Abdominal Radiology

Abdom Radiol (2016)
DOI: 10.1007/s00261-016-0914-5

"Incidentalomas" on abdominal and pelvic CT in emergency radiology: literature review and current management recommendations

Siavash Behbahani,[1] Sameer Mittal,[1] Michael N. Patlas,[2] Mariam Moshiri,[3] Christine O. Menias,[4] Douglas S. Katz[1]

[1]Department of Radiology, Winthrop-University Hospital, 259 First Street, Mineola, NY 11501, USA
[2]Department of Radiology, Hamilton General Hospital, McMaster University, 237 Barton St., East Hamilton, ON L8L 2X2, Canada
[3]Department of Radiology, University of Washington Medical Center, 1959 NE Pacific Street, Seattle, WA 98195, USA
[4]Department of Radiology, Mayo Clinic, 13400 E. Shea Blvd., Scottsdale, AZ 85259, USA

Abstract

The purpose of this article is to familiarize radiologists and clinicians with a subset of common and uncommon incidental findings on abdominal and pelvic computed tomography examinations, including hepatic, splenic, renal, adrenal, pancreatic, aortic/iliac arterial, gynecological, and a few other miscellaneous findings, with an emphasis on "incidentalomas" discovered in the emergency setting. In addition, we will review the complex problem of diagnosing such entities, and provide current management recommendations. Representative case examples, which we have encountered in our clinical practices, will be demonstrated.

Key words: Incidental findings—Abdominal and pelvic computed tomography (CT)—Emergency radiology—Management guidelines

This article will review the common task of handling selected common and uncommon incidental findings on emergency CT of the abdomen and pelvis, and will provide a systematic approach for their management, using current guidelines. Representative common as well as less common cases, which we have encountered in our clinical practices, will be demonstrated. A selected literature review will be performed, with an emphasis on larger, recent series in the emergency imaging and related literature. Given that the evaluation of such "incidentalomas" on abdomen and pelvic CT is a large and complicated topic, where each specific organ could be the subject of a full review article, we will review neither bowel abnormalities, nor findings in the skin, breasts, bones, or lung bases, but will focus on key findings and current recommendations for several selected organs.

What is an Incidentaloma?

An 'incidentaloma' is an incidentally discovered mass or lesion, detected using imaging—performed for an unrelated reason. This includes any unanticipated findings which are detected but which are not directly related to the clinical indication for the specific imaging examination.

Computed tomography (CT) is of course a "global examination" of the part(s) of the body which are scanned, and is often the first imaging examination in the emergency setting. CT can also potentially be harmful, by providing an excessive amount of information, particularly information unrelated to the reason(s) the examination was (were) performed, which can subsequently lead to an unwarranted amount of procedures/imaging, with possible adverse effects.

There are evolving guidelines and variations with respect to the management of incidentalomas; however, radiologists and/or clinicians may not necessarily be adhering to these current guidelines [1–3]. Abdominal and pelvic incidentalomas on CT, and their corresponding management, have received substantial attention relatively recently, particularly after the publication of the initial American College of Radiology (ACR) white paper in 2010, followed by several additional related ACR white papers in 2013 [4].

Correspondence to: Siavash Behbahani; *email:* Sbehbahani@winthrop.org

Published online: 30 September 2016

Following up incidentalomas is not without potential cost, financial or otherwise. Even though most of these incidental findings are benign or prove to be benign, their management can produce substantial anxiety and stress for both the referring physician and the patient. In addition, increase in healthcare costs, increased utilization of physician time, and patients' time spent on additional care are other potential major costs of their management. Examples of such follow-ups include but are not limited to bodily fluid/serological tests, further imaging, and/or interventions, which could potentially either help or harm the patient. The general idea of "better safe than sorry" for both patient and clinician, and the clinicians' and radiologists' fear of litigation [5], can lead to a "cascade syndrome" of testing and follow-up. Therefore, the format of the radiologist's CT report and proper communication of the findings with the clinician as well as their appropriate management recommendations have become essential.

In a small survey of academic radiology practices prior to the publication of the ACR white papers on incidentalomas, interobserver radiologist agreement on body CT incidentaloma recommendations was quite variable [6], depending in part on the experience and personal preference of the individual radiologist. In addition, there is the risk of overdiagnosis, particularly of malignancy. In particular, the majority of identified renal cell carcinomas (RCCs) are currently incidental findings (Fig. 1); however, detection of some of these RCCs may not impact a patient's life, and have potential downsides as noted above [7]. Although these patients' life expectancies may not change, their additional management can lead to potential adverse effects.

There are incidental findings which are simply normal variants which should be recognized as such on abdominal and pelvic CT, and which do not require any further follow-up. These include, for example, simple small renal cysts, simple small hepatic cysts, sebaceous cysts, and bone islands. However, there are findings which may be less clearly characterized on initial emergency CT, including small solid renal masses. The radiologist may also need to evaluate the entirety of a patient's condition, in conjunction with the referring healthcare practitioner, before making specific management recommendations. These factors include but are not limited to a patient's age, comorbidities, medical conditions, and the presence or absence of prior imaging. Management may also be influenced by the comfort level of the referring clinician, his or her experience with the specific situation, and his or her specialty [8] (Fig. 2).

General issues regarding incidentalomas

There are multiple ethical issues associated with the detection of incidentalomas. Incidentalomas are perceived by some to be a source for generating business for radiologists [9]. This was cited as one of the major reasons in 2009 by the Centers for Medicare & Medicaid Services' decision to deny routine coverage of screening CT colonography in the U.S.

The incidental detection of a previously unknown abdominal aortic aneurysm (AAA) on CT can be life saving, with a potentially great impact on a patient's life. In contrast, the identification of many other common incidental findings on CT, particularly adrenal nodules, which are almost always benign and without clinical consequence, can lead to further work up, with infrequent actual benefits [10–12].

There is relatively insufficient data to our knowledge on the evaluation of true long-term cost–benefit analyses of the consequences of incidentaloma detection.

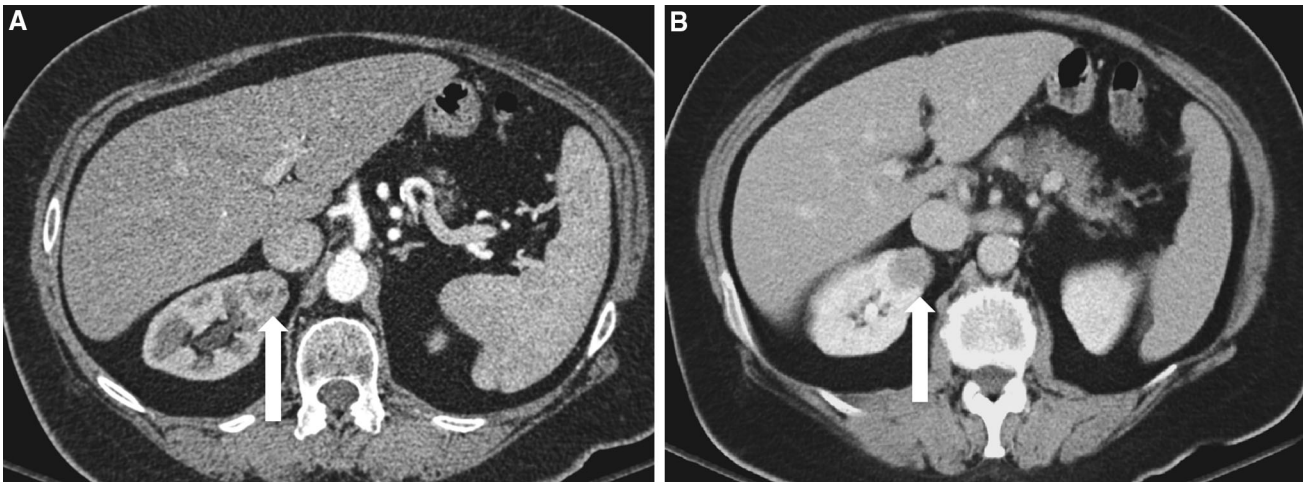

Fig. 1. **A** 64-year-old woman with shortness of breath underwent a CT pulmonary angiogram which showed an incidental, previously unknown subtle mass (2.3 cm, 48 HU) at the lower pole of the right kidney (*arrow*). **B** It is more obvious, and increased to 68 HU, on corresponding CT venography, and proved to be a renal cell carcinoma.

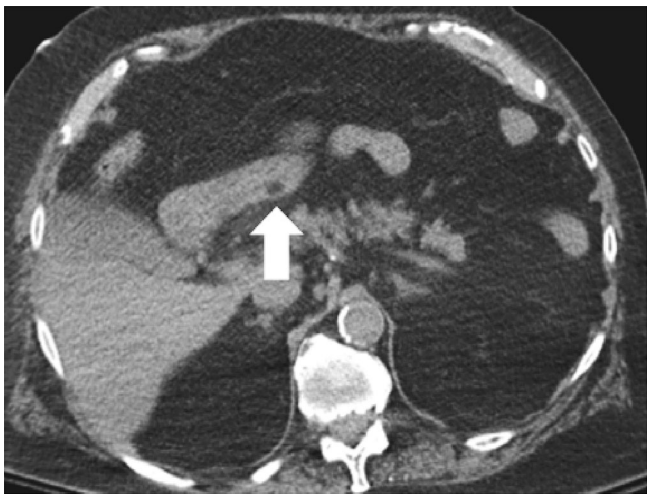

Fig. 2. Small incidental gastric lipoma (*arrow*) in a 91-year-old man on noncontrast CT performed for suspected urolithiasis.

Therefore, there is a need for more evidence-based and efficacy and/or outcomes data. The current estimates of extra costs per scan-related discovery of incidentalomas are relatively short term and are likely underestimated in the literature [13].

There are numerous reports in the imaging and clinical literature on abdominal and pelvic CT incidentalomas in multiple settings [14]. However, there are fewer reports on what to do with them, until relatively recently. There are also problems assessing the literature as to what were determined to be 'truly important' incidentalomas. The overall 'incidence' of these findings also varies amongst different studies. However, as expected, in general incidentalomas increase in incidence with increasing patient age.

A survey published in 2014 in the JACR [1] was initially distributed via e-mail, to which approximately 20% of ACR members (2895) replied. 38% of respondents had read the initial ACR white paper, and 89% of these ACR members reported using these guidelines. 51% reportedly recommended, in general, fewer additional imaging examinations compared with in the past, whereas 3% reportedly recommended, in general, more additional imaging examinations.

Detection of incidentalomas will vary depending on radiologist vigilance. For example, careful review of the scout images, the edges of the CT images, nonabdominal 'windows,' and multisequence scans, and attention to potential satisfaction of search error, are several factors influencing the detection or lack of detection of incidentalomas. Careful assessment of the entirety of available CT images is necessary, as the radiologist is responsible for the routine assessment of the skin, bones, lungs, breasts, etc. on emergency abdominal and pelvic CT [2, 15–20]. Besides reviewing all of the images on the CT scan, it is critical for the radiologist to check for older relevant imaging examinations, and to obtain a proper history if possible, in order to best attempt to determine the nature of any incidental findings, although this can be challenging, particularly in a busy after-hours imaging practice (Figs. 3, 4, 5, 6, 7 and 8). Furthermore, the lack of documented follow-up is also an additional recurrent theme in the CT incidentaloma literature [8].

Liver

Incidental hepatic findings are on occasion incompletely evaluated on a single-phase IV contrast-enhanced emergency CT, if they are not clearly simple cysts or hemangiomas, and therefore may be indeterminate in

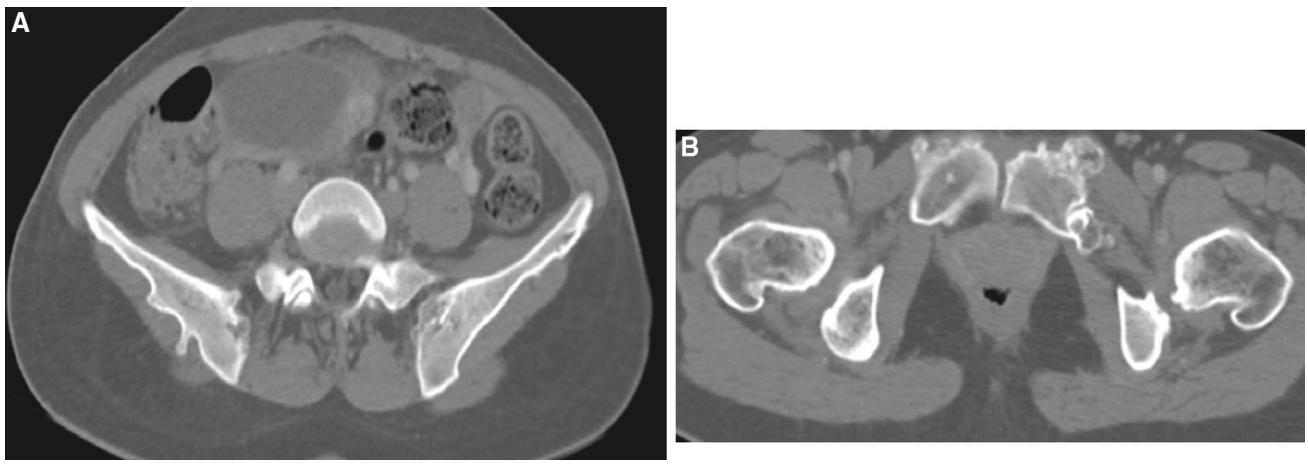

Fig. 3. 26-year-old woman presented with abdominal pain. **A** and **B** axial CT images demonstrate incidental and previously unknown multiple hereditary exostoses, which is an autosomal dominant condition with a relatively small risk of malignant degeneration; the emergency department was notified of these unexpected findings, and the need for patient follow-up and follow-up for her family.

Fig. 4. 42-year-old man with an incidental, previously unknown right lower and posterior mediastinal mass on abdominal and pelvic CT performed for lower abdominal pain; the mass proved to be a schwannoma.

nature. In general, the majority of such hepatic findings are benign, particularly in patients without a history of cirrhosis, other liver disease, or extrahepatic malignancy. In addition, many hepatic findings represent or are subsequently proven to be focal fat, hamartomas, focal nodular hyperplasia, or shunts [21]. As commented on in the original ACR white paper by Berland et al. [4], the management of and further recommendations for such incidental hepatic findings should be determined based on the CT features combined with the "level of risk." Based on these characteristics, dedicated multiphasic CT or MR, clinical and imaging follow-up, and/or biopsy, may be obtained for more definitive evaluation as indicated. Based on these recommendations, low-risk individuals are younger or equal to 40 years of age and without any known malignancy or liver dysfunction, average risk individuals are over 40 years of age, and without a known history of malignancy or hepatic dysfunction, and high-risk individuals are patients with a known history of malignancy, abnormal liver function tests, or other common hepatic risk factors [4].

For any incidental liver masses with low attenuation and clearly benign imaging features in any of the above risk factor group, no imaging follow-up is recommended. For any findings with suspicious imaging features such as ill-defined margins, more than 20 HU enhancement, or heterogeneous appearance, further evaluation with MRI is recommended. For focal abnormalities larger than 1.5 cm in high-risk patients or prominently enhancing masses without any benign imaging features, biopsy is preferred. The American College of Radiology's revised LI-RADS (Liver imaging—Reporting and Data System) provides a standardized classification system which can be used for the further management of selected focal hepatic abnormalities detected on cross-sectional imaging examinations, especially in patients with risk factors for developing hepatocellular carcinoma, particularly in patients with cirrhosis [22] (Figs. 9, 10 and 11).

Spleen

According to the ACR white paper on imaging of incidental splenic findings, most are benign and do not require biopsy [23]. However, the literature on their management and follow-up is somewhat limited to our knowledge. The evidence is mostly indirectly extrapolated from the literature regarding incidental hepatic findings; correlation with any history of malignancy and with the size(s) of the abnormality/abnormalities is the key determining factor for follow-up recommendations. After most initial CT scans with indeterminate incidental splenic findings, particularly those with indeterminate attenuation (>20 HU) and/or a heterogeneous appearance, in patients without a

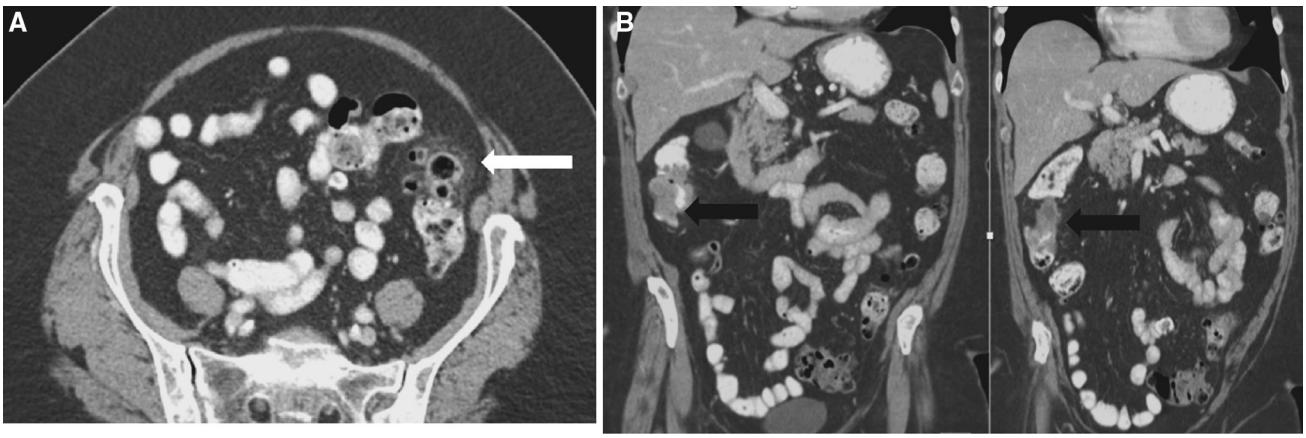

Fig. 5. **A** 82-year-old woman with descending colonic diverticulitis (*white arrow*) on coronal CT. **B** Incidentally, a previously unknown right colonic carcinoma (*black arrows*) was identified on the same examination.

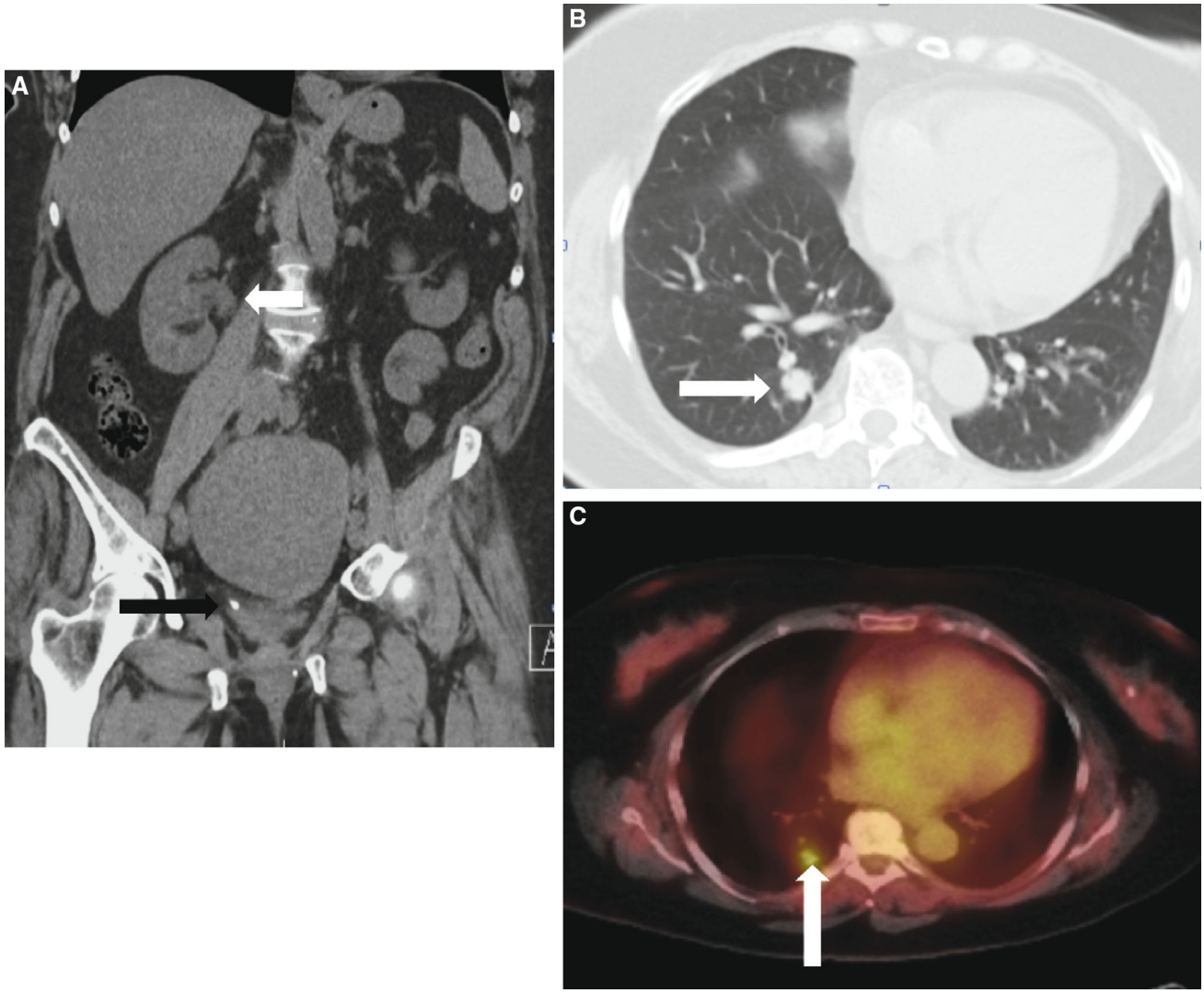

Fig. 6. **A** 62-year-old woman presented with an obstructing ureteral calculus on noncontrast CT (*white arrow*). **B** An incidental, previously unknown spiculated nodule at the right lung base (*white arrow*) was also identified, which proved to be a primary lung carcinoma (adenocarcinoma). **C** Subsequently, PET-CT showed intense hypermetabolism in the nodule (*white arrow*).

history of malignancy, follow-up MRI in 6–12 months is suggested. For splenic findings <1 cm in a patient with a history of malignancy, a follow-up MRI in 6–12 months is recommended. Furthermore, focal abnormalities larger than 1 cm in patients with a history of malignancy, even though most of these will still prove to be benign, should be evaluated with additional imaging or biopsy, as appropriate [23].

In terms of specific splenic incidentalomas, splenic cysts are common findings on cross-sectional imaging. Splenic hamartomas and lymphangiomas are considered relatively common. Splenic hemangiomas often do not have the same imaging characteristics as hepatic hemangiomas, and may demonstrate a variable appearance, in contrast to most hepatic hemangiomas. Isolated splenic lymphoma is uncommon [23].

Kidneys

Incidental renal cysts are very commonly detected on CT, including those performed in the emergency setting, and can be classified using the modified Bosniak system [24]. However, according to Siegel et al. [25], there can be interobserver disagreement amongst radiologists in some of these cases. The current recommendations are as follows [4]:

Type I (simple) and **Type II** (minimally complicated). No further workup or follow-up.

Type IIF (Multiple thin septations with or without enhancement/thick and nodular calcifications without enhancement/minimal smooth wall or septal thickening). Serial imaging for up to 5 years; however, the absence of growth does not prove benignity (Fig. 12).

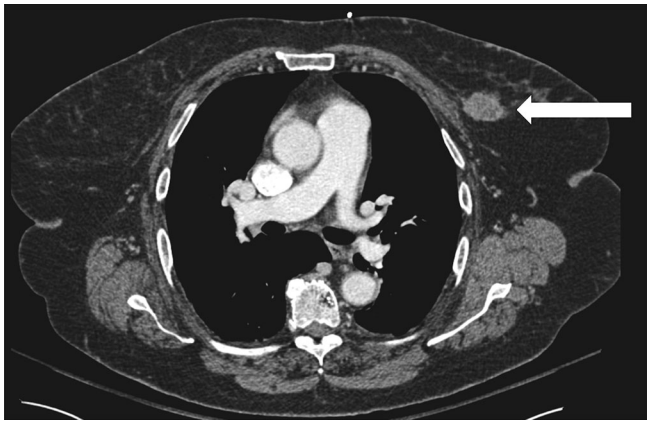

Fig. 7. 81-year-old woman with an incidental and previously unknown heterogeneous left breast mass (*white arrow*) on chest/abdominal CT performed emergently for unrelated reasons. US-guided breast biopsy performed a few days later revealed invasive ductal carcinoma.

Type III (thickened septae/multiple septae with measurable enhancement) and **Type IV** (enhancing soft-tissue components in addition to septations). Resect if patient is a surgical candidate [4].

A systematic approach should be applied to the evaluation of solid renal masses incidentally identified on CT (Fig. 13). First, the radiologist should exclude pseudotumors and fat-containing masses, i.e., angiomyolipomas. Second, a homogeneous high density (>70 HU) solid renal mass on a noncontrast CT is almost certainly a benign hyperdense cyst [26–28], and thus no further workup or follow-up is recommended. Otherwise, any heterogeneous solid mass incidentally found on CT must be considered to be a renal cell carcinoma until proven otherwise.

Percutaneous biopsy, although sometimes a controversial procedure, has a role in the diagnosis of selected renal masses. Furthermore, if a mass is smaller than 1 cm, the recommendation is generally to observe it. For renal masses larger than 1 cm, particularly if greater than 3 cm, resection if possible is recommended. Meanwhile, for selected individuals and/or poor surgical candidates, biopsy and ablation can be considered [4, 29, 30].

In recent years, there has been increased utilization of dual-energy CT for prospective evaluation of renal masses and complex cysts, as well as in conjunction with routine use in the emergency setting in case, amongst other reasons, an incidental renal mass is then discovered. Dual-energy CT offers several advantages, including the ability to assess an incidental renal process on a single IV contrast-enhanced acquisition [31, 32]. Performing dual-energy abdominal and pelvic CT routinely and reliably eliminates the need for obtaining an initial or follow-up "conventional" unenhanced CT examination, by creating virtual unenhanced images, which substantially reduces the radiation dose (by 30–50%) [31, 32].

Adrenal

Adrenal incidentalomas are very common, and are found in at least 3–7% of all adults undergoing CT including the adrenals. These incidental adrenal nodules are almost always benign. If the patient has no history of malignancy, and no evidence of other malignancy on the current CT examination, and has no known endocrine disorder, and if the adrenal nodule/mass is smaller than

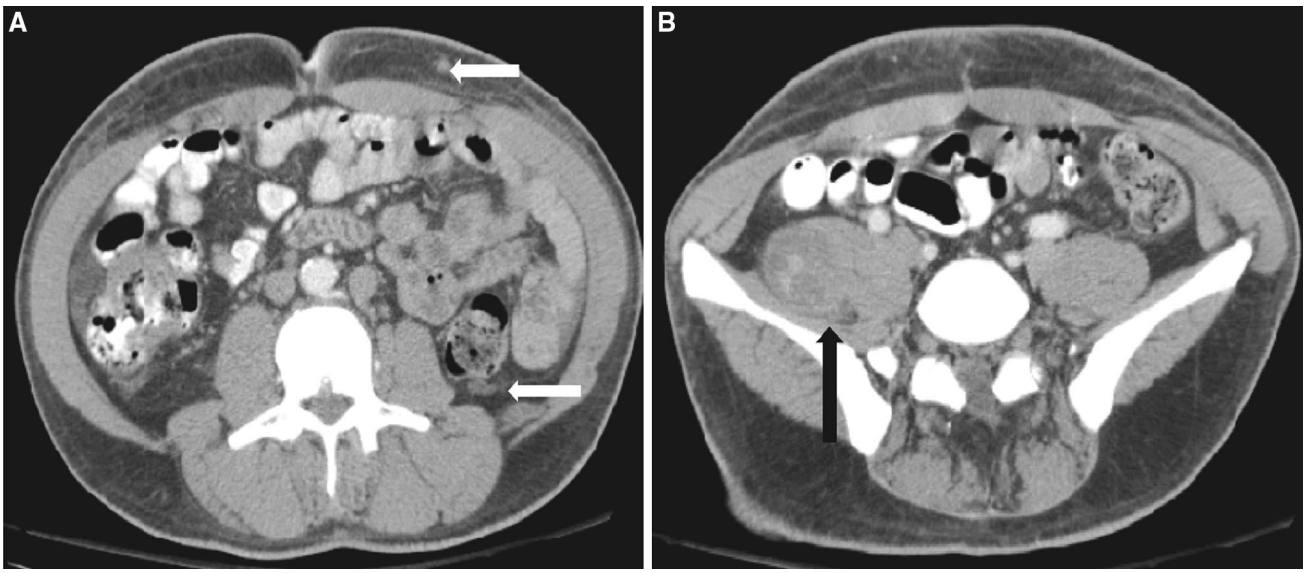

Fig. 8. **A** and **B** 45-year-old man with a new incidental diagnosis of neurofibromatosis based on the CT findings of several abdominal and pelvic soft-tissue nodules and masses (*arrows*). There is also a duplicated inferior vena cava.

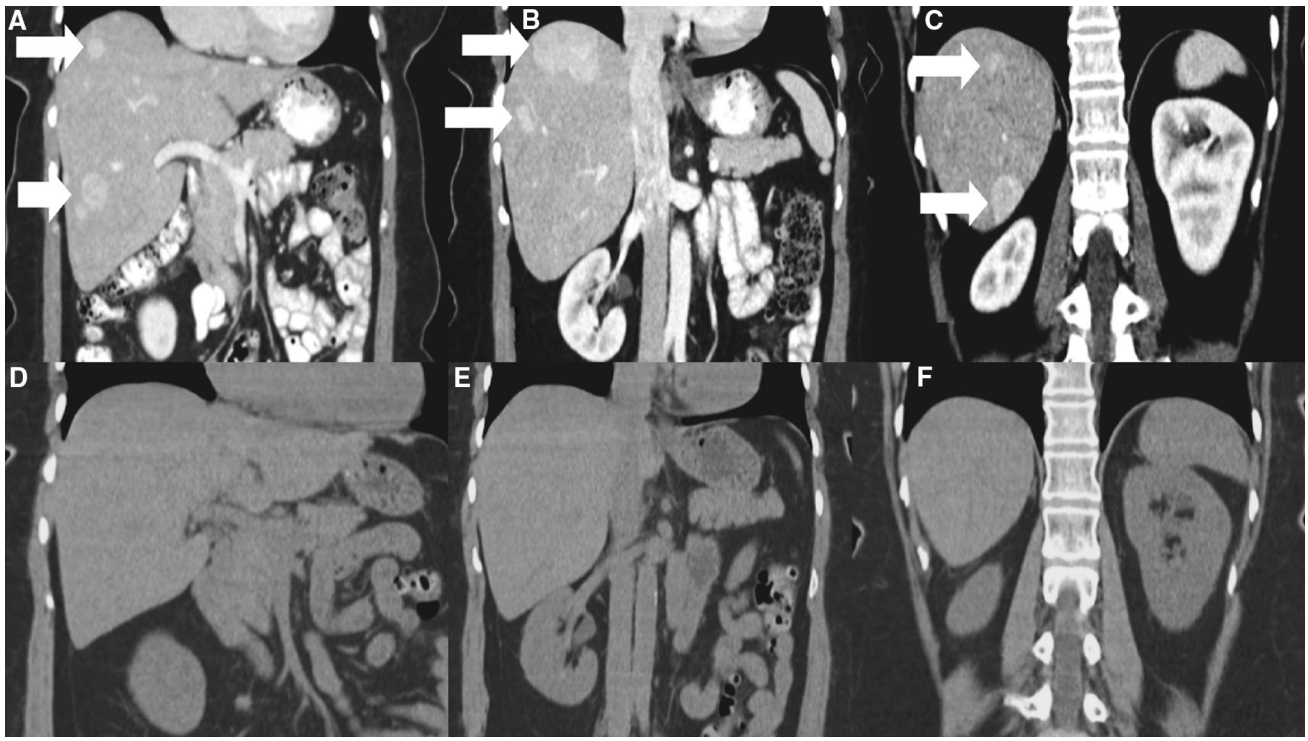

Fig. 9. 61-year-old woman with incidental multiple focal nodular hyperplasia (FNH) on enhanced (**A**–**C**) and nonenhanced CT (**D**–**F**) examinations performed at different time periods. Some of the larger foci have central hypodense scars, which is relatively characteristic, although not entirely diagnostic. This patient did not have cirrhosis, and did not have a known extrahepatic malignancy. Therefore, no follow-up was recommended.

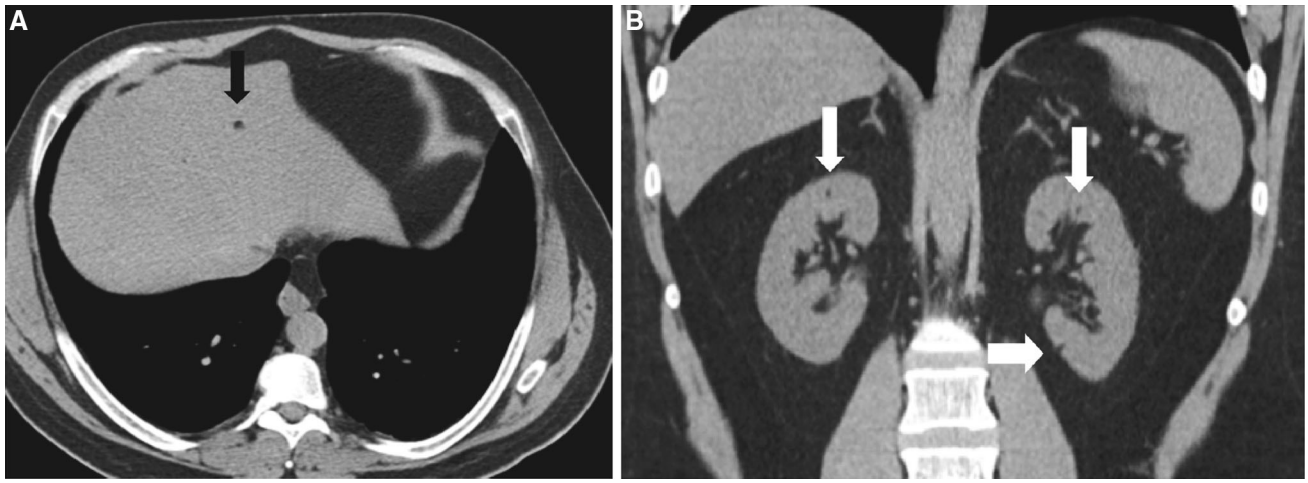

Fig. 10. **A** 43-year-old woman with incidental small hepatic (*black arrow*) and **B** renal (*white arrows*) low density foci on noncontrast CT, which represent angiomyolipomas, and therefore findings highly consistent with a previously unknown, mild form of tuberous sclerosis. On a CT examination from the previous year (not shown), these foci were called 'too small to characterize,' but they measure fat density (e.g., −51 HU), and they were unchanged on the current CT. Tuberous sclerosis is an autosomal dominant disorder, with potential implications for the patient and family members. This was communicated to the clinical staff.

4 cm, and is homogeneous and measures <10 HU, on either noncontrast or IV contrast-enhanced CT, it is almost certainly benign. These may be a lipid-rich adenoma, a cyst, or a myelolipoma. Even if the adrenal nodule measures more than 10 HU on unenhanced CT, it is still statistically much more likely to be benign [33]. Even in a patient with a known malignancy, adrenal nodules, in general, are more likely to be benign and

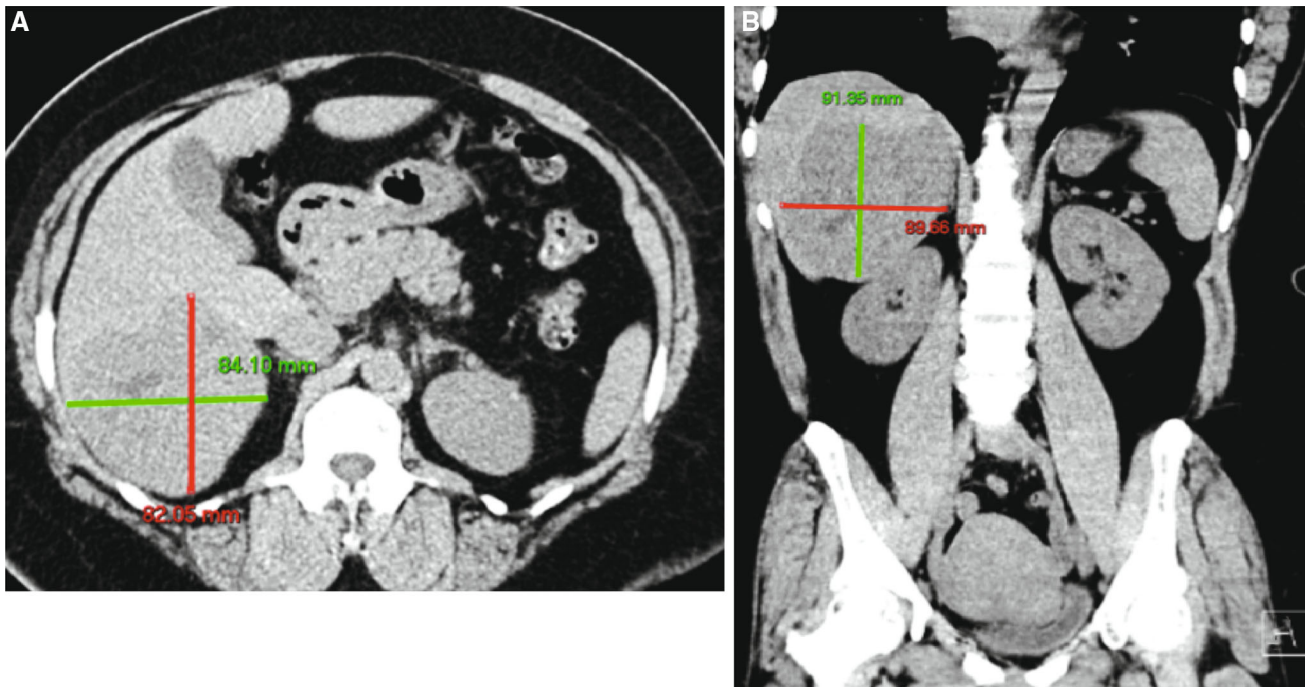

Fig. 11. 47-year-old woman with left flank pain was found to have a large right hepatic mass with lower density centrally on noncontrast CT, **A** and **B**. On further questioning by the emergency department physician, the patient stated that she has a known 'giant' hemangioma. Therefore, no further workup was needed.

Fig. 12. 74-year-old woman with an incidentally discovered, relatively large cyst (*white arrow*) with relatively thin septations at the lower pole of the left kidney on CT angiography, which was performed for suspected aortic dissection (and was negative). This was characterized as a Bosniak type IIF renal cyst.

incidental. However, in such patients, careful characterization and follow-up is necessary [34].

If the incidental adrenal nodule does not fit into the above mentioned criteria, delayed CT images at 15 min can be performed. If the patient has already left the radiology office/department, a repeat CT examination with initial unenhanced images is recommended. If this is still indeterminate at that time, an adrenal mass protocol, including portal venous and delayed phases, with performance of washout calculations, should be obtained. In addition, dual-energy IV contrast-enhanced CT could be prospectively obtained in all emergency department patients undergoing IV contrast-enhanced abdominal CT; virtual unenhanced images could then be generated to accurately address the nature of any incidentally detected adrenal nodules [35–37].

There is a small selected group of patients with incidental adrenal nodules/masses for which follow-up MRI, PET/CT, biopsy, and even surgery may have a role [5, 10, 11, 38] (Figs. 13, 14 and 15).

Pancreatic solid and cystic masses

Occasionally, incidental solid pancreatic masses will be identified on abdominal and pelvic CT examinations performed for unrelated reasons. Most likely these will prove to be relatively small 'non-functioning' islet cell tumors, i.e., neuroendocrine tumors, although a small and incidental pancreatic adenocarcinoma may relatively rarely be encountered. In a retrospective review of 60 cases of neuroendocrine tumors of the pancreas which were incidentally detected on MDCT examinations, the mean tumor size was 2.9 cm [39]. The tumors had a solid or complex appearance. Overall, slightly greater than 50% proved to be malignant (32, or 53%), and 30% of the tumors with a mean size of less than 3 cm were malignant. Calcification was a strong predictor of more

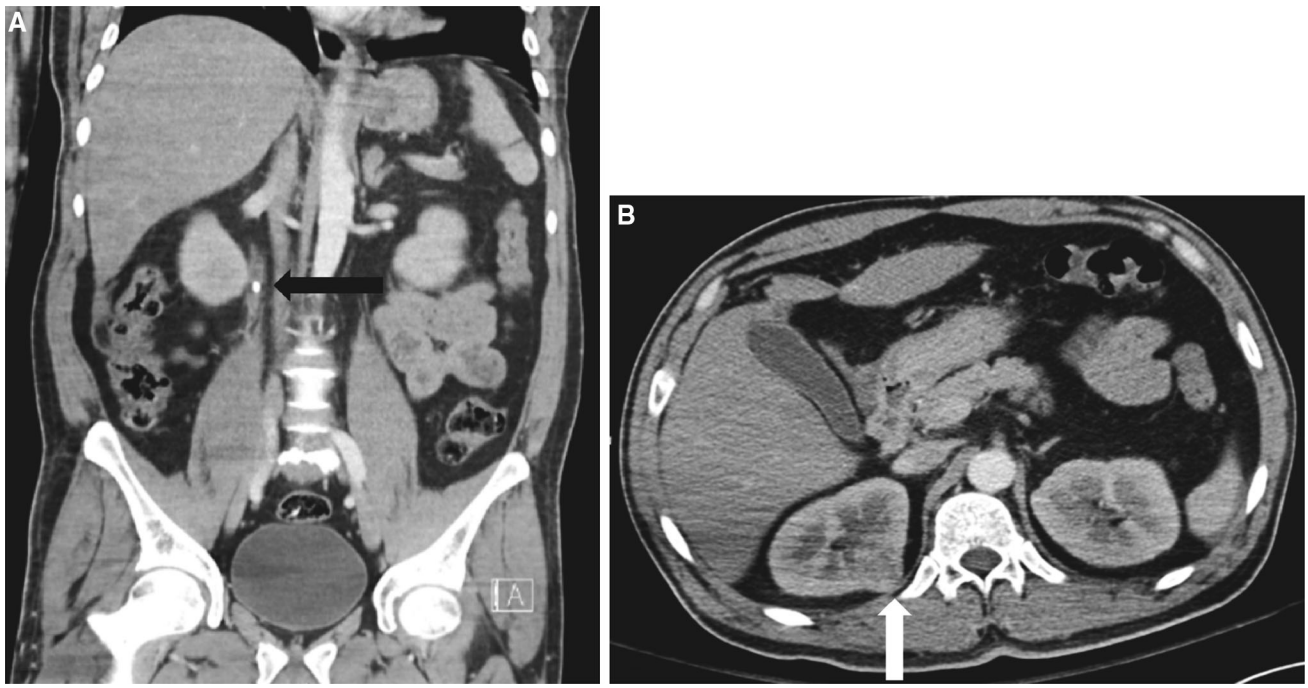

Fig. 13. 39-year-old man with stab injuries. **A** There was an incidental proximal right ureteral calculus (*black arrow*) with obstruction on abdominal and pelvic CT, and **B** there was also an exophytic, 2.5 cm, previously unknown, incidental right renal mass (*white arrow*), which proved to be a clear cell renal carcinoma.

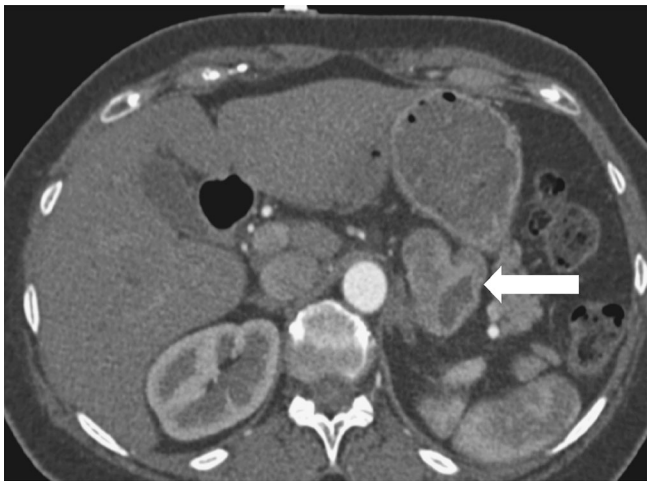

Fig. 14. 59-year-old normotensive woman with an incidental, heterogeneous 4 cm mass on abdominal CT extending from the lateral limb of the left adrenal (*white arrow*), which was subsequently proven to be a pheochromocytoma.

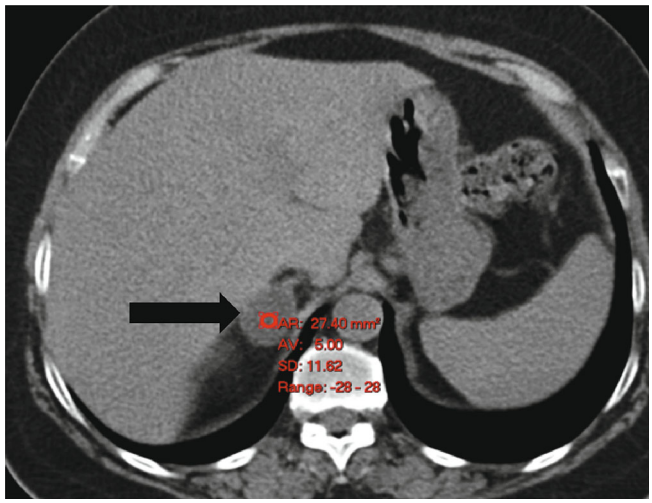

Fig. 15. 59-year-old woman with a new diagnosis of left breast cancer. Initial CT showed a 2.9-cm right adrenal nodule measuring 53 HU, which was indeterminate (not shown). The same nodule measured 5 HU on follow-up noncontrast CT done several days later, representing an adenoma (*black arrow*).

aggressive behavior, as well as main pancreatic duct dilatation, local invasion, and associated lymphadenopathy [39]. We are not aware of any recent data reviewing the incidental detection of pancreatic adenocarcinoma on abdominal and pelvic CT (excluding studies specifically screening high-risk patients for pancreatic tumors using CT), particularly in the emergency setting.

A small but nontrivial subset of tumors traditionally included in the cystic category can have a purely solid appearance on CT and on MR, including serous tumors, as well as solid and pseudopapillary epithelial neoplasms [40–42]. Another consideration for an incidentally detected, solid pancreatic mass is an intrapancreatic

splenule. This may have a pathognomonic appearance, or if not a diagnostic then a strongly suggestive appearance (i.e., a solid small nodule in the pancreatic tail which is identical in density to the spleen) then a multiphasic CT or MR, or a heat-damaged nuclear red blood cell scan, can be performed [43]. In general, these incidentally detected solid pancreatic neoplasms (excluding the intrapancreatic splenule) need to undergo biopsy for further assessment.

Pancreatic cysts are being increasingly identified as incidental findings on MDCT scans of the abdomen, including in the emergency setting, and are problematic for accurate diagnosis and management. Although only a brief discussion of this complex and somewhat controversial topic is possible in this review article, the morphology of the cyst should be considered, i.e., is it a nonspecific simple cyst, or does its appearance suggest a more focused differential diagnosis or a specific diagnosis? What is its relationship to the pancreatic ductal system [44, 45]? The patient's age, sex, history, and concurrent medical conditions must be considered as well. The differential diagnosis is relatively broad, and includes serous tumors, mucinous tumors (including IPMNs), cystic neuroendocrine tumors, solid and pseudopapillary tumors, pseudocysts, epithelial cysts, and lymphoepithelial cysts. A multidisciplinary approach is best for prospective management [46].

The radiologist should attempt to initially characterize the incidentally detected pancreatic cyst (or cysts), and to make recommendations as to whether immediate/short-term imaging follow-up (e.g., MR/MRCP, endoscopic ultrasound) and/or aspiration/biopsy may be helpful, versus just follow-up in a year (or, in very selected patients, no follow up). The ACR recommends initial nonsurgical management for pancreatic cysts incidentally detected which measure less than 3 cm in diameter, and which do not have 'worrisome features,' and particularly if they measure less than 1.5 cm in diameter [4]. Such worrisome imaging features include mural nodules, a dilated common duct, involvement of the main pancreatic duct, and associated adenopathy. Cysts measuring less than 2 cm should undergo a 1-year follow-up imaging examination (preferably with MR, to eliminate any further radiation exposure), and if unchanged, the guidelines do not recommend any further follow-up. If equal to or larger than 3 cm, the cyst should be considered for surgery, unless it is clearly a serous tumor (and without other indications for intervention). If follow-up CT is done, it ideally should be performed with a dedicated pancreatic protocol. Aspiration of cysts, particularly under endoscopic ultrasound guidance, is very helpful, especially for cysts >3 cm, and particularly if resection is being considered [4].

Very recently, this ACR recommendation to discontinue follow-up imaging after 1 year of stability has been challenged. A series of 259 patients with 380 small, asymptomatic pancreatic cysts were retrospectively reviewed [47]. There was a mean follow-up of 2.2 years; mean initial cyst size was 9.4 mm, and there was a median of 3 MR examinations per patient. In 27% of the patients, the cysts grew over time, with a median total growth and a median annual growth of 4.8 mm and 2.3 mm/year, respectively. 11% grew after an initial 1-year period of stability. The patient's age, the initial cyst size, and the presence of septations (25%) were not predictive of growth [47].

In addition to the ACR guidelines, there are several other organizations which have published somewhat different recommendations for the assessment and follow-up of incidentally detected pancreatic cysts [48, 49]. The recent guidelines from the American Gastroenterological Association, in particular, noted the 'very poor quality of the evidence' and the absence of long-term follow-up data on such patients [49].

Abdominal aortic and iliac aneurysms

According to the ACR white paper [50], management of abdominal aortic and iliac arterial aneurysms is primarily based on the size of the aneurysms, and varies from interval follow-up with cross-sectional imaging, not otherwise specified by modality, to surgical referral. The recommendations of initial management of AAAs are detailed in Table 1.

An isolated iliac artery aneurysm is usually a rare incidental CT finding, as it typically is a concurrent finding with an AAA. Management is as follows [50]: for any iliac artery aneurysm measuring 3–3.5 cm, an initial 6-month follow-up with cross-sectional imaging is recommended, and for any iliac artery aneurysm larger than 3.5 cm, close follow-up or treatment is recommended.

Al-Thani et al. [51] reported a series of over 13,000 patients who underwent abdominal and pelvic CT. Approximately 0.5% (61) of the patients had an incidental AAA, with a mean diameter of 5.3 cm, most of which were found in older men with risk factors, particularly a smoking history. Approximately 67% of these AAAs were infrarenal. On 3-year follow-up, 8% (5) had ruptured, with a 60% (3) patient mortality. Most were infrarenal aneurysms with maximum axial plane diameter measurements of greater than 5.5 cm.

Table 1. Recommended initial follow-up imaging/management of abdominal aortic aneurysm (AAA) [21]

Max. diameter of AAA	Recommended imaging interval
2.5–2.9 cm	5-year follow-up
3.0–3.4 cm	3-year follow-up
3.5–3.9 cm	2-year follow-up
4.0–4.4 cm	1-year follow-up
4.5–4.9 cm	6-month follow-up
5.0–5.5 cm	3–6-month follow-up
AAA greater than 5.5 cm	Surgical/endovascular referral

Gynecologic

Asymptomatic ovarian/adnexal cysts, particularly if small and uncomplicated, are very common findings on CT. These very rarely represent a previously unknown malignancy. In a series of 2869 asymptomatic women 50 years or older who underwent CT colonography, approximately 4% (118 patients) had indeterminate adnexal masses. From this group, 80 patients underwent further imaging and/or surgical resection (26 patients); none of these adnexal masses were subsequently proven to be malignant [52]. In a series of 3131 patients who underwent CT and US examinations through the emergency department during a 2-month period at one institution, 16.4% (514) had incidental findings, with the ovary being the most common site (42% = 214 patients) [53]. An ACR white paper on this topic, addressing the detection of such cysts on CT, has also been published [54]. A stepwise systematic approach is recommended. Comparison with available prior imaging should be performed as the first step in the evaluation of an adnexal abnormality [54]. Next, the characteristics and size of the finding should be categorized (Figs. 16 and 17). It is also essential to obtain additional history, such as if the patient is premenopausal, perimenopausal, or postmenopausal.

Many imaging characteristics are diagnostic or strongly suggestive of a specific gynecologic diagnosis on CT. These include, but are not limited to, teratoma, hydrosalpinx, peritoneal inclusion cyst, and exophytic leiomyoma.

On computed tomography, cysts which are oval or round, unilocular and of uniform fluid attenuation, with a regular wall, without solid nodules, and less than 10 cm in maximum diameter, are considered "benign-appearing cysts." Cysts containing layering hemorrhage in premenopausal women are also considered benign-appearing cysts. "Probably benign cysts" are defined based on ACR recommendations as cysts which have angulated margins, are not round or oval, or are poorly or incompletely imaged [54]. In premenopausal women, a benign-appearing or probably benign-appearing cyst measuring equal to or less than 3 cm should be considered normal. Adnexal cysts larger than 3 cm but smaller to or equal to 5 cm in premenopausal women are large enough to be further characterized. If the cyst is asymptomatic and is benign-appearing to the radiologist, no further follow-up is recommended. The white paper recommends a short-term follow-up ultrasound evaluation in 6–12 weeks for benign-appearing cysts larger than 5 cm, and for probably benign cysts larger than 3 cm [54]. Further evaluation and appropriate follow-up based on sonographic appearance should be obtained [54, 55].

In early postmenopausal women, a follow-up ultrasound in 6–12 months is recommended for benign-appearing cysts of 3–5 cm in maximum diameter. However, in early postmenopausal women, a prompt sonographic evaluation is recommended for any benign-appearing cyst larger than 5 cm, to exclude small wall nodules, and for probably benign cysts larger than 3 cm [54].

Fig. 16. 86-year-old woman with an incidental, relatively large left adnexal/ovarian cyst with a simple appearance (*black arrow*).

In a late postmenopausal patient, no follow-up ultrasound is recommended for any asymptomatic benign-appearing cyst less than or equal to 3 cm. However, a prompt sonographic evaluation is recommended for any probably benign cyst larger than 1 cm [54].

There is no specific guideline for a prominent endometrium which is incidentally detected on CT, to our knowledge; however, we suggest follow-up ultrasound in postmenopausal patients, if it would potentially change patient's management. Additional factors to be considered for further evaluation are the patient's age, menopausal status, menstruation cycle, and any history of hormonal therapy.

Biliary tract

Recommendations for management of incidental biliary tract findings are available in the ACR white paper on the gallbladder and biliary tract [56]. We have seen several cases of incidental gallbladder carcinomas on CT in our practices. For findings including focal wall thickening, a soft-tissue mass, and/or intraluminal material which is not clearly sludge or calcification, further evaluation with ultrasound is advised (Fig. 18).

Incidentally detected, mild common bile duct or common hepatic duct dilation, greater than 6 mm in

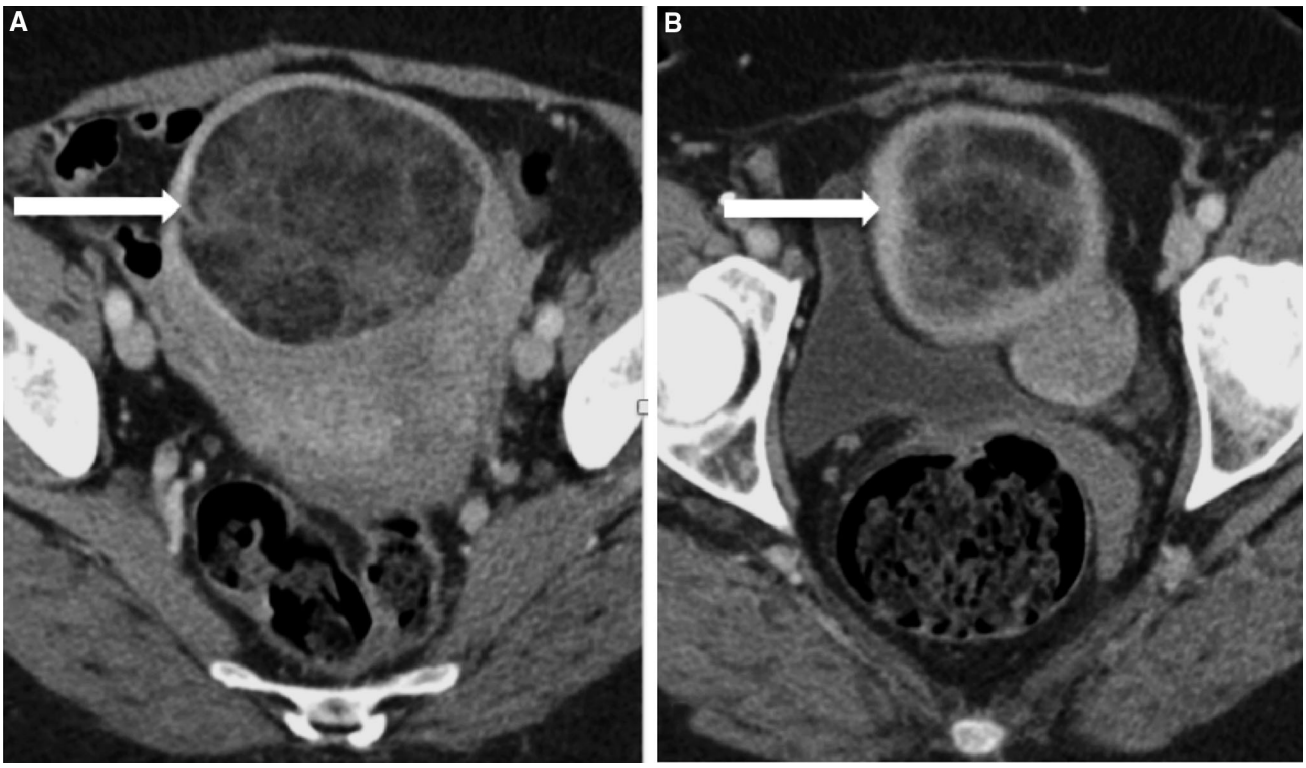

Fig. 17. **A** and **B** 71-year-old woman with incidental uterine fibroids on CT, including a relatively large fibroid containing macroscopic fat, representing a lipoleiomyoma (*white arrows*). Therefore, no follow-up was recommended.

patients younger than 60 years of age or 10 mm in post-cholecystectomy patients, in the setting of a normal alkaline phosphatase and a normal bilirubin, is unlikely to be clinically significant [56].

Lymph nodes

One of the ACR white papers provides additional scenarios, including the evaluation of incidental enlarged and/or an increased number of abdominal and/or pelvic lymph nodes [23]. The initial step is to compare the current CT with any prior imaging. Furthermore, obtaining additional history, particularly a history of malignancy, and evaluation of the CT features, is essential for further evaluation. These CT characteristics include the size, number, and location of the lymph nodes, as well as the presence or absence of central fat, assessment of enhancement, and evidence of necrosis or calcification [23].

Incidentalomas on emergency abdominal and pelvic CT: selected literature review

In a study by Shuaib et al. [2], 290 patients with abdominal pain who underwent CT of the abdomen and pelvis had 283 incidental findings, of which 144 (51%) were felt to be benign, 114 (40%) were categorized as indeterminate, and 25 (9%) were determined to be potentially important. There was a statistically significant difference in the percentage of patients whose management changed when specific recommendations were made for the incidentalomas in the official CT report, compared to those patients where no management recommendations were made in the CT report (70% vs. 2%).

A review of 1 year of emergency abdomen and pelvic CT scans at one institution, which included 1155 patients, demonstrated that 700 examinations had findings which were benign, particularly diverticular disease, liver cysts, and gallstones, but 143 incidental findings which were categorized as indeterminate/urgent [57]. In this series, 24 previously unknown neoplasms were detected and confirmed, including 4 pancreatic, 4 colonic, and 4 renal tumors. Furthermore, 259 patients received recommendations for additional testing, including 190 for additional imaging, which added 11% to the imaging relative value units, and 141 patients were recommended to have another specialty consult [57].

In a study of 624 patients who underwent CT angiography of the chest and/or abdomen and pelvis, 5.6% had previously unknown important extra-arterial findings, including 6 malignancies [58]. Another study demonstrated that 15 of 423 patients (3.5%) had a new diagnosis of malignancy based on CT angiography of the abdomen, pelvis, and/or lower extremities [59].

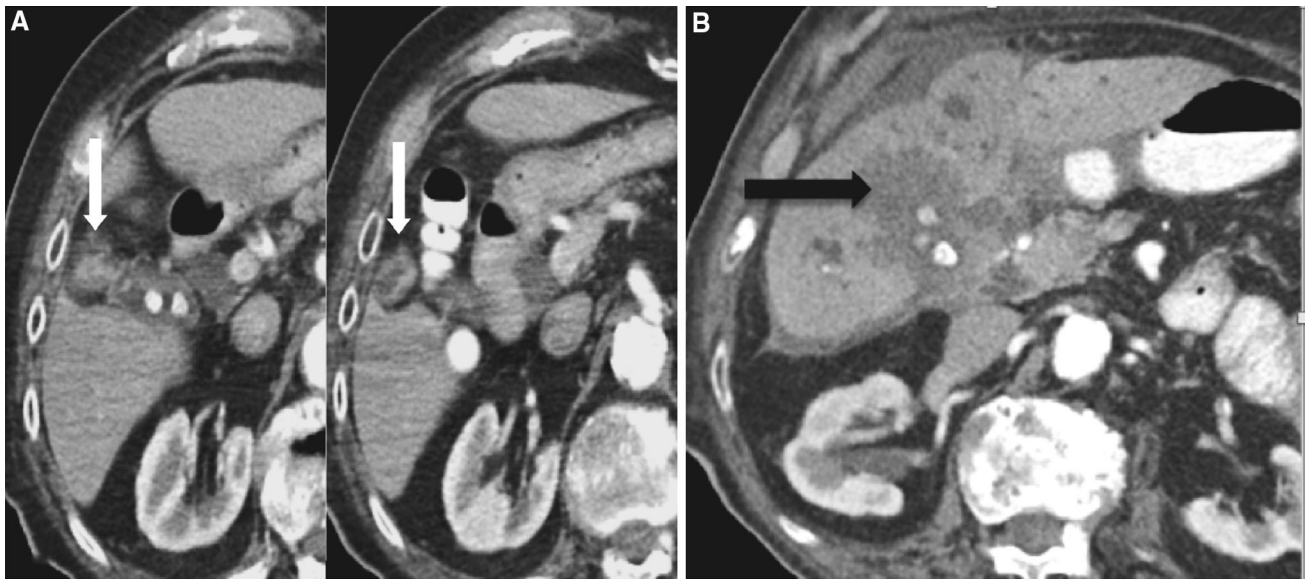

Fig. 18. **A** 92-year-old woman with an incidental gallbladder mass correctly identified and reported by the interpreting radiologist on initial CT (*white arrows*). **B** The patient did not have further workup or follow-up, and returned 2 years later with symptomatic, locally invasive gallbladder carcinoma (*black arrow*).

In a study by Naidu et al. [8], 40 (15%) out of 275 patients who underwent CT angiography of the abdomen, pelvis, and/or lower extremities had potentially highly important incidental findings, and 77 (17%) had potentially moderately important incidental findings. Several previously unknown malignancies were ultimately diagnosed.

In a retrospective study which evaluated the abdominal and pelvic CT scans in 876 patients with suspected acute appendicitis, incidental findings were common, and as with other studies, increased in incidence with increasing patient age [60]. The rate of incidental findings was 78% in patients older than 50, vs 23% in patients under the age of 20. The findings were usually of "low clinical significance," but a minority of patients required further workup or follow-up. As expected, the estimated costs associated with the incidental findings correspondingly increased with increasing patient age [60]. Somewhat surprisingly, in a study of 165 pediatric patients who underwent CT for suspected appendicitis, approximately 18% (30) had incidental findings [61] (Fig. 19).

Multiple studies of trauma CT scans of the chest, abdomen, and pelvis have demonstrated incidental findings. In one series [62], 1474 incidental findings were found in 1103 (35.4%) of 3113 patients, and approximately 6% required further workup. In a second series [63], 211 (43%) incidental findings were discovered in a group of 480 patients. Even for the potentially serious findings, the documented follow-up was poor in this second series. In a third series [64], 9 (0.9%) out of 1047 patients were diagnosed with previously unknown malignancy.

Recently, publication of a multiyear study of 1295 patients from 2004–2006 with potentially important incidental findings on CT examinations performed without contrast (30%), with IV contrast (7%), or without and with IV contrast (63%), was published. The patients underwent CT for workup of hematuria, and were then followed for 6–8 years [65]. 214 (11%) incidental findings were discovered in 143 patients, of which 93 (65%) had follow-up, including 84 patients who underwent further imaging. These findings included 6 cancers and 9 AAAs. 30 patients underwent subsequent invasive procedures, including 16 surgeries. There was probable therapeutic benefit in 25 (17%) of the 143 patients, but 6 patients had serious complications, including 2 deaths. There was an average estimated added cost of $385.00 U.S. for all patients, which is the highest reported cost per patient in such an abdominal incidentaloma (or other incidentaloma on imaging) series so far [65], to our knowledge.

Latest literature

In a study by Hanna et al., 1967 emergency CT examinations of all parts of the body were performed during a 2-month period at one institution. In this study, the handling of incidental CT findings was compared with societal guidelines retrospectively, using the official CT reports [53]. From the entire group, 329 CT examinations had relevant incidental findings. 39.8% of the recommendations in the official reports for those examinations were discordant with the published guidelines, according to the authors.

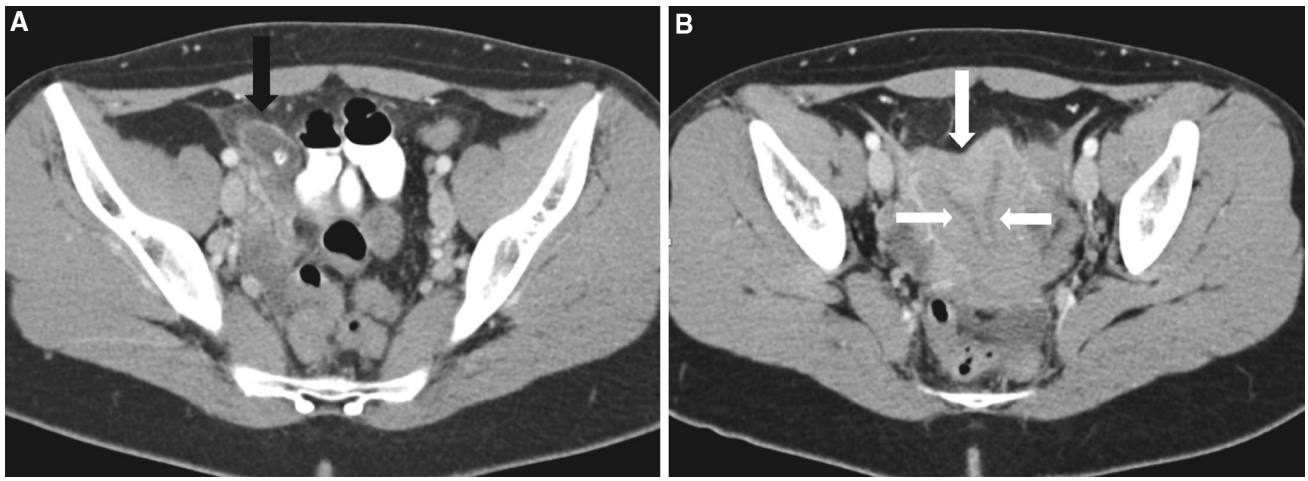

Fig. 19. **A** and **B** 15-year-old female with appendicitis (*black arrow*) had an incidental, previously unknown, bicornuate uterus (*white arrows*). A bicornuate uterus is a developmental variant which has potential implications for the patient's future fertility, and the pediatric emergency department physician was notified of this incidental finding.

There are continuous and further efforts in the imaging literature to provide comprehensive, updated, and more simplified forms of management recommendations to radiologists and clinicians. For example, very recent, modified recommendations for the management of adrenal incidentalomas were published by Garrett et al. [66]. This highlights the continuing problem of appropriate management of abdominal and pelvic CT incidentalomas by radiologists and referring clinicians, including those in the adrenal, and emphasizes the need for further research in various aspects of incidentaloma management.

Increasing attention has been given to quality improvement projects regarding the management of incidentalomas identified on imaging. For example, a quality improvement project at one institution on trauma CT examinations of the abdomen and pelvis demonstrated that documentation of patient notification of incidental findings improved from 17.7% to 32.4%, 9 months after initiation of a quality improvement mechanism. Here, an attempt was made to notify patients of their incidental findings directly, as well as taking other measures to improve follow-up. For example, a note was placed in the discharge summary, and direct referral was made to appropriate specialists [67].

Additional reporting issues

Both radiologists and clinicians should review available guidelines/appropriateness criteria when incidental findings are encountered on abdominal and pelvic CT. In addition, radiologists should make more concrete recommendations for follow-up or for dismissal of incidental findings. For example, as Berlin recommends, terminology such as "an incidental finding of a 5 mm nodule in the liver is noted; the likelihood that this represents significant pathology is extremely remote" should be utilized in CT reports [68]. In addition, a very recent article by Pandharipande et al. explore the risks and benefits of nondisclosure of clinically unimportant incidental findings on imaging, and propose, as an example, potential criteria to be debated on reporting clinically unimportant simple renal cysts [69].

It is of utmost importance for radiologists to document potentially relevant unanticipated nonemergent findings in the official CT reports, as this is seen as a continued source of litigation [68–70]. Additionally, clinicians should consult with radiologists directly in problematic or complicated cases, to determine the most optimal management for their patients.

Conclusion

The detection of abdominal and pelvic "incidentalomas" on CT examinations, particularly in the emergency setting, raises many issues, particularly how to best manage these patients. However, other management aspects, including financial, legal, and ethical issues, may influence the recommendations and/or how the clinician approaches these findings. This is of particular importance in an era of increasing CT utilization and technological advancements, but also of cost containment and appropriate utilization of resources.

There is currently a need for more evidence-based guidelines for reporting and management of incidentalomas, as well as for improving mechanisms of communication with referring physicians and patients, for ensuring appropriate follow-up. As always, the art of medicine needs to take into account that specific patients' situations vary, and may require unique management.

Compliance with ethical standard

Funding This review article was not funded by any entity.

Conflict of interest Author Siavash Behbahani declares that he has no conflict of interest. Author Sameer Mittal declares that he has no conflict of interest. Author Michael N. Patlas declares that he has no conflict of interest. Author Mariam Moshiri declares that she has no conflict of interest. Author Christine O. Menias declares that she has no conflict of interest. Author Douglas S. Katz declares that he has no conflict of interest.

Ethical approval This is a review article. This article does not contain any studies with human participants or animals performed by any of the authors.

References

1. Berland LL, Silverman SG, Megibow AJ, Mayo-Smith WW (2014) ACR members' response to JACR white paper on the management of incidental abdominal CT findings. J Am Coll Radiol 11:30–35
2. Shuaib W, Johnson JO, Salastekar N, et al. (2014) Incidental findings detected on abdomino-pelvic multidetector computed tomography performed in the acute setting. Am J Emerg Med 32:36–39
3. Clark TJ, Coats G (2016) Adherence to ACR incidental finding guidelines. J Am Coll Radiol S1546–1440(16):30316-7
4. Berland LL, Silverman SG, Gore RM, et al. (2010) Managing incidental findings on abdominal CT: white paper of the ACR incidental findings committee. J Am Coll Radiol 7:754–773
5. Berland LL (2011) The American College of Radiology strategy for managing incidental findings on abdominal computed tomography. Radiol Clin North Am 49:237–243
6. Johnson PT, Horton KM, Megibow AJ, Jeffrey RB, Fishman EK (2011) Common incidental findings on MDCT: survey of radiologist recommendations for patient management. J Am Coll Radiol 8:762–767
7. Palsdottir HB, Hardarson S, Petursdottir V, et al. (2012) Incidental detection of renal cell carcinoma is an independent prognostic marker: results of a long-term, whole population study. J Urol 187:48–53
8. Naidu SG, Hara AK, Brandis AR, Stone WM (2010) Incidence of highly important extravascular findings detected on CT angiography of the abdominal aorta and the lower extremities. AJR 194:1630–1634
9. Sistrom CL, Dreyer KJ, Dang PP, et al. (2009) Recommendations for additional imaging in radiology reports: multifactorial analysis of 5.9 million examinations. Radiology 253:453–461
10. Choyke PL (2006) ACR appropriateness criteria on incidentally discovered adrenal mass. J Am Coll Radiol 3:498–504
11. Boland GWL, Blake MA, Hahn PF, Mayo-Smith WW (2008) Incidental adrenal lesions: principles, techniques, and algorithms for imaging characterization. Radiology 249:756–775
12. Hassan C, Pickhardt P, Laghi A, et al. (2008) Computed tomographic colonography to screen for colorectal cancer, extracolonic cancer, and aortic aneurysm: model simulation with cost effectiveness analysis. Arch Intern Med 168:696–705
13. Ding A, Eisenberg JD, Pandharipande PV (2011) The economic burden of incidentally detected findings. Radiol Clin North Am 49:257–265
14. Katz DS, Scheer M, Lumerman JH, et al. (2000) Alternative or additional diagnoses on unenhanced helical computed tomography for suspected renal colic: experience with 1000 consecutive examinations. Urology 56:53–57
15. Monzawa S, Washio T, Yasuoka R, et al. (2013) Incidental detection of clinically unexpected breast lesions by computed tomography. Acta Radiol 54:374–379
16. Wu CC, Cronin CG, Chu JT, et al. (2012) Incidental pulmonary nodules detected on abdominal computed tomography. J Comput Assist Tomogr 36:641–645
17. Chan PL, Reddy T, Milne D, Bolland MJ (2012) Incidental vertebral fractures on computed tomography. N Z Med J 125:45–50
18. Bartalena T, Giannelli G, Rinaldi MF, et al. (2009) Prevalence of thoracolumbar vertebral fractures on multidetector CT: underreporting by radiologists. Eur J Radiol 69:555–559
19. Katz DS, Ganson G, Klein MA, Mazzie JP (2013) CT of the skin and subcutaneous tissues. Emerg Radiol 20:57–68
20. Barille MF, Wu JS, McMahon CJ (2014) Femoral head avascular necrosis: a frequently missed incidental finding on multidetector CT. Clin Radiol 69:280–285
21. Gore RM, Newmark GM, Thakrar KH, Mehta UK, Berlin JW (2011) Hepatic incidentalomas. Radiol Clin North Am 49:291–322
22. American College of Radiology (2014) Liver Imaging Reporting and Data System. www.acr.org/Quality-Safety/Resources/LIRADS. Accessed 8 June 2016
23. Heller MT, Harisinghani M, Neitlich JD, Yeghiayan P, Berland LL (2013) Managing incidental findings on abdominal and pelvic CT and MRI, part 3: white paper of the ACR incidental findings committee II on splenic and nodal findings. J Am Coll Radiol 10:833–839
24. Bosniak MA (2012) The Bosniak renal cyst classification: 25 years later. Radiology 262:781–785
25. Siegel CL, McFarland EG, Brink JA, et al. (1997) CT of cystic renal masses: analysis of diagnostic performance and interobserver variation. AJR 169:813–818
26. O'Connor SD, Pickhardt PJ, Kim DH, Oliva MR, Silverman SG (2011) Incidental finding of renal masses at unenhanced CT: prevalence and analysis of features for guiding management. AJR 197:139–145
27. Pooler BD, Pickhardt PJ, O'Connor SD, et al. (2012) Renal cell carcinoma: attenuation values on unenhanced CT. AJR 198:1115–1120
28. Jonisch AI, Rubinowitz AN, Mutalik PG, Israel GM (2007) Can high-attenuation renal cysts be differentiated from renal cell carcinoma at unenhanced CT? Radiology 243:445–450
29. Silverman SG, Israel GM, Herts BR, Richie JP (2008) Management of the incidental renal mass. Radiology 249:16–31
30. Heilbrun ME, Remer EM, Casalino DD, et al. (2015) ACR Appropriateness Criteria indeterminate renal mass. J Am Coll Radiol 12:333–341
31. Mileto A, Nelson RC, Paulson EK, Marin D (2015) Dual-energy MDCT for imaging the renal mass. AJR 204:W640–W647
32. Ascenti G, Mazziotti S, Mileto A, et al. (2012) Dual-source dual-energy CT evaluation of complex cystic renal masses. AJR 199:1026–1034
33. Song JH, Chaudhry FS, Mayo-Smith WW (2007) The incidental indeterminate adrenal mass on CT (>10 H) in patients without cancer: is further imaging necessary? Follow-up of 321 consecutive indeterminate adrenal masses. AJR 189:1119–1123
34. Song JH, Chaudhry FS, Mayo-Smith WW (2008) The incidental adrenal mass on CT: prevalence of adrenal disease in 1049 consecutive adrenal masses in patients with no known malignancy. AJR 190:1163–1168
35. Mileto A, Nelson RC, Marin D, Choudhury KR, Ho LM (2014) Dual-energy multidetector CT for the characterization of incidental adrenal nodules: diagnostic performance of contrast-enhanced material density analysis. Radiology 274:445–454
36. Glazer DI, Keshavarzi NR, Maturen KE, et al. (2014) Adrenal incidentaloma triage with single source (fast kVp switch) dual energy CT. AJR 203:329–335
37. Botsikas D, Triponez F, Boudabbous S, et al. (2014) Incidental adrenal lesions detected on enhanced abdominal dual-energy CT: can the diagnostic workup be shortened by the implementation of virtual unenhanced images? Eur J Radiol 83:1746–1751
38. Song JH, Mayo-Smith WW (2011) Incidentally discovered adrenal mass. Radiol Clin North Am 49:361–368
39. Gallotti A, Perez Johnston R, Bonaffini PA, et al. (2013) Incidental neuroendocrine tumors of the pancreas: MDCT findings and features of malignancy. AJR 200:355–362
40. Gabata T, Terayama N, Yamashiro M, et al. (2005) Solid serous cystadenoma of the pancreas: MR imaging with pathologic correlation. Abdom Imaging 30:605–609
41. Manfredi R, Ventriglia A, Mantovani W, et al. (2015) Mucinous cystic neoplasms and serous cystadenomas arising in the body-tail

of the pancreas: MR imaging characterization. Eur Radiol 25:940–949
42. Raman SP, Kawamoto S, Law JK, et al. (2013) Institutional experience with solid pseudopapillary neoplasms: focus on computed tomography, magnetic resonance imaging, conventional ultrasound, endoscopic ultrasound, and predictors of aggressive histology. J Comput Assist Tomogr 37:824–833
43. Kawamoto S, Johnson PT, Hall H, et al. (2012) Intrapancreatic accessory spleen: CT appearance and differential diagnosis. Abdom Imaging 37:812–827
44. Sahani DV, Kadavigere R, Saokar A, et al. (2005) Cystic pancreatic lesions: a simple imaging-based classification system for guiding management. RadioGraphics 25:1471–1484
45. Katz DS, Friedel DM, Kho D, Georgiou N, Hines JJ (2007) Relative accuracy of CT and MRI for characterization of cystic pancreatic masses. AJR 189:657–661
46. Lennon AM, Manos LL, Hruban RH, et al. (2014) Role of a multidisciplinary clinic in the management of patients with pancreatic cysts: a single-center cohort study. Ann Surg Oncol 21:3668–3674
47. Brook OR, Beddy P, Pahade J, et al. (2016) Delayed growth in incidental pancreatic cysts: are the current American College of Radiology recommendations for follow-up appropriate? Radiology 278:752–761
48. Tanaka M, Fernández-del Castillo C, Adsay V, et al. (2012) International consensus guidelines 2012 for the management of IPMN and MCN of the pancreas. Pancreatology 12:183–197
49. Vege SS, Ziring B, Jain R, Moayyedi P, Clinical Guidelines Committee American Gastroenterology Association (2015) American Gastroenterological Association Institute guideline on the diagnosis and management of asymptomatic neoplastic pancreatic cysts. Gastroenterology 148:819–822
50. Khosa F, Krinsky G, Macari M, Yucel EK, Berland LL (2013) Managing incidental findings on abdominal and pelvic CT and MRI, part 2: white paper of the ACR incidental findings committee II on vascular findings. J Am Coll Radiol 10:789–794
51. Al-Thani H, El-Menyar A, Shabana A, et al. (2014) Incidental abdominal aneurysms: a retrospective study of 13,115 patients who underwent a computed tomography scan. Angiology 65:388–395
52. Pickhardt PJ, Hanson ME (2010) Incidental adnexal masses detected at low-dose unenhanced CT in asymptomatic women age 50 and older: implications for clinical management and ovarian cancer screening. Radiology 257:144–150
53. Hanna TN, Shekhani H, Zygmont ME, Kerchberger JM, Johnson JO (2016) Incidental findings in emergency imaging: frequency, recommendations, and compliance with consensus guidelines. Emerg Radiol 23:169–174
54. Patel MD, Ascher SM, Paspulati RM, et al. (2013) Managing incidental findings on abdominal and pelvic CT and MRI, part 1: white paper of the ACR incidental findings committee II on adnexal findings. J Am Coll Radiol 10:675–681
55. Levine D, Brown DL, Andreotti RF, et al. (2010) Management of asymptomatic ovarian and other adnexal cysts imaged at US: Society of Radiologists in Ultrasound Consensus Conference Statement. Radiology 256:943–954
56. Sebastian S, Araujo C, Neitlich JD, Berland LL (2013) Managing incidental findings on abdominal and pelvic CT and MRI, part 4: white paper of the ACR incidental findings committee II on gallbladder and biliary findings. J Am Coll Radiol 10:953–956
57. Kelly ME, Heeney A, Redmond CE, et al. (2015) Incidental findings detected on emergency abdominal CT scans: a 1-year review. Abdom Imaging 40:1853–1857
58. Katz DS, Jorgensen MJ, Rubin GD (1999) Detection and follow-up of important extra-arterial lesions with helical CT angiography. Clin Radiol 54:294–300
59. Iezzi R, Cotroneo AR, Filippone A, et al. (2007) Extravascular incidental findings at multislice CT angiography of the abdominal aorta and lower extremity arteries: a retrospective review study. Abdom Imaging 32:489–494
60. Ozao-Choy J, Kim U, Vieux U, Menes TS (2011) Incidental findings on computed tomography scans for acute appendicitis: prevalence, costs, and outcome. Am Surg 77:1502–1509
61. Halverson M, Delgado J, Mahboubi S (2014) Extra-appendiceal findings in pediatric abdominal CT for suspected appendicitis. Pediatr Radiol 44:816–820
62. Ekeh AP, Walusimbi M, Brigham E, Woods RJ, McCarthy MC (2010) The prevalence of incidental findings on abdominal computed tomography scans of trauma patients. J Emerg Med 38:484–489
63. Munk MD, Peitzman AB, Hostler DP, Wolfson AB (2010) Frequency and follow-up of incidental findings on trauma computed tomography scans: experience at a level one trauma center. J Emerg Med 38:346–350
64. van Vugt R, Dekker HM, Deunk J, et al. (2011) Incidental findings on routine thoracoabdominal computed tomography in blunt trauma patients. J Trauma 72:416–421
65. Morgan AE, Berland LL, Ananyev SS, Lockhart ME, Kolettis PN (2015) Extraurinary incidental findings on CT for hematuria: the radiologist's role and downstream cost analysis. AJR 204:1160–1167
66. Garrett RW, Nepute JC, Hayek ME, Albert SG (2016) Adrenal incidentalomas: clinical controversies and modified recommendations. AJR 206:1170–1178
67. Collins CE, Cherng N, McDade T, et al. (2015) Improving patient notification of solid abdominal viscera incidental findings with a standardized protocol. J Trauma Manag Outcomes 9:1
68. Berlin L (2013) How do you solve a problem like incidentalomas? Appl Radiol. http://appliedradiology.com/articles/how-do-you-solve-a-problem-like-incidentalomas. Accessed 5/25/2016
69. Pandharipande PV, Herts BR, Gore RM, et al. (2016) Rethinking normal: benefits and risks of not reporting harmless incidental findings. J Am Coll Radiol 13:764–767
70. Berlin L (2015) Communicating nonroutine radiologic findings to the ordering physician: will (should) information technology-assisted communication replace direct voice contact? Radiology 277:332–336