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Recommendations for the Management of the Incidental Renal Mass in Adults: Endorsement and Adaptation of the 2017 ACR Incidental Findings Committee White Paper by the Canadian Association of Radiologists Incidental Findings Working Group

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Since the publication of the first landmark paper by the American College of Radiology (ACR) Incidental Findings Committee in 2010, that committee has been providing valuable guidance to radiologists throughout the world on how to manage incidental imaging findings [1]. In 2017, the Canadian Association of Radiologists (CAR) received feedback from its membership that there was a need for a Canada-specific set of incidental findings guidelines which would acknowledge the unique distribution of imaging modalities and resource limitations that radiologists in this country face. The CAR Incidental Findings Working Group was formed in February 2018 and tasked with either adapting pre-existing ACR guidelines to meet the concerns of the CAR membership or authoring new guidelines.

The Working Group was directed by the CAR to author a series of manuscripts covering the management of incidental findings across multiple organ systems. The consensus of the Group was to begin with the management of incidental renal masses, as there was specific membership feedback that there should be a greater role for ultrasound than existed in the previously published ACR guidelines [2]. Computed tomography (CT) and magnetic resonance imaging (MRI) are both used for initial mass characterization and follow-up for more complex lesions in Canada, but in order to reduce radiation exposure to patients and provide the most cost-effective care possible, many Canadian radiologists rely heavily on ultrasound when renal visualization is satisfactory. A need was identified for an additional flowchart detailing the management of the incidental renal mass discovered on ultrasound.

The Working Group consists of a mixture of academic subspecialty and general radiologists and includes the primary author of the corresponding ACR white paper. The group began by reviewing the ACR guidelines, taking into consideration CAR member feedback, and identifying areas where there may be discrepancies with Canadian practice patterns, difficulties in following the guidelines as written, or areas in which an alternative approach was more cost-effective. To research and support any changes, a literature database in the cloud was established consisting of the references used by the ACR committee, to which we added additional papers which had become available since that publication along with manuscripts providing supporting evidence of any proposed changes.

A PubMed English literature search by all committee members was performed between March 2018-June 2018 to review current evidence on renal incidental findings (Kidney/diagnostic imaging [MESH] and incidental [All Fields], incidental renal mass [Title], incidental renal mass [All Fields], incidental renal lesion [All Fields]), renal masses (Kidney Neoplasms/diagnostic imaging [MESH], Kidney Neoplasms/diagnosis [MESH] and review [ptyp], Kidney Neoplasms/epidemiology [MESH] and review [ptyp], Kidney Neoplasms/

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physiopathology [MESH] and review [ptyp], Kidney Neoplasms/therapy [MESH] and review [ptyp]) renal cysts (Radiology [MESH] and renal cyst (All Fields), Kidney Diseases, Cystic/diagnostic imaging [MESH], Kidney Diseases, Cystic/diagnosis [MESH]), and the role of specific modalities in the workup of renal incidental masses (Kidney Neoplasms [MESH] and Ultrasonography [MESH], Kidney Neoplasms [MESH] and Tomography, X-Ray Computed [MESH], Kidney Neoplasms [MESH] and Magnetic Resonance Imaging [MESH]). Reports limited to animal studies were excluded. The review demonstrated that the ACR guidelines remain the only comprehensive set of practice recommendations dealing with the imaging and follow-up of incidental renal masses. All changes to the ACR guidelines were discussed as a group for consensus. A draft of this manuscript was posted for 30 days on the CAR website for membership feedback prior to submission for publication, and all member comments were addressed prior to manuscript submission.

The Working Group wishes to acknowledge the tremendous pre-existing work of the ACR Incidental Findings Committee, and as such, it was considered most appropriate to present this document as an endorsement and adaptation of their white paper, since it builds on the foundation the ACR has previously laid out. A summary of the changes from the ACR white paper can be found in Appendix 1. It is important to state that while the flowcharts presented are based on the best available scientific evidence, there are still significant gaps in the literature and ultimately, these flowcharts reflect consensus recommendations rather than a well-established standard of care.

Background on Renal Masses

As many as 41% of patients undergoing computed tomography show renal cysts, and renal cell carcinoma has an estimated annual incidence of 2%, most of which are discovered incidentally [3,4]. The majority of incidentally discovered renal cell carcinomas are early stage and treatable lesions, and the risk of metastatic disease increases with tumour size and growth rate [3,5]. On this basis, there has been an increasing trend towards active surveillance for small masses, even if solid [6,7]. Nevertheless, metastatic disease can occur even with solid masses in the 1−2 cm range, necessitating an individualized treatment approach which takes into consideration the patient's age and comorbidities, patient desire for treatment, and the expert opinion of a urologist [3,6,7]. Incidental cystic masses are classified using the Bosniak system, where increasing levels of internal complexity correlate to risk of malignancy [6,8].

Management of the Incidental Renal Mass: Outline

The document has been divided into 6 sections, each detailing a flowchart for the management of a particular incidental renal finding. The first 3 flowcharts deal with the workup of masses identified by modality, whereas the final 3 flowcharts address the workup by the category of lesion (cystic versus solid versus solid containing fat). Flowcharts 1−3 frequently continue into flowcharts 4−6 once basic characteristics of the mass have been determined. Flowcharts are as follows:

Flowchart 1: Incidental renal mass on non-contrast CT.

Flowchart 2: Incidental renal mass on contrast enhanced CT.

Flowchart 3: Incidental renal mass on ultrasound.

Flowchart 4: Incidental cystic renal mass.

Flowchart 5: Incidental solid mass or mass too small to characterize (TSTC).

Flowchart 6: Incidental renal mass containing fat.

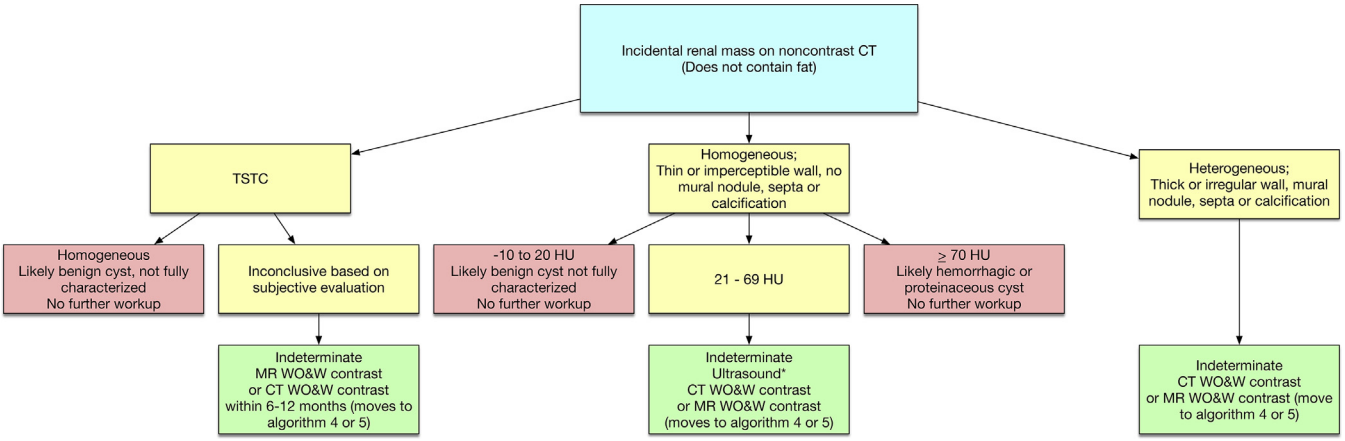
Considerations Applicable to All Flowcharts

These guidelines are intended for adults who are 18 years or older and should not be applied to individuals who have a pre-existing condition (for example, a malignancy elsewhere that could lead to renal metastatic disease) or genetic syndrome which predisposes to renal malignancy. When encountering any incidental renal mass, radiologists are encouraged to include all of the following details in their report: size, attenuation value (if CT)/echogenicity (if ultrasound)/signal characteristics (if MRI), homogeneity versus heterogeneity, enhancement or Doppler flow, internal complexity (including estimation of Bosniak category for cystic lesions), and whether there has been any change from prior studies.

When evaluating for evidence of mass enhancement on CT, a change of $\leq$ 10 HU between the non-contrast and post-contrast images is considered nonenhancement; change of $>$ 10 to $<$ 20 HU is considered equivocal for enhancement (stricter criteria of 10−15 HU could be used for exophytic or larger masses less prone to beam hardening artifact); and $\geq$ 20 HU is considered definitive for enhancement [9,10]. Assessment of enhancement on MRI is much more challenging, as signal intensity can vary depending on the pulse sequence used, equipment used, patient variation, and transmit/receive gains. Acknowledging this, when all parameters are kept constant on pre-contrast and post-contrast imaging, a 15% increase in signal intensity within a mass 2−4 minutes following gadolinium administration is considered positive for enhancement [11]. Visible signal following subtraction imaging can also indicate enhancement, as long as great care is taken to avoid anatomic misregistration, which can be difficult without the use of specialized workstation software.

For any flowchart, if prior studies are available for comparison, indeterminate masses with no change in imaging features for at least 5 years can usually be considered clinically insignificant [12,13]. Patient age and clinical status (particularly comorbidities, suitability as a surgical candidate, and life expectancy) should also be factored in to any management decisions.

The flowcharts utilize colour coding aligned with the 2018 ACR white paper they are based on for consistency [2]. Yellow boxes indicate points in which clinical or imaging



Flowchart 1. **Incidental renal mass on non-contrast CT.** If the mass contains fat attenuation (<−10 HU), proceed to Flowchart 6. If prior studies are available for comparison, indeterminate masses with no change in imaging features for at least 5 years can be considered clinically insignificant. CT = computed tomography; MR = magnetic resonance; TSTC = too small to characterize; WO&W = without and with. *Ultrasound if the radiologist believes that there is a chance at successful characterization based on lesion appearance, location, and patient body habitus.

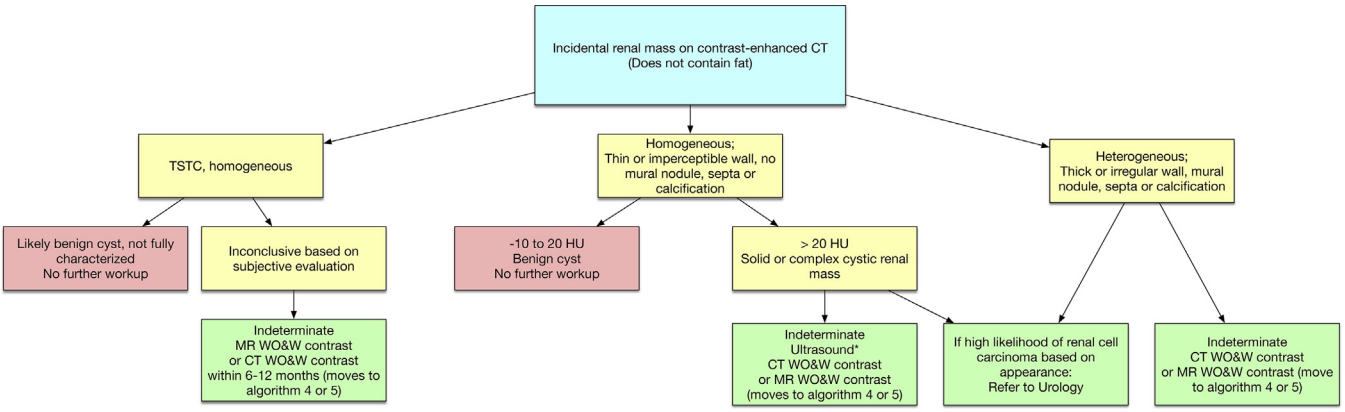
data must be synthesized and often branch based on those results. Red boxes indicate points where the workup may be terminated. Green boxes indicate recommendations for further evaluation or management or that the workup moves to a different flowchart as indicated.

Flowchart 1: Incidental Renal Mass on Non-Contrast CT

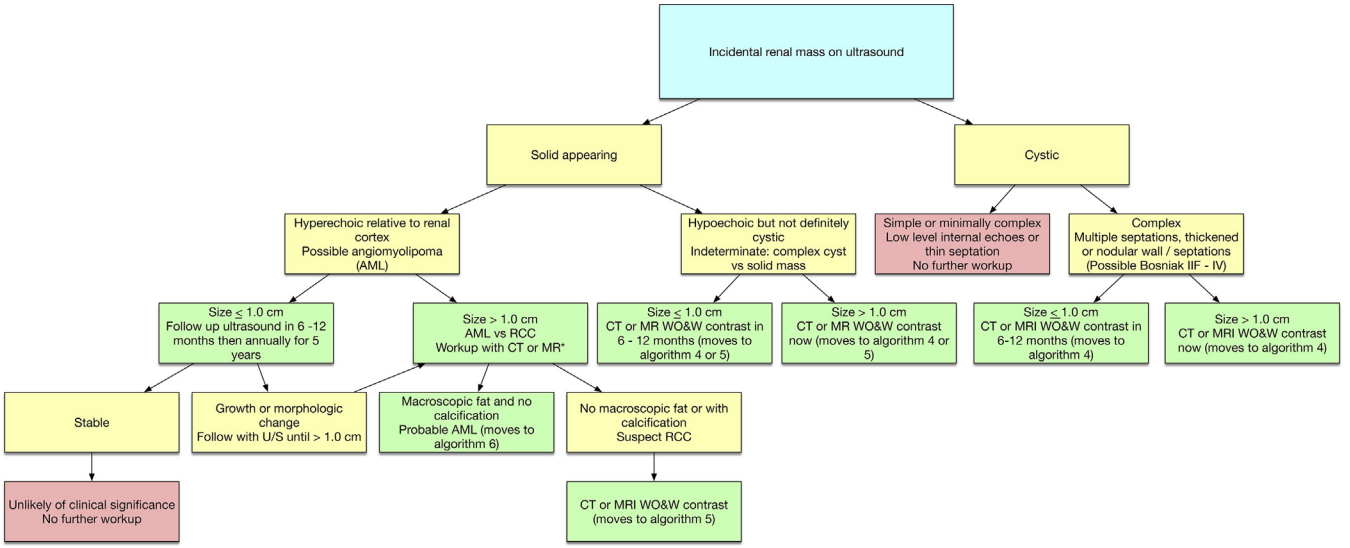
The first decision point when encountering an incidental renal mass on non-contrast CT (Flowchart 1) is to determine if it contains fat (<−10 HU on region of interest measurement). If so, the radiologist should use Flowchart 6. If there is no evidence of fat within the mass, the next decision to make is if the mass is TSTC and otherwise for larger masses if it is homogeneous (and thus possibly a simple or mildly complex cyst) or heterogeneous.

The decision of whether a mass is too small to characterize is an individual one for which there is no strict size threshold, and many factors will contribute to this analysis. These include size of the mass (often <1 cm), image quality, and the signal-to-noise ratio of the scan (radiologists will feel more confident assessing smaller masses when less image noise is present), and lesion conspicuity (masses whose density varies considerably from that of the surrounding renal parenchyma will be easier to categorize).

Several papers have shown that the density of a homogeneous mass on non-contrast CT can safely categorize it as a cyst if region of interest measurements either fall between −10 to 20 HU or are equal to or greater than 70 HU (as a result of proteinaceous or hemorrhagic content) [14−17]. A recent study showed that in a population of patients 40−69 years of age, none of the 42 homogeneous masses on non-contrast CT with density values of 21−39 HU proved to be clinically significant after 5 years. However, it was the view of the Working Group that masses in this density range are sufficiently uncommon that the flowchart should not be altered on the basis of this one series given that there is little



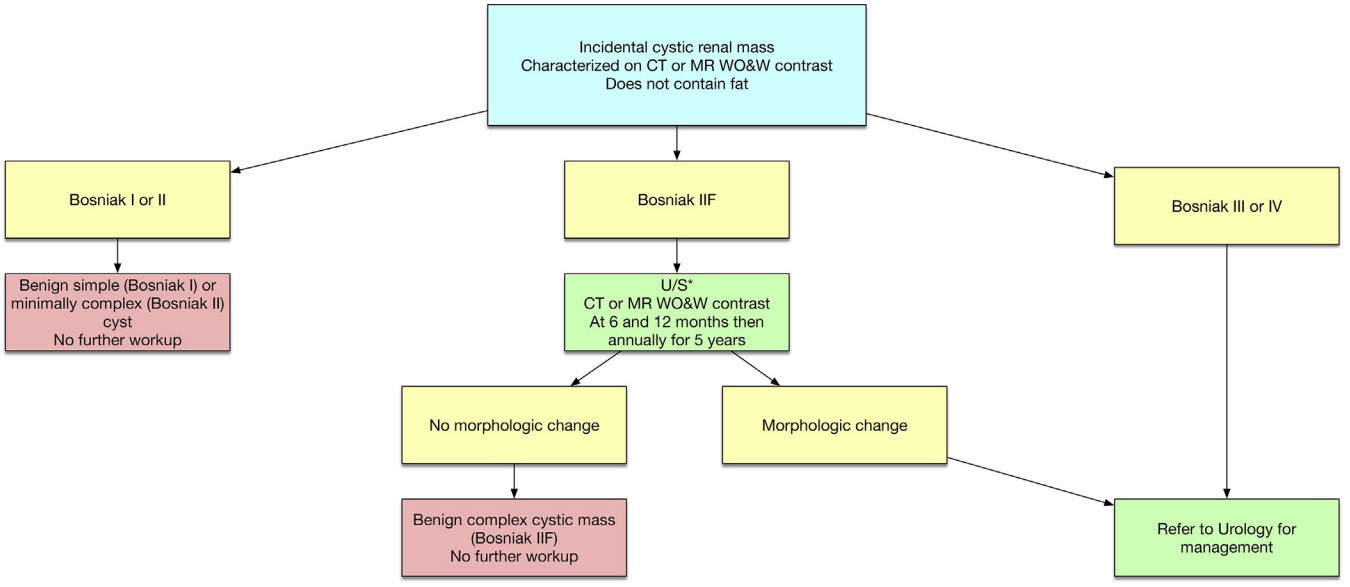
Flowchart 2. **Incidental renal mass on contrast-enhanced CT.** If the mass contains fat attenuation (<−10 HU), proceed to Flowchart 6. If prior studies are available for comparison, indeterminate masses with no change in imaging features for at least 5 years can be considered clinically insignificant. CT = computed tomography; MR = magnetic resonance; TSTC = too small to characterize; WO&W = without and with. *Ultrasound if the radiologist believes that there is a chance at successful characterization based on lesion appearance (suspected complex cyst), location, and patient body habitus.



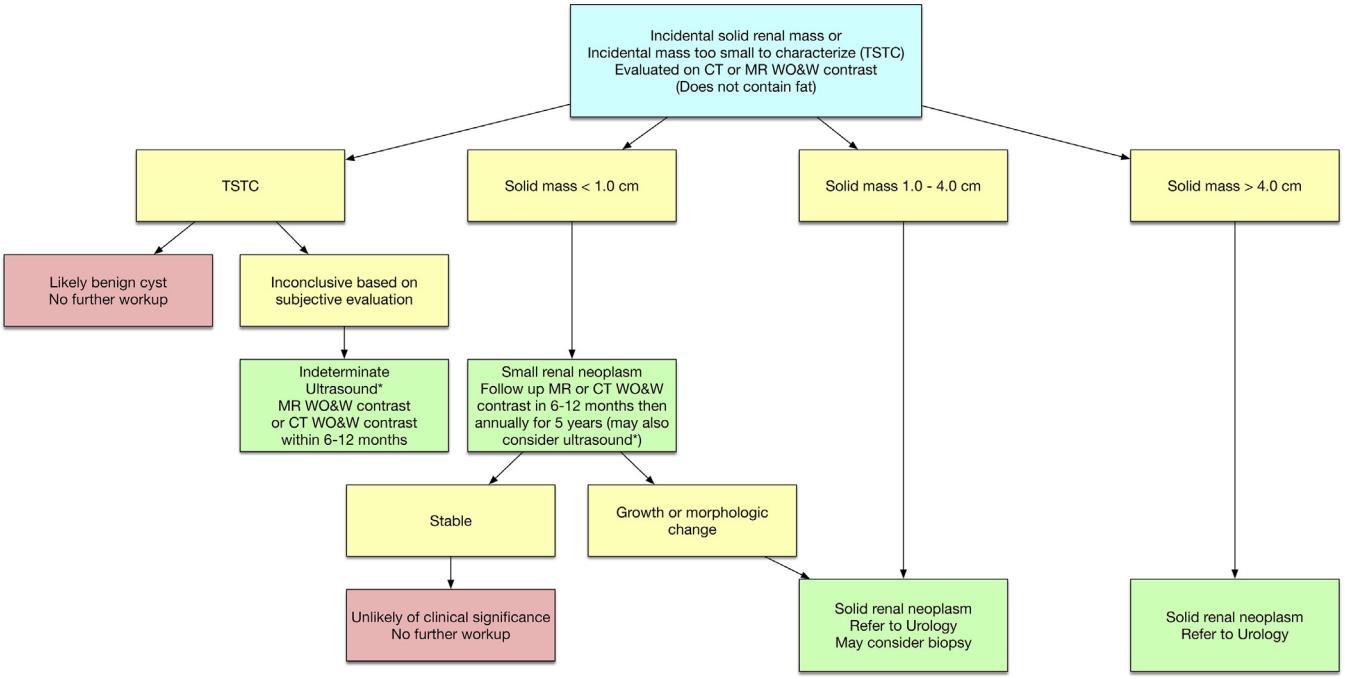
Flowchart 3. **Incidental renal mass on ultrasound.** See Table 1 for Bosniak classification system. If prior studies are available for comparison, indeterminate masses with no change in imaging features for at least 5 years can be considered clinically insignificant. AML = angiomyolipoma; CT = computed tomography; MR = magnetic resonance; MRI = MR imaging; RCC = renal cell carcinoma; U/S = ultrasound; WO&W = without and with. *Radiologists may preferentially investigate with MRI or limited non-contrast renal CT first to evaluate for macroscopic fat in younger patients.

downside to performing one more test for further investigation [18].

There are 2 main areas where the CAR flowchart for the incidental mass on non-contrast CT differs from the ACR white paper. First, it is the conclusion of the Working Group that ultrasound should be considered whenever possible as the first modality to investigate homogeneous masses in the 21−69 HU density range rather than MRI or CT, as long as the radiologist feels that there is a reasonable chance at successful sonographic characterization based on the appearance of the mass, size, location, and patient body habitus (with particular attention to distance from the skin surface and the amount of intervening fat, both of which will reduce sonographic visualization). Masses at the extreme poles of the kidneys can be more challenging to visualize with ultrasound, particularly those arising from the left kidney, and the smaller the mass the more difficult it may be to identify. This change recognizes the lower cost and greater availability of sonography across Canada, particularly in smaller or more remote communities, as well as evidence of its ability to make a diagnosis for a significant number of lesions in this subgroup [19].

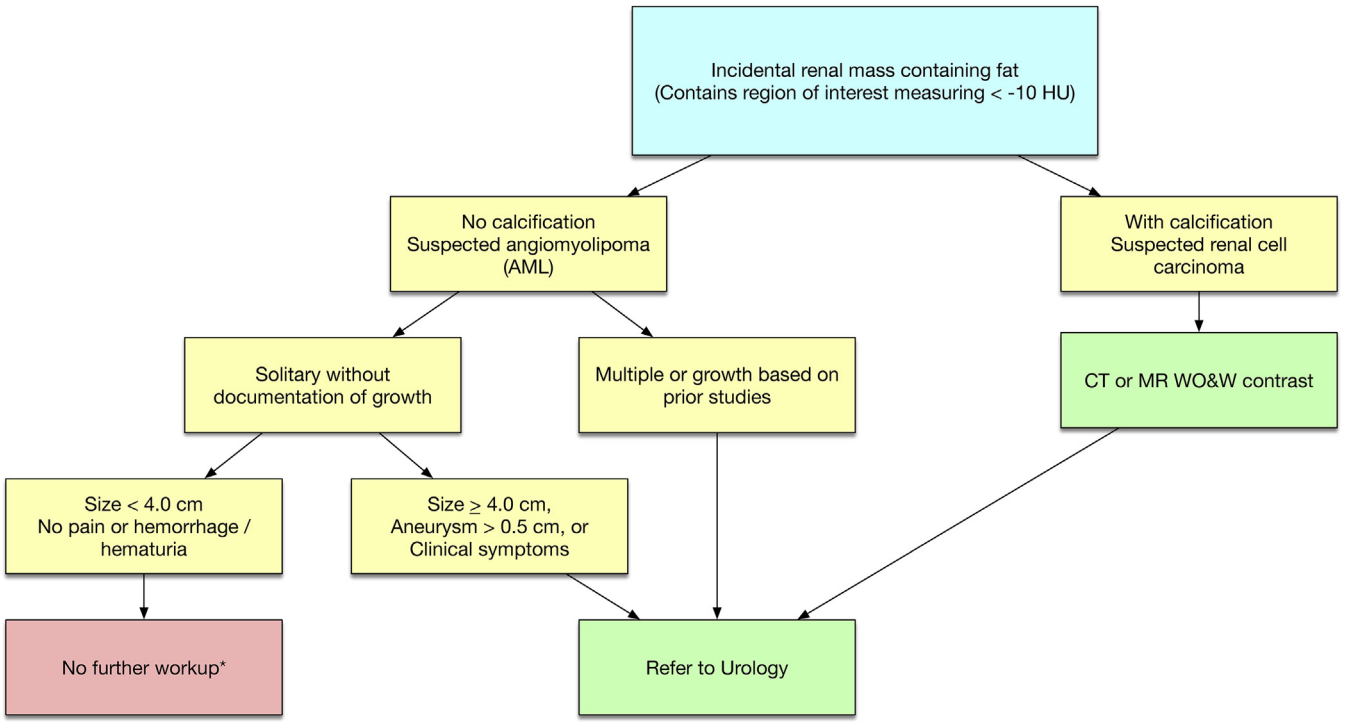


Flowchart 4. **Incidental cystic renal mass.** See Table 1 for Bosniak classification system. CT = computed tomography; MR = magnetic resonance; U/S = ultrasound; WO&W = without and with. *Ultrasound if the radiologist believes that there is a chance at successful characterization based on lesion appearance, location, and patient body habitus.



Flowchart 5. **Incidental solid mass or mass too small to characterize.** CT = computed tomography; MR = magnetic resonance; TSTC = too small to characterize; WO&W = without and with. *Ultrasound if the radiologist believes that there is a chance at successful characterization based on lesion appearance, location, and patient body habitus.

Second, while the Working Group acknowledges that there is some potential advantage to working up a renal mass with MRI over CT, access to MRI remains a considerable issue across the country [20,21]. CT is more widely available, less expensive, less susceptible to motion artifact, and offers a very straightforward method of quantitatively assessing for enhancement within a mass with density measurements [8,10]. Realistically, a renal MRI may take weeks



Flowchart 6. **Incidental renal mass containing fat.** CT = computed tomography; MR = magnetic resonance; WO&W = without and with. *The need for radiologic follow-up of angiomyolipomas < 4.0 cm is questionable, but it is recommended that radiologists discuss preferred management with their local urologist, as some feel that a period of active surveillance may be warranted to exclude a mass demonstrating significant growth.

to months to obtain in many regions, whereas a CT can be arranged expeditiously in most Canadian communities. For these reasons, CT was promoted to the preferred first modality to workup heterogenous masses and homogeneous masses with density ranging between 21-69 HU who are thought to be poor candidates for ultrasound. In some cases, radiologists may opt for MRI as the initial workup modality, including for younger patients where radiation exposure is a greater concern or if the wait time is not a concern. MRI remains the preferred modality for inconclusive masses that are too small to characterize on the initial non-contrast CT and require further investigation, due to the limitations of CT density measurements at this size and the wait time to MRI being less of an issue with smaller masses.

Flowchart 2: Incidental Renal Mass on Contrast Enhanced CT

The flowchart for the incidental renal mass on contrast enhanced CT is largely similar in that after excluding the presence of fat, the main decision tree revolves around whether the mass is too small to characterize, homogeneous (and possibly/likely cystic), or heterogeneous. If the presence of fat in a heterogeneous lesion is considered to be equivocal on contrast-enhanced CT, reconstructions with a reduced slice thickness or even a follow-up non-contrast acquisition through the kidneys can be helpful to clarify this [22]. One major deviation from the ACR white paper in these Canadian guidelines is the inclusion of an end point from either the homogeneous or heterogenous pathways where the radiologist concludes that there is a high likelihood of renal cell carcinoma based on the appearance. The Working Group agreed that there are many masses which even on a single phase postcontrast CT appear to be either Bosniak IV or predominantly solid and would thus require urologic referral regardless of the outcome of a multiphasic CT or MRI [8]. The rationale for creating this new end point is that given wait times for further imaging and specialist referral in many regions, it is more important to begin the referral process earlier when these patients will need treatment, biopsy, or ongoing imaging follow-up best managed through a surgical subspecialist.

For reasons already outlined under Flowchart 1, the group consensus was that CT without and with contrast was also promoted above MRI to workup homogeneous masses with density values of $>$ 20 HU, unless radiation exposure is a particular concern. Additionally, ultrasound was added as a recommended modality to assess homogeneous masses with density values of $>$ 20 HU when there is the suspicion that it may represent a complex cyst (provided the radiologist feels that lesion location and patient body habitus would facilitate visualization) based on evidence that a diagnosis can be made with sonography in a significant number of these cases [19].

Flowchart 3: Incidental Renal Mass on Ultrasound

Based on CAR member feedback, a new flowchart to address the management of the incidental renal mass identified on ultrasound (conventional, non-contrast-enhanced) was created. This flowchart begins with the decision of whether or not the mass is cystic or solid, and cystic masses of Bosniak category IIF or greater will receive more definitive follow-up imaging with CT or MRI (in which case the workup moves to Flowchart 4).

For masses determined to be solid, the next decision is whether or not the mass is homogeneously hyperechoic compared to renal cortex (and possibly fatty) or hypoechoic. Given that there is evidence that ultrasound is an accurate modality for assessing the size of renal masses, and that subcentimetre angiomyolipomas are not an uncommon finding, hyperechoic masses $\leq$ 1 cm can be followed with ultrasound unless morphologic change is encountered on subsequent imaging [23,24]. While in theory a small number of these masses could represent renal cell carcinoma, current consensus is that a conservative approach to masses of this size is warranted due to the low risk of metastasis [2,5,6,25,26]. Hyperechoic masses larger than 1 cm and all hypoechoic masses would be assessed with CT or MRI without and with contrast, at which point the workup would move to either Flowchart 4 (for cystic masses), 5 (for solid masses), or 6 (for masses containing fat). Radiologists should be careful to differentiate masses requiring follow-up or further investigation from parenchymal calcification or milk-of-calcium cysts (which may demonstrate tram-line calcification or calcification which is persistently dependent).

Flowchart 4: Incidental Cystic Renal Mass

Once a mass has been characterized as cystic, we recommend that it be assessed using the Bosniak renal cyst classification system (Table 1) in order to facilitate communication between radiologists, urologists and nephrologists [8,10]. No further workup is required for Bosniak category I or II cysts. With regard to Bosniak IIF cysts, the Working Group diverges from the ACR white paper and recommends ultrasound as a preferred modality for follow-up, as long as the radiologist feels that lesion location and patient body habitus will facilitate adequate visualization. Ultrasound has been shown to be accurate at evaluating these masses for size, and assessment of internal architecture is excellent provided the mass can be adequately seen [23,24]. Cystic masses should be interrogated for any change in internal structure (particularly progressive thickening, irregularity, or nodularity of internal septations or the cyst wall, development of Doppler flow or contrast enhancement within the lesion or its wall/septae, and indistinctness of the margins between the lesion and adjacent renal parenchyma). As there are, at this time, no long-term studies of ultrasound as a primary modality for the follow-up of Bosniak IIF cysts, radiologists are encouraged to move to CT or MRI if there are any concerns that they may not be able to assess the above findings adequately. For more complex Bosniak IIF cysts that may be statistically more likely to progress (particularly those with indistinct interfaces with adjacent renal parenchyma, wall/septal irregularity, or wall/septal thickening on the initial CT or MRI), radiologists may consider alternating

Table 1
The Bosniak renal cyst classification system

Category	Description	% Risk of malignancy [41]
I	A benign simple cyst with a hairline-thin wall that does not contain septa, calcifications, or solid components; it has water attenuation and does not enhance; no intervention is needed.	3.2
II	A benign cystic lesion that may contain a few hairline-thin septa in which perceived (not measurable) enhancement may be appreciated; fine calcification or a short segment of slightly thickened calcification may be present in the wall or septa; uniformly high-attenuating lesions (< 3 cm) that are sharply marginated and do not enhance (hyperdense cysts).	6
IIF	Cysts may contain multiple hairline-thin septa; perceived (not measurable) enhancement of a hairline-thin smooth septum or wall; there may be minimal thickening of wall or septa, which may contain calcification that may be thick and nodular, but no measurable contrast enhancement is present; no enhancing soft-tissue components; totally intrarenal and well-marginated non-enhancing high-attenuating renal lesions (> 3 cm) are also included in this category.	6.7
III	Cystic masses with thickened irregular or smooth walls or septa and in which measurable enhancement is present.	55.1
IV	Cystic masses that can have all of the criteria of category III but also contain distinct enhancing soft-tissue components independent of the wall or septa.	91

between ultrasound and CT/MRI for the annual follow-up throughout the 5-year period [27].

Bosniak III and IV masses require referral to a urologist for further management.

A follow-up period of 5 years is recommended for Bosniak IIF cysts based on a prior study of 156 Bosniak IIF cysts that showed that, of the 10.9% of lesions that progressed, all had demonstrated change by 3.2 years [27].

Flowchart 5: Incidental Solid Mass or Mass Too Small to Characterize

The flowchart is based on classification by size; using the principle that the smaller the mass, the less likely it is to metastasize or even be clinically significant [3,5,6,25,26]. There is one significant change from the ACR white paper where the Working Group recommends consideration of ultrasound for the surveillance of inconclusive masses which are TSTC on CT/MRI as long as the radiologist is of the opinion that visualization can be adequate. Given the reduced likelihood of a clinically significant mass at this size, as well as the established efficacy of ultrasound in accurately measuring masses, it was the consensus of the group that this was a more cost- and resource-sensitive approach to follow-up in this category [23,24].

Flowchart 6: Incidental Renal Mass Containing Fat

Once fat is identified within a mass (regions measuring < -10 HU), the first decision point in this flowchart is to determine if there are calcifications within the mass, which are rare in an angiomyolipoma and raise concern for renal cell carcinoma [10,28–30]. Masses with calcification should be treated as possible renal cell carcinoma and be referred to a urologist in conjunction with a full workup with MRI or CT without and with contrast.

Masses containing fat but without calcification should be referred to a urologist if: multiple masses are present (for consideration of tuberous sclerosis investigation), size ≥ 4 cm (due to the increased risk of a complication), if there is an identifiable intralesional aneurysm > 0.5 cm, if there is evidence of growth based on prior studies, or if there is any clinical evidence of symptoms or complication (flank pain, hematuria, or evidence of perilesional hemorrhage) [10,30,31]. While imaging follow-up is not considered mandatory for angiomyolipomas < 4.0 cm, radiologists should consider that the management of these smaller masses remains somewhat controversial, and some urologists prefer a period of active surveillance to exclude a mass demonstrating significant growth velocity [32]. The Working Group recommends that radiologists discuss preferred management with their local urologic specialists in the absence of strong scientific evidence to guide management in this subgroup.

Dual-Energy Computed Tomography and Contrast-Enhanced Ultrasound

Active research is ongoing to evaluate the use of dual-energy computed tomography to generate virtual non-contrast reconstructions to potentially allow for the determination of enhancement within a hyperdense mass based on a single postcontrast CT acquisition, and to improve the sensitivity of CT for iodine uptake with a renal mass. There is conflicting evidence in the literature on whether established density values would still apply to dual energy datasets, particularly virtual non-contrast images [33–35]. The Working Group did not feel that this technology was sufficiently mature to include in the flowcharts at this time [36–38].

Similarly, contrast-enhanced ultrasound shows promise in the further characterization of otherwise indeterminate solid and cystic renal masses but was not included in the flowcharts due to limited use and availability across the country [39,40].

It is anticipated that with increased published evidence of efficacy and real-world use of these modalities, they will eventually enter the standard workup flowcharts, but until that time radiologists should judiciously apply the results of these studies to their analysis.

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Appendix 1. Summary of Changes from the ACR Incidental Findings Committee White Paper

Flowchart 1: Incidental renal mass on non-contrast CT.

Ultrasound is recommended as a modality of choice to investigate homogeneous masses with density values ranging between 21-69 HU, and CT is the preferred modality for workup if the radiologist is of the opinion that sonographic visualization would not be adequate, unless radiation exposure is a particular concern.

Flowchart 2: Incidental renal mass on contrast-enhanced CT.

If a radiologist feels that a mass has a high likelihood of a mass being renal cell carcinoma, the flowchart recommends referral to Urology at that point even prior to further work up. Ultrasound is now listed as a modality of choice in investigating suspected minimally complex cysts measuring $>$ 20 HU, with CT promoted above MRI for investigating more complex masses unless radiation exposure is a particular concern.

Flowchart 3: Incidental renal mass on ultrasound.

This flowchart is entirely new.

Flowchart 4: Incidental cystic renal mass.

It is recommended that ultrasound be considered as a modality for following Bosniak IIF cysts if it is the opinion of the radiologist that sonographic visualization may be adequate.

Flowchart 5: Incidental solid mass or mass too small to characterize (TSTC).

Lesions which are too small to characterize on CT/MRI can be followed with ultrasound if it is the opinion of the radiologist that sonographic visualization will be adequate.

Flowchart 6: Incidental renal mass containing fat.

The flowchart clarifies that no further workup is necessary for angiomyolipomas $<$ 4 cm only if the patient is asymptomatic and in consultation with a radiologist's local urology practitioners.