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Guideline Compliance Regarding Chest Imaging of Suspicious cT1 Renal Masses in MUSIC-KIDNEY

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Full-length article available at https://doi.org/10.1097/UPJ.0000000000000408.

Study Need and Importance: Although recommended by most major urological societies, appropriate chest imaging for staging of patients who present with renal masses is often overlooked. Moreover, the guidelines remain vague for determining which patients should get staging exams and what type of imaging study should be ordered.

What We Found: A significant proportion of patients presenting with renal masses do not get staging chest imaging of any type. This remained true in renal masses greater than 5 cm. Despite Michigan Urological Surgery Improvement Collaborative guideline dissemination, education, and value-based reimbursement incentive, completion of recommended imaging and type was not routinely performed (see Figure). At the practice level, significant variation in compliance with chest imaging remained.

Limitations: Our study excluded higher-stage renal cell carcinoma at presentation and only focused on stage I renal cell carcinoma. Additionally, we only looked at imaging rates related to radiographical renal mass size and did not incorporate other clinical findings. There are some inherent limitations to the data collection, including reason for chest imaging and whether it was ordered and not completed.

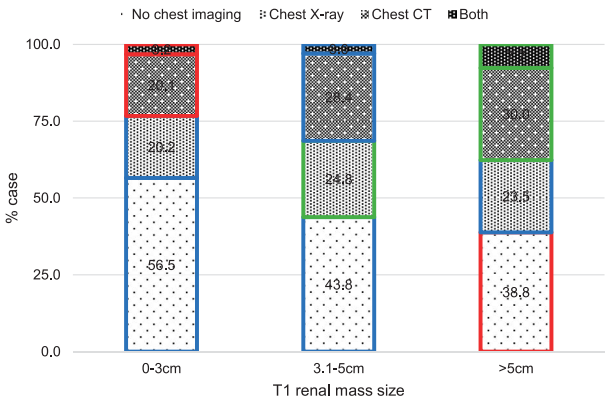

Figure. Percentage of cases with no chest imaging, chest x-ray, computerized tomography (CT), or both sorted by renal mass size. As size of renal mass increases, recommendations for chest imaging performance of type chance. The colored borders represent whether chest imaging performance or type is acceptable (blue), recommended (green), or not recommended (red) in each size stratum.

Interpretation for Patient Care: Across a statewide collaborative with a variety of practice types and settings represented, compliance with guidelines for staging chest imaging remains low. Even in patients presenting with renal masses greater than 5 cm, recommended imaging is not obtained, potentially resulting in missed metastatic disease.

https://doi.org/10.1097/UPJ.0000000000000408
Vol. 10, 327-333, July 2023
Published by Wolters Kluwer

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Guideline Compliance Regarding Chest Imaging of Suspicious cT1 Renal Masses in MUSIC-KIDNEY

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Abstract

Introduction: Multiple urological societies recommend chest imaging for suspicious renal masses using chest x-ray or CT as clinically indicated. The purpose of chest imaging is to assess for thoracic metastasis at the time of renal mass diagnosis. Ideally, imaging use and type are commensurate with risk related to tumor size and clinical stage. We examined current practice patterns with chest imaging compliance in the state of Michigan and implemented clinician education and value-based reimbursement incentivization on guideline adherence.

Methods: MUSIC (Michigan Urological Surgery Improvement Collaborative)-KIDNEY (Kidney mass: Identifying and Defining Necessary Evaluation and therapY) is a statewide initiative focusing on quality improvement for patients with cT1 renal masses. Data regarding chest imaging in MUSIC and panel discussion occurred at an in-person MUSIC meeting in October 2019. Adherence to chest imaging guidelines was made a value-based reimbursement metric at the triannual MUSIC meeting in January 2020. Adherence was defined as optional in renal masses <3 cm (CT not indicated), recommended in renal masses 3-5 cm (chest x-ray preferred), and required in renal masses >5 cm (CT preferred). The MUSIC registry was queried for percentage of patients receiving chest imaging by type. Factors associated with adherence were assessed.

Results: There was significant practice-level variation in chest imaging rates across the 14 contributing practices, ranging from 11% to 68%. Compliance with MUSIC guidelines for chest imaging during evaluation of T1 renal masses was 81.8% overall, with only 61.8% of patients with masses >5 cm meeting the guideline requiring imaging with preference for CT. Factors associated with increased adherence included larger tumor size (T1b vs T1a) and solid (vs cystic or indeterminate) tumor ($P < .05$ for each). Prior to value-based reimbursement introduction, 46.7% of patients underwent imaging of either type, compared to 49.0% post-intervention. Imaging rates

Submitted February 1, 2023; accepted April 28, 2023; published April 7, 2023.

Support: AS, JQ, and AJ received support from Blue Cross Blue Shield of Michigan, which sponsors MUSIC.

Conflict of Interest: The Authors have no conflicts of interest to disclose.

Ethics Statement: All participating sites received Institutional Review Board approval for their ongoing participation in MUSIC quality improvement efforts.

Author Contributions: Data analysis and interpretation: AS, AJ, JQ, KG, SN; Conception and design: AS, AJ, BL, KG; Critical revision of the manuscript for scientific and factual content: AS, AJ, JQ, KG, SN; Drafting the manuscript: AS, BL; Supervision: AS, AJ, BL, KG; Administrative support: AS, AJ, BL, JQ, KG, SN; Collaboration and discussion with co-authors to reach the final objectives of this manuscript: AS, AJ, BL, JQ, KG, SN; Statistical analysis: JQ; Other: SN.

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https://doi.org/10.1097/UPJ.0000000000000408
Vol. 10, 327-333, July 2023
Published by Wolters Kluwer

only slightly increased in masses >5 cm (58.3% before value-based reimbursement vs 61.2% after, $P = .56$) and 3-5 cm (50.0% before value-based reimbursement vs 56.2% after, $P = .0585$).

Conclusions: Chest imaging guideline adherence during the initial evaluation of cT1 renal masses is acceptable, particularly given that most masses are <3 cm, for which metastatic risk is low. However, despite consensus from major urological societies regarding imaging for masses >4-5 cm, imaging rates were low across MUSIC. After educational and value-based reimbursement incentive initiation, rates of imaging for 3-5−cm and >5-cm masses changed only slightly. There remains significant practice variability and room for improvement.

Key Words: kidney neoplasms, cell carcinoma, renal cell

Chest imaging is recommended by the AUA, European Association of Urology (EAU) and the National Comprehensive Cancer Network (NCCN) as part of the initial workup for a suspicious renal mass for detection of thoracic metastasis. The chest is the second most common site of synchronous metastasis in cT1 renal cell carcinoma (RCC) with about 25% of metastasis at presentation occurring in the lung.[1,2] The guidelines remain quite vague when it comes to stratification of who should get chest imaging and what type of imaging is recommended. The AUA lists this as a "clinical principle," indicating that this intervention is widely agreed upon by urologists, but there is a gap in the evidence to support it.[3] The AUA, EAU, and NCCN guidelines state that chest CT scan should be done for higher-risk tumors, patients who present with symptoms concerning for chest metastasis, and those with concerning chest x-ray (CXR). These statements do not offer guidance based on tumor size or decision to pursue treatment.[4,5]

Multiple series have demonstrated that as the size of a renal mass increases, the rate of synchronous lung metastasis proportionally increases.[1,6] Imaging use and type should therefore be commensurate with the oncologic risk of the tumor, which is conveyed by size. When evaluating a patient with a renal mass, urologists are limited in most cases to radiographic imaging to ascertain tumor risk, with size and clinical tumor stage being the most pertinent characteristics. Advanced imaging and renal mass biopsy may aid in more precise tumor risk stratification, and incorporation of these in a renal mass workup supports a risk-based approach to an individual's metastatic evaluation.

The Michigan Urological Surgery Quality Improvement Collaborative (MUSIC) launched the KIDNEY (Kidney mass: Identifying and Defining Necessary Evaluation and therapY) program in 2017.[7] It is primarily a quality improvement (QI) initiative for management of localized T1 renal masses. There are 17 practices and 100 physicians who are currently participating in MUSIC-KIDNEY, and this division of MUSIC continues to grow. MUSIC is unique in that data are collected for thousands of patients evaluated at a wide array of practice types and settings, and include roughly 90% of the practices in the state of Michigan. This gives us a true representation of urological practice in the state of Michigan.[8] Perhaps more importantly, rather than functioning as merely a data registry, the collaborative provides multiple avenues for interaction between participating urologists, enabling cross-pollination of ideas, observation of, and learning from best practices, all in a noncompetitive, collaborative environment.[9] Areas that are deemed to be particularly important in the quality of care delivered to patients are identified and supported by value-based reimbursements (VBRs) to the practices when goals are achieved. Additionally, education and updates are presented triannually at collaborative-wide meetings.

Although obtaining chest imaging is widely accepted by urologists as a necessary part of the workup for renal mass patients, rates of imaging were noted to be low in MUSIC.[10] This is likely representative of a more global issue of non-adherence to guidelines that extends further than the state of Michigan. The objective of this project was to ascertain current urological practice in the state of Michigan for chest staging dependent on renal mass size and observe adherence to perform appropriate chest imaging during workup of patients with renal masses after educational sessions and introduction of the VBR metric.

Methods

MUSIC-KIDNEY started collecting data in 2017, and currently there are 3,550 patients enrolled. Data are collected by trained abstractors at each site, initially at least 120 days after initial presentation. This process has been previously described.[7] Patients who were studied included those with a new diagnosis of cT1 renal mass, regardless of plan for treatment or surveillance. Patients were excluded if they had a clinically benign renal mass (angiomyolipoma or simple cyst), if the tumor size was greater than 7 cm, and if there was known nodal or metastatic disease. Data on patient and tumor characteristics were collected on each patient including age, race, Charlson Comorbidity Index, tumor size, and tumor descriptions (complex cyst, indeterminate, or solid). Additionally, information about practice type, practice volume, initial management plan, and follow-up afterward were collected.

The physician-led KIDNEY working group, composed of experienced kidney surgeons in Michigan, met in May 2019. At that meeting, guidelines for chest imaging within MUSIC based on size of renal mass were discussed and a consensus was reached. Adherence was defined as optional chest imaging in renal masses <3 cm (CT not indicated), recommended in renal masses 3-5 cm (CXR preferred), and required in renal masses >5 cm (CT preferred; Figure 1).

Panel discussion regarding chest imaging practice and preferences took place at the in-person MUSIC meeting in June 2019. The focus was on current status of guidelines (AUA, NCCN, EAU), review of the literature regarding risk of synchronous and metachronous thoracic metastases in renal cancer, a discussion of whether these provided sufficient guidance at present, or whether additional guidance was felt to be needed and of benefit. Consensus was obtained. At the October 2019 meeting, presentation on the current state of chest imaging performance according to the guidelines discussed in May was presented, accompanied by education on the utilization and importance of chest imaging. After seeing the low degree of adherence to chest imaging guidelines, it was incentivized by creating a VBR metric surrounding this issue with a goal of 55% adherence overall. This was announced at the triannual MUSIC meeting in January 2020. At that time, placards explaining MUSIC recommendations were distributed for physicians to reference in their offices (Figure 1).

The primary outcome of interest was chest imaging utilization within 6 months of initial clinical visit, as well as guideline-compliant imaging (as defined in Figure 1). Given the aforementioned MUSIC collaborative-wide meeting timeline and topic of discussion, 2 time periods were defined: pre-intervention (prior to January 10, 2019) and post-intervention (January 2, 2020, and later). Chest imaging utilization during these 2 periods was compared to understand the impact of MUSIC meeting on chest imaging adoption within the state.

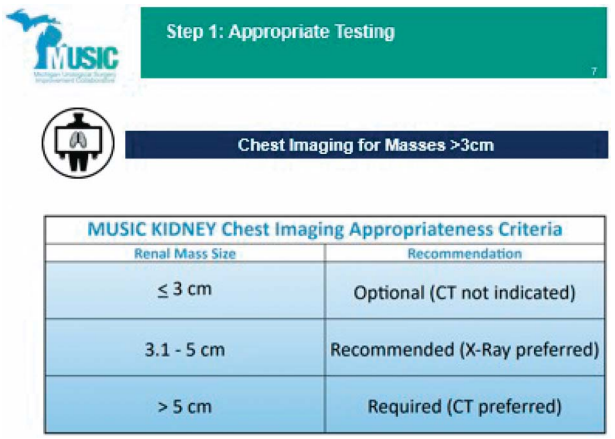

Figure 1. Placard distributed to Michigan Urological Surgery Improvement Collaborative (MUSIC) urologists which demonstrates recommendations for chest imaging performance and type based on tumor size. CT indicates computerized tomography; KIDNEY, Kidney mass: Identifying and Defining Necessary Evaluation and therapY.

Clinical and demographic characteristics of patients were compared between those who had chest imaging vs those who did not using χ^2 test for categorical measures and Wilcoxon rank-sum test for continuous measures. Among sites with at least 5 patients, practice-level variation on the use of chest imaging during the pre-intervention period was assessed. The rate of chest imaging before vs after intervention was compared—overall and stratified by tumor size group (0-3 cm, 3.1-5 cm, and >5 cm)—using χ^2 test. Compliance in chest imaging was also assessed for each tumor size group.

Results

A total of 3,550 patients met the inclusion criteria, of which 1,674 (47.2%) had chest imaging. The Table demonstrates differences in patient characteristics between those who had chest imaging and those who did not. Patients who underwent chest imaging tend to have higher Charlson Comorbidity Index score, larger tumors, solid tumors, and were more likely to have treatment as opposed to surveillance for initial management ($P < .05$ for each). In addition, patients with chest imaging were more likely to be treated at academic sites and higher-volume sites ($P < .05$ for each).

Prior to intervention, significant practice level variation on chest imaging utilization was observed, with chest imaging rates ranging from 11% to 68% overall across 10 sites. For 0- to 3-cm and 3.1- to 5-cm tumors, the range was 13% to 62% and 21% to 73%, respectively. Even for tumors greater than 5 cm, with more clear indications for imaging, rates varied from 17% to 82%.

Overall, no significant difference in chest imaging utilization was observed before vs after intervention (46.7% vs 49.0%, $P = .19$). This was also the case when looking at each tumor size subgroup: among those with 0- to 3-cm tumors, 42.6% patients had chest imaging in the pre-intervention and 43.4% in the post-intervention group. For 3.1- to 5-cm tumors, 50.0% and 56.2% had chest imaging in pre- and post-intervention groups, respectively. For 5.1- to 7-cm tumors, the rates were 58.2% and 61.2%.

Figure 2 demonstrates the type of imaging performed by tumor size. Among patients with 0- to 3-cm tumors (n=1,117), 78.7% of patients had guideline-compliant imaging, including 57.5% without imaging and 20.2% with CXR only. In the 3.1- to 5-cm category (n=552), the recommendation was for some type of imaging, with CXR being the preferred type, but chest CT being acceptable as well. The data show that 53.6% patients

Table.
Relationship Between Patient and Tumor Factors on Chest Imaging Compliance Upon Diagnosis of cT1 Renal Mass

Variable	All		No chest imaging		Chest imaging		*P* value
No. patients	3,550		1,876		1,674		
Age, median (IQR), y	65.0 (56.0-74.0)		66.0 (56.0-74.0)		65.0 (55.0-73.0)		.09
Age, No. (%), y							.311
≤50	595	(16.8)	299	(15.9)	296	(17.7)	
51-70	1,738	(49.0)	919	(49.0)	819	(48.9)	
>70	1,217	(34.3)	658	(35.1)	559	(33.4)	
Race, No. (%)							.057
White	2,721	(76.6)	1,414	(75.4)	1,307	(78.1)	
African American	469	(13.2)	251	(13.4)	218	(13.0)	
Other/unknown	360	(10.1)	211	(11.2)	149	(8.9)	
Charlson Comorbidity Index, No. (%)							< .001
0	1,773	(50.0)	1,044	(55.7)	729	(43.6)	
1	712	(20.1)	390	(20.8)	322	(19.3)	
≥2	1,063	(30.0)	442	(23.6)	621	(37.1)	
Tumor size, median (IQR), cm	2.7	(1.8-4.0)	2.5	(1.7-3.6)	2.9	(2.0-4.3)	< .001
Tumor stage, No. (%)							< .001
T1a	2,709	(76.3)	1,519	(81.0)	1,190	(71.1)	
T1b	841	(23.7)	357	(19.0)	484	(28.9)	
Tumor type, No. (%)							< .001
Solid	2,751	(77.5)	1,297	(69.1)	1,454	(86.9)	
Complex cyst	275	(7.7)	189	(10.1)	86	(5.1)	
Indeterminate	524	(14.8)	390	(20.8)	134	(8.0)	
Treatment decision, No. (%)							< .001
No treatment	1,730	(48.7)	1,040	(55.5)	690	(41.2)	
Treatment	1,819	(51.3)	835	(44.5)	984	(58.8)	
Practice type, No. (%)							< .001
Academic	844	(23.8)	290	(15.5)	554	(33.1)	
Private/community based	229	(6.5)	133	(7.1)	96	(5.7)	
Hybrid	2,477	(69.8)	1,453	(77.5)	1,024	(61.2)	
Practice annualized volume							< .001
≤30 renal masses/y	290	(8.2)	197	(10.5)	93	(5.6)	
>30 renal masses/y	3,259	(91.8)	1,679	(89.5)	1,580	(94.4)	

in this group had guideline-compliant imaging, including 24.8% with CXR only, 25.9% with CT only, and 2.9% with both. In the >5-cm category (n=186), the recommendation was that chest imaging was required, with CT scan being the preferred method. Only 61.8% of patients in this group had guideline-compliant chest imaging, including 25.8% with CXR only, 29.0% with CT only, and 7.0% with both. Even in the greater than 5 cm group, 38.2% patients still had no imaging at all.

Discussion

Despite national guidelines and consensus that chest imaging should be performed on patients with concern for higher-risk tumors, compliance with chest imaging remains low. In the state of Michigan, we observed that roughly half of patients do not receive chest imaging despite recommendations for either CXR or CT scan as appropriate for tumor size. The AUA and NCCN guidelines lack explicit recommendations regarding imaging type related to patient- and tumor-specific characteristics as well as future management plans.[3-5]

In MUSIC, we described a set of recommendations for chest imaging related to tumor size, as this is a readily available parameter in the evaluation of every renal mass. Several studies have quantified risk of metastasis stratified by radiographic tumor size. In a recent analysis of the National Cancer Database, 25,838 patients from a contemporary cohort were studied. The risk of synchronous lung metastasis in renal masses less than 4 cm was found to be uniformly low with a maximum of 1.3% in each centimeter size stratification, although not zero. Beyond 4 cm, the risk of synchronous metastasis increased with each centimeter increase, with 2.2% for masses 4.0-4.9 cm, 4.1% for masses 5.0-5.9 cm, 6.9% for masses 6.0-6.9 cm, and 10.5% for masses 7.0-7.9 cm.[6] This trend continued, up to 23.4% of patients with synchronous metastasis who presented with tumors greater than 10 cm.[11] Data from the MUSIC database mirrors. Multiple other studies have also shown similar trends and rates of metastasis related to tumor size.[12,13]

Chest imaging rates were still low with 48.9% of patients not receiving any imaging at all, even in the largest size strata, despite this category having a legitimate risk of synchronous pulmonary metastasis at diagnosis. Of patients with >5 cm masses in MUSIC, only 36.0% received a CT scan, which was the recommended imaging type. Further, only 61.9%

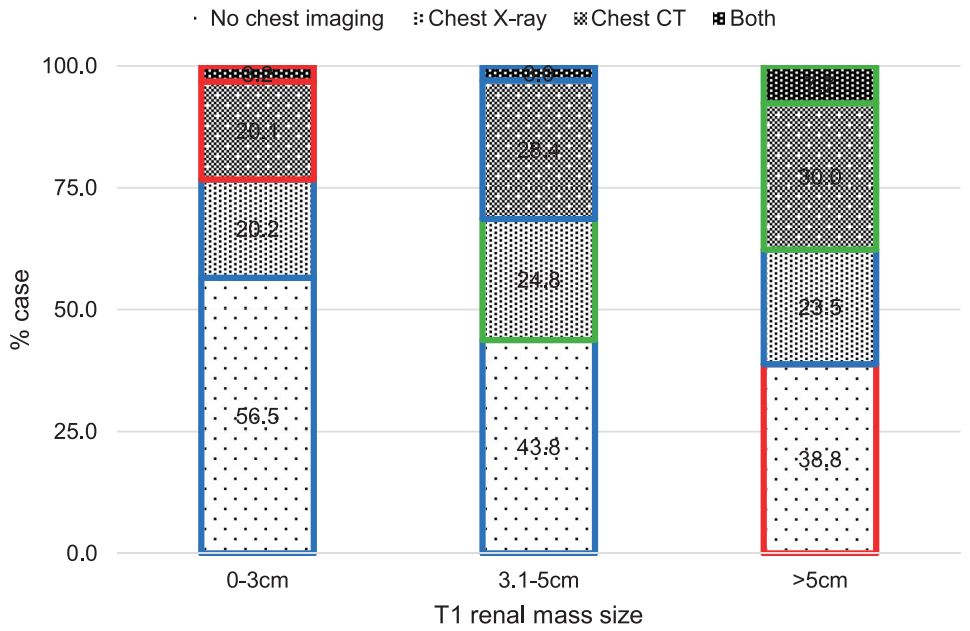

Figure 2. Percentage of cases with no chest imaging, chest x-ray, computerized tomography (CT), or both sorted by renal mass size. As size of renal mass increases, recommendations for chest imaging performance of type chance. The colored borders represent whether chest imaging performance or type is acceptable (blue), recommended (green), or not recommended (red) in each size stratum.

were in compliance with performance of any chest imaging. Even after education and implementation of the VBR metric, chest imaging adherence in this group remained poor. In a previous study by Larcher et al, a nomogram was developed to predict who would benefit the most from staging chest CT using preoperative characteristics including tumor stage of cT1b or higher, nodal stage cN1, presence of systemic symptoms and preoperative blood counts showing anemia or thrombocytopenia.[14] If any one of these 4 clinical findings were identified, the risk of pulmonary metastasis was considered high enough to warrant chest CT. Furthermore, if none of these findings are identified, then chest CT scan is not indicated. At this cutoff, 37% of negative chest CT scans can be spared.[14] Recent data from Jamil et al support this, with a contemporary cohort of more than 120,000 patients with renal masses less than 4 cm.[6] In this study, only 0.9% of patients had a synchronous chest metastasis, making up only 8% of all patients diagnosed with a synchronous chest metastasis. This upholds the rationale for a recommendation of chest CT in the >5 cm group and CXR for lower stage lesions.

Our findings are not significantly different than a study looking at timing of preoperative chest imaging studies based on stage. In this single institution study by Moideen et al, only 39.0% of patients who were stage II or above had a CT chest within 3 months of surgery.[15] When looking at all patients in clinical stage I, II, or III groups, the percentage of patients who had chest imaging of any type within 3 months of surgery was 61.6%; even when looking only at stage II, the percentage of patients with imaging of any type was only 74.0%, meaning roughly a quarter of patients with high-risk clinical presentation did not receive appropriate preoperative staging.

Under- and overutilization of appropriate staging imaging and preoperative evaluation are important metrics in patients with localized RCC. Our data from MUSIC are unique in that they show a cross-section of preoperative staging practices across academic and community practices within Michigan, which is likely representative of urological practice within the United States as a whole. MUSIC's setup and execution is advantageous for understanding areas for potential QI. Data are entered by each individual practice, validated by the coordinating center, reported in comparison with the data from all other practices, and then evaluated to identify practice level variation with a goal to implement best practices across the collaborative. We found that chest imaging rates for cT1 RM differ significantly between practices, with some practices rarely obtaining imaging to others reaching almost 85%. In general, larger-volume practices were more likely to adhere to chest imaging guidelines, although some sizable practices were at the lower end of the spectrum as well.

Based on the observations of low overall chest imaging rates and wide variation, we implemented a VBR metric to incentivize performance of chest imaging in patients with renal masses >3 cm, and particularly in patients with RM >5 cm. Additionally, this QI opportunity has been discussed at 3 collaborative-wide MUSIC meetings (each attended by >100 urologists) to provide education and refresh on the guidelines, and placards for easy reference in the office were

provided. Despite this, we saw no significant increase in chest imaging adherence over the measured period. This begs the question if there is adequate buy-in from urologists regarding current guideline-based staging recommendations. The current guidelines may be considered too vague, too stringent, or insufficient given the lack of guidance for risk stratification as it relates to staging imaging.

Our study has several limitations. First, the focus of MUSIC-KIDNEY and data collected was limited to stage I RCC. Perhaps a bigger impact may have been seen if cT3a cancers were included (those with renal vein, segmental vein, and/or sinus fat invasion). Second, the study looked strictly at chest imaging rates in relation to radiographical size. Other factors such as symptoms and laboratory findings were not included in the stratification of recommendations. Additionally, the registry does not identify the reason for or against chest imaging, including whether CXR was ordered for preoperative safety reasons not related to kidney cancer. It also does not identify if chest imaging was ordered but the patient did not comply with recommendations. Lastly, a bulk of the post-intervention collection period was interrupted by COVID-related delays and hesitancy of patients to intersect with the medical setting, which could have affected adherence rates at the patient level.

While the benefit of precise chest staging is recognized in larger and higher-risk kidney masses, many have voiced skepticism that any chest imaging is important or necessary for asymptomatic small kidney masses. Further, there remains uncertainty in the accuracy of CXR as a diagnostic modality for renal cancer lung metastasis. This likely contributed to the lack of change after intervention. In the future, the focus should surround preoperative evaluation specifically in high-risk renal masses. Additionally, future work will look within the MUSIC registry at accuracy of CXR and CT scan for diagnosing true metastatic spread of kidney cancer stratified by renal mass size. Nonetheless, our study serves as a baseline for adherence to chest imaging rates and has identified this as a ripe area for QI given the significant practice-level variation.

Conclusions

Chest imaging guideline adherence in MUSIC during the initial evaluation of cT1 renal masses is poor despite consensus of recommendation from major urological societies. The statements by the EAU, AUA, and NCCN are vague and leave room for interpretation. Chest imaging compliance is limited, even in the highest-risk category of >5.1-cm tumors, with adherence to the MUSIC recommendation of chest CT in only 36.0% of cases and MUSIC requirement of chest imaging in only 61.9%. Practice level variation was noted to be significant. Improvements are modest thus far, but we expect with additional time, we will continue to see progress, particularly in the high-risk kidney tumors.

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