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Addition of the Fleischner Society guidelines to chest CT exam interpretive reports improves adherence to recommended follow-up care for incidental pulmonary nodules

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Abstract

Rationale and Objectives—To determine whether the addition of the Fleischner Society guidelines to chest computed tomography (CT) reports identifying incidental pulmonary nodules affects follow-up care.

Patients and Methods—Beginning in 2008, a template containing the Fleischner Society guidelines was added at the interpreting radiologist's discretion to chest CT reports describing incidental solid pulmonary nodules at our institution. The records of all medical centers in [blinded] were used to capture the complete medical history of local patients >35 yo diagnosed with a pulmonary nodule from April 1, 2008–October 1, 2011. Patients with a history of cancer or previously diagnosed nodule, or who died before follow-up were excluded. Patients were categorized by whether they did (“template group”) or did not (“control group”) have the template added. Nodule size and smoking history were used to determine recommended follow-up care. Differences in follow-up were compared between groups using Pearson's Chi-Squared test.

Results—A total of 510 patients (276 template, 234 control) were included in the study. Only 198 patients (39%) received their recommended follow-up care. Template group patients were significantly more likely to receive recommended follow-up care compared to control group patients (45% vs. 31%, $p=0.0014$). Most patients whose management did not adhere to Fleischner Society guidelines did not receive a recommended follow-up chest CT (210/312, 67%).

Conclusions—The addition of the Fleischner Society guidelines to chest CT reports significantly increases the likelihood of receiving recommended follow-up care for patients with incidental pulmonary nodules. Additional education is needed to improve appropriate guideline utilization by radiologists and adherence by ordering providers.

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Keywords

Pulmonary nodule; radiology report; Fleischner Society; management guidelines

INTRODUCTION

Lung cancer accounts for approximately 27% of all cancer deaths and is the leading cause of cancer death among both men and women in the United States¹. The American Cancer Society estimates 221,200 new cases of lung cancer and 158,040 deaths from lung cancer for 2015¹. Patients with stage IA lung cancer have a five-year survival rate greater than 60%, however survival rates rapidly decline as the stage of disease increases.

With increasing utilization and improving resolution of computed tomography (CT), growing numbers of noncalcified solid pulmonary nodules are detected. In response to the need for follow up management of these incidentally found nodules, the Fleischner Society devised a set of evidence based recommendations in 2005². These recommendations classify patients at least 35 years old into low and high risk groups depending on smoking history, family history of lung cancer, or exposure to asbestos, radon, or uranium. Despite publication of such guidelines, follow up of solid pulmonary nodules has still been suboptimal. Eisenberg et al. reported only 79% of radiologists were aware of and only 59% of radiology practices employed such guidelines³.

In 2008, our institution began a quality improvement initiative where a standardized template of follow-up recommendations based on the Fleischner guidelines (Figure 1) was inserted into the official report of chest CT exams at the interpreting radiologist's discretion. Expectations were communicated to all radiologists that these procedures were to be employed for all solid noncalcified pulmonary nodules that could not be considered definitely as benign based on imaging appearance. However, little was known as to whether the insertion of this template affected ordering physician clinical practice patterns and follow-up care in these patients. The purpose of this study was to compare follow-up, including time to follow-up and type of imaging exam ordered, in local patients who received the template versus local patients who did not receive the template.

SUBJECTS AND METHODS

Study Population

The protocol for this study was HIPAA-compliant, approved by the [blinded] Institutional Review Boards, and carried out in accordance with the Declaration of Helsinki. The population for this study was derived from [blinded] County, [blinded] patients followed by the [blinded]. The [blinded] is a compilation of medical records of all healthcare providers in [blinded] County, enabling the longitudinal analysis of a local patient's complete medical history⁴⁻⁶. Residency status is estimated for all patients based upon mailing addresses to confirm whether a patient was a resident of [blinded] County during a particular timeframe. All patient data was retrieved from the archived medical records of [blinded].

The study population was derived from [blinded] County residents who received a chest CT exam at [blinded] from April 1, 2008 to October 1, 2011 where one or more solid pulmonary nodules were incidentally identified. Patients who were not residents at the time of CT exam or in the 14 months following the exam were excluded. Patients were also excluded if they 1) did not provide research authorization, 2) were ≥ 35 years old at the time of the exam, 3) had a prior history of lung transplantation or malignancy other than non-melanoma skin cancer 4) had a pulmonary nodule diagnosed by prior imaging, 5) had a non-solid or partially-solid nodule, 6) were diagnosed with lung cancer or had a lung mass suspicious for malignancy at the time of the CT exam, or 7) died before the recommended follow-up interval.

Data Retrieval

Patients who received a chest CT exam at [blinded] from April, 2008 to October, 2011 were initially identified using our radiology informatics system. A free text search was performed on the interpretive reports of these exams to identify reports that contained the terms “nodule” or “nodules.” An automated search was then performed on these reports to determine which ones contained the thoracic nodule template. Cases where the report did not include the template but did include specific follow-up recommendations that adhered to the Fleischner guidelines in the report text (n=24) were re-classified into the template group. The subspecialty of the interpreting radiologist was also retrieved. Automated searches were then performed using the [blinded] and institutional databases to identify and exclude any patients who did not provide research authorization, who were not residents during the study timeframe, who were under 35 years old at the time of exam, or who had a history of malignancy other than non-melanoma skin cancer.

The remaining included patients then underwent manual review of their CT report and medical records by [blinded]. All false positive reports (i.e. “No pulmonary nodules”, “Thyroid nodule detected”, etc.) were excluded. Patients with prior history of pulmonary nodules or cancer were identified and excluded. Four thoracic radiologists ([blinded]) reviewed all remaining reports to confirm that the nodule was not previously identified, that the nodule was not attributable to infection, and that the nodule was solid, and to confirm the largest size nodule documented in the report. The largest size of non-spherical nodules was determined by taking the average of the length and width of the nodule. Demographic information, including age, gender, and smoking history was retrieved by a combination of automated retrievals, review of patient provided information, and manual chart review.

All potential pulmonary nodule follow-up imaging exams and procedures, including chest CT, positron emission tomography/CT (PET/CT), and biopsy, performed in the 14 months following the initial chest CT exam were retrieved by a combination of automated retrieval and chart review. All identified exams and procedures were manually reviewed to determine whether they were performed for nodule follow-up. Exams performed for other indications were excluded. Specialty of the ordering provider of the initial chest CT exam and all follow-up exams was retrieved. All referrals to Pulmonology were identified in the 14 months following the initial chest CT exam for patients whose initial CT exam was not ordered by a pulmonologist. Referrals for reasons other than the incidental nodule were

excluded. Patients who died before their recommended follow-up timeframe were identified and excluded.

Defining adherence to Fleischner guidelines

Largest nodule size reported and smoking history were used to determine the recommended follow-up care for each patient as per the Fleischner guidelines. Included patients were classified into four subgroups based on the largest nodule size reported (≤ 4 mm, >4 – 6 mm, >6 – 8 mm, and >8 mm). Patients were defined as high risk if they had any history of smoking. Adherent follow-up for low-risk patients with nodules ≤ 4 mm was defined as no further imaging. Adherent follow-up for all other patients was defined as the recommended modality (CT, PET/CT, biopsy) occurring in the recommended month plus or minus additional months to account for scheduling (± 1 month window for recommended follow-up at 3 months or 6–12 months, ± 2 months window for recommended follow-up at 12 months). Deviation from the recommended modality or timeframes was classified as non-adherent follow-up. Non-adherent follow-up was further categorized by whether 1) guidelines recommended follow-up imaging but it was not performed, 2) guidelines did not recommend follow-up imaging but it was performed, 3) follow-up imaging was performed too early (before the recommended timeframe window), or 4) follow-up imaging was performed too late (after the recommended timeframe window).

Statistical analysis

Statistical analyses were performed using JMP 9 (Cary, NC). Linear regression was used to examine whether there was a significant increasing or decreasing trend in template utilization and adherence to Fleischner guidelines over the study timeframe. Significant differences in clinical characteristics (age, largest nodule size, high vs. low risk) between the template and control groups were determined using the Wilcoxon Rank-Sum test for continuous variables and Pearson's Chi-Squared test for categorical variables. Pearson's Chi-squared test was used to compare adherent follow-up rates between the template and control patient groups. Significant differences were defined as $p < .05$.

RESULTS

A total of 510 patients (276 template patients, 234 control patients) met all inclusion criteria (Figure 2). Patients in the template group had similar clinical characteristics compared to patients in the control group (Table 1). Half of the cohort had a history of smoking and was considered high risk. Patients with large nodules were more likely to have the template added to their reports compared to patients with small nodules (>8 mm 18/30, 60% vs. ≤ 4 mm 141/284, 50%). Chest CT exams interpreted by thoracic radiologists were significantly more likely to have the template added compared to exams read by other radiology subspecialists ($p < .0001$). The template was more likely to be added to exams ordered by primary care and pulmonary providers compared to exams ordered by emergency department (ED) providers or other specialties. Within the study cohort, radiologist utilization of the template significantly increased over time from 41% (55/135) of all reports in 2008 to 69% (67/97) of all reports in 2011 ($p = .0271$, Supplemental Figure 1).

Only 198 patients (39% of cohort) received their recommended follow-up care (Table 2). There was a non-significant increase in adherence to Fleischner guidelines over the study timeframe from 36% (49/135) to 46% (45/97) ($p=.14$, Supplemental Figure 1). Template patients were significantly more likely to receive their recommended follow-up care compared to control patients (45% (125/276) vs. 31% (73/234), OR=1.80 (95% CI 1.27–2.63), $p=.0014$). This trend was observed for all patient age and nodule size subgroups, with a larger effect noted for patients with nodules between 4 and 8 mm (OR 3.94, $p=.0043$ for >4–6mm and OR 5.76, $p=.0172$ for >6–8mm) compared to patients with nodules larger than 8 mm (OR 1.40, $p=.72$). High risk patients who had the template added were significantly more likely to receive recommended follow-up care compared to high risk control patients (37% (53/143) vs. 12% (15/124), OR=4.28 (2.26–8.10), $p<.0001$, however the template did not affect follow-up care in low risk patients ($p=.90$). The template had a larger effect on guideline adherence when patients were diagnosed with multiple nodules compared to solitary nodules and when the exam was ordered by pulmonologists, ED providers, and other specialties compared to primary care providers.

Of the 312 patients who did not receive their recommended follow-up care, the majority ($n=210$, 67%) did not have a follow-up chest CT exam ordered when follow-up was recommended (Table 3). The percent of patients who did not have any follow-up when recommended was similar between template and control patients (66% (100/151) vs. 68% (110/161), respectively). Template patients were more likely to have a chest CT exam ordered when not recommended (15% (23/151) vs. 6.8% (11/161)) compared to control patients. Control patients were more likely to have a chest CT exam ordered too early (14% (22/161) vs. 6.6% (10/151) or have a biopsy or PET/CT ordered when not recommended (1.9% (3/161) vs. 0.7% (1/151)) compared to template patients. Similar findings were observed when examining the nodule size subgroups.

The specialty of the provider who ordered the initial chest CT exam had a direct effect on whether patients received their recommended follow-up care (Table 4). Fleischner guideline adherence was lowest in patients where the initial chest CT exam was ordered by ED providers (31%, 47/154) and highest in patients where the exam was ordered by pulmonologists (49%, 22/45). Patients whose initial chest CT exam was ordered by primary care providers were less likely to not have follow-up imaging ordered as recommended, but more likely to have recommended follow-up imaging ordered too late compared to patients whose initial exam was ordered by other specialties. Almost all cases of lung biopsy or PET/CT overutilization occurred in patients whose initial exam was ordered by primary care providers (75%, 3/4).

A small percentage of patients whose initial chest CT exam was not ordered by a pulmonologist were subsequently referred to Pulmonology because of their incidental nodule (Supplemental Table 1, 11%, 51/414). Demographics and template utilization were similar between referred and non-referred patients. Patients with larger nodules were significantly more likely to be referred to a pulmonologist compared to patients with smaller nodules (6.9% (18/259) of patients with < 4 mm nodules to 32% (9/28) of patients with >8 mm nodules, $p=.0002$). Patients referred to a pulmonologist were significantly more likely to

receive their recommended follow-up care than patients that were not referred (51% (26/51) vs. 36% (150/414), $p<.0001$).

DISCUSSION

Our study of 510 local patients found that the addition of the Fleischner Society guidelines to the interpretive report of chest CT exams where incidental pulmonary nodules are noted significantly increased the likelihood of receiving recommended follow-up care. This increase was consistently observed for all patient age and nodule size groups. These findings indicate that the content and structuring of interpretive reports has a large effect on how ordering providers structure follow-up care and healthcare delivery. However, overall adherence to follow-up care was low, and most patients did not receive a follow-up chest CT exam ordered as recommended. While both template utilization and adherence to Fleischner guidelines increased over the timeframe of this study, additional education and electronic medical record (EMR) tools could further improve patient care.

We found that the addition of the Fleischner guideline template had a larger positive effect on the likelihood of receiving recommended follow-up care in patients with nodules between 4–8 mm compared to patients with nodules > 8 mm. While the addition of the template did not affect whether patients were subsequently referred to a pulmonologist for nodule management, referred patients were more likely to receive their recommended follow-up care, possibly because patients with larger nodules were more likely to be referred. This finding suggests that clinicians are more aware of follow-up guidelines for large nodules but may be less certain of how to manage smaller nodules. Additional awareness of the Fleischner guidelines, which provide a standardized approach for follow-up based on nodule size, appears to help clinicians better manage these patients with smaller nodules.

Prior studies have also demonstrated that the structure of interpretive reports can affect follow-up care for incidental pulmonary nodules. Elias et al. compared follow-up in patients before ($n=17$) and after ($n=72$) the implementation of an institutional template and observed an increased rate of appropriate follow-up after implementation (35% before vs. 57% after), with significant improvement observed in high-risk patients (11% before vs. 51% after)⁷. Woloshin et al surveyed 447 clinicians and found that an example report that included the Fleischner Society guidelines had higher adherence to recommended follow-up than a report without these guidelines (72% vs. 32%, respectively)⁸. Blagev et al examined 99 CT pulmonary angiography exams and determined that incidental pulmonary nodule follow-up rates were highest for reports when the nodule was noted in the impression (47%) compared to reports where specific follow-up was recommended (29%) or reports where the nodule was only mentioned in the findings (0%)⁹. Our current study improves upon these prior studies in several ways. First, we examined a substantially larger cohort of patients over a longer period of time to confirm that the addition of the template significantly improves follow-up care. Second, we limited our analysis to local patients and medical centers to minimize the possibility that patients received follow-up care elsewhere. Third, we specifically examined the effect of the medical specialty of the ordering provider on adherence to the Fleischner Society guidelines.

Low utilization of Fleischner guidelines by interpreting radiologists and low adherence to recommended follow-up imaging by ordering providers have also been reported by prior studies^{9–13}. Multiple factors might have influenced the radiologist's decision to add the Fleischner Society guideline template, including training, established personal practice patterns, the presence of other more urgent findings in the report, and the decision to offer specific follow-up guidelines instead of using a template. Additional education and communication among radiologists and between radiologists and ordering providers could improve both utilization and adherence. Our study suggests that targeting education at specific specialties and subspecialties, such as non-thoracic radiologists, primary care providers, and ED providers, would be the most effective strategy to improve utilization and adherence. In addition, automated EMR search tools and trigger algorithms could be utilized. Lu et al demonstrated that implementation of a clinical decision support tool improved the adherence of radiologists to departmental guidelines for managing pulmonary nodules¹⁴. These tools could be used to identify new interpretive reports diagnosing incidental pulmonary nodules and ensure that a template with recommended follow-up care is added to the report before it is finalized. Natural language processing and triggering algorithms could also be used to monitor patients who have been diagnosed with an incidental pulmonary nodule in order to remind providers that follow-up imaging is needed. For example, Murphy et al demonstrated that a medical record-based triggering algorithm can help identify patients who did not receive timely follow-up for abnormal lung findings¹⁵. Automated medical record software tools can be complex and complicated to implement, however they would have the potential to be much more time- and cost-effective compared to manual monitoring.

The Fleischner Society guideline template used by our institution contains all potential recommendations for follow-up based on patient risk and largest nodule size. This generic template may create confusion and increase the risk of non-adherent follow-up care compared to using one recommendation tailored to the patient. As evidence for this hypothesis, we observed that template group patients were more likely to have a CT ordered when it was not recommended compared to control group patients. Adding individualized follow-up guidelines would increase the likelihood that patients receive their recommended follow-up care; however reviewing patient history in order to create a personalized recommendation can be time-consuming for the interpreting radiologist. One alternative could be to have the provider classify the patient as high or low risk when the chest CT exam was ordered to minimize chart review by the radiologist. Another option could be to incorporate medical record searches and natural language processing to automatically determine patient risk and nodule size and assign the correct recommendation to each patient.

Several study limitations exist. First, our findings are representative of a select group of patients and providers at a small number of medical centers in one geographic location. Other practices may observe different rates of utilization of similar Fleischner Society guideline templates and adherence to recommended follow-up care for incidental pulmonary nodules. Second, while we specifically chose a cohort of local patients who most likely received care only at the included medical centers, any follow-up imaging performed at outside centers would not have been captured in our analysis. Third, certain patient

subgroups may have been insufficiently powered to detect significant differences between template and control groups due to small sample sizes. Fourth, an analysis of long-term outcomes in relation to template and guideline utilization was outside of the scope of this study. Finally, as this study was retrospective in nature we were unable to confirm whether the presence or absence of the template truly affected follow-up care, or determine whether deviations from recommended follow-up guidelines were attributable to patient or provider choices.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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GUIDELINES FOR FOLLOW-UP of solid nodules detected incidentally at CT (newly detected indeterminate nodule in persons 35 years of age or older).~ These apply to solitary pulmonary nodules or multiple pulmonary nodules. If multiple nodules are present, then the **size of the largest nodule** determines follow-up.

NODULE SIZE (mm)* LOW-RISK PATIENT@

4 or less	No further follow up
>4-6	CT at 12 mo; If unchanged, no further follow-up
>6-8	CT at 6-12 mo then at 18-24 mo if no change
>8	Consider immediate work up with contrast-enhanced CT or PET, or biopsy or follow-up with CT imaging at 3, 9, and 24 mo

NODULE SIZE (mm)* HIGH-RISK PATIENT+

4 or less	CT at 12 mo; If unchanged, no further follow-up
>4-6	CT at 6-12 mo then at 18-24 mo if no change
>6-8	CT at 3-6 mo then at 9-12 and 24 mo if no change
>8	Consider immediate work up with contrast-enhanced CT or PET, or biopsy or follow-up with CT imaging at 3, 6, 12 and 24 mo

*Average of length and width

@Minimal or absent history of smoking and of other known risk factors

+History of smoking or of other known risk factors

~Nonsolid (ground-glass) or partly solid nodules may require longer follow-up to exclude indolent adenocarcinoma

Figure 1.
Template added to chest CT exam reports identifying incidental pulmonary nodules.

Figure 2.
Study Population Flowchart.

Table 1

Study demographics

	Template group	Control group	p value
N	276	234	
Age at CT scan	60 (49–72)	64 (51–75)	.0512
Age groups			.27
35–49	75 (27%)	51 (22%)	
50–64	86 (31%)	71 (30%)	
>=65	115 (42%)	112 (48%)	
Year of scan (median, IQR)	2010 (2009–2010)	2009 (2008–2010)	<.0001
Female sex	135 (49%)	121 (52%)	.53
Past or current smoker (high risk)	143 (52%)	124 (53%)	.79
Solitary nodule reported (vs. multiple)	128 (46%)	99 (42%)	.36
Largest nodule size reported			.14
<=4mm	141 (51%)	143 (61%)	
>4–6mm	86 (31%)	55 (24%)	
>6–8mm	31 (11%)	24 (10%)	
>8mm	18 (6.5%)	12 (5.1%)	
CT report read by thoracic radiologist (vs. other subspecialty)	182 (66%)	82 (35%)	<.0001
CT scan ordering provider specialty *			.0072
Primary care	95 (34%)	58 (25%)	
ED	68 (25%)	86 (37%)	
Pulmonary	29 (11%)	16 (6.8%)	
Other specialty	84 (30%)	74 (32%)	

*="Primary care" includes family practice, internal medicine, and preventative medicine. "Other specialties" includes critical care, surgery, oncology, neurology, and cardiovascular specialties.

Table 2

Effect of template on adherence to Fleischner guidelines

	Template group	Control group	Odds ratio (95% CI) *	p value
N	276	234		
Guidelines followed				
All patients	125 (45%)	73 (31%)	1.83 (1.27–2.63)	.0014
By largest reported nodule				
<=4mm	74/141 (53%)	59/143 (41%)	1.57 (0.98–2.51)	.07
>4–6mm	28/86 (33%)	6/55 (11%)	3.94 (1.51–10.3)	.0043
>6–8mm	14/31 (45%)	3/24 (13%)	5.76 (1.42–23.4)	.0172
>8mm	9/18 (50%)	5/12 (42%)	1.40 (0.32–6.11)	.72
By patient risk				
High risk	53/143 (37%)	15/124 (12%)	4.28 (2.26–8.10)	<.0001
Low risk	72/133 (54%)	58/110 (53%)	1.06 (0.64–1.76)	.90
By number of nodules reported				
Solitary nodule	53/128 (41%)	32/99 (32%)	1.48 (0.85–2.56)	.16
Multiple nodules	72/148 (49%)	41/135 (30%)	2.17 (1.33–3.54)	.0017
By patient age				
35–49	30/75 (40%)	14/51 (27%)	1.76 (0.82–3.80)	.18
50–64	39/86 (45%)	24/71 (34%)	1.63 (0.35–3.11)	.19
>=65	56/115 (49%)	35/112 (31%)	2.09 (1.21–3.59)	.0099
By initial CT exam ordering provider specialty				
Primary care	38/95 (40%)	27/58 (47%)	0.77 (0.40–1.48)	.50
ED	26/68 (38%)	21/65 (24%)	1.92 (0.96–3.83)	.08
Pulmonary	17/29 (59%)	5/16 (31%)	3.12 (0.86–11.3)	.12
Other specialty	44/84 (52%)	20/74 (27%)	2.97 (1.52–5.79)	.0019

* Odds of template group vs. control group.

Table 3

Types of non-adherence to Fleischner guidelines

	Template group	Control group	p value
All patients with non-adherent follow-up	151	161	.0400
Chest CT not ordered when recommended	100 (66%)	110 (68%)	
Chest CT ordered when not recommended	23 (15%)	11 (6.8%)	
Chest CT ordered too soon	10 (6.6%)	22 (14%)	
Chest CT ordered too late	17 (11%)	15 (9.3%)	
Biopsy/PET ordered when not recommended	1 (0.7%)	3 (1.9%)	
Largest nodule <=4mm	67	84	.0137
Chest CT not ordered when recommended	37 (55%)	53 (63%)	
Chest CT ordered when not recommended	23 (34%)	11 (13%)	
Chest CT ordered too soon	3 (4.5%)	12 (14%)	
Chest CT ordered too late	4 (6.0%)	7 (8.3%)	
Biopsy/PET ordered when not recommended	0	1 (1.2%)	
Largest nodule >4-6mm	58	49	.42
Chest CT not ordered when recommended	41 (71%)	35 (71%)	
Chest CT ordered when not recommended	0	0	
Chest CT ordered too soon	7 (12%)	9 (18%)	
Chest CT ordered too late	9 (16%)	4 (8.2%)	
Biopsy/PET ordered when not recommended	1 (1.7%)	1 (2.0%)	
Largest nodule >6-8mm	17	21	.52
Chest CT not ordered when recommended	15 (88%)	15 (71%)	
Chest CT ordered when not recommended	0	0	
Chest CT ordered too soon	0	1 (4.8%)	
Chest CT ordered too late	2 (12%)	4 (19%)	
Biopsy/PET ordered when not recommended	0	1 (4.8%)	
Largest nodule >8mm	9	7	.48
Chest CT not ordered when recommended	7 (77%)	7 (100%)	
Chest CT ordered when not recommended	0	0	
Chest CT ordered too soon	0	0	
Chest CT ordered too late	2 (22%)	0	
Biopsy/PET ordered when not recommended	0	0	

Table 4

Guideline adherence by initial chest CT exam ordering provider specialty

	Primary care [*]	ED	Pulmonary	Other specialties [*]
All patients (n)	153	154	45	158
Unique ordering providers (n)	89	37	27	127
Adhered to guidelines (% of all patients)	65 (42%)	47 (31%)	22 (49%)	64 (41%)
No imaging ordered as recommended (% of adhered)	35 (54%)	21 (45%)	14 (64%)	41 (64%)
Imaging ordered as recommended	30 (46%)	26 (55%)	8 (36%)	23 (36%)
Did not adhere to guidelines	88	107	23	94
CT not ordered when recommended (% of non-adhered)	54 (61%)	76 (71%)	16 (70%)	64 (68%)
CT ordered when not recommended	11 (13%)	10 (9.4%)	2 (8.7%)	11 (12%)
CT ordered too soon	6 (6.8%)	9 (8.4%)	3 (13%)	11 (12%)
CT ordered too late	14 (16%)	9 (8.4%)	2 (8.7%)	7 (7.5%)
Biopsy or PET/CT ordered when not recommended	3 (3.4%)	0	0	1 (1.1%)

^{*} =“Primary care” includes family practice, internal medicine, and preventative medicine. “Other specialties” includes critical care, surgery, oncology, neurology, and cardiovascular specialties.