

A Mediastinal Mistake

Dina M. Nassar, MD, MSc,^{a,b} Priya Narayanan Jain, MD^{a,b}

A 12-month-old boy with no significant medical history was transferred from a referring hospital to our facility with 3 days of nasal congestion, dry cough, and fever. His mother reported that the highest temperature measured at home was 37.9°C. The patient was afebrile on initial presentation to the referring hospital, and his examination was notable for clear nasal discharge with a normal respiratory examination result. There was no increased work of breathing and no decreased breath sounds or abnormal lung sounds on examination. The patient was noted to be well appearing, smiling, and interactive.

A chest radiograph (CXR) was performed at the referring hospital, which showed a relatively dense opacity in the left upper lobe extending to the apex. Although the pediatric radiologist who read this image noted that the increased density in the left lung apex could represent the thymus, a paraspinal process could not be excluded because of the lack of visualized lung markings (Fig 1). Of note, the opacity also could not be visualized on a lateral view, making the differential between anterior, middle, and posterior pathologies more difficult. Because of this uncertainty, and the varying gravity of mediastinal pathologies, further evaluation with computed tomography (CT) or MRI was recommended.

After discussion with the medical team and the parents, and because of the possibility that additional evaluation with a pediatric hematology-oncology team may be needed, the decision was made to transfer the patient to our facility, a tertiary-care children's hospital, for further management.

On arrival to our institution, the patient appeared well with no signs of distress and stable vital signs. The patient had blood work, including a complete blood count and basic metabolic panel, which was unremarkable. Inflammatory markers showed a normal C-reactive protein of 0.1 and an elevated erythrocyte sedimentation rate of 26, which was attributed to the patient's viral illness. The decision was made before proceeding with a CT to obtain a repeat CXR. On repeat imaging, an opacity was again visualized in the left upper lobe (Fig 2). Because of the alignment of both reads (both read by pediatric radiologists) and continued concern for pathology, a CT of the chest without contrast was performed on the night of admission.

This showed that the opacity seen on chest radiography corresponded to the thymus. There was no mediastinal mass. The patient was discharged on hospital day 2 with a presumed viral illness. Of note, the patient did not require any respiratory interventions during his hospitalization.

DISCUSSION

In reviewing this case, 1 of the most important questions it raises is the utility of diagnostic imaging in the pediatric population. Any time a young child presents with symptoms of fever and cough, pneumonia should be included in the differential diagnoses. Although a CXR can be considered to assess for pneumonia, it should be used only when

www.hospitalpediatrics.org

DOI:<https://doi.org/10.1542/hpeds.2019-0082>

Copyright © 2019 by the American Academy of Pediatrics

Address correspondence to Priya Narayanan Jain, MD, Children's Hospital at Montefiore, 3411 Wayne Ave, 8th Floor, Bronx, NY 10467.

E-mail: pjain@montefiore.org

HOSPITAL PEDIATRICS (ISSN Numbers: Print, 2154-1663; Online, 2154-1671).

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

Dr Nassar drafted the initial manuscript and reviewed and revised the manuscript; Dr Jain reviewed and revised the manuscript; and both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

^aChildren's Hospital at Montefiore, Bronx, New York; and ^bDepartment of Pediatrics, Albert Einstein College of Medicine, Bronx, New York



FIGURE 1 Initial anteroposterior CXR (left). Note the opacity in the left upper field. A lateral view (right) is also shown. Note that opacity is not visualized with this view.

clinically indicated. Literature has shown that there are certain clinical signs that increase or decrease the likelihood of a child having pneumonia.¹⁻⁵ If these signs, such as respiratory rate, work of breathing, and auscultation examination results, are normal, a radiograph result is unlikely to be positive for pneumonia.^{2,4,5} Hypoxia (oxygen saturation $\leq 92\%$) has been shown to be the strongest predictor of pneumonia.⁵ For our patient, 3 days of relatively mild symptoms in combination with his benign pulmonary examination, normal oxygen saturation, and lack of fever and the findings described above should likely not have been an indication for a CXR.

Although there is no standardized algorithm to determine if a CXR is needed when evaluating a child for a respiratory illness, it is not clear in this case why the clinician ordered a CXR for our patient. It is possible that the clinician who initially evaluated the patient at the referring (nonpediatric) emergency department was not as comfortable or familiar with providing medical care to a pediatric patient. As a result of this unfamiliarity, a CXR was likely ordered to aid in final diagnosis.

Risks of Radiation

For our patient, an unnecessary CXR led to an unneeded admission with more interventions, including a chest CT. Exposure

to radiation is not without its own risks, and this is especially true in the pediatric population, in which children are still growing and developing. CT radiation can increase the incidence of DNA damage, ultimately making an individual more vulnerable to developing cancer.⁶⁻⁸ Children are particularly susceptible because of their smaller stature and lower shielding capacity, which means that the same dose of radiation can affect a child's internal organs more so than an adult's.^{6,8} Numerous studies have shown that there is an increased risk of leukemia and solid cancers after high-dose radiation.⁶⁻⁹ One retrospective cohort study spanning >20 years with a sample size of 176 587 children showed that in the 10 years after an initial CT for patients <10 years old, 1 excess case of leukemia and 1 excess case of brain tumor per 10 000 patients was reported.⁹ It is important, therefore, that this knowledge factor into a physician's decision when determining whether imaging is warranted in a particular case.

Hidden Harms of Workup

This case highlights more than just the objective effects of unnecessary imaging. While placing an intravenous line, getting bloodwork, and obtaining imaging may be considered more routine in adult practice, one cannot undervalue the psychological stress and effects of this on a young child. When children are taken out of their homes and daily lives and confined to a hospital, even for a short period of time, there can be a tremendous amount of both physical and emotional stress.¹⁰⁻¹² Anxiety, sleep problems, nightmares, fear, and confusion are some of the most commonly seen responses children may have to their hospitalizations.¹⁰ Furthermore, these effects are not limited to the children; literature has shown that hospitalizations can cause stress on the families and caregivers as well.¹⁰⁻¹² In our case, the patient's parents faced extreme anxiety and fear that their son may have an oncologic process. This was amplified by the fact that almost 20 hours passed at our institution before the CT was obtained. Multiple discussions with the family throughout their first day of hospitalization showed their



FIGURE 2 Repeat CXR, anteroposterior view (left). Again, note the opacity in the left upper aspect. Also shown is a repeat CXR, lateral view (right).

frustration and worry. Although the medical team was ultimately able to relieve these fears, it could have been an avoidable situation.

Cost-effectiveness

No discussion of medical imaging would be complete without a brief discussion on cost-effectiveness. For our patient, the need for further evaluation led to an interfacility transfer, 2-day hospitalization, repeat CXR, bloodwork, and CT, ultimately leading to additional hundreds, if not thousands, of dollars in medical expenses.

Operational quality, or the idea that system improvements can increase efficiency and promote higher-value care while reducing costs, is an important topic to consider.¹³ For our patient, this could have been applied if decisions had been made differently during his initial presentation. Although no patient should be denied a necessary medical test or image study if clinically needed, it is important for clinicians to consider the possible downstream effects and potential costs of seemingly benign interventions.

CONCLUSIONS

Acute respiratory illnesses are among the most common reasons children are taken to see a physician during infancy.¹ Although it can be difficult in large, urban centers, where increasing patient populations have resulted in time limitations, and where radiography is readily available, there are numerous factors that should be taken into consideration before obtaining imaging. Most important is to evaluate on a case-by-case basis on the basis of a patient's particular history and physical examination findings. This information can be used for risk stratification, to evaluate children for likelihood of radiographic findings, and to determine who could benefit from imaging.⁵ With this patient, CXR was not indicated given his well appearance, benign symptoms, and normal respiratory examination results and can be considered an error of commission. Without clinically significant findings that would indicate a more serious underlying respiratory illness,

such as pneumonia, this patient had little to no benefit from imaging. Unneeded imaging studies have the potential for more harm, especially when incidental findings lead to a cascade of medical interventions. Overuse frequently exposes patients to unnecessary radiation, and the effects of this can be considered a growing public health issue given the existing high usage of these more advanced imaging modalities and the associated costs.^{7,14} In the case of our patient, there were multiple times along the process when steps could have been taken to reduce medical intervention. If the patient had presented with hypoxia, for example, that would have been a stronger factor in support of obtaining imaging. If the patient had presented with a fever for 5 days or more, this could also have indicated a more serious pathology warranting imaging. Furthermore, a discussion about less invasive imaging modalities, such as chest sonography, could have been had. There is no easy answer to the issue of overuse of imaging in the medical field. Greater use of practice guidelines is perhaps 1 way to counter this and is something that should continue to be researched and developed across medical institutions.

REFERENCES

1. Margolis P, Gadomski A. The rational clinical examination. Does this infant have pneumonia? *JAMA*. 1998;279(4):308–313
2. Wipf JE, Lipsky BA, Hirschmann JV, et al. Diagnosing pneumonia by physical examination: relevant or relic? *Arch Intern Med*. 1999;159(10):1082–1087
3. Hazir T, Nisar YB, Qazi SA, et al. Chest radiography in children aged 2–59 months diagnosed with non-severe pneumonia as defined by World Health Organization: descriptive multicentre study in Pakistan. *BMJ*. 2006;333(7569):629
4. Shah SN, Bachur RG, Simel DL, Neuman MI. Does this child have pneumonia?: the rational clinical examination systematic review [published correction appears in

- JAMA*. 2017;318(13):1284]. *JAMA*. 2017;318(5):462–471
5. Neuman MI, Monuteaux MC, Scully KJ, Bachur RG. Prediction of pneumonia in a pediatric emergency department. *Pediatrics*. 2011;128(2):246–253
6. Miglioretti DL, Johnson E, Williams A, et al. The use of computed tomography in pediatrics and the associated radiation exposure and estimated cancer risk. *JAMA Pediatr*. 2013;167(8):700–707
7. Shi L, Tashiro S. Estimation of the effects of medical diagnostic radiation exposure based on DNA damage. *J Radiat Res (Tokyo)*. 2018;59(2,suppl 2):ii121–ii129
8. Krille L, Zeeb H, Jahnen A, et al. Computed tomographies and cancer risk in children: a literature overview of CT practices, risk estimations and an epidemiologic cohort study proposal. *Radiat Environ Biophys*. 2012;51(2):103–111
9. Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. *Lancet*. 2012;380(9840):499–505
10. Rokach A. Psychological, emotion, and physical experiences of hospitalized children. *Clin Case Rep Rev*. 2016;2(4):399–401
11. Commodari E. Children staying in hospital: a research on psychological stress of caregivers. *Ital J Pediatr*. 2010;36:40
12. Coon ER, Quinonez RA, Moyer VA, Schroeder AR. Overdiagnosis: how our compulsion for diagnosis may be harming children. *Pediatrics*. 2014;134(5):1013–1023
13. Sachdeva RC, Jain S. Making the case to improve quality and reduce costs in pediatric health care. *Pediatr Clin North Am*. 2009;56(4):731–743
14. Hendee WR, Becker GJ, Borgstede JP, et al. Addressing overutilization in medical imaging. *Radiology*. 2010;257(1):240–245

A Mediastinal Mistake

Dina M. Nassar and Priya Narayanan Jain

Hospital Pediatrics 2019;9;919

DOI: 10.1542/hpeds.2019-0082 originally published online October 16, 2019;

Updated Information & Services	including high resolution figures, can be found at: http://hosppeds.aappublications.org/content/9/11/919
Supplementary Material	Supplementary material can be found at:
References	This article cites 14 articles, 3 of which you can access for free at: http://hosppeds.aappublications.org/content/9/11/919#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): Hospital Medicine http://www.hosppeds.aappublications.org/cgi/collection/hospital_medicine_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.hosppeds.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.hosppeds.aappublications.org/site/misc/reprints.xhtml

Hospital Pediatrics®

AN OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

A Mediastinal Mistake

Dina M. Nassar and Priya Narayanan Jain

Hospital Pediatrics 2019;9:919

DOI: 10.1542/hpeds.2019-0082 originally published online October 16, 2019;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://hosppeds.aappublications.org/content/9/11/919>

Hospital Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Hospital Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2019 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

