

CLINICAL AND DIAGNOSTIC EVALUATION OF THE INAPPROPRIATENESS OF CHEST RADIOGRAPHY WITHIN THE FIRST 24 HOURS IN CHILDREN WITH SUSPECTED PNEUMONIA

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Abstract. Pneumonia in children remains one of the most significant problems in modern pediatrics due to its high prevalence and the risk of complications associated with delayed diagnosis. Chest radiography is widely used as a standard imaging method for confirming the diagnosis; however, its use in the early stage of the disease may have limited diagnostic value and contribute to unnecessary radiation exposure.

Classically, four stages of lobar pneumonia are distinguished: congestion, red hepatization, gray hepatization, and resolution. In the early stage (congestion stage), morphological changes in lung tissue are minimal, which limits the diagnostic performance of radiographic imaging.

To evaluate the diagnostic appropriateness of chest radiography performed within the first 24 hours in children with suspected pneumonia and to assess the benefits of delayed imaging in reducing radiation exposure.[1]

The study was conducted at City Polyclinic No. 3 in Shymkent. Radiological data from five children aged 1–3 years with clinically confirmed pneumonia were analyzed. Chest radiography was performed on the first day of illness and repeated on the third day. Additionally, a questionnaire survey of 10 general practitioners was conducted to assess clinical decision-making and awareness of radiation exposure.[2]

On the first day of illness, no radiological abnormalities were detected in 100% of patients despite clinical signs of pneumonia. On the third day, all children (100%) demonstrated radiological features consistent with inflammatory changes in the lungs. Repeated imaging resulted in a twofold increase in cumulative radiation exposure. According to the survey, 70% of physicians prescribe chest radiography within the first day of illness, while only 40% are aware of its limited diagnostic value in early disease stages.

Thus, chest radiography performed within the first 24 hours in children with suspected pneumonia has low diagnostic yield due to minimal morphological changes at the early stage of the disease. Delayed imaging improves diagnostic accuracy and reduces radiation exposure without compromising diagnostic quality.[3]

Keywords: pneumonia, stages of pneumonia, chest radiography, radiation exposure, delayed diagnosis.

**БАЛАЛАРДА ПНЕВМОНИЯҒА КҮДІК КЕЗІНДЕ КЕУДЕ ҚУЫСЫ
АҒЗАЛАРЫНЫҢ РЕНТГЕНОГРАФИЯСЫН АЛҒАШҚЫ ТӘУЛІКТЕ
ЖҮРГІЗУДІҢ ОРЫНСЫЗДЫҒЫНА КЛИНИКАЛЫҚ-ДИАГНОСТИКАЛЫҚ
ТАЛДАУ**

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Аңдатпа. Балалардағы пневмония қазіргі педиатрияның өзекті мәселелерінің бірі болып қала береді, бұл аурудың жоғары таралуымен және уақтылы диагностикаланбаған жағдайда асқынулардың даму қаупімен байланысты. Кеуде қуысы ағзаларының рентгенографиясы диагнозды растаудың кеңінен қолданылатын әдісі болып табылады, алайда аурудың ерте кезеңдерінде оны қолдану төмен диагностикалық ақпараттылықпен сипатталып, негізсіз жоғары сәулелік жүктемеге әкелуі мүмкін.

Классикалық түсінік бойынша үлестік пневмония дамуының төрт сатысы ажыратылады: қан толу (прилив), қызыл және сұр бауырлану (опеченение) және жазылу сатысы. Ерте кезеңдерде (қан толу сатысы) өкпе тініндегі морфологиялық өзгерістер минималды болады, бұл рентгенологиялық бейнелеу мүмкіндігін шектейді.

Зерттеудің мақсаты балаларда пневмонияға күдік кезінде кеуде қуысы ағзаларының рентгенографиясын алғашқы тәулікте жүргізудің диагностикалық мақсаттылығын бағалау және зерттеуді кешіктіріп орындаудың сәулелік жүктемені азайту тұрғысынан артықшылықтарын негіздеу болды.

Зерттеу Шымкент қалалық №3 емханасында жүргізілді. Клиникалық түрде расталған пневмониясы бар 1–3 жас аралығындағы 5 баланың рентгенологиялық деректері талданды. Рентгенография аурудың бірінші тәулігінде және үшінші тәулігінде қайталап орындалды. Сонымен қатар 10 жалпы практика дәрігеріне анкеталық сауалнама жүргізіліп, клиникалық тактикасы мен сәулелік жүктеме туралы хабардарлық деңгейі бағаланды.

Аурудың бірінші тәулігінде барлық пациенттерде рентгенологиялық өзгерістер анықталмады, клиникалық белгілер болғанына қарамастан. Үшінші тәулікте барлық балаларда өкпе тініндегі қабыну үдерісіне тән рентгенологиялық өзгерістер анықталды. Қайталама зерттеу жалпы сәулелік жүктеменің екі есеге артуына әкелді. Сауалнама нәтижелері бойынша дәрігерлердің 70%-ы рентгенографияны аурудың алғашқы тәулігінде тағайындайды, ал тек 40%-ы ғана ерте кезеңдерде зерттеудің төмен ақпараттылығын біледі.

Осылайша, балаларда пневмонияға күдік кезінде кеуде қуысы ағзаларының рентгенографиясын алғашқы тәулікте жүргізу морфологиялық өзгерістердің жеткіліксіз айқын болуына байланысты төмен диагностикалық құндылыққа ие. Зерттеуді кешіктіріп орындау оның ақпараттылығын арттырып, сәулелік жүктемені диагностикалық сапаны төмендетпей азайтуға мүмкіндік береді.

Түйін сөздер: пневмония, пневмония сатылары, рентгенография, сәулелік жүктеме, кешіктірілген диагностика.

КЛИНИКО-ДИАГНОСТИЧЕСКОЕ ОБОСНОВАНИЕ НЕРАЦИОНАЛЬНОСТИ ВЫПОЛНЕНИЯ РЕНТГЕНОГРАФИИ ОРГАНОВ ГРУДНОЙ КЛЕТКИ В ПЕРВЫЕ СУТКИ ПРИ ПОДОЗРЕНИИ НА ПНЕВМОНИЮ У ДЕТЕЙ

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Аннотация. Пневмония у детей остаётся актуальной проблемой современной педиатрии в связи с высокой распространённостью заболевания и риском развития осложнений при несвоевременной диагностике. Рентгенография органов грудной клетки широко используется для подтверждения диагноза, однако её применение в ранние сроки заболевания может обладать низкой диагностической информативностью и сопровождаться неоправданным увеличением лучевой нагрузки.

Классически выделяют четыре стадии развития долевой пневмонии: стадия прилива, красного и серого опеченения, а также стадия разрешения. На ранних этапах (стадия прилива) морфологические изменения в лёгочной ткани выражены минимально, что ограничивает возможности рентгенологической визуализации.

Цель исследования: оценить диагностическую целесообразность выполнения рентгенографии органов грудной клетки в первые сутки при подозрении на пневмонию у детей и обосновать преимущества отсроченного проведения исследования с позиции снижения лучевой нагрузки.

Исследование проведено на базе городской поликлиники №3 г. Шымкента. Проанализированы рентгенологические данные 5 детей в возрасте от 1 до 3 лет с клинически подтверждённой пневмонией. Рентгенография выполнялась в первый день заболевания и повторно на третьи сутки. Дополнительно проведено анкетирование 10 врачей общей практики с целью оценки клинической тактики и уровня осведомлённости о лучевой нагрузке.

На первый день заболевания у всех пациентов рентгенологические изменения отсутствовали, несмотря на наличие клинических признаков пневмонии. На третьи сутки у всех детей выявлены характерные рентгенологические признаки воспалительного процесса в лёгких. Повторное исследование приводило к двукратному увеличению

суммарной лучевой нагрузки. По данным анкетирования, 70% врачей назначают рентгенографию в первые сутки заболевания, при этом лишь 40% осведомлены о низкой информативности исследования на ранних стадиях.

Выполнение рентгенографии органов грудной клетки в первые сутки при подозрении на пневмонию у детей обладает низкой диагностической ценностью в связи с ранней стадией морфологических изменений заболевания. Отсроченное проведение исследования повышает его информативность и позволяет снизить лучевую нагрузку без ухудшения качества диагностики.

Ключевые слова: пневмония, стадии пневмонии, рентгенография, лучевая нагрузка, отсроченная диагностика.

Introduction. Pneumonia in children remains one of the most significant problems in modern pediatrics due to its high prevalence and the risk of complications associated with delayed diagnosis. In clinical practice, chest radiography is traditionally used as the primary method for confirming the diagnosis; however, its use requires strict justification, particularly considering the increased sensitivity of the pediatric organism to ionizing radiation.[4]

According to classical concepts established more than a century ago, lobar pneumonia progresses through four consecutive stages: congestion, red hepatization, gray hepatization, and resolution. During the congestion stage (days 2–3 of illness), hyperemia and pulmonary tissue edema predominate, accompanied by increased capillary permeability and the onset of exudation. However, at this stage, structural changes in the alveoli are insufficiently pronounced, which limits their visualization on radiographic examination.

In the subsequent stages—red hepatization (days 4–6) and gray hepatization (days 7–9)—there is accumulation of exudate within the alveolar spaces, increased cellular infiltration, fibrin deposition, and consolidation of lung tissue. It is during these stages that morphological changes become detectable by radiographic imaging. During the resolution stage (days 9–11), gradual resorption of exudate and restoration of normal lung structure are observed.[5],[6]

Clinical presentation and physical examination findings, particularly auscultation, are closely related to the stage of the inflammatory process. In the early stages of the disease, findings such as diminished vesicular breath sounds, crepitation, harsh breathing with prolonged expiration, as well as localized moist and dry rales may be present. As the disease progresses, auscultatory findings become more pronounced, allowing suspicion of pneumonia even before clear radiographic changes appear.[7]

Thus, analysis of the medical history and auscultatory findings allows the clinician to roughly assess the stage of the disease and determine management strategy. However, performing chest radiography within the first 24 hours in the absence of established morphological changes may reduce the diagnostic value of the study. In some cases, a negative early radiographic result may mislead the clinician and potentially delay the initiation of therapy.

Despite this, in clinical practice, chest radiography is often performed within the first day of illness when its diagnostic value remains low. This leads to an unjustified increase in radiation exposure without providing significant diagnostic information. An additional factor is the

common practice of performing follow-up radiography after completion of treatment, even in cases of favorable clinical dynamics.[8]

Therefore, reconsideration of the timing and indications for radiological examination in children with suspected pneumonia is warranted. A rational approach based on initial clinical assessment with auscultatory findings, followed by radiography at later stages of the disease (e.g., on day 3), may help reduce unnecessary radiation exposure without compromising diagnostic accuracy.

The aim of this study is to provide a clinical and diagnostic justification for delayed chest radiography in children with suspected pneumonia from the perspective of minimizing radiation exposure.[9],[10]

Materials and Methods. The study was conducted at City Polyclinic No. 3 in Shymkent. Radiological data from five children aged 1–3 years with clinically confirmed pneumonia were analyzed. All examinations were performed with informed parental consent and in the presence of their parents.

All patients were monitored from the onset of the first clinical symptoms of the disease. At the initial stage, diagnosis was based on medical history taking, assessment of complaints, and findings of the physical examination, including mandatory chest auscultation. Particular attention was paid to characteristic auscultatory findings such as decreased breath sounds, crepitation, as well as moist and dry rales.

Chest radiography was performed over the course of the disease: on the first day after the onset of clinical manifestations and repeated on the third day. For each patient, a comparative analysis of radiological findings was carried out at both the early and delayed stages of the disease.

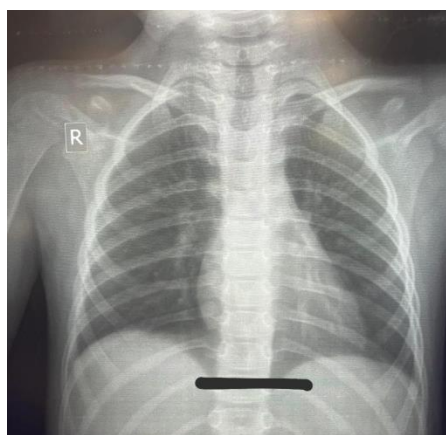


Figure1- In Patient No. 1, no radiographic evidence of pneumonia was observed on the chest radiograph on day 1 of illness.



Figure2- In Patient No. 1, chest radiography performed on day 3 of illness demonstrated marked radiographic findings consistent with left lower lobe pneumonia.

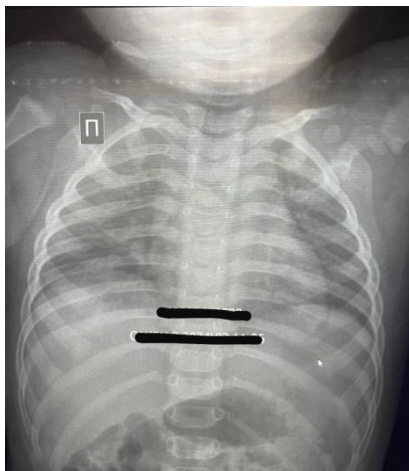


Figure3- In Patient No. 2, no radiographic evidence of pneumonia was observed on the chest radiograph on day 1 of illness.



Figure4- In Patient No. 2, chest radiography performed on days 3–4 of illness revealed radiological signs consistent with bilateral bronchopneumonia.

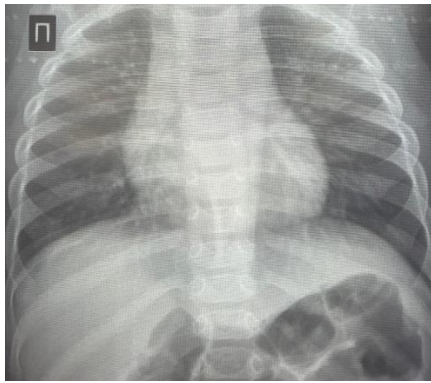


Figure5- In Patient No. 3, no radiographic evidence of pneumonia was observed on the chest radiograph on day 1 of illness.

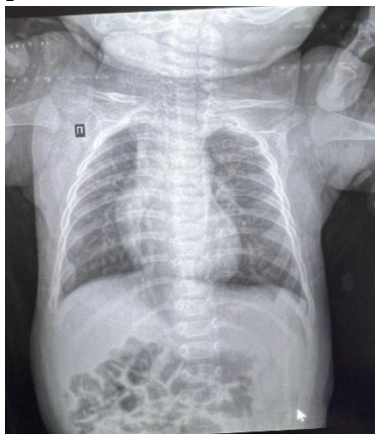


Figure6- In Patient No. 3, chest radiography performed on days 3–4 of illness demonstrated radiological findings consistent with bilateral bronchopneumonia.

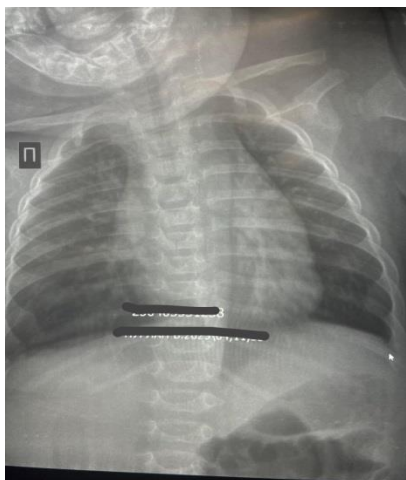


Figure7- In Patient No. 4, no radiographic evidence of pneumonia was observed on the chest radiograph on day 1 of illness.



Figure8- In Patient No. 4, chest radiography performed on day 4 of illness demonstrated radiological findings consistent with bilateral bronchopneumonia.

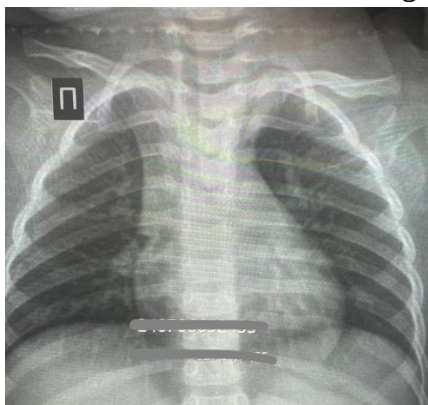


Figure9- In Patient No. 5, no radiographic evidence of pneumonia was observed on the chest radiograph on day 1 of illness.

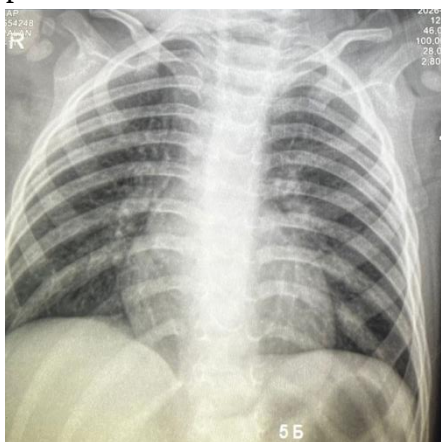


Figure10. In Patient No. 5, chest radiography performed on day 3 of illness demonstrated radiological findings consistent with bilateral bronchopneumonia.

In addition, the dosimetric exposure received by patients during radiological examinations was evaluated. The mean effective dose of a single chest radiograph in children was estimated at approximately 0.02–0.05 mSv. Thus, when the examination was performed on the first day and repeated on the third day, the cumulative radiation exposure was approximately doubled, which is of clinical relevance in pediatric practice given the increased radiosensitivity of the child's organism.

In addition, a paper-based questionnaire survey was conducted among general practitioners (GPs) to assess their clinical approach in cases of suspected pneumonia in children, including the timing of chest radiography and attitudes toward radiation exposure. The

questionnaire included items regarding the preferred timing of radiological examination, reliance on clinical findings in establishing the diagnosis, and the frequency of follow-up chest radiography after treatment.

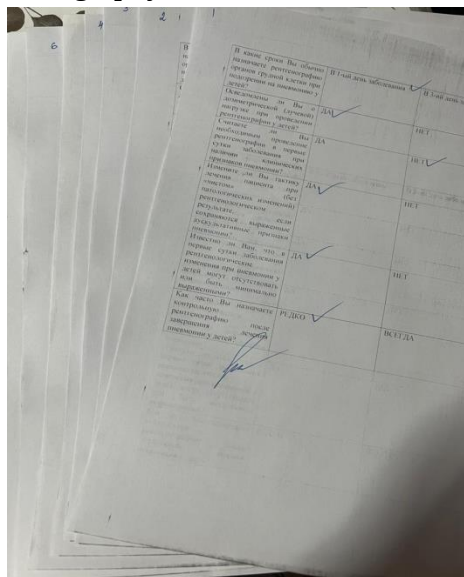


Figure11- Paper-based questionnaire survey

The questionnaire included the following items:

- At what time points do you usually prescribe chest radiography in children with suspected pneumonia?
- Are you aware of the radiation (dosimetric) exposure associated with chest radiography in children?
- Do you consider chest radiography necessary on the first day of illness in the presence of clinical signs of pneumonia?
- Would you modify your treatment approach if a chest radiograph shows no pathological changes, while pronounced auscultatory signs of pneumonia persist?
- Are you aware that radiographic changes in pediatric pneumonia may be absent or minimally expressed during the first day of illness?
- How often do you prescribe follow-up chest radiography after completion of pneumonia treatment in children?

Ethical Considerations. The study was conducted in accordance with the fundamental principles of medical ethics and confidentiality. Personal data of the pediatric patients included in the study were not used and are not subject to disclosure. All results are presented in an aggregated form without any identifying information.

Similarly, data obtained from the questionnaire survey of general practitioners were analyzed anonymously. Personal data of respondents, as well as the specific name of the healthcare institution where the survey was conducted, are not disclosed. Participation of physicians in the study was voluntary, and data processing was performed in a de-identified form.

The study was observational in nature and did not infringe upon the rights of patients or medical personnel.

Results. Analysis of radiological data from five pediatric patients aged 1–3 years with clinically confirmed pneumonia demonstrated that on the first day of illness, no radiographic

abnormalities of the chest were detected in all patients (100%). However, the clinical presentation in all examined cases corresponded to the initial manifestations of pneumonia, including characteristic auscultatory findings.

On repeat chest radiography performed on day 3 of illness, all five children (100%) showed radiographic signs of inflammatory changes in the lung parenchyma consistent with pneumonia of varying severity. Thus, the diagnostic yield of chest radiography significantly increased when the examination was performed at a delayed time point.

Analysis of radiation exposure demonstrated that when chest radiography was performed twice (on days 1 and 3), the cumulative radiation dose was doubled compared to a single examination, which is of clinical importance in pediatric practice.

According to the results of the questionnaire survey of general practitioners (GPs), in which 10 specialists participated, the following was established:

- 70% of physicians (7 out of 10) prescribe chest radiography within the first day of suspected pneumonia in children;
- 60% (6 out of 10) of respondents are aware of the radiation (dosimetric) exposure associated with radiological examinations in children;
- 65% (6–7 out of 10) of physicians reported that they may modify treatment tactics in cases of a “normal” chest radiograph on the first day of illness, even in the presence of pronounced auscultatory signs;
- 40% (4 out of 10) of respondents are aware that radiographic changes in pediatric pneumonia are often absent or minimally expressed during the first day of illness;
- 70% (7 out of 10) of physicians regularly prescribe follow-up chest radiography after completion of treatment.

Thus, the obtained data indicate a high frequency of early chest radiography prescription and insufficient awareness among a proportion of physicians regarding the temporal evolution of radiographic changes in pediatric pneumonia, which may contribute to unnecessary radiation exposure.

Proposed solution to the problem

To reduce excessive radiation exposure in children with suspected pneumonia, the implementation of a stepwise clinical and diagnostic algorithm is proposed. It is based on the initial assessment of the patient's condition using medical history and physical examination, including mandatory chest auscultation, without obligatory chest radiography within the first day of illness in the absence of severe or life-threatening symptoms.[11],[12]

Chest radiography is recommended to be performed in a delayed manner, approximately on day 3 of illness, when the likelihood of detecting inflammatory changes is significantly higher. This approach allows for increased diagnostic yield while simultaneously reducing the number of low-informative examinations.

In addition, it is recommended to limit routine follow-up chest radiography after treatment in cases with clear positive clinical dynamics, reserving it only for strict clinical indications (prolonged course, complications, or lack of improvement). An important component of this approach is improving the awareness of general practitioners regarding the temporal evolution of radiographic changes in pediatric pneumonia, as well as the fact that radiographic

findings may be normal during the first day of illness. This can be achieved through regular training seminars, clinical guidelines, and standardized patient management algorithms.[13]

Regular seminars, lectures, and workshops for primary care physicians are recommended, focusing on the stages of pneumonia and the characteristics of early radiographic manifestations.

Radiation exposure awareness

Systematic improvement of healthcare professionals' awareness regarding radiation doses associated with pediatric radiological examinations and principles of radiation safety is essential.

Thus, the implementation of a clinically oriented approach with delayed chest radiography allows for optimization of pneumonia diagnosis in children, reduction of radiation exposure, and improvement in the rational use of diagnostic resources.

Conclusion. The conducted study demonstrated that in children with clinically confirmed pneumonia, no radiographic abnormalities were detected on the first day of illness in all observed patients (100%), whereas on day 3, all children (100%) showed characteristic signs of inflammatory changes in the lung parenchyma. This indicates a higher diagnostic yield of chest radiography when performed in a delayed manner.

It was additionally established that performing chest radiography on the first day of illness and repeating it on day 3 results in a twofold increase in cumulative radiation exposure, which is a significant factor in pediatric practice given the high radiosensitivity of the child's organism.

The results of the questionnaire survey of general practitioners (n = 10) revealed that a considerable proportion of specialists prescribe chest radiography at early stages of the disease; however, insufficient awareness was noted regarding the temporal progression of radiographic changes in pediatric pneumonia and the risks of excessive radiation exposure.

Thus, the proposed clinical and diagnostic approach, based on the initial assessment of the patient's condition using medical history and auscultatory findings with delayed chest radiography (approximately on day 3 of illness), allows for improved diagnostic efficiency and reduced radiation exposure without compromising diagnostic quality.

It is recommended that this approach be implemented in clinical practice and that awareness among primary care physicians regarding the rational use of radiological methods in suspected pediatric pneumonia be enhanced.

Implementation of clinical guidelines and management algorithms

Development and wide dissemination of standardized protocols regulating indications and optimal timing for chest radiography in pediatric pneumonia, with emphasis on delayed imaging in clinically stable patients.

Emphasis on primary diagnosis based on medical history and auscultatory findings, with chest radiography performed only when clinically indicated or in a delayed manner.

Quality control of medical care

Monitoring the frequency of chest radiography in children with pneumonia at the primary care level and analysis of the appropriateness of imaging studies, followed by feedback to physicians.

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