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Heinz, Sabine A; Yakar, Derya; Kwee, Thomas C

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Recommendations in Second Opinion Radiology Reports of Abdominal Imaging Examinations: Referring Clinicians' Compliance and Diagnostic Outcome

Sabine A. Heinz¹
Derya Yakar
Thomas C. Kwee

OBJECTIVE. The purpose of this study was to investigate how often referring clinicians comply with recommendations in second opinion radiology reports of abdominal imaging examinations, determinants of their compliance, and diagnostic outcome of recommendations.

MATERIALS AND METHODS. This retrospective study included 2225 consecutive tertiary center second opinion radiology reports of abdominal imaging examinations performed at outside institutions.

RESULTS. Referring clinicians followed 163 of 307 recommendations, corresponding to a frequency of 53.1% (95% CI, 47.5–58.6%). Logistic regression analysis showed no significant association between referring clinicians' compliance and any of the investigated variables, which included patient age, sex, hospitalization status, indication for reinterpretation, strength and clarity of the recommendation, whether the recommendation was made because of perceived insufficient quality of the original imaging examination, and experience of the radiologist who performed the reinterpretation. Of the 275 recommendations that were eligible for a subanalysis on diagnostic outcome, 147 (53.5%) were followed by the referring clinicians and yielded a malignant diagnosis in 30 cases (20.4%). Of the 128 recommendations that were not followed, the advice would have yielded a malignant diagnosis in four cases (3.1%) if it had been followed. The proportions of malignant diagnoses were significantly different between the recommendations that were followed and those that were not ($p < 0.001$), favoring a higher proportion of the former.

CONCLUSION. Recommendations in second opinion reports of abdominal imaging examinations are frequently followed by referring clinicians, but it remains unclear as to which factors influence their compliance. These recommendations lead to a malignant diagnosis in a considerable number of cases.

Second opinion interpretations of imaging examinations originating from nonacademic hospitals are commonly performed at tertiary care centers [1]. At our institution, they account for approximately 3.6% of all procedures performed, and abdominal imaging examinations constitute the vast majority of secondary interpretations. Secondary interpretations may have clinical value. For example, a study of 398 secondary interpretations of abdominal imaging examinations reported that 20 primary reports (5.0%) had high clinical impact interpretative discrepancies, whereas none of the secondary reports contained any high clinical impact discrepancies when compared with the final diagnosis made on the basis of clinical notes, pathologic examination, and subsequent imaging studies [2]. Several other studies have reported similar findings [3–9].

Importantly, the radiology report of the secondary interpretation may contain a recommendation to the referring clinician to perform further diagnostic tests, whether imaging or otherwise, to clarify findings of indeterminate nature. There is a lack of literature on how frequently recommendations in second opinion radiology reports are followed by referring clinicians and what determinants, if any, affect referring clinicians' compliance. Furthermore, the diagnostic outcome of recommendations in second opinion radiology reports remains unclear. Because the number of secondary interpretations and associated cumulative healthcare costs have risen considerably [1], insight into the practice and value of recommendations in second opinion radiology reports has become increasingly important. This information may be useful to improve communica-

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¹All authors: Department of Radiology, Medical Imaging Center, University Medical Center Groningen, University of Groningen, Hanzeplein 1, PO Box 30.001, 9700 RB Groningen, The Netherlands. Address correspondence to D. Yakar (d.yakar@umcg.nl).

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tion between the referring clinician and the radiologist who performs the secondary interpretation and to verify the hypothesis that these recommendations by subspecialty radiologists add clinical value.

The purpose of this study was therefore to investigate how often referring clinicians comply with recommendations in second opinion radiology reports of abdominal imaging examinations, determinants of their compliance, and diagnostic outcome of recommendations.

Materials and Methods

Study Design

This retrospective, single-center study was approved by the local institutional review board of the University Medical Center Groningen, and informed consent was waived. A research fellow reviewed 2225 second opinion radiology reports of abdominal imaging examinations originating from nonacademic hospitals. The second opinion interpretations were performed at our tertiary care center within a consecutive 12-month period (November 25, 2016, to November 24, 2017), following a similar methodologic approach to the one used in a study on FDG PET/CT examinations [10]. Secondary interpretations were included if they contained a recommendation for additional imaging or other diagnostic tests. Reports with recommendations for additional diagnostic tests that would have been performed anyway (i.e., following an institutional guideline or protocol), and recommendations for which compliance could not be assessed at the time of the study (e.g., a recommendation to request older imaging examinations performed elsewhere for comparison) were excluded.

Practice of Secondary Interpretations

Secondary interpretations are performed by subspecialty radiologists at our institution after approval of the treating clinician's request and upload of the imaging examination in our institutional PACS. Treating clinicians have to follow this formal procedure to obtain a second opinion report. Curbside consultations are not accepted.

Data Extraction

The following general variables were extracted for each secondary abdominal imaging report: patient age, patient sex, hospitalization status (inpatient or outpatient) at the time of the secondary interpretation, indication for the imaging examination (infectious, inflammatory, oncologic, trauma, vascular, or miscellaneous), and years of experience of the most senior radiologist signing the report of the secondary interpretation (calculated from the completion of residency). Furthermore, the following variables were assessed in regard

to the recommendation: type of recommendation, strength of the recommendation (hard [with wording such as "it is advised to" or "it is indicated to"] or soft [with wording such as "it can be considered to" or "it is suggested to"]), clarity of the description of the recommendation (specific recommendation [with wording such as "referral to urology" or "compare with previous scans"] or no specific recommendation [with wording such as "further evaluation" or "clinical follow-up"]), whether the recommendation was made because of perceived insufficient quality of the original imaging examination, and the compliance of the referring clinician to the recommendation.

Compliance of the referring clinician was determined as follows: after the procedure or procedures recommended in the second opinion report were identified, patient records were scrutinized to determine whether the procedure took place. If a recommended procedure was identified in the hospital information system after the second reading, records were examined for a connection to the second reading, subsequently including or excluding this procedure as resulting from the second reading.

The diagnostic outcome of the recommendation was determined on the basis of all available subsequent examinations that were conducted within a 1.5-year follow-up period. Five diagnostic outcome groups were defined for each potential finding in the secondary abdominal imaging report for which a recommendation for further diagnostic testing was issued: a malignant diagnosis was established (i.e., cancer); a benign diagnosis was established; a benign diagnosis needing further follow-up was established (e.g., benign neoplasm diagnosis according to the D10–D36 section of the 10th revision of the International Statistical Classification of Diseases and Related Health Problems) needing further long-standing follow-up according to treatment guidelines; a potential finding in the secondary abdominal imaging report was no longer detectable at the time of further diagnostic testing; and the nature of a potential finding in the secondary abdominal imaging report could not be determined although additional diagnostic tests may have been performed. Recommendations resulting from perceived insufficient quality of the original imaging examination were excluded from this diagnostic outcome analysis.

Statistical Analysis

The frequency of examinations with a recommendation as a proportion of the total amount of secondary abdominal imaging interpretations was calculated. In addition, the frequency of referring clinicians' compliance with the recommendations made in the secondary abdominal reports was cal-

culated. Association of this compliance with patient age, patient sex, hospitalization status, indication for the reinterpretation, strength and clarity of the recommendation, insufficient quality of the original imaging examination, and experience of the most senior radiologist who signed the report was determined using univariate logistic regression. Frequencies of diagnostic outcomes according to the aforementioned five groups were calculated, and differences were assessed using the Fisher exact test. Any *p* values less than 0.05 were considered statistically significant. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) (version 25, IBM).

Results

Recommendations and Patients

The 2225 second opinion readings (327 of which involved a reinterpretation of multiple imaging modalities) included 1839 (71.8%) CT scans, 668 (26.1%) MRI studies, 31 (1.2%) sonographic examinations, 14 (0.5%) fluoroscopic examinations, and 10 (0.4%) conventional radiographic examinations. Of the 2225 reports, 273 (12.3%) contained at least one recommendation for additional imaging or further diagnostic tests.

Of these 273 reports, 217 (79.5%) contained recommendations for additional imaging, 22 (8.1%) involved recommendations for both additional imaging and other examinations, and 34 (12.5%) included recommendations for further examination other than imaging. Distribution of male and female patients was 119 (43.6%) and 154 (56.4%), respectively. Mean patient age $\pm$ SD was 55.6 ± 19.1 years old (range, 0–90 years old), and the majority of patients (96.3%) were outpatients. Most reinterpretations were for oncologic indications (71.8%), followed by miscellaneous reasons (24.5%), infectious indications (1.5%), and inflammatory, traumatic, and vascular indications (each 0.7%). Experience of the subspecialty radiologist who performed the secondary interpretation ranged from 0 to 30 years, with a mean of 4.4 ± 3.2 years.

Ten recommendations were excluded, eight because they would have been performed anyway according to institutional protocol and two because compliance to the recommendation could not be assessed. Because 27 reports contained two recommendations, six had three recommendations, and one had five recommendations, the total number of recommendations in the remaining 264 reports amounted to 307 recommendations for additional imaging or other examinations (Fig. 1).

Clinician Compliance With Second Opinion Reports

Fig. 1—Pie chart shows distribution of number of recommendations in 264 second opinion abdominal imaging reports that contained at least one recommendation. Blue indicates reports with one recommendation ($n = 230$), red indicates reports with two recommendations ($n = 27$), green indicates reports with three recommendations ($n = 6$), and purple indicates report with five recommendations ($n = 1$).

Table 1 provides detailed information on recommendation characteristics.

Frequency and Determinants of Clinician Compliance With Recommendations

Referring clinicians complied with 163 of 307 recommendations, corresponding to a frequency of 53.1% (95% CI, 47.5–58.6%). Univariate logistic regression showed no significant association between referring clinicians' compliance with a recommendation and any variable, including patient age, patient sex, hospitalization status, indication for the reinterpretation, strength of the recommendation, clarity of the description of the recommendation, whether the recommendation was made because of perceived insufficient quality of the original imaging

TABLE 1: Recommendations Made in Secondary Abdominal Imaging Reports

Variable	No. (%) of Patients
Type of recommendation	
Recommendation for additional diagnostic imaging	245 (79.8)
Recommendation for tissue sampling ^a	26 (8.5)
Recommendation for additional diagnostic examination other than imaging	7 (2.3)
Referral to a specific subspecialty	14 (4.6)
Recommendation for clinical follow-up	5 (1.6)
Other	10 (3.3)
Strength of the recommendation	
Hard	124 (40.4)
Soft	183 (59.6)
Clarity of the recommendation	
Specific recommendation	278 (90.6)
No specific recommendation	29 (9.4)
Recommendation made due to quality issues of the available imaging examination	
Yes	32 (10.4)
No	275 (89.6)
Referring clinicians' compliance	
Recommendation followed exactly	134 (43.6)
Recommendation followed in an alternative way	29 (9.4)
Recommendation not followed	144 (46.9)

Note—A total of 307 recommendations were made in 264 of the 2225 reviewed reports.

^aIncludes recommendations for tissue sampling, either with or without a specification for image-guided tissue sampling.

examination, or experience of the radiologist who performed the reinterpretation. Table 2 provides additional details on univariate logistic regression.

Diagnostic Outcome of Recommendations Made in Secondary Abdominal Imaging Reports

Of the total 307 recommendations, 32 were excluded from this subanalysis because they

were made as a result of perceived insufficient quality of the original imaging examination.

The majority of the remaining 275 recommendations in this subanalysis involved hepatopancreatobiliary organs ($n = 152$, 55.3%), followed by the genitourinary tract ($n = 45$, 16.4%) and the lung ($n = 18$, 6.5%). Other areas included lymph nodes ($n = 10$, 3.6%), breast ($n = 9$, 3.3%), and the digestive tract

TABLE 2: Univariate Logistic Regression of the Association of Potential Determinants and Clinician Compliance With Recommendations in Second Opinion Reports

Potential Determinant	Univariate Analysis	
	OR	<i>p</i>
Patient age (y, continuous scale)	0.99 (0.98–1.00)	0.115
Patient sex (male vs female)	1.36 (0.87–2.14)	0.183
Hospitalization status (inpatient vs outpatient)	0.88 (0.28–2.79)	0.827
Indication for reinterpretation (oncologic vs others)	0.95 (0.57–1.56)	0.824
Strength of the recommendation (hard vs soft)	1.40 (0.88–2.22)	0.151
Clarity of description of recommendation (specific vs nonspecific)	1.97 (0.90–4.33)	0.090
Recommendation made because of perceived insufficient quality of original imaging examination (yes vs no)	0.87 (0.42–1.81)	0.711
Experience of radiologist giving second opinion (y, continuous scale)	0.96 (0.89–1.03)	0.238

Note—Values in parentheses are 95% CI. OR = odds ratio.

Fig. 2—Pie charts show distribution of diagnostic outcome by recommendations in second opinion abdominal imaging reports. Dark blue indicates malignant diagnosis ($n = 34$), red indicates benign diagnosis ($n = 71$), green indicates benign diagnosis needing follow-up ($green, n = 8$), purple indicates finding no longer detectable ($n = 7$), and light blue indicates outcome could not be determined ($n = 155$).

A, Hepatopancreatobiliary system ($n = 152$).

B, Genitourinary system ($n = 45$).

C, Lung ($n = 18$).

D, Lymph nodes ($n = 10$).

E, Breast ($n = 9$).

F, Digestive tract ($n = 5$).

G, Other organ systems or body areas ($n = 36$).

($n = 5$, 1.8%). A further 36 (13.1%) recommendations involved other areas such as the lumbar spine and pelvic bones. Figure 2 provides details on the diagnostic outcome for each of these areas.

Of the 275 recommendations in this sub-analysis, 147 (53.5%) were followed by the referring clinicians, and they led to a malignant diagnosis in 30 cases (20.4%). Of the 128 that were not followed, the advice would have led to a malignant diagnosis in four cases (3.1%) if it had been followed. In all four cases, recommendations were made for a test that added no value because of earlier diagnostic tests of which the radiologist was not informed at the time of the second opinion reading. The proportions of malignant diag-

noses were significantly different between the recommendations that were followed and those that were not ($p < 0.001$). Figure 3 and Table 3 provide further details on diagnostic outcome of the recommendations.

Discussion

Recommendations for additional diagnostic tests (imaging or otherwise) are commonly issued in radiology reports. In this series of more than 2000 secondary abdominal imaging reinterpretations, 12.3% contained at least one such recommendation to the referring clinician. Even though the mean number of years of experience since completion of residency for the radiologists in this study was fairly short (4.4 ± 3.2 years), that did not

necessarily lead to a higher number of recommendations. Previous studies have found that experience should be viewed not only in number of years or number of imaging examination reports but also in terms of personal ability and talent [11, 12]. Until now, there has been a lack of data on the downstream handling and outcome of recommendations in second opinion reports compiled by subspecialty radiologists. This study found that only a slight majority of these recommendations (53.1%) are followed by the clinicians who requested the second opinion readings.

To gain an understanding on why some recommendations are followed but some are not, we investigated several potential determinants, including patient age, sex,

Clinician Compliance With Second Opinion Reports

Fig. 3—Bar graph shows diagnostic outcomes of 275 recommendations (32 of 307 total recommendations were excluded from this subanalysis because they pertained to insufficient quality of original imaging examination). Recommendations that were followed by referring clinician are shown in blue; those that were not followed are shown in red.

hospitalization status, indication for the re-interpretation, strength and clarity of the recommendation, and experience of the radiologist who performed the re-interpretation, but none proved to be significant. Surprisingly, clinicians were not likely to follow a recommendation that was made because of perceived insufficient quality of the original imaging examination. Overall, the reasons why recommendations in secondary reports are followed by referring clinicians remain somewhat elusive. In light of these findings (i.e., slightly less than half of all recommendations are not followed, and none of the investigated determinants were found to be significantly associated with referring clinicians' compliance), we hypothesize that many requested secondary interpretations

are redundant and do not add to clinical decision making, regardless of any recommendation given by the subspecialty radiologist in the report. Further research is necessary to verify this hypothesis, to identify factors that can prospectively predict which secondary interpretations are clinically futile, and to determine the cost-effectiveness of second opinion readings, along with a sensitivity analysis. Such an effort has the potential to reduce healthcare overutilization and associated costs. On the other hand, a nonnegligible proportion of recommendations that were followed by the referring clinicians (20.4%) led to a malignant diagnosis, and this proportion of malignant diagnoses was significantly higher than that of recommendations that were not followed (3.1%). This result sug-

gests that recommendations by subspecialty radiologists in second opinion reports may add clinical value in some instances, possibly because the interpretation of the radiologist is enhanced when relevant additional clinical information is provided by the referring physician. This assumption seems to be supported by the four cases in which the recommendation that would have led to a malignant diagnosis was not followed because other appropriate diagnostic tests were already performed. However, in all four cases, the radiologist had no information about the prior diagnostic tests at the time of the second opinion reading.

Although there is a lack of literature on recommendations in second opinion reports, some studies have examined this issue for primary radiology reports. Harvey et al. [13] analyzed 29,318 outpatient chest radiographs obtained at a tertiary care center. They aimed to evaluate association of the wording of radiologist recommendations for chest CT with the likelihood of recommendation adherence and the diagnostic yield of the recommended follow-up CT. Harvey et al. reported an adherence rate to radiologists' recommendations of 59.1%, which is similar to that of this study. They also reported that strong wording of the recommendation had a significant association with the performance of the recommended follow-up CT within 90 days ($p < 0.001$) [13]. However, there was no significant difference between the strong and weak recommendation groups with regard to the incidence of clinically relevant findings ($p = 0.16$) or malignancy ($p = 0.08$) [13]. The latter two findings reported by Harvey et al. were not seen in our study. This discrepancy can be explained by the fact that our study involved second opinion readings of abdominal imaging examinations and included recom-

TABLE 3: Established Diagnostic Outcome, According to Referring Clinicians' Compliance

Referring Clinicians' Compliance, Diagnostic Outcome	Manner in Which Diagnosis Was Established
Recommendation followed exactly	
Cholangiocarcinoma	ERCP including cytologic brush
Lymph node metastases	FDG PET/CT
Prostate carcinoma	Biopsy
Recommendation not exactly followed	
Liver adenoma	Follow-up of the liver lesion was done using sonography instead of the recommended MRI
Recommendation not followed	
Hepatocellular carcinoma	Histopathologic examination of surgically excised liver part instead of recommended CT or MRI examination
Hemangioma	No morphologic change of the liver lesion on a follow-up MRI after 14 months instead of recommended biopsy

mentations for both imaging and other diagnostic tests. In another study, Mabotuwana et al. [14] investigated the presence of additional imaging recommendations and adherence rates to these recommendations for two sites in datasets of 923,885 and 763,059 radiologic examinations, respectively, using automated follow-up detection and matching algorithms. Reported frequencies of recommendations were 11.4% and 20.9%, respectively, with overall adherence rates of 51.9% and 52.0% [14]. Although Mabotuwana et al. did not report on second opinion readings, the frequencies and adherence rates they reported are similar to those in this study. However, the study by Mabotuwana et al. used an automated search strategy, did not consider recommendations for additional examinations other than imaging, did not investigate determinants of referring clinicians' compliance to recommendations, and did not examine consequences in terms of diagnostic yield. In contrast, a study by Lee et al. [15] evaluated 11,751 pediatric radiology reports that contained 526 (4.5%) recommendations and reported clinicians' compliance with 96% of recommendations. Referring clinicians' compliance was associated with point of care, that is, whether the patient was treated in the emergency department as an inpatient or an outpatient ($p = 0.001$), but not with type of communication ($p = 0.33$), study type ($p = 0.51$), or type of follow-up recommendation ($p = 0.23$) [15]. Differences in frequency of recommendations and adherence rates between the Lee et al. study and ours may be explained by population differences, because incidental findings for which recommendations are made occur less commonly in children, but the number of life-years at stake is higher.

Our study had several limitations. First, it was performed at a tertiary care center in The Netherlands, where neither radiologists nor referring clinicians have any financial incentives to either give or adhere to a recommendation. This situation might influence frequency of and adherence rates to recom-

mendations. Thus, our results may not be applicable in other healthcare systems. Second, this study included second opinion reports of abdominal imaging examinations mostly performed with outpatients, and the results may be different in other radiology subspecialties or more balanced populations of inpatients and outpatients. Third, the influence of other potential determinants on clinician compliance with recommendations in second opinion reports, such as skill and reputation of the subspecialty radiologist, experience of the referring clinician, and input of multidisciplinary meetings, were not assessed because these variables lack objective measures. In addition, we could not determine whether referring clinicians actually read the second opinion reports because the notes in the electronic patient records provided limited information regarding the referring clinician's awareness of the recommendation. Fourth, the influence of the recommendations in the second opinion reports on treatment planning, prognostication, and patient outcome was not determined.

In conclusion, recommendations in second opinion reports of abdominal imaging examinations are frequently followed by referring clinicians, but it remains unclear as to which factors influence their compliance. These recommendations lead to a malignant diagnosis in a considerable number of cases.

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