Patient-centered clinical impact of incidentally detected abnormalities on chest CT scans

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Purpose

With improved access, and the growing number of CT exams performed per patient, there is an increase in the number of incidental findings (IFs), (1). A CT scan incidental finding is any incidentally detected & previously unsuspected finding that is not related to the indication for the CT examination (2).

A significant literature already addresses IFs discovered in the course of clinical care or screening but there is no consensus on handling IFs in the research context (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 may cause a cascade of unintended consequences. Clinicians need to know how to manage these unexpected findings in order to avoid undesirable consequences (1).

Potentially important IFs were defined as any previously undetected findings requiring further medical follow up or investigation. If the findings from the additional studies required a change in management, it is recorded as a clinically important incidental finding (4). Most incidental findings have no proven clinical or prognostic significance, but a few have immediate clinical importance (5). The common occurrence of abnormal findings requiring referral or further investigations raises practical, ethical and medico-legal issues which need to be carefully considered (3).

The purpose of study was to demonstrate the spectrum of incidentally detected findings on chest CT scans and to evaluate the clinical impact of different significant abnormalities on patient management.
Methods and Materials

This study was approved by the institutional review board of the University of Washington Medical Center (UWMC). The requirement for informed patient consent was waived.

Cases Selection

CT scans of the chest were retrospectively reviewed using a search from the radiology information system (Z-vision Clario, Seattle WA) of UWMC to identify cases with uniquely different incidental findings (we excluded repeated findings). We were interested in demonstrating the wide spectrum of incidental findings, rather than tabulating the most common findings. Using the final written reports as truth, a total of 113 CT scans were retrospectively selected for the presence of 163 incidental findings of different anatomical & pathological distribution from a total of 364 incidental findings diagnosed within a period of 10 months between the first of January and the end of November 2012. There were 50 male and 63 female patients with an age range 18-96 years, and a mean age of 57.3 years. The clinical history was reviewed from the hospital information system to ensure that the indication for chest CT scan was not related to the incidentally detected finding.

Inclusion criteria included the spectrum of incidental findings on chest CT scans performed for adults >18 years, and with a proof of diagnosis. Exclusion criteria included children, and patients with no definite proof of diagnosis.

Proof of diagnosis

The incidental findings were reviewed retrospectively by the three authors, by consensus, (18, 6 and 27 years of experience) to confirm that they are correlated to the final radiology report which we used as the reference standard. The gold standard for diagnosis was by pathologic proof, especially for radiological suspicious malignant masses, by other diagnostic workup, and/or by stability on follow up CT scan to confirm benign lesions.

Data Interpretation

The spectrum of incidental findings was presented according to their anatomical location & their pathological classification.

From a patient-centered perspective, clinical significance was determined according to the need for further diagnostic workup and/or therapy, as judged by two radiologists (S.M. & W.S.). The management of the clinically significant cases was reviewed from the hospital information system to determine the impact of the diagnosis on the patient further management. They were categorized into two main pathological groups: group A (non-
malignant) & group B (malignant) to be correlated with age & sex. Patients were divided into two age groups: Group I (<50 years) and group II (≥ 50 years).

**Statistical analysis**

Data are analyzed, summarized, and classified. The number & percentage of the classified anatomical & pathological groups were calculated for the spectrum of IFs and for the clinically significant findings using a database worksheet (Excel, Microsoft). Age and sex in the clinically significant cases were correlated with their pathological distribution.
Results

The spectrum of the incidentally detected findings on chest CT scans of different anatomic & pathological distribution included 163 uniquely different IFs from 113 patients: 50 males (44.3%) and 63 females (55.7%) with an age range 18-96 years, and a mean age of 57.3 years. Seventy-two patients had multiple IFs.

Anatomical Distribution of the spectrum of the incidental findings on chest CT scans (Fig. 1 on page 10 & Table 1 on page 10):

The order of anatomical areas with IFs from the highest to the least frequent was: cardiovascular (n=29, 17.8%) > pulmonary (n=25, 15.3%) > bony (n= 16, 9.8%) > mediastinum (n=15, 9.2%) > chest wall soft tissue including breasts (n=12, 9.2%) > liver (n=10, 6.1%) > kidneys (n=8, 4.9%) > spleen (n=7, 4.3%) > lower neck (n=4, 2.5%). Intra-thoracic lesions were noted most commonly (n=89, 54.6%).

Pathological classification of the spectrum of IFs included (Table 1 on page 10 & Fig. 2 on page 11): 57 miscellaneous (35%), 36 congenital (22.1%), 23 benign (14.1%), 20 vascular (12.3%), 15 inflammatory (9.2%), and 12 malignant findings (7.3%).

From a total of 364 findings, 38 different findings were judged clinically significant (10.4%) requiring further workup and/or therapy in 9.6% (n=35) and 7.1% (n=26) respectively. The mean age of this clinically significant group was 56.1 years, and their age range was 18-81 years. They included 12 males & 26 females.

Anatomical distribution of the clinically significant group (Table 2 on page 12 & Fig. 3 on page 13):

The order of frequency of the anatomic areas with clinically significant findings from the most to the least frequent was: pulmonary (29%), mediastinum (18.4%), cardiovascular (15.8%), breasts (7.9%), liver, pleura & bony (5.2% for each), and tracheobronchial tree & peritoneum (2.7% for each). Again, intra-thoracic clinically significant IFs were noted most commonly (n=27, 71.1%).

Table 2 on page 12 & Fig. 4 on page 14 showed the pathological classification of the clinically significant findings: 12 malignant (31.6%), 9 miscellaneous (23.7%), 7 benign (18.4%), 5 inflammatory (13.2%), 4 vascular (10.5%), and one congenital finding (2.6%).
They were divided into two main pathological groups: Group A=non malignant (n=26, 68.4%) e.g. Fig. 6 on page 15 & Fig. 7 on page 16 and group B=malignant (n=12, 31.6%) e.g. Fig. 8 on page 16, Fig. 9 on page 17, Fig. 10 on page 17 & Fig. 11 on page 18. The 12 malignant findings of different pathological and anatomical distribution represented 7.3% of the spectrum of 163 IFs and 3.3% of the total 364 IFs.

**Correlation of the clinically significant cases with age and sex:**

Cases were divided into two age groups: Group I (<50 years) including 13 patients (34.2%) & group II (≥50 years) including 25 patients (65.8%), (Fig. 5 on page 15 A). Malignant findings were more in group II (n=12, 92.3%) than group I (one case, 7.7%). The non-malignant group included 12 (46.2%) & 14 cases (53.8%) from groups I & II respectively. The non-malignant findings were the most frequent in both age groups.

IFs in the non malignant group A were more common in both males & females than the malignant group B, (Fig. 5 on page 15 B). Females were more prevalent in both groups A (n=19) and B (n=7) than males (n=7) and (n=5) respectively.

**The impact on the management of the clinically significant cases included (Table 2 on page 12):**

*The cases which needed further diagnostic workup (n=35, 21.5% of the 163 different findings & 9.6% of the total 364 IFs): Twenty-two findings needed follow up by chest CT scan either to ensure stability or to assess treatment. Diagnosis of 13 findings were confirmed or followed by further imaging modalities such as x-rays, ultrasound, cardiac MRI, PET-CT, abdominal CT, and sono-mammography. Pathologic proof was obtained in 20 of the significant findings (including all radiological findings with suspicious malignancy) either by biopsy, postoperative, or by diagnostic intervention as thyroid-FNA, arthrocentesis, bone marrow aspiration, or pleural fluid analysis.

*Those which needed clinical therapy (n=26, 16% of the 163 different findings & 7.1% of the total 364 IFs findings) including therapeutic interventional procedures as cardiac defibrillator and pleural fluid drain (n=2), medical (n=14), surgical (n=13), or multi-therapy.
**Fig. 6**: Left hilar mass (A & B) proved to be solitary mediastinal fibrous tumor in a female 21yo C/O cough.  
*References*: Department of Radiology, UWMC, Washington University - WA/USA

**Fig. 7**: Mildly hypodense hepatic FNH detected on chest CT scan (A) in a female 45yo C/O post stem cell transplant lung infection, confirmed by abdominal MRI in pre-contrast (B) & post-contrast arterial (C), venous (D) and 20 minutes (E) phases.  
*References*: Department of Radiology, UWMC, Washington University - WA/USA
Fig. 8: Lung ground glass opacities (A) and nodules (B & C) proved to be multiple Bronchiolo-alveolar carcinoma in a female 82yo performing chest CT scan for surveillance of cancer colon.  
References: Department of Radiology, UWMC, Washington University - WA/USA

Fig. 9: Lung adenocarcinoma detected as small ground glass opacity (A) with adjacent cyst (B) in female 59 yo performing chest CT scan for assessment of dilated aorta.  
References: Department of Radiology, UWMC, Washington University - WA/USA

Fig. 10: Lung mass proved to be spindle cell sarcoma seen on chest CT scan (A) performed following a motor vehicle accident in a male 57yo & was seen hot on PET CT scan (B).  
References: Department of Radiology, UWMC, Washington University - WA/USA
**Fig. 11**: Breast cancer mass not detected in first CT scan (A) in a female 67 yo and progressed on follow up chest CT scan (B) performed after 10 months for follow up of interstitial lung disease.

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Table 1: Spectrum of the 163 incidentally detected findings on chest CT scans

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Anatomical distribution of the spectrum of incidental findings

Fig. 1

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Fig. 2

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Table 2: Clinically significant cases with impact on the patient management

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Fig. 3

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Fig. 4
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Fig. 5
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**Fig. 6:** Left hilar mass (A & B) proved to be solitary mediastinal fibrous tumor in a female 21yo C/O cough.

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Fig. 11: Breast cancer mass not detected in first CT scan (A) in a female 67 yo and progressed on follow up chest CT scan (B) performed after 10 months for follow up of interstitial lung disease.

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Conclusion

We demonstrated the wide spectrum of incidentally detected findings (IFs) of different anatomical & pathological distribution on chest CT scans. The frequency of common IFs have been previously studied (1, 6, 2). We also evaluated the impact of the clinically significant IFs on the patient management. From a total of 364 incidental findings, 38 different incidental abnormalities (10.4%) were judged clinically significant requiring further workup and/or therapy in 9.6% and 7.1% respectively. They represented 23.3% of the spectrum of different incidental findings.

A wide variation exists in the percentage of findings that qualify as clinically significant. The percentage of patients with at least one clinically significant finding varies from 2.8% to 45.6% (7, 8). Some studies include all findings that require additional diagnostic workup, while others mention only those findings that need immediate therapeutic impact. No standardized guidelines for the management of incidental findings exist. According to Killeen et al (9), the most prudent strategy is to individualize further evaluation. Hall et al (10) detected that 24% of incidental findings required diagnostic follow up. Jacob et al (11) suggested that the first issue is to recognize IFs, and then to decide which are important to justify further investigations. They found that the prevalence of IFs requiring additional investigations was found to be 7.7 and 14.2% of patients undergoing chest CT scans for coronary artery disease or lung cancer, respectively.

Aldington et al (3) found that IFs were not limited to the respiratory system, with about half of the findings detected being extra-pulmonary. Our results showed that the intra-thoracic lesions represented 54.6% of the spectrum of IFs and 71.1% of the clinically significant group. The total studied population with IFs included 3.3% malignant abnormalities. Failure to recognize important subtle lesion on CT scan may lead to a false reassurance & delay in diagnosis resulting in a poorer prognosis. The malignant IFs represented the lowest % among the spectrum (7.3%) but the highest in the clinically significant group (31.6%) as compared to other pathological groups. The clinically significant findings were highest in the older age group ≥ 50 years (65.8%), and the malignant IFs (92.3%). Our findings are in agreement with Aldington et al (3) who also found that older age was associated with increased risk of a CT scan respiratory incidental abnormality requiring referral or further investigation.

Clinically significant IFs included the diagnosis and/or treatment of urgent or acute conditions, of suspicious malignant masses, the primary prevention of long term complications (as premature atherosclerosis, and valve calcifications), the avoidance of diagnostic confusion on follow up CT or other imaging modality (as hiatus hernia, and right aortic arch), and the confirmation of lesion stability on follow up study. Hiatus hernia could mimic a mass in the left atrium on trans-thoracic echo, so it is good reason to describe it in
the report (12). Although cardiac abnormalities may not have implications in acute clinical management, they may be, nonetheless, important in long term care. Reporting these cardiac findings may influence primary prevention of atherosclerotic events. Reporting of cardiomegaly may trigger further cardiac investigations & treatment (13). Interatrial lipomatous hypertrophy has also been associated with atrial arrhythmia & pulmonary emphysema (14).

The limitations of our study include the lack of calculation of the frequency of individual findings, though this was purposefully not a concern in this study. We also did not perform a cost/benefit analysis of the impact of IFs.

**We conclude** that from a patient-centered perspective, clinically significant IFs (10.4%) needing further diagnostic workup and/or therapy were noted in (9.6%) and (7.1%), respectively. Malignant cases represented 3.3% of the total group and 31.6% of the clinically significant group. Detection of the clinically significant incidental abnormalities on chest CT scans are profoundly important for optimal patient care.
References


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