REVIEW ARTICLE

Incidental findings in imaging diagnostic tests: a systematic review

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ABSTRACT. The objective of this review is to summarise the available evidence on the frequency and management of incidental findings in imaging diagnostic tests. Original articles were identified by a systematic search of the MEDLINE, EMBASE and Cochrane Library Plus databases using appropriate medical headings. Extracted variables were study design; sample size; type of imaging test; initial diagnosis; frequency and location of incidental findings; whether clinical follow-up was performed; and whether a definitive diagnosis was made. Study characteristics were assessed by one reviewer and checked by a second reviewer. Any disagreement was solved by consensus. The relationship between the frequency of incidental findings and the study characteristics was assessed using a one-way ANOVA test, as was the frequency of follow-up of incidental findings and the frequency of confirmation. 251 potentially relevant abstracts were identified and 44 articles were finally included in the review. Overall, the mean frequency of incidental findings was 23.6% (95% confidence interval (CI) 15.8–31.3%). The frequency of incidental findings was higher in studies involving CT technology (mean 31.1%, 95% CI 20.1–41.9%), in patients with an unspecific initial diagnosis (mean 30.5, 95% CI 0–81.6) and when the location of the incidental findings was unspecified (mean 33.9%, 95% CI 18.1–49.7). The mean frequency of clinical follow-up was 64.5% (95% CI 52.9–76.1%) and mean frequency of clinical confirmation was 45.6% (95% CI 32.1–59.2%). Although the optimal strategy for the management of these abnormalities is still unclear, it is essential to be aware of the low clinical confirmation in findings of moderate and major importance.

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Imaging techniques play a major role in the management of many patients. The quality of imaging examinations has improved considerably and access to these new devices has increased, assuming that ''newer is better'' [1]. However, these techniques often give rise to findings that are incidental to the reason the study was ordered. The growing number of imaging techniques performed per patient causes an increase in the number of incidental findings. How these findings should be managed is far from settled.

A classical example of an incidental finding is an adrenal mass discovered unexpectedly through imaging examinations, dubbed ''incidentalomas'' [2]. Other incidental findings include the unexpected pulmonary nodules observed during chest imaging tests, which have been subject to particular research attention owing to their potential clinical relevance [3].

The description of an unexpected finding can trigger additional medical care including unnecessary tests, other diagnostic procedures and treatments which in some cases may pose an additional risk to the patient. This process has been called the ''cascade effect'' [4]. Clinicians need to know how to deal with unexpected findings in order to avoid any undesirable consequences. The absence of convincing evidence from controlled studies leads to unawareness of the prognostic significance and treatment implications for unexpected findings. However, there are some studies describing the frequency of these findings in different clinical settings, using several imaging techniques, and providing some recommendations to deal with them.

The aim of this review was to appraise the prevalence of incidental findings in clinical practice according to several relevant variables.

Methods and materials

The systematic review was conducted to assess the frequency of incidental findings reported in imaging diagnostic techniques, the follow-up and the degree of confirmation of these findings, and the related variables. We defined an incidental finding as any abnormality not related to the illness or causes that prompted the diagnostic imaging test.

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Search strategy

We searched all articles published until 31 December 2007. The MEDLINE, EMBASE and Cochrane Library Plus databases were searched by using exploded headings under the terms: *incidental finding*, *unexpected finding*, *clinical cascade*, *serendipity* (by using the Boolean operator OR), AND *diagnostic imaging* OR specific modalities such as *computed tomography, MR, ultrasound*, etc.

Two authors independently cross-checked reference lists for additional relevant articles.

To avoid publication biases, as the articles spanned about two decades and the availability of the imaging modalities varied over the years, we plotted the selected studies onto a funnel plot. This graph was roughly symmetrical and thus publication bias was not present.

Eligibility criteria

Initial criteria for inclusion of studies in the systematic review were original articles aiming to describe the frequency of incidental findings in clinical practice in the imaging diagnostic field published until 31 December 2007. Language was restricted to English.

To appraise the quality of primary studies, we used the quality assessment tool named QUADAS [5]. We selected those articles fulfilling more than seven items.

Data extraction

Two authors independently extracted the following data: study design (observational retrospective or prospective and medical record review); study sample size; type of imaging test carried out: (a) CT; (b) radiographs; (c) other techniques, including MRI, ultrasonography and positron emission tomography (PET) and (d) a combination of more than one technique, for instance CT/PET; initial diagnosis grouped in different categories, mainly based on the 10th Revision of the International Statistical Classification of Diseases, Injuries and Causes of Death (ICD-10): (a) neoplasm, (b) diseases of the genitourinary and digestive system, (c) mental and behavioural disorders, diseases of the nervous system and diseases of the senses, diseases of the circulatory system and endocrine, nutritional and metabolic diseases, (d) diseases of the respiratory system, (e) diseases of the musculoskeletal system and connective tissue and (f) no specification (categories b–f do not include neoplasms); location of the incidental finding: (a) unspecified location (findings out with the organ under study without a specific localisation; for example, extra-urinary findings), (b) abdomen, (c) musculoskeletal system, skin and head-neck, and (d) chest and breast; characteristics of the incidental finding, according to the classification shown in Table 1 (studies describing, for example, ''extracolonic findings'' were classified of ''major importance'' because they included several types of abnormalities with both important and unimportant consequences); number of incidental findings; percentage of patients with complete clinical follow-up; percentage of patients with clinical confirmation of the incidental finding; and main authors' conclusions.

The authors independently checked all of the extracted data against the publications twice, to ensure correct and complete data extraction. Any discrepancies in extracted data were discussed, and disagreements were resolved by consensus with the third author.

Statistical analysis

Some variables were grouped owing to limited data for analysis. These include MRI, ultrasound and PET in the variable ''technique''; genitourinary and gastrointestinal system and central nervous, circulatory and endocrine system in the variable ''initial diagnosis''; and musculoskeletal system, skin and head–neck in the variable ''location''.

Study characteristics were summarised as means and their 95% confidence interval (CI) or frequencies and proportions. The relationship between the main variables of interest (frequency of incidental findings, frequency of follow-up and frequency of confirmation) and the study characteristics was assessed by one-way ANOVA test. We considered variables with a p-value of less than 0.05 to be significant. Analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 15.0. (SPSS Inc., Chicago, IL).

Results

Literature search

We identified 251 potentially relevant abstracts; (Figure 1) of these, 89 articles were retrieved for full text review and finally 44 articles were included in the systematic review [6–49]. (The characteristics of these 44 reviewed articles are listed in Annex 1.)

Description of the studies

The 44 original reports were published between 1986 and 2007 (Table 2). The main imaging techniques carried out were CT in 26 studies (59%), combination of more than one technique in 8 studies (18%), other techniques such as MRI, ultrasound and PET in 7 papers (16%), and radiographs in 3 articles (7%). The most frequently described diagnosis was neoplasm (18; 41%) followed by diseases of the genitourinary or gastrointestinal system (7; 16%). The median sample size was 496 (interquartile range (IQR) 225–1750) and mean frequency of incidental findings was 23.6 (95% CI 15.8–31.3). Most papers described incidental findings with an unspecified localisation (15; 34%) or abnormalities located in abdomen (13; 30%).

Description of original papers in relation to frequency of incidental findings

Smaller studies (those with a sample size under the median 496) reported a higher frequency of incidental findings (mean 29.9, 95% CI 19.2–40.8) than larger studies (mean 17.2, 95% CI 5.9–28.5) (Table 2). The rest of the analysed variables did not show any significant

Table 1. Classification of the incidental findings detected according to their clinical importance: major, moderate and minor

Major	Moderate	Minor
Malignant or premalignant tumours		
Head–chest	*Head–chest*	*Head–chest*
Parietal meningioma	Chiari malformation	Hürthle cell adenoma
Orbital mass	Circle of Willis calcifications	Arachnoid cyst
Parotid mass	Mastoiditis	Large cisterna magna
Severe foraminal stenosis	Thyroid incidentalomas	Follicular adenoma
		Parathyroid adenoma
Vascular	*Vascular*	*Vascular*
Aortic aneurysm	Pulmonary artery dilatation	Left-sided vena cava
Thoracic aneurysm	Signs of portal venous hypertension	Retroaortic left renal vein
Iliac artery aneurysm	Atherosclerosis	Vascular graft
Thrombus	Hepatic or vertebral haemangioma	
Common femoral artery pseudoaneurysm	Abdominal aortic ectasia	
Dissecting aorta	Coronary artery calcification	
	Iliac artery ectasia	
	Rectus muscle haemangioma	
Reticuloendothelial	*Reticuloendothelial*	*Reticuloendothelial*
Lymphadenopathy	Splenomegaly	Splenic cyst
Abdominal lymph node >1 cm		Abdominal lymph node <1 cm
Hepatobiliary	*Hepatobiliary*	*Hepatobiliary*
Solid hepatic mass	Common bile duct dilatation	Calcified hepatic or splenic granulomas
Solid pancreatic mass	Gallstone	Cholelithiasis
Indeterminate liver lesion ⩾1 cm	Hepatomegaly	Hepatic cysts
Indeterminate pancreatic lesion ⩾1 cm	Indeterminate hepatic lesion	Hepatic steatosis
	Liver cirrhosis	Pancreatic head cyst
	Pancreatic calcifications	Small perihepatic fluid collection
	Pancreatic mass	Indeterminate liver lesion <1 cm
	Pancreatitis	Hepatic haemangioma
	Mild pancreatic duct dilatation	
Gynaecological	*Gynaecological*	*Gynaecological*
Ovarian teratoma	Breast nodule	Simple ovarian cyst
Complex ovarian or adnexal cyst	Uterine enlargement	Uterine fibroids
Post-menopausal endometrial thickening		Uterine calcifications
		Bartholin's cysts
Musculoskeletal	*Musculoskeletal*	*Musculoskeletal*
Vertebral body deformation suspected destruction		Pigmented villonodular synovitis
Lytic bone lesion		Spondylolisthesis
Indeterminate sclerotic bone lesion		Degenerative spine changes
		Diffuse osteopenia
		Sclerotic bone lesion, likely bone island
		Spina bifida occulta
		Osteoarthritis
Peritoneal cavity	*Peritoneal cavity*	*Peritoneal cavity*
Appendicitis	Abdominal wall hernia	Appendiceal stone
Indeterminate retroperitoneal masses	Pelvic fluid collection	Umbilical hernia
Pelvic mass		Hiatal, ventral, umbilical, or Bochdalek's hernia
Ascites	*Renoadrenal*	
Indeterminate soft-tissue mass in abdominal wall	Adrenal adenoma	*Renoadrenal*
	Adrenal mass with benign appearance	Adrenal myelolipoma
Ileal wall thickening	Hydronephrosis	Bladder diverticulum
Renoadrenal	Indeterminate adrenal nodule	Bladder stone
Adrenal mass with indeterminate appearance	Prostate enlargement	Gallbladder absent or not seen
	Renal angiomyolipoma	Mild renal parenchymal reduction
Hydronephrosis with marked parenchymal reduction	Renal parenchymal reduction	Renal atrophy
	Solitary kidney	Renal calculi
Renal mass	Pyelonephritis	Renal cyst
Severe bilateral renal parenchymal reduction	Urethra–pelvic junction obstruction	Renal malrotation
	Bladder outlet obstruction	Small renal calcifications
Suspected undescended testis	Complex renal cyst	Suspected renal stones
Gallbladder wall thickening	Scrotal hydrocoele	Suspected ureteric stone
Soft-tissue density within the gallbladder		

Table 1. Continued

Major	Moderate	Minor
Gastrointestinal tract	*Gastrointestinal tract*	*Gastrointestinal tract*
Bowel obstruction	Hyperplastic colonic polyp	Hiatal hernia
Gastric mass	Bowel inflammation	Diaphragmatic hernia
Terminal ileum mass or thickening	Diverticulosis	Focal gastritis
Bowel wall thickening	Inguinal hernia or bowel-containing abdominal hernia	Gastric fundus diverticulum
		Rectal inflammation and/or haemorrhoids
Thoracic cavity	*Thoracic cavity*	*Thoracic cavity*
Cardiomegaly	Bronchiectasis	Calcified pulmonary nodules
Idiopathic pulmonary fibrosis	Pericardial effusion	Pleural plaques
Pneumothorax	Pneumobilia	Subcutaneous emphysema
Pulmonary embolism	Pulmonary nodules	Lung base subsegmental atelectasis, scarring, and dependent changes
	Pulmonary parenchymal opacity	Diaphragmatic calcification
	Consolidation and infiltrates	Cystic lung lesion
	Interstitial lung disease	Pericardial granuloma
	Pleural fluid	
	Pulmonary emphysematous bullae	
	Mitral annulus calcifications	
	Tracheomalacia	
		Others
		Splenic, pulmonary, hepatic or adrenal granuloma
		Lipoma
		Findings in orthodontic panoramic radiographs: radio-opacities, thickening of mucosal lining in sinus, periapical inflammatory lesion, dentigerous cyst, cyst within alveolar bone, odontoma, altered tooth morphology, marginal bone loss

differences related to finding frequency. The frequency of incidental findings was higher in studies involving CT technology (mean 31.1, 95% CI 20.1–41.9) or patients with a non-specific initial diagnosis (mean 30.5, 95% CI 0–81.6) or when the location of the incidental findings was unspecified (mean 33.9, 95% CI 18.1–49.7).

Most studies included findings considered of major importance (27; 61.4%), whereas 12 (27.3%) evaluated findings of moderate significance, and five (11.4%) showed abnormalities of minor importance. Studies were more likely to include findings of major importance when the initial diagnosis was neoplasm (14; 51.9%), and findings of minor consequences were more likely to be presented when the initial diagnosis was related to the musculoskeletal system (2; 40.0%) ($p = 0.019$). Localisation of the findings was also related to the characteristics of the findings: findings in musculoskeletal system, skin, and head and neck were more likely to be of minor importance (3 studies; 60%) than the other localisations ($p = 0.023$) (data not shown).

Description of original papers according to the frequency of clinical follow-up and clinical confirmation

Out of 44 studies, 11 (25%) carried out clinical follow-up of all the unexpected findings reported and 27 (61%) studies performed work-up of only some of them (Table 3). The mean frequency of clinical follow-up was 64.5% (95% CI 52.9–76.1%). No differences between the studied variables and the mean clinical follow-up were shown. Nevertheless, studies involving patients with unspecific initial diagnosis (mean 75.4, 95% CI 8.4–100.0) and unexpected abnormalities located in the musculoskeletal system, the skin, head or neck constitute the higher frequency of clinical work-up.

Findings of minor importance (mean 87.9, 95% CI 64.0–111.6) were more likely to be followed up than those of major (mean 61.4, 95% CI 47.9–74.9) or moderate (mean 65.0, 95% CI 40.4–89.7) consequences, but the differences were not statistically significant ($p = 0.485$) (data not shown).

With regard to clinical confirmation, 11 (25.0%) studies did not verify any of the unexpected findings: 8 (18.2%) articles confirmed the clinical significance of all the abnormalities and 25 (56.8%) confirmed some of them. The mean frequency of clinical confirmation was 45.6% (95% CI 32.1–59.2). Unexpected findings located in the abdomen showed the highest frequency of clinical confirmation (mean 77.4, 95% CI 54.5–100.0) in comparison with other locations such as the musculoskeletal system, the skin, head or neck (mean 46.1, 95% CI 8.9–83.2), chest or breast (mean 13.4, 95% CI 0.0–34.6) or unspecified location (mean 34.9, 95% CI 15.2–54.7) ($p = 0.014$).

Findings of minor importance (mean 87.9, 95% CI 64.0–111.6) were more likely to be confirmed than those of major (mean 43.0, 95% CI 11.2–64.6) or moderate (mean 37.9, 95% CI 40.4–89.7) importance, but the differences were not statistically significant ($p = 0.114$) (data not shown).

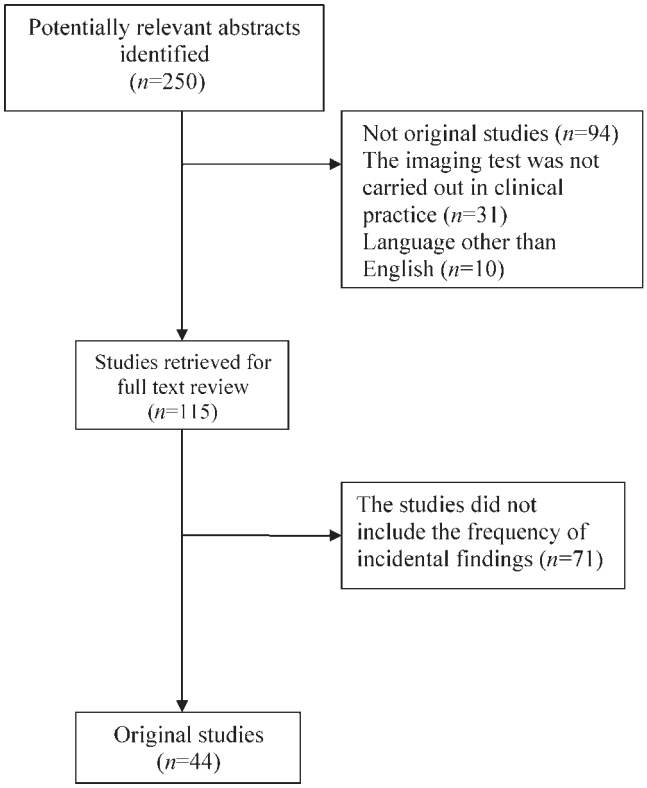

Figure 1. Description of the literature search.

Discussion

In an effort to determine the frequency and variables related to incidental findings in imaging tests, we systematically reviewed the literature. As we expected, the higher frequency of incidental findings was observed in studies involving CT, but there were no differences with respect to other imaging techniques. The wider field of view of CT has led to better visualisation of organs and tissues and, therefore, a higher probability of encountering additional findings. We were unable to establish the difference between various types of CT (CT colonography, multidetector CT, etc.) owing to the relatively small number of studies focusing on unexpected findings.

An important percentage of the patients in whom unexpected findings were observed underwent further evaluation with more imaging tests or other diagnostic tests and procedures. Although the mean frequency of clinical confirmation was high for findings of minor importance, it was lower for abnormalities of major or moderate importance. The difficulty is in distinguishing between those findings that can be characterised without additional imaging and those that can be ignored or those that may need additional follow-up [50].

In this paper, we have tried to classify the possible unexpected findings in three different groups according to their clinical relevance: major, moderate and minor. This classification of severity could be open to question and we cannot consider this classification as a strict rule to manage these abnormalities; it can be used only as a support aid to make the diagnostic work-up easier. We tried to classify the findings according to the most common situations in practice. However, depending on each particular patient, an incidental finding could be considered as major, minor or of non-pathological importance. For example, the definition of osteoarthritis as an incidental abnormality is age related. We could assume that some results are biased because of this classification, but the categorisation of a particular unexpected abnormality would not have a great influence on the global result.

In this study, we have also shown that incidental findings of major importance were more likely in patients with the initial diagnosis of neoplasm than, for instance, in patients with an initial diagnosis related to the musculoskeletal system.

The role of the radiologist is crucial in deciding whether an image feature is normal or a potentially important diagnostic discovery. Nevertheless, with a different perspective, the incidental finding is also a problem for clinicians, and the collaboration between radiologists and clinicians is essential to deal with these abnormalities [51].

The critical question concerning incidental findings is not only whether they should be reported, but also how often they occur and what is their effect economically and clinically. However, there are few studies evaluating the cost-effectiveness of incidental findings. In the analysis of incidental extra-urinary findings with multidetector CT (MDCT) urography [28], the authors evaluated the impact on subsequent imaging costs. In this case, only a small percentage of patients were imaged further and, hence, detecting extra-urinary disease did not mean a substantial increase in per-patient imaging costs. Another study [16] was performed to assess the clinical resources and costs associated with the investigation and treatment of extracolonic lesions when using CT colonography. In this research, however, resources consumed as a result of extracolonic findings approximately doubled the costs of diagnostic computer tomography colonography (CTC).

Unfortunately, many radiologists are rarely consulted and they perform and interpret the imaging reports without patients' clinical information [52]. In fact, most of the studies in this review separately involved either radiologists or clinicians. Nevertheless, in one study [24] the high number of non-cardiac findings detected by MDCT caused the authors to recommend close co-operation between cardiologists and radiologists in defining these more accurately. Each radiologist and clinician should try to balance the potential to diagnose a disease that may cause morbidity and mortality against unnecessary testing and treatment, which carry their own risks together with patient anxiety and the cost to society. The discussion is made especially complex by the absence of professional guidelines. Some recommendations, however, have been described in an attempt to clarify the situation [53]. The recommendations include, among others things, factors such as the assessment of the potential risk of the incidental finding for the patient or the availability of a beneficial treatment that justifies follow-up of the abnormality. However, the optimal strategy for evaluation of a patient with an unexpected finding discovered is unclear and remains controversial. The ideal study to resolve these controversies would be a prospective multicentre randomised (or even non-randomised) trial. However, we lack such a study. This

Table 2. Description of the 44 original studies analysed in the systematic review and their main characteristics according to the mean of incidental findings

Variables[a,b]	Original studies (*n*, %)	Finding frequency (mean; 95% CI)
Technique		
CT	26 (59)	31.1 (20.1–41.9)
More than one technique	8 (18)	13.9 (0–37.1)
Other (MRI, ultrasound, PET)	7 (16)	13.4 (4.3–22.5)
Radiograph	3 (7)	8.7 (0–26.8)
Year		
1986–2004	15 (34)	24.3 (13.7–34.9)
2005–2007	29 (66)	23.2 (12.4–34.1)
Type of study		
Observational prospective	23 (52)	21.3 (11.0–31.6)
Medical record review	14 (32)	29.7 (11.8–47.5)
Observational retrospective	7 (16)	19.1 (1.6–36.6)
Initial diagnosis		
Neoplasm	18 (41)	27.1 (13.3–40.8)
Genitourinary + gastrointestinal system	7 (16)	24.9 (0.1–40.6)
Nervous central + circulatory + endocrine system	7 (16)	21.6 (4.6–38.6)
Unspecific localisation	5 (11)	30.5 (0–81.6)
Respiratory system	4 (9)	11.9 (3.5–20.3)
Musculoskeletal system	3 (7)	8.6 (0–27.2)
Location		
Unspecific localisation	15 (34)	33.9 (18.1–49.7)
Abdomen	13 (30)	22.6 (10.2–34.9)
Musculoskeletal system and skin, head–neck	10 (23)	15.7 (0–37.2)
Chest and breast	6 (14)	13.2 (3.2–23.2)
Study size		
<496	22 (50)	29.9 (19.2–40.8)
$\geqslant 496$	22 (50)	17.2 (5.9–28.5)
Total	44 (100)	23.6 (15.8–31.3)

[a]One-way ANOVA. *t*-test.
CI, confidence interval; PET, positron emission tomography.

review of the literature includes a broad spectrum of unexpected findings detected by different techniques and with several consequences. Even though future studies are needed to evaluate the outcomes of the clinical management decisions, these data could help characterise the problem in order to establish professional guidelines.

There are some general limitations to this review, which should be kept in mind. The wide variation in detection rates for incidental lesions could be due to heterogeneity of the selected studies. Accordingly, previous studies have shown this variation in relation to the lack of standardised guidelines in the definition and management of incidental abnormalities [54]. As we mentioned previously, we did not have a sufficient sample size to establish differences in more detail, such as the specific type of imaging techniques. Moreover, this was a challenging topic for a systematic review; incidental findings are difficult to define and identify in literature searches. We tried, however, to be consistent and specific with regard to our inclusion and exclusion criteria and our data extraction methods so as to avoid omitting or including studies inappropriately. For the selection of the articles we applied QUADAS [5], designed specifically to assess the quality of primary studies included in diagnostic systematic reviews; although the outcomes of this review are not test accuracy, the methodological criteria are still applicable. During the diagnostic process, many radiologists can detect incidental findings and perform additional examinations before completing the report. For example, in the pre-operative assessment, they might carry out a CT examination after detecting an abnormality on a radiograph. These cases would be hidden to any investigation of unexpected findings.

Conclusions

In conclusion, we have found a high percentage of incidental findings in imaging tests, especially with CT examinations and patients with non-specific initial diagnoses. Most patients with abnormalities were clinically followed up, especially those with findings of minor importance. However, only some of them were clinically confirmed. It is important to be aware of the high percentage of patients who undergo further evaluation owing to the presence of unexpected findings, but without obtaining clinical confirmation of these abnormalities.

The classification of the incidental findings we have shown in this study and the characteristics of the abnormalities with a greater probability of clinical confirmation could aid radiologists and clinicians in the management of incidental findings.

Table 3. Description of the clinical follow-up and clinical confirmation of the diagnosis in the 44 original studies analysed in the systematic review according to their main characteristics evaluated

Variable[a,b]	% Clinical follow-up (mean, 95% CI)	% Clinical confirmation (mean, 95% CI)
Technique		
CT	60.0 (43.5–76.5)	48.7 (27.2–70.2)
More than one technique	69.8 (54.0–84.0)	45.8 (22.9–68.6)
Other (MRI, ultrasound, PET)	69.0 (31.0–100)	41.1 (0.9–81.2)
Radiograph	100 (–)	24.0 (–)
Year		
1986–2004	67.2 (47.2–87.1)	61.2 (34.9–87.4)
2005–2007	63.0 (47.6–78.4)	38.6 (22.4–54.8)
Type of study		
Observational prospective	56.6 (40.4–72.7)	50.3 (29.5–71.1)
Medical record review	68.9 (45.6–92.2)	31.6 (10.3–52.9)
Observational retrospective	84.4 (51.2–100)	57.9 (7.9–100)
Diagnosis		
Neoplasm	65.9 (51.4–80.5)	48.4 (30.0–66.8)
Genitourinary + gastrointestinal system	64.4 (27.5–100)	75.7 (26.0–100)
Nervous central + circulatory + endocrine system	43.9 (0–88.9)	10.2 (0–30.5)
Unspecific localisation	75.4 (8.3–100)	40.2 (0–100)
Respiratory system	58.3 (0–100)	15.2 (0–100)
Musculoskeletal system	100 (–)	62.0 (0–100)
Location[b]		
Abdomen	69.5 (48.8–90.1)	77.4 (64.5–100)
Unspecific localisation	57.4 (37.9–76.8)	34.9 (15.2–50.1)
Musculoskeletal system and skin, head–neck	72.8 (38.6–100)	46.1 (8.9–83.2)
Chest and breast	58.3 (0–100)	13.4 (0–34.6)
Study size		
<496	72.3 (53.6–90.9)	50.7 (28.6–72.7)
$\geqslant 496$	58.3 (42.7–73.8)	41.7 (22.9–60.5)
Total	64.5 (52.9–76.1)	45.6 (32. –59.2)

[a]One-way ANOVA. *t*-test.
[b]*p*-value: 0.014 for the variable ''% clinical confirmation''.
CI, confidence interval; PET, positron emission tomography.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

All authors contributed substantially to the drafting, review and revision of the manuscript.

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References

1. Deyo R. Cascade effects of medical technology. Annu Rev Public Health 2002;23:23–44.
2. Young WF. Clinical practice. The incidentally discovered adrenal mass. N Engl J Med 2007;356:601–10.
3. Beigelman-Aubry C, Hill C, Grenier PA. Management of an incidentally discovered pulmonary nodule. Eur Radiol 2007;17:449–66.
4. Mold JW, Stein HFC. The cascade effect in the clinical care of patients. N Engl J Med 1986;314:512–14.
5. Whiting P, Rutjes AW, Reitsma JB, Bossuyt PM, Kleijnen J. The development of QUADAS: a tool for the quality assessment of studies of diagnostic accuracy included in systematic reviews. BMC Med Res Methodol 2003;3:25–37.
6. Bogsrud TV, Karantanis D, Nathan MA, Mullan BP, Wiseman GA, Collins DA, et al. The value of quantifying 18F-FDG uptake in thyroid nodules found incidentally on whole-body PET-CT. Nucl Med Commun 2007;28:373–81.
7. Are C, Hsu JF, Schoder H, Shah JP, Larson SM, Shaha AR. FDG-PET detected thyroid incidentalomas: need for further investigation? Ann Surg Oncol 2007;14:239–47.
8. Ritchie G, McGurk S, McCreath C, Graham C, Murchison JT. Prospective evaluation of unsuspected PE on contrast enhanced multidetector CT scanning. Thorax 2007;62:536–40.
9. Khan KY, Xiong T, McCafferty I, Riley P, Ismail T, Lilford RJ, et al. Frequency and impact of extracolonic findings detected at computed tomographic colonography in symptomatic population. Br J Surg 2007;94:355–61.
10. Wang G, Lau EW, Shakher R, Rischin D, Ware RE, Hong E, et al. How do oncologists deal with incidental abnormalities on whole-body fluorine-18 fluorodeoxyglucose PET/CT? Cancer 2007;109:117–24.
11. Paluska TR, Sise MJ, Sack DI, Sise CB, Egan MC, Biondi M, et al. Incidental CT findings in trauma patients: incidence and implications for care of the injured. J Trauma 2007;62:157–61.
12. Vierikko T, Järvenpää R, Autti T, Oksa P, Huuskonen M, Kaleva S, et al. Chest CT screening of asbestos-exposed workers: lung lesions and incidental findings. Eur Respir J 2007;29:78–84.
13. Koos R, Kühl HP, Mühlenbruch G, Wildberger JE, Günther RW, Mahnken AH. Prevalence and clinical importance of aortic valve calcification detected incidentally on CT scans: comparison with echocardiography. Radiology 2006;241:76–82.

14. Belfi L, Ortiz A, Katz D. Computed tomography evaluation of spondylolysis and spondylolisthesis in asymptomatic patients. Spine 2006;31:907–10.
15. Choksi VR, Marn CS, Bell Y, Carlos R. Efficiency of a semiautomated coding and review process for notification of critical findings in diagnostic imaging. AJR Am J Roentgenol 2006;186:933–6.
16. Xiong T, McEvoy K, Morton DG, Halligan S, Lilford RJ. Resources and costs associated with incidental extracolonic findings from CT colonography: a study in a symptomatic population. Br J Radiol 2006;79:948–61.
17. Morris CA, Carrino JA, Lang P, Solomon DH. Incidental vertebral fractures on chest radiographs. J Gen Intern Med 2006;21:352–6.
18. Even-Sapir E, Lerman H, Gutman M, Lievshitz G, Zuriel L, Polliack A, et al. The presentation of malignant tumors and pre-malignant lesions incidentally found on PET-CT. Eur J Nucl Med Mol Imaging 2006;33:541–52.
19. Shetty SK, Maher MM, Hahn PF, Halpern EF, Aquino SL. Significance of incidental thyroid lesions detected on CT: correlation among CT, sonography, and pathology. AJR Am J Roentgenol 2006;187:1349–56.
20. Sebastian AJ, Paddon AJ. Clinically unsuspected pulmonary emboli: an important secondary finding in oncology CT. Clin Radiol 2006;61:81–5.
21. Bondemark L, Jeppsson M, Lindh-Ingildsen L, Rangne K. Incidental findings of pathology and abnormality in pretreatment orthodontic panoramic radiographs. Angle Orthod 2006;76:98–102.
22. Bruzzi JF, Truong MT, Masom EM, Mawlawi O, Podoloff DA, Macapinlac HA, et al. Incidental findings on integrated PET/CT that do not accumulate 18F-FDG. AJR Am J Roentgenol 2006;187:1116–23.
23. Bovio S, Cataldi A, Reimondo G, Sperone P, Novello S, Berruti A, et al. Prevalence of adrenal incidentaloma in a contemporary computerized tomography series. J Endocrinol Invest 2006;29:298–302.
24. Onuma Y, Tanabe K, Nakazawa G, Aoki J, Nakajima H, Ibukuro K, et al. Noncardiac findings in cardiac imaging with multidetector computed tomography. J Am Coll Cardiol 2006;48:402–6.
25. Weber F, Knopf H. Incidental findings in magnetic resonance imaging of the brains of healthy young men. J Neurol Sci 2006;240:81–4.
26. Osman MM, Cohade C, Fishman EK, Wahl RL. Clinically significant incidental findings on unenhanced CT portion of PET/CT studies: frequency in 250 patients. J Nucl Med 2006;46:1352–5.
27. Eskandary H, Sabba M, Khajehpour F, Eskandari M. Incidental findings in brain computed tomography scans of 3000 head trauma patients. Surg Neurol 2006;63:550–3.
28. Liu W, Mortele KJ, Silverman SG. Incidental extraurinary findings at MDCT urography in patients with hematuria: prevalence and impact on imaging costs. AJR Am J Roentgenol 2005;185:1051–6.
29. Israel O, Yefremov N, Bar-Shalom R, Kagana O, Frenkel A, Keidar Z, et al. PET/CT detection of unexpected gastrointestinal foci of 18F-FDG uptake: incidence, localization patterns, and clinical significance. J Nucl Med 2005;46:758–62.
30. Ishimori T, Patel PV, Wahl RL. Detection of unexpected additional primary lesions with PET/CT. J Nucl Med 2005;46:752–7.
31. Majumdar SR, Kim N, Colman I, Chahal AM, Raymond G, Jen H, et al. Incidental vertebral fractures discovered with chest radiography in emergency department. Arch Intern Med 2005;165:905–9.
32. Ares Valdés Y, Fragás Valdés R. Incidental renal cell carcinoma. Arch Esp Urol 2005;58:417–20.
33. Yee J, Kumar NN, Godara S, Casamina JA, Hom R, Galdino G, et al. Extracolonic abnormalities discovered incidentally at CT colonography in a male population. Radiology 2005;236:519–26.
34. Campbell J, Kalra MK, Rizzo S, Maher MM, Shepard JA. Scanning beyond anatomic limits of the thorax in chest CT: findings, radiation dose, and automatic tube current modulation. AJR Am J Roentgenol 2005;185:1525–30.
35. Ng CS, Doyle TC, Courtney HM, Campbell GA, Freeman AH, Dixon AK. Extracolonic findings in patients undergoing abdomino-pelvic CT for suspected colorectal carcinoma in the frail and disabled patient. Clin Radiol 2004;59:421–30.
36. Agress H, Cooper BZ. Detection of clinically unexpected malignant and premalignant tumors with whole-body FDG PET: histopathologic comparison. Radiology 2004;230:417–22.
37. Kang HW, No JH, Chung JH, Min YK, Lee MS, Lee MK, et al. Prevalence, clinical and ultrasonographic characteristics of thyroid incidentalomas. Thyroid 2004;14:29–33.
38. Schragin JG, Weissfeld JL, Edmundowicz D, Strollo DC, Fuhrman CR. Non-cardiac findings on coronary electron beam computed tomography scanning. J Thorac Imaging 2004;19:82–6.
39. Hellström M, Svensson MH, Lasson A. Extracolonic and incidental findings on CT colonography (virtual colonoscopy). AJR Am J Roentgenol 2004;182:631–8.
40. Ginnerup Pedersen B, Rosenkilde M, Christiansen TE, Laurberg S. Extracolonic findings at computed tomography colonography. Gut 2003;52:1744–7.
41. Cai Q, Baumgarten DA, Affronti JP, Waring JP. Incidental findings of thickening luminal gastrointestinal organs on computed tomography: an absolute indication for endoscopy. Am J Gastroenterol 2003;98:1734–7.
42. Fitzgerald TL, Smith AJ, Ryan M, Atri M, Wright FC, Law CH, et al. Surgical treatment of incidentally identified pancreatic masses. Can J Surg 2003;46:413–18.
43. Hasegawa I, Boiselle PM, Raptopoulos V, Hatabu H. Tracheomalacia incidentally detected on CT pulmonary angiography of patients with suspected pulmonary embolism. AJR Am J Roentgenol 2003;181:1505–9.
44. Ahmad NA, Ather MH, Rees J. Incidental diagnosis of diseases on un-enhanced helical computed tomography performed for ureteric colic. BMC Urol 2003;3:2.
45. Brown J, Smith RC, Lee CH. Incidental enhancing lesions found on MR imaging of the breast. AJR Am J Roentgenol 2001;176:1249–54.
46. Völk M, Strotzer M, Lenhart M, Techert J, Seitz J, Feuerbach S. Frequency of benign hepatic lesions incidentally detected with contrast-enhanced thin-section portal venous phase spiral CT. Acta Radiol 2001;42:172–5.
47. Messersmith WA, Brown D, Barry MJ. Incidental findings on ED abdominal CT scans. Am J Emerg Med 2001;19:479–81.
48. Weder W, Schmid RA, Bruchhaus H. Detection of extrathoracic metastases by positron emission tomography in lung cancer. Ann Thorac Surg 1998;66:886–93.
49. Iko BO. Serendipity in cholangiography. Scand J Gastroenterol 1986;124:213–18.
50. Ferrucci JT. Clinical problem-solving: trapped by an incidental finding. N Engl J Med 2002;326:1432.
51. Gutknecht DR. Meador revisited: nondisease in the nineties. Ann Intern Med 1992;116:873–4.
52. Royal HD, Siegel BA, Murphy WA Jr. An incidental finding: a radiologist's perspective. AJR Am J Roentgenol 1993;160:237–40.
53. Aron DC. The adrenal incidentaloma: disease of modern technology and public health problem. Rev Endocr Metab Disord 2001;2:335–42.
54. Jacobs PC, Mali WP, Grobbee DE, van der Graaf Y. Prevalence of incidental findings in computed tomographic screening of the chest: a systematic review. J Comput Assist Tomogr 2008;32:214–21.

Annex 1. Description of the 44 studies, including data of unexpected finding frequency

Study, year, reference	Type of study	Techniques evaluated	Initial diagnosis	Sample	Incidental finding	Finding classification	Finding frequency	Follow-up	Clinical confirmation	Conclusions
Bogsrud et al 2007 [6]	Medical record review	^{18}F-FDG-PET/CT	Study of oncology imaging	7347 patients	Abnormal FDG uptake	Moderate importance	79/7347 (1.1%)	48/79 (60.1%) patients were followed up	Confirmation in 46 (95.8%) patients: 31 as benign and 15 patients as malignant.	Incidental finding of a nodule with high FDG uptake in thyroid gland should always be reported as primary or secondary malignancy and further evaluation should be recommended
Are et al 2007 [7]	Experimental prospective	^{18}F-FDG-PET	Patients with primary malignancies	8800 patients	Thyroid abnormality	Moderate importance	263/8800 (2.9%)	57 (21.7%) patients were followed up	21 pathologies were confirmed (7.9%)	Prevalence of incidentalomas is low, but focal uptakes remain high among this group and requires an operative intervention and fine needle aspiration cytology
Ritchie et al 2007 [8]	Experimental prospective	Multidetector CT	Inpatients undergoing scanning of the chest for an indication other than suspected pulmonary embolism	487 patients	Pulmonary embolism	Major importance	28/487 (5.7%)	No	No	There is a high prevalence of unsuspected pulmon ary embolism. The incidence increases with age and there is no statistical correlation with length of admission or associated malignancy
Khan et al 2007 [9]	Experimental prospective	CT colonography	Suspected or known colorectal cancer	225 patients	Extracolonic findings	Major importance	116/225 (51.5%)	104 (89%) were selected for follow up: outpatient appointments, radiological tests and surgical procedures	24 (21%) cases were confirmed	Frequency of extracolonic findings increased with age and most of them are insignificant. Guidelines can avoid unnecessary tests
Wang et al 2007 [10]	Experimental prospective	PET/CT	Known or suspected cancer	1727 patients	Any focal extrathyroidal accumulation of FDG	Major importance	199/1727 (12%)	181/199 (91%) follow-up by PET and CT	59 (33%) were confirmed as malignancies.	Most findings were benign. Experienced readers of whole-body FDG-PET/CT can avoid unnecessary investigations, reducing cost and patient anxiety
Paluska et al 2007 [11]	Medical record review	CT	Patients who received at least one spiral CT in trauma department	848 patients	Cyst, masses, calcifications, nodes, embolism, thrombosis	Moderate importance	289/848 (34%)	Follow-up in 2 weeks: 108 (12.7%)	Clinical confirmation: 15 (1.7%)	Incidental findings are more common in women and older patients. An organised approach is essential to deal with them
Vierikko et al 2007 [12]	Experimental prospective	Chest radiography, spiral CT and high-resolution CT	Asbestos-exposed workers	633 patients	Non-calcified lung nodules	Moderate importance	277/633 (44%)	46 (16.6%) patients were submitted for further investigations	4 (1.4%) were judged as clinically important	Spiral CT and even high-resolution CT is more useful to screening for lung cancer than chest radiography in asbestos-exposed workers

Annex 1. Continued

Study, year, reference	Type of study	Techniques evaluated	Initial diagnosis	Sample	Incidental finding	Finding classification	Finding frequency	Follow-up	Clinical confirmation	Conclusions
Koos et al 2006 [13]	Experimental retrospective	CT echocardiography	Patient underwent multidetector CT of the chest	402 patients	Aortic valve calcification	Moderate importance	72/402 (18%)	Follow-up in 100% patients	Confirmation of aortic stenosis in 21/72 (29%) patients.	Aortic valve calcification, a common finding, predicts the grade of calcification, which is correlated with moderate or severe aortic valve disease
Belfi et al 2006 [14]	Experimental retrospective	CT	Abdominal pain and fever	510 patients	Spondylolysis and spondylolisthesis	Minor importance	29/510 (5.7%) cases of spondylolysis at L5	Follow-up 100% by a neuroradiologist	Confirmation in 100% of patients.	The high prevalence of spondylolysis as an unrelated finding reminds clinicians to be aware when they perform CT
Choksi et al 2006 [15]	Experimental retrospective	Radiograph, sonography, CT, MRI, urography, myelography, angiography	NA	37736 radiology examina-tions	Suspected malignancy	Major importance	395/37736 (1%)	In 351/395 (88.8%) patients further investigation was carried out	188 (47.6%) cases were malignant	The authors developed a system to ensure that incidental findings received adequate care
Xiong et al 2006 [16]	Medical record review	CT colonography	Diagnosis of colorectal cancer	225 patients	Extracolonic findings	Major importance	116/225 (53%)	All patients were followed (100%)	Confirmation in 24 patients (20.7%).	Resources consumed by an extracolonic finding approximately doubled the cost of diagnostic CTC
Morris et al 2006 [17]	Medical record review	Radiograph thorax	NA	10291 patients	Vertebral fractures	Major importance	Patients with incidental vertebral fracture: 142 (1.4%)	No	No	Fracture documentation was associated with an increased likelihood of starting an osteoporosis medication. It is impor tant to value these findings to improve osteoporosis management
Even-Sapir et al 2006 [18]	Experimental prospective	PET/CT	Known or suspected cancer	2360 patients	Malignancy	Major importance	151/2360 (6.4%)	115 (76.2%) patients were followed up	41(27.2%) malignancies were confirmed	Combination of PET and CT increases probability to define correctly incidental tumours
Shetty et al 2006 [19]	Medical record review	Thoracic and cervical CT	NA	NA	Abnormality in the thyroid gland	Moderate importance	230 patients	Follow-up: 100% (with thyroid sonography)	Confirmation of malignancy in 11.3%.	Sonography is a useful adjunctive test after the incidental detection of a thyroid abnormality on CT
Sebastian et al 2006 [20]	Experimental prospective	Chest CT	Patients with malignancy	385 patients	Pulmonary embolism	Major importance	10/385 (2.6%)	Follow-up in 2 (20%) patients	Confirmation in 2 (20%) patients	Formal review of pulmonary arteries during chest CT review in oncology patients is recommended
Bondemark et al 2006 [21]	Experimental prospective	Orthodontic panoramic radiographs	Patients randomly selected from an orthodontic clinic	496 patients	Orthodontic abnormalities	Minor importance	43/496 (8.7%)	No	No	The clinician should be aware of the potential to detect pathology and abnormality in pre-treatment orthodontic panoramic radiographs

Annex 1. Continued

Study, year, reference	Type of study	Techniques evaluated	Initial diagnosis	Sample	Incidental finding	Finding classification	Finding frequency	Follow-up	Clinical confirmation	Conclusions
Bruzzi et al 2006 [22]	Medical record review	PET/CT	Patients with non-small cell lung cancer	321 patients	Abnormalities without abnormally increased ^{18}F-FDG uptake	Minor importance	1231 abnormalities in 263 patients (82%)	No	No	Among patients with non-small cell lung cancer undergoing PET/CT, there is a high prevalence of CT abnormalities that may be clinically important
Bovio et al 2006 [23]	Experimental prospective	CT	Screening programme of lung cancer	520 patients	Adrenal masses	Moderate importance	23/520 (4.4%)	Follow-up in all the patients	Clinical confirmation in all the patients	Adrenal masses incidentally detected during CT scans are increasing. Definition of prevalence is a necessary requisite to achieve management strategies
Onuma et al 2006 [24]	Experimental prospective	Multidetector CT	Suspected coronary artery disease	503 patients	Non-cardiac findings	Major importance	292 (58.1%) patients.	114 (22.7%) patients with clinical or radiological follow-up	A total of 114 patients (22.7%) had clinically significant findings	Owing to the high number of non-cardiac findings by multidetector CT, car diologists and radiologists should work together to define them accurately
Weber et al 2006 [25]	Experimental prospective	MRI	Routine medical screening	2536 patients	Intracranial abnormalities: tumours, arachnoid cysts, vascular abnormalities	Major importance	166/2536 (6.5%)	1 (0.6%) patient had further work-up	Confirmation in 1 (0.6%) of the patients	Only a small percentage of the small abnormalities detected require urgent medical attention
Osman et al 2005 [26]	Experimental prospective	Unenhanced CT, PET, CT	Known or suspected cancer	250 patients	Renal mass, liver cirrhosis, abdominal aortic aneurysm, kidney lesion, sclerotic bone metastasis	Major importance	7/250 (3%)	4 (57.0%) patients underwent a PET/CT follow	Confirmation in 4 (57.0%) cases	Findings need to be analysed to prevent alterations in clinical management of these patients
Eskandary et al 2005 [27]	Experimental prospective	Brain CT	Multiple traumas	3000 patients	Bone lesion, calcification, arachnoid cyst	Minor importance	30/3000 (1%)	Follow-up in 100% patients	Confirmation in 100% patients	Prevalence of some incidental findings in head-injured patients detected by brain CT scans could be considered as representative of the general population
Liu et al 2005 [28]	Experimental prospective	CT urography	Haematuria	344 patients	Extraurinary findings	Major importance	259/344 (75.3 %)	39 (15.1%) patients had follow-up	Confirmation of high importance of 20 (7.7%) findings	Detecting extraurinary findings may be impor tant because significant morbidity and mortality may be prevented
Israel et al 2005 [29]	Medical record review	PET/CT	Known or suspected malignancy	4390 patients	Focally increased ^{18}F-FDG uptake	Major importance	58/4390 (1.3%)	Follow-up in 34 (59%) patients	11 (32%) patients were confirmed as having malignant tumours	Incidental focal ^{18}F-FDG uptake is significant in most patients. Adequate follow-up with invasive procedures and imaging results is necessary to determine malignancy of those diseases

Annex 1. Continued

Study, year, reference	Type of study	Techniques evaluated	Initial diagnosis	Sample	Incidental finding	Finding classification	Finding frequency	Follow-up	Clinical confirmation	Conclusions
Ishimori et al 2005 [30]	Medical record review	^{18}F-FDG-PET/CT	Known or suspected primary malignant lesions	1912 patients	New primary malignant lesions	Major importance	79/1912 (4.1%)	Follow-up in 40 (51%) patients	22 (27.8%) patients were pathologically confirmed	Besides the presence of false-positive results, the newly detected lesions have an excellent probability of cure because of their early stage
Majumdar et al 2005 [31]	Medical record review	Chest radiography	Chest radiography evaluation in emergency department	459 patients	Moderate to severe vertebral fractures	Major importance	72/459 (16%)	Follow-up in all patients	Findings were confirmed in 24% patients	As the population ages, the prevalence of osteoporosis is going to increase; it is essential to implement case-finding strategies for elderly people
Ares Valdés et al 2005 [32]	Experimental retrospective	Ultrasound, CT	Gastrointestinal symptoms	30 patients	Renal cell carcinoma	Major importance	6/30 (20%) cases	All patients were submitted to surgery, treatment and follow-up 60–120 months	Confirmation in 100% of the cases	Incidental renal cell carcinoma has a low incidence; conservative surgery is applied for incidental small renal masses and radical surgery is used for masses with large dimensions
Yee et al 2005 [33]	Experimental prospective	CT colonography	Colorectal cancer screening	500 patients	Extracolonic findings	Major importance	315/500 (63%)	Follow-up in 35 (31%) patients	13 (4.1%) findings were confirmed as clinically important	A substantial number of both average- and high-risk patients had extracolonic findings. Cost for work-up is low and does not increase patients' morbidity and mortality
Campbell et al 2005 [34]	Experimental prospective	Chest CT	Routine departmental protocol in patients with benign, indeterminate or malignant disease	148 patients	Extrapulmonary findings	Major importance	31/148 (20.9%)	No	No	Reports of incidental find ings in patients with non-malignant disease do not add any relevant information
Ng et al 2004 [35]	Experimental prospective	Abdominopelvic CT	Suspicious colorectal carcinoma	1031 patients (1077 cases)	Extracolonic findings	Major importance	261/1077 (24%)	344 findings: 156 (45%) underwent follow-up	133 (85%) cases were confirmed	Extracolonic findings detected on CT scans may help in staging colorectal cancer
Agress et al 2004 [36]	Experimental prospective	^{18}F-FDG PET	Known or suspected cancer	1750 patients	Unusual hypermetabolism localisation	Major importance	53/1750 (3%)	45 (85%) patients were followed up with CT, MRI	30 (71%) were either malignant or premalignant tumours; 9 proved benign and 3 represented false-positive findings	Results of this study emphasise the need for follow-up of these abnormalities because the majority represent either malignant or premalignant neoplasms
Kang et al 2004 [37]	Medical record review	Ultrasound	Patients referred for evaluation of thyroid gland	1475 patients	Thyroid nodules	Moderate importance	198/1475 (13.4%)	Follow-up: 100%	Confirmation of malignancy in 57 (28.8%) patients.	Occult thyroid cancers are a fairly common finding with ultrasonography. They can be used in the decision about optimal management strategies

Annex 1. Continued

Study, year, reference	Type of study	Techniques evaluated	Initial diagnosis	Sample	Incidental finding	Finding classification	Finding frequency	Follow-up	Clinical confirmation	Conclusions
Schragin et al 2004 [38]	Experimental retrospec-tive	Electron beam CT	Patients with a routine cardiac EBT scanning	1356 patients	Non-cardiac abnormalities	Major importance	278/1356 (20.5%)	Follow-up with CT in 57 (20.5%) of the patients	Confirmation by passive follow-up in all patients	With the relatively high detection of significant non-cardiac pathology in EBT, consideration should be given for radiologists to interpret the scans
Hellstrom et al 2004 [39]	Experimental prospective	CT colonography	Patients with known or suspected colorectal disease	111 patients	Extracolonic findings	Major importance	Moderate or major findings in 65 (58.6%) patients	Follow-up in 61 (97%) of the patients	Confirmation in 14 (13%) patients	The presence of unexpected findings must be taken into account when CT colonography is considered for routine diagnostic work-up or screening
Ginnerup Pedersen et al 2003 [40]	Experimental prospective	Multidetector CT colonography	Surveillance for former colorectal cancer or large bowel adenoma	75 patients	Extracolonic abnormalities	Major importance	49/75 (65%)	8 (12%) patients with additional work-up	Confirmation of the pathologies in the 8 (12%) patients	High prevalence of incidental findings makes multidetector CT a problematic screening tool. The authors emphasise the need for patients to be informed of the possibility of incidental findings and consequent additional work-up
Cai et al 2003 [41]	Experimental prospective	CT	Gastrointestinal disease	12021 patients	Thickened distal oesophagus, caecum, sigmoid colon or rectum	Major importance	117/12021 (1%).	67 (57.3%) had documented further endoscopic examination	81% of patients with thickening of the distal oesophagus, and 13% of patients with thickening of the caecum confirmed the abnormalities	Incidental findings of thickened luminal gastrointestinal organs on CT are not uncommon and warrant further endoscopic examination to determine significant abnormalities
Fitzgerald et al 2003 [42]	Experimental prospective	Ultrasound, MRI and CT	Pelvic pain, breast cancer staging, renal colic, vaginal bleeding	53 patients	Pancreatic masses	Major importance	7/53 (13.2%)	Follow-up in 100% patients	The diagnosis was confirmed in 7 (100%) patients	The identification of pancreatic incidentalomas appears to be increasing secondary to the broad application of high-resolution imaging
Hasegawa et al 2003 [43]	Experimental retrospective	CT pulmonary angiography	Suspected pulmonary embolism	163 patients	Tracheomalacia	Moderate importance	16/163 (10%)	No	No	Tracheomalacia is a relatively common incidental finding. Physicians must be careful reviewing central airways and pulmonary vasculature in patients with suspected pulmonary embolism
Ahmad et al 2003 [44]	Medical record review	Unenhanced helical CT	Flank pain suggestive of renal/ureteric colic	233 patients	Extrarenal/uteric findings	Major importance	28/233 (12%)	20/28 (71%) were followed up by surgical procedures, biochemical or biopsy evaluation	20/28 (71%) findings were confirmed	A wide variety of significant alternative or additional diagnoses can be reliably identified on unenhanced helical CT for suspected renal/ureteric colic

Annex 1. Continued

Study, year, reference	Type of study	Techniques evaluated	Initial diagnosis	Sample	Incidental finding	Finding classification	Finding frequency	Follow-up	Clinical confirmation	Conclusions
Brown et al 2001 [45]	Medical record review	MRI	Patients referred for equivocal mammographic findings	103 patients	Focal enhancing lesions on breast	Moderate importance	30/103 (29%)	Follow-up in 29 (96.6%) patients	Cancer confirmation in 1 (3.3%) patient	Focal enhancing lesions are unlikely to be malignant
Völk et al 2001 [46]	Experimental prospective	Contrast-enhanced hepatic spiral CT	NA	100 patients	Benign hepatic lesions	Minor importance	33/100 (33%)	21 (63.6%) patients were followed up with CT studies, MRI and percutaneous ultrasound	21 (63.6%) cases were confirmed	Benign hepatic lesions are relatively common on portal venous phase spiral CT
Messersmith et al 2001 [47]	Medical record review	Abdominal CT	Suspected nephrolithiasis	307 patients	Hiatal hernia, renal cysts, fatty liver, small pericardial effusion, ovarian mass, hepatic mass	Moderate importance	145/307 (47%)	11 (7.6%) cases were followed up with abdominal CT	Confirmation of all findings that none yield any serious disease	An incidental finding in CT scans done in the Emergency Department due to renal colic has a high rate, but the follow-up rate is low. Lack of resources does not allow further investigations
Weder et al 1998 [48]	Experimental prospective	Whole body FDG-PET	Evaluation of non-small cell lung cancer patients	100 patients	Extrathoracic metastases	Major importance	19/100 (19%)	All findings were followed up	Confirmation 100% histologically or radiologically	Whole body FDG-PET is an excellent method to detect extrathoracic metastasis
Iko 1986 [49]	Experimental prospective	Colangiography, ultrasound, CT	NA	107 patients	6 bilomas, 3 aberrant bile ducts, 3 hepatic and 3 subphrenic abscesses and 2 gastrobiliary fistulae	Moderate importance	17/107 (16%)	Follow-up in 100% patients	Confirmation in 100% patients	Cross-sectional imaging will clarify situations where confusing accumulations occur in cholangiography

CI, confidence interval; CTC, computed tomography colonography; EBT, electron beam tomography; ^{18}F-FDG-PET, 18F-fluorodeoxyglucose positron emission tomography; PET, positron emission tomography.