American College of Radiology
ACR Appropriateness Criteria®
Pancreatic Cyst

Variant: 1 Incidentally detected pancreatic cyst less than or equal to 2.5 cm in size. Initial evaluation.

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen with IV contrast multiphase	May Be Appropriate	☢☢☢☢
US abdomen endoscopic	Usually Not Appropriate	O
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 2 Incidentally detected pancreatic cyst greater than 2.5 cm in size. No high-risk stigmata or worrisome features. Initial evaluation.

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
US abdomen endoscopic	May Be Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen with IV contrast multiphase	May Be Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 3 Incidentally detected pancreatic cyst greater than 2.5 cm in size. High-risk stigmata or worrisome features. Initial evaluation.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen endoscopic	Usually Appropriate	O
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen with IV contrast multiphase	May Be Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 4 Incidentally detected main pancreatic duct dilation greater than 7 mm in size. Suspected main duct intraductal papillary mucinous neoplasm (IPMN). Initial evaluation.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen endoscopic	Usually Appropriate	O
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
MRI abdomen without IV contrast with MRCP	Usually Appropriate	O
CT abdomen with IV contrast multiphase	May Be Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 5 Follow-up imaging of pancreatic cyst.

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
MRI abdomen without IV contrast with MRCP	Usually Appropriate	O
CT abdomen with IV contrast multiphase	Usually Appropriate	☢☢☢☢
US abdomen endoscopic	Usually Not Appropriate	O
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Panel Members

Kelly Fábrega-Foster, MD, MA[a]; Ihab R. Kamel, MD, PhD[b]; Jeanne M. Horowitz, MD[c]; Hina Arif-Tiwari, MD[d]; Mustafa R. Bashir, MD[e]; Victoria Chernyak, MD, MS[f]; Alan Goldstein, MD[g]; Joseph R. Grajo, MD[h]; Nicole M. Hindman, MD[i]; Aya Kamaya, MD[j]; Michelle M. McNamara, MD[k]; Kristin K. Porter, MD, PhD[l]; James M. Scheiman, MD[m]; Lilja Bjork Solnes, MD, MBA[n]; Pavan K. Srivastava, MD[o]; Atif Zaheer, MD[p]; Laura R. Carucci, MD.[q]

Summary of Literature Review

Introduction/Background

Incidental pancreatic cysts are now increasingly detected on imaging studies performed for unrelated indications. [1-3]. Both increased imaging utilization and improved cross-sectional technique are responsible for the more frequent detection of progressively smaller cysts [4-6]. The most commonly encountered pancreatic cysts include intraductal papillary mucinous neoplasms (IPMNs), serous cystadenoma, mucinous cystic neoplasm (MCN), and pseudocysts [6,7].

There is a very small risk that an incidental pancreatic cyst may be malignant [8]. For instance, an incidental pancreatic cyst on MRI has a 10 in 100,000 chance of being a mucinous invasive malignancy and a 17 in 100,000 chance of being a ductal carcinoma [8]. The risk of malignant transformation in pancreatic cysts is estimated to be 0.24% per year [9], varying according to histologic subtype [7,10]. Yet there is considerable overlap in the imaging appearance of histologically distinct pancreatic cysts, particularly those <3 cm in size, with over 60% of cysts lacking a specific radiologic appearance on CT or MRI [6]. Another important feature in the natural history of pancreatic cysts is the small risk of pancreatic adenocarcinoma developing at a separate site within the pancreas [4,7,11-13]. Although the risk of cyst-related or concomitant pancreatic malignancy is small, there is a need to characterize incidental pancreatic cysts effectively at initial imaging in order to guide management.

Consensus Guidelines and Special Morphologic Considerations

There are several expert consensus guidelines for management of incidental pancreatic cysts. These have defined specific morphologic features to stratify cysts into two categories based on whether or not they possess "worrisome features" or "high-risk stigmata." Worrisome features include 1) cyst size ≥3 cm, 2) thickened or enhancing cyst wall, 3) nonenhancing mural nodule, and 4) main pancreatic duct caliber ≥5 to 9 mm (simplified to 7 mm here in accordance with the ACR White Paper on Management of Incidental Pancreatic Cysts [7]). High-risk stigmata include 1)

obstructive jaundice with cyst in the head of the pancreas, 2) enhancing solid component within a cyst, and 3) main pancreatic duct caliber ≥10 mm in the absence of obstruction. Cysts lacking these features are stratified based on size. The association between cyst size and risk of high-grade dysplasia or invasive carcinoma is well recognized; however, there is no specific size threshold to quantify risk [1,7,13-15]. Generally, invasive carcinoma is rare in asymptomatic cysts <3 cm in size [16,17].

Appropriate imaging evaluation of incidental pancreatic cysts is critical because morphology determines management. As an example, surveillance is generally recommended for cysts <3 cm in size without worrisome features or high-risk stigmata [7,13]. Cysts with worrisome features undergo sampling with endoscopic ultrasound fine-needle aspiration (EUS-FNA) [8-10] and those with high-risk stigmata are typically resected [8-10]. For management recommendations please refer to the ACR White Paper on Management of Incidental Pancreatic Cysts [7].

The following recommendations refer to the initial imaging evaluation of pancreatic cysts incidentally detected and incompletely evaluated on imaging studies performed for unrelated indications. The recommendations below apply irrespective of the imaging modality in which the cyst was initially detected. CT abdomen, MRI abdomen with MRCP, and US abdomen endoscopic are included in the discussion. These are the three conventional imaging modalities used in the workup of pancreatic cysts. Although we acknowledge the added value of US (especially contrast-enhanced US) in select cases in which workup with conventional imaging is inconclusive or incomplete, US has been omitted from the discussion because it is not routinely used in this setting.

Discussion of Procedures by Variant

Variant 1: Incidentally detected pancreatic cyst less than or equal to 2.5 cm in size. Initial evaluation.

Variant 1: Incidentally detected pancreatic cyst less than or equal to 2.5 cm in size. Initial evaluation.

A. CT Abdomen

MRI is preferred over contrast-enhanced CT in this setting. The sensitivity and specificity of CT for distinguishing IPMN from other cystic pancreatic lesions is 80.6% and 86.4% compared with 96.8% and 90.8% for MRI [3,18]. Advantages of CT include its ease of implementation and excellent spatial resolution. Multidetector CT provides critical diagnostic information pertaining to the presence or absence of calcifications (both in the background parenchyma and in the cyst proper), ductal dilation, intralesional septations, mural nodules, and pancreatic duct communication [6,15].

When CT is performed instead of MRI, a dual-phase contrast-enhanced pancreatic protocol CT (including late arterial and portal venous phases with multiplanar reformations) is recommended. Intravenous (IV) contrast increases sensitivity for detecting worrisome features and high-risk stigmata and improves characterization of a cyst's internal architecture as well as its relationship to adjacent anatomic structures [1,7-10,13,19-21]. If clearly discerned on CT, communication with the main pancreatic duct suggests a diagnosis of IPMN [1,13,19-21]. The relative sensitivity of pancreatic protocol multidetector CT for detecting internal septations, mural nodules, and communication with the pancreatic duct have been reported to be 73.9% to 93.6%, 71.4%, and 86%, respectively [6,15,22].

Variant 1: Incidentally detected pancreatic cyst less than or equal to 2.5 cm in size. Initial evaluation.

B. MRI Abdomen with MRCP

Contrast-enhanced MRI with MR cholangiopancreatography (MRCP) is considered the procedure of choice in this setting because of its superior soft-tissue contrast and superior ability to demonstrate ductal communication [6-10]. The reported sensitivity of thin-slice 3-D MRCP acquisitions for demonstrating communication of a cyst with the pancreatic duct is as high as 100% [6,22]. Communication with the main pancreatic duct is suggestive of IPMN, although this may also be seen in the setting of pseudocysts [6]. The sensitivity of MRI for detection of internal septations is 91% [6,22], and its diagnostic accuracy for distinguishing between malignant and nonmalignant lesions ranges between 73.2% and 91% [6,23,24]. In distinguishing IPMN from other cystic lesions, studies have reported a sensitivity of 96.8% and a specificity of 90.8% [3,18].

Variant 1: Incidentally detected pancreatic cyst less than or equal to 2.5 cm in size. Initial evaluation.

C. US Abdomen Endoscopic

EUS-FNA is not recommended for initial characterization of pancreatic cysts ≤2.5 cm in size. With EUS, morphologic characterization is achieved at the cost of a more invasive approach. The unique advantage of EUS is its ability to perform FNA of cyst fluid and soft tissue [6,17,25]. At least 2 mL of aspirated fluid, corresponding to a cyst size of 1.7 cm, is necessary to perform cytology and biomarker analysis using FNA [26]. Because the risk of malignant transformation in cysts <3 cm in size is extremely low [17,27], the risks of performing EUS-FNA in this setting may outweigh the diagnostic benefits.

Variant 2: Incidentally detected pancreatic cyst greater than 2.5 cm in size. No high-risk stigmata or worrisome features. Initial evaluation.

Variant 2: Incidentally detected pancreatic cyst greater than 2.5 cm in size. No high-risk stigmata or worrisome features. Initial evaluation.

A. CT Abdomen

MRI is preferred over contrast-enhanced CT in this setting because of its superior sensitivity and specificity in differentiating cystic pancreatic lesions. Studies comparing the sensitivity and specificity of CT versus MRI in distinguishing IPMN from other cystic pancreatic lesions report values of 80.6% to 86.4% for CT and 96.8% to 90.8% for MRI [3,18]. In cases in which contrast-enhanced MRI with MRCP cannot be performed, a dual-phase contrast-enhanced pancreatic protocol CT (including late arterial and portal venous phases with multiplanar reformations) may be of value. The use of IV contrast improves detection of worrisome features and high-risk stigmata and better demonstrates a cyst's relationship to surrounding anatomy [1,7-10,13,19-21]. If clearly discerned on CT, communication with the main pancreatic duct suggests a diagnosis of IPMN [1,13,19-21]. The relative sensitivity of pancreatic protocol multidetector CT for detecting internal septations, mural nodules, and communication with the pancreatic duct are 73.9% to 93.6%, 71.4%, and 86%, respectively [6,15,22].

Variant 2: Incidentally detected pancreatic cyst greater than 2.5 cm in size. No high-risk stigmata or worrisome features. Initial evaluation.

B. MRI Abdomen with MRCP

Because of its superior soft-tissue resolution and noninvasive approach, contrast-enhanced MRI with MRCP is generally favored over CT or EUS-FNA in this setting [6-10]. The diagnostic accuracy

of MRI for distinguishing between malignant and nonmalignant lesions ranges from 73.2% to 91% [6,23,24]. Its accuracy at diagnosing the specific type of cyst is slightly lower at 50% [23]. However, an exception may be the distinction of IPMN from other cystic lesions, in which studies have reported a sensitivity of 96.8% and specificity of 90.8% [3,18].

Variant 2: Incidentally detected pancreatic cyst greater than 2.5 cm in size. No high-risk stigmata or worrisome features. Initial evaluation.

C. US Abdomen Endoscopic

Because of its invasive approach, the decision to perform EUS-FNA in this setting must depend upon a careful consideration of the diagnostic benefits and risks. A cyst size of 3 cm alone is considered a worrisome feature associated with a 3-times-greater risk of cyst-related malignancy [9] and may prompt EUS-FNA even in the absence of other worrisome features [17]. For this reason, many centers perform EUS-FNA in lieu of MRI with MRCP as the initial imaging step in this setting [14,26]. Although worrisome features may be undetectable or absent in smaller cysts, they should prompt evaluation with EUS-FNA when present. Some authors have suggested that EUS-FNA should be reserved for cysts demonstrating at least two worrisome features, with the specific aim of increasing diagnostic specificity [9]. However, because each worrisome feature confers a unique relative risk of malignancy (such that each feature must be weighed separately in any assessment of overall risk), others have reported that EUS-FNA should be considered for any cyst ≥2.5 cm with at least one other worrisome feature [7]. This approach recognizes the inherent complexity in risk calculations for individual cysts and acknowledges that even cysts slightly <3 cm may possess worrisome features and still contain sufficient fluid for EUS-FNA. A cyst size of 1.7 cm contains sufficient fluid to perform FNA with cytology and carcinoembryonic antigen and amylase levels [7]. Cytological evaluation may identify atypia, dysplasia, or neoplasia in these cysts [7,13,25]. The presence of high-grade epithelial atypia in IPMN detects approximately 30% more cancers than the presence of worrisome imaging features alone [13]. Although it is true that a 3-times increased risk of malignancy is modest in absolute terms given the low baseline risk of adenocarcinoma [9], this is still substantial given the dismal survival rate for adenocarcinoma and the potential survival benefit of enabling an early diagnosis of dysplasia rather than malignancy.

In a study of over 300 patients with pancreatic cysts, the addition of EUS-FNA to the diagnostic workup significantly altered the management strategy in nearly 72% of patients [28]. Management algorithms integrating clinical data, imaging, and fluid analysis have reported cyst classification sensitivities of 90% to 100% and specificities of 92% to 98% [7,25]. The addition of EUS-FNA to management algorithms combining clinical history and imaging may also reduce unnecessary surgeries by 91% [7].

Variant 3: Incidentally detected pancreatic cyst greater than 2.5 cm in size. High-risk stigmata or worrisome features. Initial evaluation.

Variant 3: Incidentally detected pancreatic cyst greater than 2.5 cm in size. High-risk stigmata or worrisome features. Initial evaluation.

A. CT Abdomen

The presence of high-risk stigmata or worrisome features significantly increases the risk of malignancy, and therefore EUS-FNA is favored over CT in this setting [8,9,14]. In cases in which EUS-FNA cannot be performed and the patient is not a candidate for MRI with MRCP, a dual-phase contrast-enhanced pancreatic protocol CT may still be of value for cyst characterization or presurgical planning [1,7-10,13,19-21]. The use of IV contrast improves detection of worrisome

features and high-risk stigmata and the assessment of surrounding anatomy [1,7-10,13,19-21].

Variant 3: Incidentally detected pancreatic cyst greater than 2.5 cm in size. High-risk stigmata or worrisome features. Initial evaluation.
B. MRI Abdomen with MRCP

The presence of high-risk stigmata or worrisome features significantly increases the risk of malignancy, and therefore EUS-FNA is favored over MRI in this setting [8,9,14]. In equivocal cases or cases in which EUS-FNA cannot be performed, MRI with and without IV contrast with MRCP may be of value, potentially allowing further characterization of a cyst's internal architecture and a more specific diagnosis. When performed in conjunction with MRCP, the reported sensitivity for detection of worrisome features, such as enhancing internal septations, is approximately 91% [6,22]. The diagnostic accuracy for distinguishing between malignant and nonmalignant lesions ranges between 73.2% and 91% [6,23,24]. Contrast-enhanced MRI with MRCP may also be performed as a complement to EUS-FNA in this setting, establishing a baseline for future follow-up and facilitating detection of additional worrisome features or synchronous lesions.

Variant 3: Incidentally detected pancreatic cyst greater than 2.5 cm in size. High-risk stigmata or worrisome features. Initial evaluation.
C. US Abdomen Endoscopic

When high-risk stigmata or worrisome features are present, the appropriate initial imaging study is EUS-FNA [7-10]. The unique advantage of EUS-FNA is its ability to distinguish mucinous from nonmucinous lesions by means of biochemical markers assayed from cyst fluid samples. This facilitates a specific diagnosis in many cases [25,28-30]. For instance, the presence of nongut mucin supports a diagnosis of mucinous neoplasm. Carcinoembryonic antigen levels <5 ng/mL suggest pseudocyst or serous cystadenoma. A carcinoembryonic antigen threshold level in the range of 192 to 200 ng/mL is 80% accurate for diagnosis of a mucinous cyst [13,29]. Amylase levels of >250 IU/L suggest a pseudocyst. Molecular assays for markers such as K-ras, GNAS, PTEN, VHL, TP53, and PIK3CA may also assist in differentiating neoplastic cystic lesions and predicting cyst behavior. When performed in centers with expertise in EUS-FNA, cytological evaluation can identify atypia, dysplasia, or neoplasia [7,13,25]. Studies have demonstrated that the presence of high-grade epithelial atypia in IPMN detects approximately 30% more cancers than the presence of worrisome imaging features alone [13].

Although worrisome features may be undetectable or absent in smaller cysts, they should prompt evaluation with EUS-FNA when present. It is worth noting that a cyst size of 3 cm alone is considered a worrisome feature associated with a 3-times-greater risk of cyst-related malignancy [9], prompting EUS-FNA even in the absence of other worrisome features. The presence of additional worrisome features, such as a solid component, further increases the risk of malignancy by up to eight times [9,31]. Some authors have suggested that EUS-FNA should be reserved for cysts demonstrating at least two worrisome features, with the specific aim of increasing diagnostic specificity [9]. However, because each worrisome feature confers a unique relative risk of malignancy (such that each feature must be weighed separately in any assessment of overall risk), EUS-FNA should be considered for any cyst ≥2.5 cm with at least one other worrisome feature [26]. This approach recognizes the inherent complexity in risk calculations for individual cysts and acknowledges that even cysts slightly <3 cm may possess worrisome features and still contain sufficient fluid for EUS-FNA. Although it is true that a 3 to 8 times increased risk of malignancy is modest in absolute terms given the low baseline risk [9], this is still a substantial risk given the dismal survival rate for pancreatic carcinoma and the potential survival benefit of enabling an early

diagnosis of dysplasia rather than malignancy.

Variant 4: Incidentally detected main pancreatic duct dilation greater than 7 mm in size. Suspected main duct intraductal papillary mucinous neoplasm (IPMN). Initial evaluation.

Variant 4: Incidentally detected main pancreatic duct dilation greater than 7 mm in size. Suspected main duct intraductal papillary mucinous neoplasm (IPMN). Initial evaluation. A. CT Abdomen

Although contrast-enhanced CT may also assist in detection of synchronous lesions, it is not the preferred imaging modality in this setting. The presence of main pancreatic ductal dilation is considered a "worrisome feature" (5–9 mm) or one of several "high-risk stigmata" (≥1 cm) [7,8,10,13]. In the absence of ancillary evidence of chronic pancreatitis or main pancreatic duct obstruction, this feature should raise concern for main duct IPMN. Main duct IPMN carries a risk of malignant degeneration of approximately 57% to 92% compared with 25% for branch duct IPMN [1,7-10,32]. The presence of main duct dilation ≥1 cm should prompt surgical referral, and pancreatic ductal dilation between 5 to 9 mm should prompt EUS-FNA [7-10].

Variant 4: Incidentally detected main pancreatic duct dilation greater than 7 mm in size. Suspected main duct intraductal papillary mucinous neoplasm (IPMN). Initial evaluation. B. MRI Abdomen with MRCP

Although MRI with and without IV contrast with MRCP is highly sensitive for delineating pancreatic ductal anatomy [6,22], the presence of pancreatic ductal dilation >7 mm is a worrisome feature that should raise the question of main duct IPMN. Given the high associated rates of malignancy (57%–92%), pancreatic ductal dilation between 5 to 9 mm should prompt EUS-FNA [1,7-10,32]. Nonetheless, contrast-enhanced MRI with MRCP may assist in detection of additional worrisome features, including enhancing mural nodule or thick septation or synchronous lesions, and should be performed prior to EUS-FNA for this reason.

Variant 4: Incidentally detected main pancreatic duct dilation greater than 7 mm in size. Suspected main duct intraductal papillary mucinous neoplasm (IPMN). Initial evaluation. C. US Abdomen Endoscopic

EUS-FNA is the procedure of choice when main duct IPMN is suspected but degree of ductal dilation does not meet criteria for surgical referral (≥1 cm) [1,7-10,32]. The presence of main pancreatic ductal dilation >7 mm is considered a worrisome feature that should prompt EUS-FNA given the high risk of malignancy associated with main duct IPMN (57%–92%) [7-10]. High spatial resolution imaging and the ability to perform fluid analysis or tissue sampling render EUS-FNA superior to MRI and CT in this setting. However, MRI with and without IV contrast with MRCP is recommended prior to EUS-FNA because MRI provides morphologic information to complement FNA findings and establishes a baseline for future follow up if needed. If an alternative cause for main duct dilation is found, such as a stricture or mass, it may obviate the need for FNA.

Variant 5: Follow-up imaging of pancreatic cyst.

Variant 5: Follow-up imaging of pancreatic cyst. A. CT Abdomen

The risk of malignant transformation of a pancreatic cyst is approximately 0.24% per year [9]. Once a pancreatic cyst has been characterized on a dedicated baseline examination, subsequent follow-up may be performed with either CT or MRI. There is no evidence to suggest that MRI is superior to CT for detection of new or developing worrisome features or pancreatic ductal adenocarcinoma,

and cysts that change at follow up typically do so by increasing size, which is well assessed by either modality [7], although modality concordance between baseline and follow-up examinations may facilitate comparison. For CT follow-up, a dual-phase contrast-enhanced pancreatic protocol CT, including late arterial and portal venous phases, should be performed [7,8].

The frequency and duration of follow-up is controversial and depends on multiple factors, including patient age, family history of pancreatic ductal adenocarcinoma, cyst size, and whether or not there has been prior surgical resection of a pancreatic cyst. For patients with a nonspecific pancreatic cyst without a history of prior surgery, the surveillance plan will depend upon patient age and the cyst size. Follow-up intervals are generally in the range of 6 months to every 2 years for a minimum of 5 to 10 years [7-9]. Development of high-risk stigmata or worrisome features during the surveillance period should prompt EUS-FNA or surgical evaluation. For patients with a previous history of surgery for IPMN or invasive MCN without residual disease, continued surveillance is recommended, in view of the small yearly risk of pancreatic ductal adenocarcinoma of 0.7% to 0.9% [8]. For patients with known IPMN in the remnant pancreas, residual IPMN at the surgical margins, or new postoperative recurrence of IPMN, surveillance recommendations are less well defined [8]. To date, there is no evidence basis for the recommended size threshold to follow-up cysts. Based on limited clinical and published experience, a cyst <5 mm may require one follow-up CT or MRI at 2 years. Demonstrating stability at 2 years is sufficient to stop surveillance.

Variant 5: Follow-up imaging of pancreatic cyst.
B. MRI Abdomen with MRCP

The risk of malignant transformation of a pancreatic cyst is approximately 0.24% per year [9]. Once a pancreatic cyst has been characterized on a dedicated baseline examination, subsequent follow-up may be performed with either CT or MRI. There is no evidence to suggest that MRI is superior to CT for detection of new or developing worrisome features or pancreatic ductal adenocarcinoma [7], although modality concordance between baseline and follow-up examinations may facilitate comparison.

The issue of whether IV contrast is necessary for MRI follow-up of pancreatic cysts remains controversial. Noncontrast MRI is associated with shorter scan times, with some sources citing little difference in the ability to detect evolving dysplastic changes compared with a contrast-enhanced study [7,33,34]. However, the use of IV contrast may permit detection of high-risk stigmata such as enhancing mural nodules. An abbreviated protocol MRI, including T2-weighted sequences and dual-phase (late arterial and portal venous phase) contrast-enhanced acquisitions, has been shown to be equivalent to standard pancreatic protocol MRI for detection of evolving dysplasia [7,34].

The frequency and duration of follow-up is controversial and depends on multiple factors, including patient age, family history of pancreatic ductal adenocarcinoma, cyst size, and whether or not there has been prior surgical resection of a pancreatic cyst. For patients with a nonspecific pancreatic cyst without a history of prior surgery, the surveillance plan will depend upon patient age and the cyst size. Follow-up intervals are generally in the range of 6 months to every 2 years for a minimum of 5 to 10 years [7-9]. Development of high-risk stigmata or worrisome features during the surveillance period should prompt EUS-FNA or surgical evaluation [8,9,14,26]. For patients with a previous history of surgery for IPMN or invasive MCN without residual disease, continued surveillance is still recommended in view of the small yearly risk of pancreatic ductal adenocarcinoma [8]. For patients with known IPMN in the remnant pancreas, residual IPMN at the surgical margins, or new postoperative recurrence of IPMN, surveillance recommendations are less

well defined [8]. To date, there is no evidence basis for the recommended size threshold to follow-up cysts. Based on limited clinical and published experience, a cyst <5 mm may require one follow-up CT or MRI at 2 years. Demonstrating stability at 2 years is sufficient to stop surveillance.

Variant 5: Follow-up imaging of pancreatic cyst.
C. US Abdomen Endoscopic

The risk of malignant transformation of a pancreatic cyst is approximately 0.24% per year [9]. Although detection of new or evolving dysplasia may prompt evaluation with EUS-FNA, EUS-FNA is not recommended for routine follow-up of pancreatic cysts because of its invasive approach [7-10]. Patients who undergo EUS-FNA without concerning results may resume surveillance with CT or MRI according to the recommendations for cysts without high-risk stigmata or worrisome features [7-9].

Summary of Recommendations

- **Variant 1:** MRI abdomen without and with IV contrast with MRCP is usually appropriate for the initial evaluation of an incidentally detected pancreatic cyst ≤2.5 cm in size.
- **Variant 2:** MRI abdomen without and with IV contrast with MRCP is usually appropriate for the initial evaluation of an incidentally detected pancreatic cyst >2.5 cm in size with no high-risk stigmata or worrisome features.
- **Variant 3:** US abdomen endoscopic and MRI abdomen without and with IV contrast with MRCP are usually appropriate for the initial evaluation of an incidentally detected pancreatic cyst >2.5 cm in size with high-risk stigmata and worrisome features. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).
- **Variant 4:** US abdomen endoscopic, MRI abdomen without and with IV contrast with MRCP, and MRI abdomen without IV contrast with MRCP are usually appropriate for the initial evaluation of incidentally detected main pancreatic duct dilation >7 mm in size with suspected main duct IPMN. US abdomen endoscopic and either dual-phase or noncontrast MRI abdomen with MRCP are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).
- **Variant 5:** CT abdomen with IV contrast multiphase, MRI abdomen without and with IV contrast with MRCP, and MRI abdomen without IV contrast with MRCP are usually appropriate for the follow-up imaging of pancreatic cyst. CT abdomen with IV contrast multiphase and either dual-phase or noncontrast MRI abdomen with MRCP are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [35].

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

References

1. Buerke B, Domagk D, Heindel W, Wessling J. Diagnostic and radiological management of cystic lesions: important features for radiologists. [Review]. Clin Radiol. 67(8):727-37, 2012 Aug.
2. Laffan TA, Horton KM, Klein AP, et al. Prevalence of unsuspected pancreatic cysts on MDCT. AJ Roentgenol. 191(3):802-7, 2008 Sep.
3. Zaheer A, Pokharel SS, Wolfgang C, Fishman EK, Horton KM. Incidentally detected cystic lesion pancreas on CT: review of literature and management suggestions. [Review]. Abdom Imaging. 41, 2013 Apr.
4. Freeny PC, Saunders MD. Moving beyond morphology: new insights into the characterization a management of cystic pancreatic lesions. [Review]. Radiology. 272(2):345-63, 2014 Aug.
5. Moris M, Bridges MD, Pooley RA, et al. Association Between Advances in High-Resolution Cros Imaging Technologies and Increase in Prevalence of Pancreatic Cysts From 2005 to 2014. Clin Gastroenterol Hepatol. 14(4):585-593.e3, 2016 Apr.
6. Pinho DF, Rofsky NM, Pedrosa I. Incidental pancreatic cysts: role of magnetic resonance imagir Top Magn Reson Imaging. 23(2):117-28, 2014 Apr.
7. Megibow AJ, Baker ME, Morgan DE, et al. Management of Incidental Pancreatic Cysts: A White the ACR Incidental Findings Committee. Journal of the American College of Radiology. 14(7):9 2017 Jul.
8. Tanaka M, Fernandez-del Castillo C, Adsay V, et al. International consensus guidelines 2012 for management of IPMN and MCN of the pancreas. Pancreatology. 12(3):183-97, 2012 May-Jun.
9. Vege SS, Ziring B, Jain R, Moayyedi P, Clinical Guidelines Committee, American Gastroenterolo Association. American gastroenterological association institute guideline on the diagnosis and management of asymptomatic neoplastic pancreatic cysts. Gastroenterology. 148(4):819-22; q 2015 Apr.
10. Tanaka M, Chari S, Adsay V, et al. International consensus guidelines for management of intrac papillary mucinous neoplasms and mucinous cystic neoplasms of the pancreas. [Review] [86 re Pancreatology. 6(1-2):17-32, 2006.
11. Sahora K, Crippa S, Zamboni G, et al. Intraductal papillary mucinous neoplasms of the pancreas concurrent pancreatic and periampullary neoplasms. Eur J Surg Oncol. 42(2):197-204, 2016 Feb
12. Schmid RM, Siveke JT. Approach to cystic lesions of the pancreas. [Review]. Wiener Medizinisch Wochenschrift. 164(3-4):44-50, 2014 Feb.
13. Tanaka M, Fernandez-Del Castillo C, Kamisawa T, et al. Revisions of international consensus Fu guidelines for the management of IPMN of the pancreas. [Review]. Pancreatology. 17(5):738-7 Sep - Oct.
14. Flusberg M, Paroder V, Kobi M, Rozenblit AM, Chernyak V. Patients 65 years and older with inc pancreatic cysts: Is there a relationship between all-cause mortality and imaging follow-up?. Eu 85(6):1115-20, 2016 Jun.

15. Sahani DV, Kadavigere R, Blake M, Fernandez-Del Castillo C, Lauwers GY, Hahn PF. Intraductal p mucinous neoplasm of pancreas: multi-detector row CT with 2D curved reformations--correlat MRCP. Radiology. 238(2):560-9, 2006 Feb.

16. Matsumoto T, Aramaki M, Yada K, et al. Optimal management of the branch duct type intraduc mucinous neoplasms of the pancreas. Journal of Clinical Gastroenterology. 36(3):261-5, 2003 M

17. Pausawasdi N, Heidt D, Kwon R, Simeone D, Scheiman J. Long-term follow-up of patients with discovered pancreatic cystic neoplasms evaluated by endoscopic ultrasound. Surgery. 147(1):1 Jan.

18. Song SJ, Lee JM, Kim YJ, et al. Differentiation of intraductal papillary mucinous neoplasms from pancreatic cystic masses: comparison of multirow-detector CT and MR imaging using ROC ana Journal of Magnetic Resonance Imaging. 26(1):86-93, 2007 Jul.

19. NCCN Guidelines For Patients. Pancreatic Cancer. Version 1.2017. Available at: https://www.nccn.org/patients/guidelines/pancreatic/files/assets/common/downloads/files/pa

20. Al-Hawary MM, Francis IR, Chari ST, et al. Pancreatic ductal adenocarcinoma radiology reportir consensus statement of the society of abdominal radiology and the american pancreatic assoc Gastroenterology. 146(1):291-304.e1, 2014 Jan.

21. Galvin A, Sutherland T, Little AF. Part 1: CT characterisation of pancreatic neoplasms: a pictorial Insights Into Imaging. 2(4):379-388, 2011 Aug.

22. Sainani NI, Saokar A, Deshpande V, Fernandez-del Castillo C, Hahn P, Sahani DV. Comparative performance of MDCT and MRI with MR cholangiopancreatography in characterizing small pa cysts. AJR. American Journal of Roentgenology. 193(3):722-31, 2009 Sep.

23. Chiang AL, Lee LS. Clinical approach to incidental pancreatic cysts. [Review]. World J Gastroent 22(3):1236-45, 2016 Jan 21.

24. Lee HJ, Kim MJ, Choi JY, Hong HS, Kim KA. Relative accuracy of CT and MRI in the differentiatic from malignant pancreatic cystic lesions. Clinical Radiology. 66(4):315-21, 2011 Apr.

25. Theisen BK, Wald AI, Singhi AD. Molecular Diagnostics in the Evaluation of Pancreatic Cysts. [R Pathol Clin. 9(3):441-56, 2016 Sep.

26. de Oliveira PB, Puchnick A, Szejnfeld J, Goldman SM. Prevalence of incidental pancreatic cysts magnetic resonance. PLoS ONE. 10(3):e0121317, 2015.

27. Manfredi R, Bonatti M, D'Onofrio M, et al. Incidentally discovered benign pancreatic cystic neo communicating with the ductal system: MR/MRCP imaging appearance and evolution. Radiol M (Torino). 118(2):163-80, 2013 Mar.

28. Ardengh JC, Lopes CV, de Lima-Filho ER, Kemp R, Dos Santos JS. Impact of endoscopic ultraso fine-needle aspiration on incidental pancreatic cysts. A prospective study. Scand J Gastroentero 49(1):114-20, 2014 Jan.

29. Cocieru A, Brandwein S, Saldinger PF. The role of endoscopic ultrasound and cyst fluid analysis initial evaluation and follow-up of incidental pancreatic cystic lesions. HPB. 13(7):459-62, 2011

30. Matthaei H, Feldmann G, Lingohr P, Kalff JC. Molecular diagnostics of pancreatic cysts. [Review Langenbecks Arch Surg. 398(8):1021-7, 2013 Dec.

31. Scheiman JM, Hwang JH, Moayyedi P. American gastroenterological association technical revie diagnosis and management of asymptomatic neoplastic pancreatic cysts. [Review]. Gastroente

148(4):824-48.e22, 2015 Apr.

32. Gore RM, Wenzke DR, Thakrar KH, Newmark GM, Mehta UK, Berlin JW. The incidental cystic pa mass: a practical approach. [Review]. Cancer Imaging. 12:414-21, 2012 Sep 28.

33. Macari M, Lee T, Kim S, et al. Is gadolinium necessary for MRI follow-up evaluation of cystic les pancreas? Preliminary results. AJR. American Journal of Roentgenology. 192(1):159-64, 2009 Ja

34. Pozzi-Mucelli RM, Rinta-Kiikka I, Wunsche K, et al. Pancreatic MRI for the surveillance of cystic comparison of a short with a comprehensive imaging protocol. European Radiology. 27(1):41-5 Jan.

35. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment In Available at: https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiati Assessment-Introduction.pdf.

Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

[a]Johns Hopkins University School of Medicine, Baltimore, Maryland. [b]Research Author, University of South Florida, Tampa, Florida. [c]Panel Vice-Chair, Northwestern University, Chicago, Illinois. [d]University of Arizona, Banner University Medical Center, Tucson, Arizona. [e]Duke University Medical Center, Durham, North Carolina. [f]Montefiore Medical Center, Bronx, New York. [g]UMass Medical School, Worcester, Massachusetts. [h]University of Florida College of Medicine, Gainesville, Florida. [i]New York University Medical Center, New York, New York. [j]Stanford University Medical Center, Stanford, California. [k]University of Alabama Medical Center, Birmingham, Alabama. [l]University of Alabama Medical Center, Birmingham, Alabama. [m]University of Virginia Health System, Charlottesville, Virginia; American Gastroenterological Association. [n]Johns Hopkins Bayview Medical Center, Baltimore, Maryland; Commission on Nuclear Medicine and Molecular Imaging. [o]University of Illinois College of Medicine, Chicago, Illinois; American College of Physicians. [p]Johns Hopkins Hospital, Baltimore, Maryland. [q]Specialty Chair, Virginia Commonwealth University Medical Center, Richmond, Virginia.