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Standardized report template for indeterminate renal masses at CT and MRI: a collaborative product of the SAR Disease-Focused Panel on Renal Cell Carcinoma

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Abstract

Purpose—To create a succinct yet comprehensive evidence-based structured report template for indeterminate renal masses characterized at CT and MRI.

Methods—This IRB-exempt, iterative, multi-institutional quality improvement project was informed by published data derived from a multi-institutional survey and a multi-institutional review of CT and MRI radiology reports. A two-stage blinded Delphi process by the 16-member 12-institution Society of Abdominal Radiology Disease-Focused Panel on Renal Cell Carcinoma was conducted to create a structured report template for indeterminate renal masses evaluated at CT and MRI. Individual reporting characteristics were scored by members as 'core,' 'optional,' or 'exclude.' Threshold for inclusion was ≥ 80% support. If < 80% members considered a characteristic a 'core' feature, but ≥ 80% considered it either 'core' or 'optional,' it was considered an 'optional' feature. If neither was the case, the characteristic was excluded. Free-text comments

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Conflict of interest Matthew Davenport: Royalties from Wolters Kluwer. Andrew Smith: Unrelated: president of Radiostics LLC, president of and patents received and pending for Liver Nodularity LLC, president of and patents received and pending for eRadioMetrics LLC, presidents of and patents received and pending for Color Enhanced Detection LLC. Atul Shinagare: Unrelated consultant to Arog Pharmaceuticals and research funding with GTx Inc. The other authors declare that they have no conflict of interest.

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Ethical approval Institutional review board approval was obtained, and subjects consented to participate in the survey. All study procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments.

were permitted. Characteristics considered ‘core’ by 50–99% of respondents in Round 1 (i.e., nonunanimous support) and uninvestigated free-text comments were assessed in Round 2. Core and optional structured reporting templates were derived.

Results—The response rate was 100% in Round 1 (16/16) and Round 2 (16/16). In Round 1, 5 characteristics had unanimous support as ‘core’ features. Following Round 2, 13 characteristics had ≥ 80% support as ‘core’ features, and 10 characteristics had ≥ 80% support as ‘optional’ features. Structured report templates were derived.

Discussion—Structured ‘core’ and ‘optional’ templates for indeterminate renal masses at CT and MRI were derived, which may improve compliance with reporting preferred and essential imaging characteristics.

Keywords

Renal mass; Structured reporting; Multi-institutional; Delphi; Renal cell carcinoma

Introduction

Numerous studies have found that structured, disease-focused dictation templates improve comprehensiveness and appropriateness of radiologist reports [1–7]. However, buy-in is a challenge [4]. Many radiologists are accustomed to using free-text dictation, enjoy its speed and simplicity, and in many cases, were trained primarily in that format. Structured reports with required characteristics may be perceived as laborious and technically more challenging than free-text dictation. Therefore, demonstrating the validity and necessity of individual characteristics contained within a structured template is a prerequisite to ensuring radiologist compliance. Previously established and now commonly used disease-focused templates (e.g., pancreatic [1, 3], rectal [7, 8]) have been created with the aid of multispecialty, multi-institutional collaboration. Rather than immediately assert that a change was needed and impose a new set of required report characteristics, they started with background data and consensus building. This iterative approach is what was taken by the Society of Abdominal Radiology (SAR) Disease-Focused Panel on Renal Cell Carcinoma when deriving a report template for indeterminate renal masses.

In 2017, a 35-question survey was sent to 71 urologists and 100 radiologists at nine academic institutions (response rate: 68%) investigating what characteristics were ‘essential,’ ‘preferred,’ or should be excluded from a radiology report describing an indeterminate renal mass characterized with a renal mass protocol CT or MRI [9]. However, those results did not directly inform the tension between efficiency and comprehensiveness implicit in a structured template. That work was followed in 2018 by a 12-institution (6 community, 6 academic) retrospective study of 271 radiology reports which found that ‘essential’ and ‘preferred’ characteristics were commonly omitted in relevant settings [10]. These works [9, 10] established the background data and clinical need for a structured report template in this setting. Using this information as a framework, the SAR Disease-Focused Panel on Renal Cell Carcinoma initiated a multiphase Delphi process to reach consensus on what characteristics should be included. The purpose was to create a succinct yet

comprehensive evidence-based structured report template for indeterminate renal masses evaluated at CT and MRI.

Methods

This was an institutional review board (IRB)—exempt, iterative, multi-institutional quality improvement effort. No protected health information was analyzed, and no extramural funding was utilized.

Study design

Data derived from a previously published, multi-institutional, multispecialty survey [9] and a previously published multi-institutional review of CT and MRI radiology reports [10] were used to inform a 2-stage blinded Delphi process by the 16-member 12-institution SAR Disease-Focused Panel on Renal Cell Carcinoma. All participants were familiar with the previously published background data [9, 10], and many were co-authors of the prior manuscripts. The goal of the Delphi process was to balance the expected clinical utility of each reporting characteristic against the potential efficiency penalties of a lengthy report template. The intended result was a succinct, evidence-based structured reporting template for indeterminate renal masses characterized at CT and MRI.

Individual reporting characteristics that reached consensus in the previously published survey [9] as ‘preferred’ or ‘essential’ were included in Round 1 of the Delphi process. Blinded participants scored each characteristic as ‘core’ (i.e., must be included), ‘optional,’ or ‘exclude’ with respect to inclusion in a structured report template. Each participant also was given the opportunity for free-text commentary. Characteristics considered ‘core’ by 50–99% of respondents in Round 1 (i.e., nonunanimous support) as well as uninvestigated Round 1 free-text comments were assessed in Round 2. Characteristics were not reassessed in Round 2 if they were considered in Round 1 to be ‘core’ by either 100% of respondents (i.e., not revisited due to unanimous agreement) or less than 50% of respondents (i.e., not revisited because a majority did not think it should be included in the ‘core’ template).

Following Round 2 of the Delphi process, the ‘core’ and ‘optional’ templates were created. The threshold for inclusion was ≥ 80% support [11, 12]. If less than 80% of participants considered a characteristic a ‘core’ feature, but ≥ 80% considered it either ‘core’ or ‘optional,’ it was considered an ‘optional’ feature. If neither was the case, the characteristic was excluded. Small changes to the tested wording were made to improve clarity. For each included characteristic, dictation options were created. When possible, pick-lists or numeric data were used for dictation options rather than free-text entries.

Data analysis

Responses were summarized with counts and percentages.

Results

The response rate was 100% in Round 1 (16/16) and Round 2 (16/16). In Round 1, 8 ‘essential’ characteristics [9] and 10 ‘preferred’ characteristics [9] were scored (n = 18 total

characteristics). Five of 18 (28%) characteristics (all previously deemed ‘essential’ [9]) had unanimous support as ‘core’ features (Table 1): mass size, mass type (cystic vs. solid), presence or absence of macroscopic fat, presence or absence of enhancement, and use of the Bosniak classification for cystic masses. Three of 18 (17%) had consensus (≥ 80%) support as ‘core’ features: size comparisons for solid and Bosniak IIF–IV masses, axial location of the mass (e.g., anterior), and the presence of bland thrombus peripheral to tumor thrombus (when present). Nine of 10 (90%) ‘preferred’ characteristics and 1 of 8 (13%) ‘essential’ characteristics had consensus support as ‘optional’ features. None of the tested characteristics had consensus (≥ 80%) support to exclude. Free-text commentary collected during Round 1 is summarized in Table 2 and was used to inform data collection in Round 2.

In Round 2, 5 characteristics with unanimous ‘core’ support and six characteristics with \ 50% ‘core’ support in Round 1 were not reassessed (Tables 1, 3). Five characteristics were added based on Round 1 free-text comments (Tables 2, 3). After Round 2, 13 of 23 (57%) characteristics had ≥ 80% support as ‘core’ features, and 10 of 23 (43%) characteristics had ≥ 80% support as ‘optional’ features (Table 3). No characteristic had ≥ 80% support to be excluded. Minor edits were made to the descriptions of the characteristics to improve clarity and clinical relevance based on discussions and free-text feedback.

In total, 8 of 8 (100%) tested ‘essential’ characteristics had ≥ 80% support as ‘core’ features, and 8 of 12 (67%) tested ‘preferred’ characteristics had ≥ 80% support as ‘optional’ characteristics (the other 4 had ≥ 80% support as ‘core’ characteristics) (Table 3). The remaining three characteristics did not have consensus in [9] as either ‘essential’ or ‘preferred’; of these, 2 had ≥ 80% support as ‘optional’ characteristics, and 1 had ≥ 80% support as a ‘core’ characteristic (Table 3).

Following this process, two structured reporting templates were derived: ‘core’ (Table 4) and ‘optional’ (Table 5). For each included characteristic, dictation options were created to optimize clinical care, standardize reporting, and enable data extraction.

Discussion

Our iterative, multi-institutional, multispecialty quality improvement project resulted in the creation of ‘core’ and ‘optional’ structured templates for the reporting of indeterminate renal masses at CT and MRI. The ‘core’ template is designed to be used the first time an indeterminate mass is characterized. The primary cohort of interest is masses that are possibly malignant, including solid masses without macroscopic fat and Bosniak IIF-IV cystic masses [13–16]. Benign masses (e.g., simple cysts, “classic” angiomyolipomas) likely will not benefit from the detail included in the ‘core’ template. The ‘optional’ template can be considered *a la carte* with respect to its contents. Radiology practices and referring urologists may prefer to pick and choose from the characteristics in this table (and may have differing opinions about what should be included based on their local practice pattern [9]), while some characteristics are situational depending on the imaging modality utilized (e.g., T2-weighted hypointensity is only relevant to MRI).

We expect radiologists may choose to add information not contained in either template (e.g., Nephrometry score [17, 18], probability of malignancy [9, 16, 19], likelihood of clear cell renal cell carcinoma [20]), but the goal is to promote consistent succinct reporting of important features. It is likely that routine use of the 'core' template will substantially improve compliance with recognized practice gaps [2, 3, 5–7, 10]. In 2018, Hu et al. [10] performed a 12-institution (6 community, 6 academic) retrospective study of 271 radiology reports describing a possibly malignant renal mass and found that 'essential' characteristics (as determined by prior work [9]) were included in as few as 14% (34/236) of relevant reports, and that 'preferred' characteristics were generally included in less than half of reports. Examples of commonly omitted 'essential' characteristics included presence or absence of macroscopic fat (14% [34/236]), use of relevant size comparisons (79% [111/140]), and use of the Bosniak classification for cystic masses (54% [19/35]) [10]. These data indicate that existing free-text practice patterns are not completely meeting the needs of patients and referring physicians.

Studies have repeatedly demonstrated that use of disease-focused structured reporting improves documentation of important imaging features and enhances referring provider satisfaction [2–7]. In 2015, Brook et al. [3] performed a retrospective analysis of pancreas cancer CT reports and found that use of a disease-focused structured template significantly improved reporting of key imaging features (10.6 ± 0.9 features with template vs. 7.3 ± 2.1 features without template, $p < 0.001$). They [3] also found that use of the template significantly improved accessibility of relevant information from the perspective of 3 pancreas cancer surgeons. In 2017, Dickerson et al. [2] performed a prospective quality improvement study in patients with multiple sclerosis and found that use of a disease-focused structured template significantly improved compliance in reporting 12 multiple sclerosis-relevant imaging features (11 ± 0.7 findings with template vs. 5.8 ± 2.2 findings without template, $p < 0.001$). They [2] also found that use of the template significantly improved neurologist-rated satisfaction. In 2017, Norenberg et al. [7] performed a retrospective analysis of rectal cancer MRI reports and found that use of a disease-focused structured template significantly improved reporting of 13 key imaging features (12 ± 4.6 features with template vs. 9.2 ± 10.8 features without template, $p < 0.001$). The authors [7] also found that template-based reports were more likely than free-text reports to allow definitive treatment decision-making (96 vs. 60%, $p < 0.001$), were more likely sufficient for surgical planning (94 vs. 38%, $p < 0.001$), and were given higher subjective quality scores by two experienced surgeons [5.8 ± 0.4 vs. 3.6 ± 1.2 (range: 1–6), $p < 0.001$]. Similar work will be needed to confirm that our derived template is achieving the same improvements in the setting of reporting an indeterminate renal mass.

Despite extensive background data collection and multispecialty collaboration [9, 10], it is likely that not everyone will be interested in using the devised templates. Fundamentally, any integration of new methods into clinical practice is an exercise in change management. Some practices may wish to use only a portion of the templates if it better suits their needs. The templates are designed to be used at the initial evaluation of a renal mass with CT or MRI. Other situations, such as active surveillance, assessing response after surgery or ablation, or describing a mass detected on single-phase imaging, may require a different approach. Finally, if the templates are modified by an individual practice, those changes

might be best applied to all radiologists within that practice (rather than ad hoc) to maintain intradepartmental consistency.

In conclusion, through an iterative, multi-institutional, multispecialty quality improvement project, evidence-based structured ‘core’ and ‘optional’ templates for reporting indeterminate renal masses at CT and MRI were derived that can be immediately integrated into a clinical radiology practice. It is expected that use of these templates will improve compliance in reporting preferred and essential imaging characteristics on relevant examinations [2–7], and create alignment within and across radiology practices. Future work might be best directed at studying the impact these templates have on clinical care, and determining how best to incorporate emerging data on renal mass imaging, characterization, and management (e.g., using imaging to predict the probability of clear cell renal cell carcinoma [20]).

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Table 1

Round 1 summary of Delphi results

	Core	Optional	Exclude
"Essential" characteristics according to [9]			
Mass size	*100% (16/16)*	0% (0/16)	0% (0/16)
Whether the mass is cystic or solid	*100% (16/16)*	0% (0/16)	0% (0/16)
Presence or absence of macroscopic fat	*100% (16/16)*	0% (0/16)	0% (0/16)
Presence or absence of enhancement	*100% (16/16)*	0% (0/16)	0% (0/16)
Bosniak classification for cystic masses	*100% (16/16)*	0% (0/16)	0% (0/16)
Size comparisons for solid and Bosniak IIF–IV masses	*88% (14/16)*	13% (2/16)	0% (0/16)
Axial location of the mass (e.g., anterior)	*88% (14/16)*	13% (2/16)	0% (0/16)
Staging information for solid and Bosniak III–IV masses	75% (12/16)	**25% (4/16)**	0% (0/16)
"Preferred" characteristics according to [9]			
Whether a solid mass has regions of necrosis	44% (7/16)	*50% (8/16)*	6% (1/16)
Mass margins (e.g., infiltrative, circumscribed)	75% (12/16)	*25% (4/16)*	0% (0/16)
Description of each individual Bosniak feature	25% (4/16)	*63% (10/16)*	13% (2/16)
Capsular location of the mass (e.g., > 50% exophytic, endophytic)	63% (10/16)	*38% (6/16)*	0% (0/16)
Presence of bland thrombus peripheral to tumor thrombus	**81% (13/16)**	13% (2/16)	6% (1/16)
Findings that may predict aggressiveness (e.g., T2w hypointensity)	19% (3/16)	87% *(13/16)*	0% (0/16)
Specific RCC subtype if feasible (e.g., clear cell RCC)	25% (4/16)	*75% (12/16)*	0% (0/16)
Specifying optimal follow-up imaging type	25% (4/16)	*69% (11/16)*	6% (1/16)
Specifying whether a portion or all of a mass enhances	31% (5/16)	*63% (10/16)*	6% (1/16)
Distance of the mass to the sinus fat or collecting system	75% (12/16)	*25% (4/16)*	0% (0/16)

Inputs represent characteristics considered "essential" or "preferred" in prior work [9]. Threshold for inclusion in the template was ≥ 80% support by the blinded respondents. If less than 80% considered the characteristic a core feature but the sum of support for core + optional was ≥ 80%, it was considered an optional feature. If neither was the case, the characteristic was excluded from consideration. Italic values indicate concordance and bold values indicate discordance between the Delphi process and data in [9]

Table 2

Free-text responses from Rounds 1 and 2 of the Delphi process. The text has been lightly edited for clarity and to preserve anonymity

Round 1
Findings that predict aggressiveness and the presence of bland thrombus would be good to include but may be difficult for some radiologists; hence, I categorized these as optional features. Necrosis should be optional because of the confusion over the exact meaning and lack of pathological correlate for necrosis
The presence of calcification should be optional
We should consider including polar location, local extent of disease (hilar invasion, collecting system invasion, contacts Gerota's fascia, invasion through Gerota's fascia, invasion of adjacent organs), venous invasion, enlarged lymph nodes, and distant metastases
Nephrometry score probably should be an optional feature
Differentiating urothelial from cortical origin probably should be a core or optional feature
Optional features might include vascular anomalies (if any) and the total number of lesions
Multiphase MRI or multiphase CT is necessary for subclassifying a renal mass
The location in the vertical axis (upper pole/interpolar/lower pole) needs to be a core descriptor
We may want to break down fat into macroscopic fat and microscopic fat
We include the 'clear cell RCC likelihood score,' but I understand this is uncommon at this point
Consider differentiating free-floating IVC tumor thrombus from invasive (i.e., into wall) IVC tumor thrombus
Length of tumor thrombus should be added
Round 2
It is important to report bland thrombus [21]
Components of the RENAL Nephrometry score (endophytic/exophytic, nearness to hilum/collecting system, location relative to polar lines, anterior/posterior) [17, 18] is important and should be included in the core template for indeterminate renal masses that may proceed to partial nephrectomy or ablation. These factors are not as important if the size/location of the mass precludes partial nephrectomy
Consider including tumor margins: round vs. lobular vs. infiltrative
Considering including whether tumor calcifications are present or absent
Consider including tumor heterogeneity

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Table 3

Round 2 summary of Delphi results

	Core	Optional	Exclude
Characteristics established in Round 1			
Mass size	*100% (16/16)*	0% (0/16)	0% (0/16)
Whether the mass is cystic or solid	*100% (16/16)*	0% (0/16)	0% (0/16)
Presence or absence of macroscopic fat	*100% (16/16)*	0% (0/16)	0% (0/16)
Presence or absence of enhancement	*100% (16/16)*	0% (0/16)	0% (0/16)
Bosniak classification for cystic masses	*100% (16/16)*	0% (0/16)	0% (0/16)
Whether a solid mass has regions of necrosis	44% (7/16)	*50% (8/16)*	6% (1/16)
Description of each individual Bosniak feature	25% (4/16)	*63% (10/16)*	13% (2/16)
Findings that predict aggressiveness (e.g., T2w hypointensity)	19% (3/16)	*81% (13/16)*	0% (0/16)
Specific RCC subtype if feasible (e.g., clear cell RCC)	25% (4/16)	*75% (12/16)*	0% (0/16)
Specifying optimal follow-up imaging type	25% (4/16)	*69% (11/16)*	6% (1/16)
Specifying whether a portion or all of a mass enhances	31% (5/16)	*63% (10/16)*	6% (1/16)
Characteristics re-assessed in Round 2			
Size comparisons for solid and Bosniak IIF-IV masses	*100% (16/16)*	0% (0/16)	0% (0/16)
Axial location of the mass (e.g., anterior)	*81% (13/16)*	19% (3/16)	0% (0/16)
Staging information for solid and Bosniak III-IV masses	*100% (16/16)*	0% (0/16)	0% (0/16)
Mass margins (e.g., infiltrative, circumscribed)	**88% (14/16)**	12% (2/16)	0% (0/16)
Capsular location of the mass (e.g., > 50% exophytic, endophytic)	**81% (13/16)**	19% (3/16)	0% (0/16)
Presence of bland thrombus peripheral to tumor thrombus	**88% (14/16)**	6% (1/16)	6% (1/16)
Distance of the mass to the sinus fat or collecting system	**88% (14/16)**	12% (2/16)	0% (0/16)
Characteristics added in Round 2 via Round 1 free-text suggestions			
Length of tumor thrombus	31% (5/16)	*63% (10/16)*	6% (1/16)
Whether tumor thrombus invades the wall of the IVC	31% (5/16)	***63% (10/16)***	6% (1/16)
Craniocaudal location of the mass (e.g., upper pole)	***100% (16/16)***	0% (0/16)	0% (0/16)
Presence or absence of microscopic fat (MRI only)	50% (8/16)	**50% *(8/16)***	0% (0/16)
Presence or absence of ipsilateral vascular anomalies	50% (8/16)	44% (7/16)	6% (1/16)

Inputs represent characteristics considered “essential” or “preferred” in prior work [9] as well as characteristics introduced during Round 1 free comments. Threshold for inclusion was ≥ 80% support by the blinded respondents. Italic values indicate concordance and bold values indicate discordance between the Delphi process and data in [9]. Bold italic values indicates the item was not studied in [9]

Table 4

Core structured template for the reporting of indeterminate renal masses evaluated at renal mass protocol CT or MRI

Core template	Dictation picklist
Mass size (single largest dimension)	[*X*] cm
Growth rate	Previously [*X*] cm on [most recent relevant comparison date] and [*X*] cm on [oldest relevant comparison date]
Mass type	[Cystic/solid/indeterminate]
Bosniak classification	[Not applicable (not a cystic mass)/Bosniak I (simple cyst)/Bosniak II/Bosniak IIF/Bosniak III/Bosniak IV]
Macroscopic fat	[Yes/no]
Solid enhancement	[Yes/no/equivocal]
Axial location	[Anterior/posterior/neither anterior nor posterior]
Craniocaudal location	[Upper pole/interpolar/lower pole]
Mass margins	[Circumscribed/infiltrative]
Capsular location	[≥ 50% exophytic, < 50% exophytic, endophytic]
Distance to the sinus fat or collecting system	[*X*] cm
Tumor thrombus (distal extent)	[No tumor thrombus/ipsilateral renal vein (no IVC extension)/IVC < 2 cm above renal vein/IVC ≥ 2 cm above renal vein but below hepatic veins/IVC above hepatic veins but below diaphragm/IVC above diaphragm/into right atrium]
Bland venous thrombus	[Yes/no] (optional free text description to follow)
Lymph nodes	[Normal/possible nodal metastases/definite nodal metastases] (optional free text description to follow)
Metastases in field of view	[None/possible distant metastases/definite distant metastases] (optional free text description to follow)

Items in brackets are input variables; lists separated by slashes represent input variable options

Table 5

Optional characteristics to be included in a structured template for the reporting of indeterminate renal masses evaluated at renal mass protocol CT or MRI

Optional Characteristics	Dictation picklist
Necrosis	[Not applicable (cystic mass)/yes/no]
T2w hypointensity	[Not applicable (not an MRI)/yes/no]
Microscopic fat	[Not applicable (not an MRI)/yes/no]
Enhancement type	[Entire mass/septal/mural/nodular/no enhancement]
Length of tumor thrombus	[*X*] cm
Caval wall invasion	[Definite/possible/no]
Ipsilateral renal artery anatomy	[Free text description]
Ipsilateral renal vein anatomy	[Free text description]
Description of each individual Bosniak feature	[Free text description]
Favored histology	[Clear cell RCC/papillary RCC/fat poor angiomyolipoma/RCC (unknown subtype)]
Follow-up imaging recommendation	[CT/MRI/ultrasound] in [*X*] months

Items in brackets are input variables; lists separated by slashes represent input variable options