†	Scenario 3‡
No follow-up	507 (60.8)§	334 (40.0)§	30 (3.6)
Short-term follow-up	144 (17.3)	234 (28.1)	513 (61.5)
Intermediate-term follow-up	183 (21.9)	265 (31.8)	289 (34.7)§
Biopsy or resection	0	1 (0.1)	2 (0.2)

Note.—Data are numbers of responses, with percentages in parentheses.

* Age less than 40 years, no risk.

† Age 40 years or older, no risk.

‡ Age 40 years or older, high risk.

§ Fleischner guidelines recommendation.

Despite greater rates of conformance with the Fleischner guidelines among subsets of our respondents, the performance of all respondents was relatively poor in scenarios 2 and 3 compared with the performance in scenario 1. The reason for this difference in performance is uncertain but likely multifactorial. For example, we recognize that awareness of a guideline does not imply detailed knowledge or agreement and that adoption of a written policy does not necessarily translate into practice. Furthermore, a guideline is by definition only a "guide." It does not take into account personal experience and judgment, which may in part explain why more experienced radiologists were less likely to conform to the guidelines. Additionally, with respect to years of practice experience, we

Figure 3

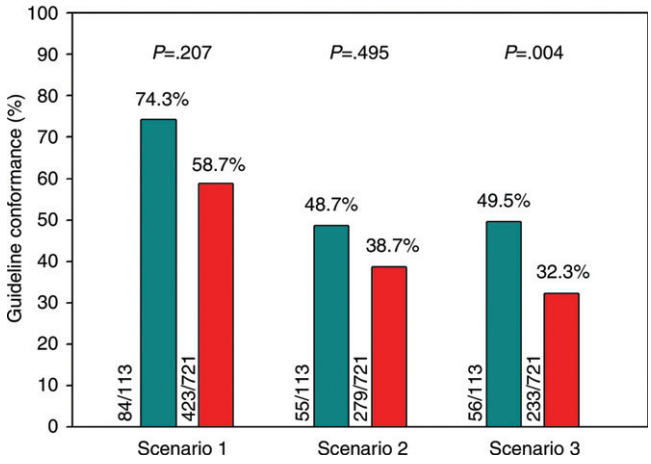

Figure 3: Bar graph shows Fleischner guideline conformance among radiologists practicing in teaching hospitals (teal) and those working in nonteaching facilities (red). Numbers are given as ratios of the raw numbers (bottom left of bar) and percentages (top of bar) with respective *P* values for pairwise comparisons (top of graph). Because the number of respondents was different between subgroups, percentages do not add up to 100%. Conformance with the Fleischner guidelines was higher in all three scenarios among those practicing in teaching hospitals than among those working in nonteaching facilities, but this difference was statistically significant only for scenario 3.

Figure 4

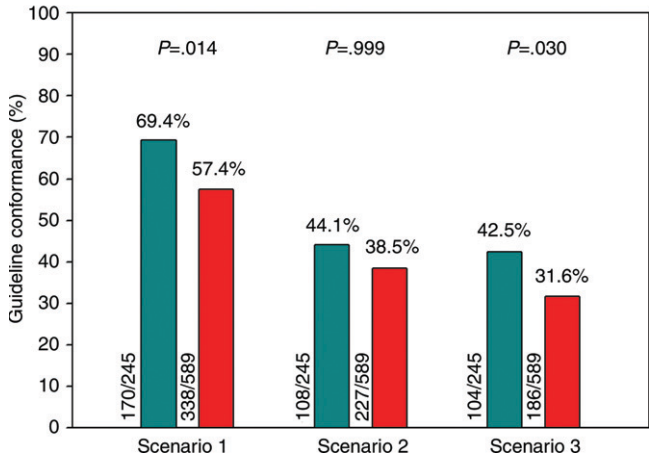

Figure 4: Bar graph shows Fleischner guideline conformance among radiologists practicing in a group with at least one member having fellowship training in chest radiology (teal) and those working in groups without a member having chest fellowship training (red). Numbers are given as ratios of the raw numbers (bottom left of bar) and percentages (top of bar) with the respective *P* values for pairwise comparisons (top of graph). Because the number of respondents was different between subgroups, percentages do not add up to 100%. Conformance with the Fleischner guidelines was higher in all three scenarios among those practicing in a group with at least one member having fellowship training in chest radiology. This difference was statistically significant for scenarios 1 and 3.

Table 5

Awareness of Fleischner Guidelines with Respect to Selection of Tube Current

Type of Examination and Tube Current Used (mAs)	Unaware of Guidelines ($n = 185$)	Aware of Guidelines ($n = 649$)
Screening CT		
≤40	2 (1.1)	4 (0.6)
41–60	11 (5.9)	21 (3.2)
61–100	19 (10.3)	72 (11.1)
101–140	29 (15.7)	167 (25.7)
>140	19 (10.3)	97 (14.9)
Unknown	105 (56.8)	288 (44.4)
Follow-up CT		
≤40	3 (1.6)	15 (2.3)
41–60	10 (5.4)	41 (6.3)
61–100	22 (11.9)	89 (13.7)
101–140	24 (13.0)	123 (19.0)
>140	19 (10.3)	75 (11.6)
Unknown	107 (57.8)	306 (47.1)

Note.—Data are numbers of respondents, with percentages in parentheses. Percentages may not add up to 100% because of rounding.

recognize that it may be more challenging for more experienced radiologists to change long-standing practice patterns as compared with radiologists who may have learned about the guidelines during their training and who have thus implemented them from the very start of their professional careers. Finally, our results could indicate a trend toward too early follow-up.

It is interesting to note that, among the respondents who knew the tube current settings at their practice, awareness of the Fleischner guidelines did not appear to be associated with the recommended use of a low-dose technique for CT examinations performed for follow up of small lung nodules. This could in part be due to the fact that the Fleischner guidelines article (6) recommends "a low-dose, thin-section, unenhanced technique" for follow-up examinations but does not define the specific scanning parameters. Thus, on the basis of our survey results, it appears that the major impact of the guidelines on radiation exposure is a reduction in the overall number of recommended follow-up CT examinations.

We acknowledge several limitations of our study. First, the response rate to our questionnaire was relatively low. However, it was comparable to that in other published studies in which physician surveys were used (13,14). Moreover, the overall number of respondents and their diverse demographics suggest that there was not a substantial

response bias in our survey. If, however, there was a response bias (which we can neither prove nor exclude), such a bias would probably have weighted the group of respondents toward individuals with awareness of the Fleischner guidelines. This should preclude an overly optimistic interpretation of our findings. Second, we acknowledge that our clinical scenarios lack the nuances that may be found in daily practice. However, such scenarios are considered a reasonable surrogate for determining practice patterns (8,9). Third, we did not provide the respondents with copies of the Fleischner or other guidelines. Although such information may have improved conformance, it would also have introduced potential bias. Fourth, because of the random nature of our selection process, it is likely that a small number of our respondents may be specialists in chest radiology. Although we were unable to separate such respondents from the larger group due to a lack of subspecialty practice information for our respondents, we assume that the anticipated small number of such respondents is unlikely to have substantially influenced the overall results of the larger sample.

In summary, although a majority of radiologists who responded to this survey are aware of the Fleischner guidelines and half have adopted them as written policy in their practices, there is considerable variability in their management recommendations for incidentally detected nodules. Future efforts are necessary to bridge the gap between awareness and implementation of these evidence-based guidelines.

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