

The incidental pulmonary nodule in a child

Part 2: Commentary and suggestions for clinical management, risk communication and prevention

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Abstract The incidental detection of small lung nodules in children is a vexing consequence of an increased reliance on CT. We present an algorithm for the management of lung nodules detected on CT in children, based on the presence or absence of symptoms, the presence or absence of elements in the clinical history that might explain these nodules, and the imaging characteristics of the nodules (such as attenuation measurements within the nodule). We provide suggestions on how to perform a thoughtfully directed and focused search for clinically occult extrathoracic disease processes (including malignant disease) that may present as an incidentally detected lung nodule on CT. This algorithm emphasizes that because of the lack of definitive information on the natural history of small solid nodules that are truly detected incidentally, their clinical management is highly dependent on the caregivers' individual risk tolerance. In addition, we present strategies to reduce the prevalence of these incidental findings, by preventing unnecessary chest CT scans or inadvertent inclusion of portions of the lungs in scans of adjacent

body parts. Application of these guidelines provides pediatric radiologists with an important opportunity to practice patient-centered and evidence-based medicine.

Keywords Chest · Computed tomography · Fleischner criteria · Pediatric · Incidental findings · Lung · Lung cancer · Lung nodule

Introduction

“Medicine is a science of uncertainty and an art of probability.”

— William Osler (1849–1919).

The question of how to practically manage incidentally detected pulmonary nodules fits within the broader issue of

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how to handle incidental findings (incidentalomas) that are increasingly identified in children as a result of a higher reliance on advanced cross-sectional imaging studies [1–4]. This issue, as it pertains to the adult population, has received attention in the lay news media [5–7] and in a recent bioethical directive by the Obama administration [8] and is only recently being formally recognized by the profession and addressed in review articles [3, 9]. Yet the detection of incidentalomas occurs with relative frequency in children as well (mainly adrenal [10] and pulmonary in origin [11]), presumably related to the increase in the use of pediatric CT in recent years [12, 13]. This, in combination with recent rapid technological advances in CT, has allowed for the routine detection of lung nodules as small as 1–2 mm on scans that cover all or part of the chest [11, 14].

Risks are inherent to both too much and too little attention to incidentally detected findings on advanced cross-sectional imaging studies. Legal authorities argue that in our era of patient-centered care, characterized by shared-informed decision-making, there is really no place for the older paternalistic approach by treating physicians to dismiss or ignore incidental findings [1, 2, 8]. Along similar lines, one could argue that it is no longer appropriate for radiologists to simply describe a pulmonary nodule that is incidentally detected without providing guidance on how to manage it. By abetting in and facilitating the increased use of CT for indications that did not exist 20 years ago, we have indirectly helped create this problem, and we believe our profession is now ethically obligated to help develop a solution [11].

Although it is usually the responsibility of the patient's personal physician to directly communicate with the family and to determine further care, the radiologist is likely to have greater experience in the management of incidentally detected pulmonary nodules. Sharing such experience by providing suggestions for follow-up is likely to be appreciated by the referring physician, and may well lead to improved patient care.

Clinical management

With the exception of the discussion following a case report of a benign lung nodule in the French literature [15] and the above-referenced book chapter [11], there is a lack of published clinical guidelines that are truly and scientifically evidence-based for the management of an incidentally identified pulmonary nodule in a child. In a recent retrospective study of 62 children with lung nodules incidentally detected on a total of 7,912 abdominal CT scans performed over 7 years at a large children's hospital [16], of the 31 children who had CT follow-up only two were found to harbor malignancy, and both had a history of underlying extrapulmonary malignant disease. This fact exposes a weakness of this study, since by including these patients in their study group, these authors used a broad definition of an "incidental pulmonary nodule on CT." Tellingly, in none of the remaining

31 children, who had no history of extrapulmonary malignancy and who had no CT follow-up, was a malignancy detected on clinical follow-up. Based on this, the authors suggested that follow-up CT is not needed in incidentally detected lung nodules in children in the absence of a history of malignancy [15]. Despite the findings of this single retrospective study, the identification of a solid nodule in a child without a history of malignancy not having the characteristics of an intrapulmonary lymph node remains a vexing situation. Should the child be screened for a clinically occult malignancy? Should the child be evaluated for granulomatous disease or other non-neoplastic process that can be associated with solid pulmonary nodules? If the nodule is incidentally identified in a lung base included on an abdominal CT, should the remainder of the lungs be imaged by a complete chest CT or a chest radiograph?

A potentially more effective way to address these questions would be to develop estimates of the likelihood that a child would have a previously undetected primary extrapulmonary malignancy that would present with a metastatic lung nodule on a CT scan performed for unrelated reasons. Reasonable risk estimates could be placed on the different outcomes of this scenario, and risk/benefit ratios may be calculated. Based on the outcome of this risk analysis, one could propose to the family an approach of "watchful waiting" (which may not include any follow-up imaging) after consideration of the following (adapted, with permission, from [11]):

- (1) Is the child otherwise healthy, growing and developing well, or is there any significant weight loss, hemoptysis, respiratory distress, lymphadenopathy or paraneoplastic syndrome that persists after the acute illness or trauma that precipitated the CT scan resolves?
- (2) Does the history and physical exam reveal anything more than what would be expected from the chief complaint that prompted the CT scan?
- (3) What is the pre-test probability, e.g., does the child live in an endemic area for pulmonary granulomatous disease? Does the child have a known history of aspiration, immunodeficiency, or an extrapulmonary malignancy? This may be supported by a basic clinical workup for infectious/granulomatous disease, immune disorder and screening for occult oncological disease. For the latter, if an imaging test is believed to be indicated, we might consider one that does not use ionizing radiation and that is age-appropriate (e.g., a screening abdominal US to rule out an occult Wilms tumor in a child younger than 5 years).
- (4) Has there been a pertinent history of travel, exposure or inhalation?
- (5) Can the family commit to a plan of watchful waiting, and is the family reliable to present for scheduled follow-up?

Figure 1 summarizes a conceptual framework that is helpful in the diagnostic management of a lung nodule detected on

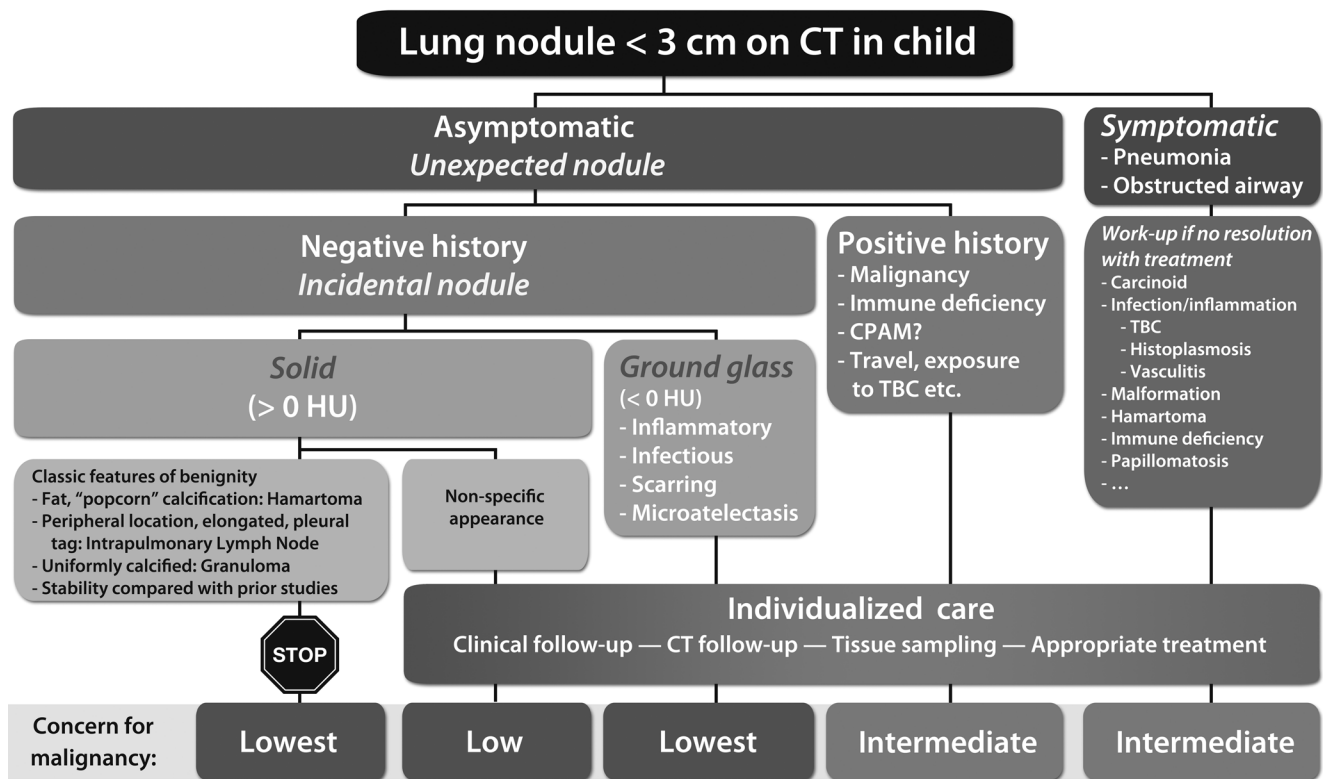


Fig. 1 Flow chart illustrates a conceptual framework for the diagnostic management of a lung nodule measuring up to 3 cm in diameter on CT in a child. Note that this is not a classic flowchart algorithm for mutually exclusive categories. It indicates that our suggested general management strategy is identical for all categories (with the exception of a classic

benign nodule), namely individualized care, as influenced by our differential post-test level of concern for malignancy (displayed as being connected by vertical lines to the appropriate category), and by the degree of tolerance for risk of the caregivers

CT in a child. Please note that although this diagram has the appearance of a flow chart or algorithm, with a few exceptions all branches of this chart lead to the same recommendation to provide individualized care guided by the post-test level of concern that the nodule may be malignant, and by the degree of tolerance for risk of the child’s caregivers, the referring physician and the interpreting radiologist.

Communication with the family

The appropriate mechanism for communicating directly with the family depends on the individual radiologist, referring physician and local care paradigm. When engaging in a discussion with a family in whom a child was diagnosed with (an) incidental pulmonary nodule (s), especially when any degree of cancer phobia is detected in that family, a balanced discussion of the merits and potential harms of imaging follow-up might include an attempted individual estimate of the cancer risk from diagnostic CT [17–19] vis-à-vis a projection of the risk that the nodule (s) may represent an early manifestation of a pulmonary (or, more likely, extrapulmonary) malignancy. The latter risk, as was discussed in part 1 of this review, is currently unknown but is projected

to be extremely low. In addition to the potential radiation risk, the risk of percutaneous biopsy or thoracoscopic surgery (as well as that related to sedation or anesthesia) may be discussed, as appropriate, in case a decision is made to proceed to tissue sampling of the nodule (s) in question. The careful conduction of such a discussion and the documentation of the understanding of the risks and benefits of follow-up with CT satisfy the requirement of informed decision-making as advocated by the Image Gently campaign and other authorities [20–23]. Physicians who engage in such discussions with parents and other caregivers should be familiar with the principles of risk communication [24–27]. The anxiety caused by the communication to parents that “something abnormal” (such as an incidental lung nodule) was found while scanning their child may be magnified in families who have experienced a diagnosis of lung cancer — perhaps by one of the CT screening studies now being advocated for older adults with risks factors. They might respond differently to hearing about risk that is perceived to be immediate (i.e. “we cannot rule out that this lung nodule is an early lung cancer”) vs. one that occurs in the distant future (“repeated CT scans to follow up this nodule might cause cancer in 20 years”), irrespective of the relative magnitudes of the risks that are communicated. There will be families who cannot tolerate the anxiety associated with any degree of

uncertainty and opt for immediate resolution (“when it is abnormal take it out now”); others will opt for imaging follow-up (“how often will my child need to be scanned to be sure?”); and yet others might agree with a plan for watchful waiting without follow-up imaging. No matter what the outcome of this discussion and irrespective of our own opinions on this matter as health care providers, it befits the modern paradigm of personalized medicine and informed decision-making to respect the decision of the family as an exercise of patient autonomy [28, 29]. The careful and ethical conduction of such a consultation with the family is, therefore, more an art than a science [30], and needs to be properly recognized as valuable and accountable care that radiologists may engage in within the future financial structure of the health care system [31].

Prevention

A more fundamental way to address this problem is to lower the frequency of incidentally detected lung nodules by discouraging the use of chest CT for unproven clinical indications [4, 32–35] through the rigorous justification of CT [36]. Examples of this are the substitution of chest CT by radiography [37] or fast MRI [38, 39] for the evaluation of minor chest wall deformities [40] such as pectus excavatum. In the care of the multi-trauma patient who sustained blunt injury to the torso, the omission of the routine chest CT from the initial total body scan has been shown not to influence patient management or outcomes, because (with the exception of suspected traumatic aortic injury) all clinically relevant chest injuries are adequately demonstrated on the upper slices of the abdominal scan acquisition [33, 41, 42]. Chest CT has been shown to have the highest yield in influencing patient management in certain congenital heart conditions, congenital lung malformations, febrile neutropenia, screening for pulmonary metastases, bronchiectasis and certain diffuse lung diseases [34], but it has less influence in focal parenchymal and pleural diseases in otherwise healthy children.

The value of chest CT for the characterization of diffuse lung diseases when no biopsy is indicated has been questioned [43], but some diffuse lung diseases such as bronchiolitis obliterans and neuroendocrine hyperplasia of infancy have highly specific CT findings that obviate the need for lung biopsy, and others such as the genetic disorders of surfactant metabolism can be suspected on the basis of CT findings and thereby prompt appropriate referral for genetic testing [44]. In all other situations, the omission of chest CT when not clinically indicated and the continued reliance on radiography should, apart from its cost- and radiation-saving aspects, also decrease the frequency of incidentally detected pulmonary nodules.

A second strategy to reduce the frequency of incidentally detected lung nodules is to inform parents of the risk of this

possibility as part of an informed consent process prior to performing a chest CT, as has recently been proposed [8, 45]. This approach remains controversial even in adults, because the perceived risk may be much larger than the actual risk. In addition, such an approach has more impact in the adult population, where incidentalomas are far more prevalent than in children; the approach might occasionally be of value when a pediatric practitioner contemplates a scan merely for medicolegal reasons or because he or she succumbs to excessive pressure from parents or clinicians.

A more rewarding strategy to follow, when the decision has been made that a CT scan is indicated, is to purposefully avoid scanning (parts of) the lungs when adjacent regions are scanned. For instance, when abdominopelvic CT is done to evaluate for a localized disease process, such as appendicitis or renal stones, the lung bases need not routinely be included. When upper extremities are scanned, the inadvertent inclusion of the lungs within the field of view can be avoided by raising the extremities. Such strategies avoid causing potential harm by “looking in the wrong places” [46], but they require pediatric imagers to carefully adhere to a focused, problem-oriented approach that has traditionally distinguished our subspecialty from the “rule-out” and “early detection through screening” mindset that prevails in adult medicine. More to the point, this requires us to have a more active role in the protocolling of studies and the real-time reviewing of preliminary findings when our patients are on the scanner, to decide whether the clinical question has been adequately addressed, or whether there is an indication to extend the scan coverage over adjacent regions such as the chest. In this sense, pediatric imagers have a unique opportunity more than in any other field of radiology to practice personalized, patient-centered medicine, in which these decisions are rooted in principles of cost-effectiveness, beneficence and evidence-based practice rather than in a futile quest for absolute certainty in all clinical scenarios [47].

Conclusion

Because of the lack of definite information on the natural history of small lung nodules that are truly detected incidentally on a CT scan in a child, no general guidelines for the management of these nodules can be formulated. Therefore management should be individualized, dependent on the risk tolerance of the caregivers. Elements to consider include the presence or absence of symptoms and clues in the clinical history that may explain these nodules, as well their imaging characteristics. A focused search for clinically occult extrathoracic disease processes (including malignant disease), immune deficiency and granulomatous disease may also be indicated. In order to lower the frequency of incidentally detected lung nodules in children, careful thought should be

paid to preventing unnecessary chest CT or inadvertent inclusion of parts of the lungs in scans of adjacent body parts.

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