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Clinical Profile and Volume of Pulmonology Consultations Requested from an Internal Medicine Emergency Clinic: An Eight-Year Retrospective Record Review

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Clinical Profile and Volume of Pulmonology Consultations Requested from an Internal Medicine Emergency Clinic: An Eight-Year Retrospective Record Review

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Abstract

Background: Pulmonology consultations support the assessment of respiratory problems in emergency care. This study aimed to describe the clinical profile, consultation volume, temporal distribution, and frequency of repeated consultations requested from an internal medicine emergency clinic.

Methods: This single-center retrospective study examined consultation records from Istanbul University Istanbul Faculty of Medicine Hospital between January 15, 2018, and June 1, 2026. Clinical information was extracted from consultation requests and pulmonologist responses using a rule-based approach. All 3,422 automated category assignments were reviewed and corrected by an internal medicine physician and a pulmonologist. Analyses distinguished unique patients from consultation records. Annual and seasonal analyses were restricted to 2020–2025 because records were available in every month.

Results: A total of 3,422 consultations involving 2,356 unique patients were included. Median age was 65.9 years (IQR, 54.0–75.3), and 54.9% of patients with assigned sex were male. The most common clinical topics at the index consultation were pneumonia/lower respiratory tract infection (26.9%) and evaluation for suspected pulmonary embolism (26.1%), followed by lung malignancy (10.5%), respiratory failure (8.1%), and pleural effusion (8.0%). Dyspnea was documented in 72.9% of patients. Repeat consultations occurred in 712 patients (30.2%), who accounted for 1,778 consultations (52.0% of all records). Among the 2,855 consultations recorded during 2020–2025, the largest seasonal proportion occurred in winter (30.1%).Overall, 338 patients (14.3%) were identified as requiring ICU admission, of whom 204 (8.7%) were admitted and 134 (5.7%) could not be admitted because of ICU bed unavailability.

Conclusions: Respiratory infection and assessment of possible pulmonary embolism predominated in this referral pathway. Patients with repeated consultations contributed substantially to recorded consultation volume. These findings may inform local service planning, although patient linkage and extraction of individual clinical indicators require further verification.

Keywords: Pulmonology consultation, emergency care, consultation patterns, repeated consultations, retrospective study.

Key points

- Pneumonia/lower respiratory tract infection and evaluation for suspected pulmonary embolism accounted for 53.0% of index consultations, while winter had the largest seasonal share of consultations during 2020–2025.

- Patients with repeated consultations represented 30.2% of the cohort but accounted for 52.0% of all consultation records, highlighting the importance of distinguishing patient counts from consultation volume when planning services.

Introduction

Respiratory symptoms are a common reason for emergency assessment and may arise from pulmonary and extrapulmonary conditions. International observational studies have identified lower respiratory tract infection, heart failure, chronic obstructive pulmonary disease (COPD), and asthma as leading diagnoses among patients presenting with dyspnea [1,2]. Older adults are an important subgroup, in whom heart failure, respiratory infection, and COPD frequently contribute to acute breathlessness [3].

Pulmonology consultations support the assessment of these heterogeneous presentations. In the Turkish multicenter PuPCEST study, which included 1,712 patients from 32 centers, dyspnea was the most frequent reason for consultation, and COPD and pneumonia were the most commonly established diagnoses [4]. Specialist assessment is also sought for unresolved problems such as unspecified hypoxia and acute hypoxic respiratory failure [5]. Describing consultation activity within a specific referral pathway can therefore complement broader emergency department studies.

Consultation processes are relevant to the organization of emergency care and have been examined as targets for improving patient flow [6]. Seasonal differences in the characteristics of patients presenting with dyspnea have also been reported, including a higher proportion of lower respiratory tract infections during winter [7]. In addition, evidence on repeated emergency attendance demonstrates why the number of patients and the number of encounters should be distinguished [8]. Although repeated attendance and repeated consultation are different measures, analyzing both unique patients and consultation records can clarify the population assessed and the recorded volume of specialist activity.

Although previous studies have characterized respiratory presentations in emergency departments and examined consultation processes, the combined assessment of patient-level clinical characteristics, repeated specialist consultation activity, temporal patterns, and intensive care requirements within a defined referral pathway remains an important area for further investigation. In particular, distinguishing the number of individual patients from the total number of consultations may provide a more comprehensive understanding of specialist service utilization. Furthermore, evaluating intensive care requirements alongside consultation patterns may offer additional insights into the relationship between clinical demand and available hospital resources.

Therefore, this study aimed to characterize pulmonology consultations requested from the internal medicine emergency clinic at Istanbul University Istanbul Faculty of Medicine Hospital between January 15, 2018, and June 1, 2026. We evaluated demographic and documented clinical characteristics, dominant consultation topics, annual and seasonal distributions, repeated consultation frequency, and intensive care admission requirements. By integrating patient-level and consultation-level analyses with intensive care disposition data, this study seeks to provide a more comprehensive description of specialist consultation activity and identify patterns relevant to hospital resource allocation and emergency care planning.

Materials and Methods

Study design and data source

This single-center, retrospective descriptive study examined available consultation records from Istanbul University Istanbul Faculty of Medicine Hospital. Records covered consultations requested from the internal medicine emergency clinic to the Department of Pulmonary Medicine between January 15, 2018, and June 1, 2026. The dataset represented this referral pathway, rather than all pulmonology consultations across the hospital. Both the consultation request narrative and the pulmonologist's assessment and recommendations were used for clinical data extraction.

Record selection and patient linkage

The hospital information system export contained 3,476 records. Fifty-four records were excluded because of data structure validation issues or missing patient identifiers/clinical text, leaving 3,422 consultations involving 2,356 unique patient keys. Eighty-eight records initially set aside during de-identification were retained after processing. Records were linked using the hospital patient number and standardized patient name. Records with different names under the same hospital number were assigned separate patient keys to avoid potentially merging different individuals. Potential fragmentation due to name variation and the distinction between duplicate export rows and separate assessments could not be independently verified from the available de-identified dataset.

Units of analysis and repeated consultations

The unique patient was the primary unit of analysis and the consultation record was the secondary unit. The first recorded consultation within the study period was the index consultation; it was not necessarily the

patient's first-ever consultation. Patient-level age and clinical topic were based on this record. Other clinical characteristics were considered documented if present in either narrative source in any consultation for that patient. Repeated consultation was defined as more than one consultation record for the same patient during the study period, encompassing both follow-up consultations during the same hospitalization and consultations during separate visits. These could not be distinguished in the available dataset; therefore, repeated consultation frequency should not be interpreted as a readmission rate. Patients were grouped as having one, two, or three or more records. Additional consultations were defined as all records beyond each patient's first recorded consultation. These measures were not adjusted for differences in observation time.

Demographic variables

Age was calculated from the interval between birth and consultation request dates, divided by 365.25. The exported age field was not used because it reflected age at extraction rather than age at consultation. Sex was obtained first from explicit narrative statements, then from a cohort-derived name dictionary and a general Turkish name dictionary. The workbook reports accuracies of 97.9% and 99.3%, respectively; however, patient-level separation during validation was not documented. Sex values inferred from names were therefore treated as derived values. Conflicts were resolved by majority vote and flagged; unresolved values remained missing. Sex proportions used only patients with an assigned value.

Clinical data extraction and classification

A locally implemented, deterministic, rule-based natural language processing approach extracted documented clinical characteristics from consultation requests and pulmonologist responses and generated initial clinical category assignments. COVID-19 positivity was treated as a separate documentation indicator. The final clinical categories used in the analyses were reviewed and corrected by physicians, as described below and in Supplementary Methods S2. Operational definitions of the final clinical topics are presented in Supplementary Table S2; illustrative expressions in that table are not a specification of the original automated extraction algorithm.

Clinical category assignment and physician review

Each consultation was assigned a single dominant clinical topic based on the consultation request and the pulmonologist's assessment and recommendations. This topic represented the principal issue evaluated or managed during the consultation, rather than necessarily the original referral reason or a confirmed diagnosis. When multiple conditions were addressed, the principal issue determined the category; there was no universal severity-based ordering of diagnoses. Coexisting conditions were recorded separately where applicable. An internal medicine physician and a pulmonologist jointly reviewed the automatically assigned categories for all 3,422 records, corrected them where necessary, and determined the final categories by

consensus. Category definitions and contextual assignment rules are provided in Supplementary Table S2 and Supplementary Methods S2. Joint consensus review did not constitute an independent assessment of interobserver agreement or automated classification performance.

Clinical indicators and missing data

Symptoms, comorbidities, imaging/procedure references, and management recommendations represented documentation rather than verified prevalence, completed procedures, or administered treatment. Lack of documentation was not interpreted as clinical absence. Because the broad malignancy indicator did not consistently encompass the lung cancer indicator, it was omitted from the main clinical table pending review of its extraction rules. Numerical vital-sign summaries were taken from the workbook and restricted to records with the relevant measurement. The dataset contained indicators for SpO_2 <90% and systolic blood pressure <90 mmHg; their precise relationship to numerical measurements versus narrative expressions was not independently verified. These indicators were reported using all patients or records as the denominator, separately from vital-sign documentation rates. Admission assessment and bed unavailability identified in consultation narratives were considered documentation indicators rather than confirmed admission outcomes. ICU admission status was evaluated separately, distinguishing patients admitted to the ICU from those with a documented indication for ICU admission who could not be admitted because of bed unavailability. Mortality, hospital length of stay, and other verified final disposition outcomes were unavailable.

Temporal analyses and sensitivity analysis

Year and month were derived from request dates. Seasons were winter (December–February), spring (March–May), summer (June–August), and autumn (September–November). All available eligible consultation records from January 15, 2018, to June 1, 2026, were included in the overall patient-level and consultation-level analyses. Annual and seasonal analyses were restricted to the six complete calendar years from 2020 through 2025, during which records were available for every month. Records from 2018–2019 were excluded only from these temporal analyses because some months lacked available records, whereas 2026 was excluded because it covered only part of the year. The presence of records in every month during 2020–2025 did not independently establish complete capture of all consultations.A sensitivity analysis restricted index-consultation demographics and category distributions to patients whose first recorded consultation occurred in 2020–2025. This assessed the effect of restricting the index period and did not reconstruct complete histories or adjust repeated consultation rates for observation time.

Statistical analysis

Continuous variables were summarized as medians and interquartile ranges, and categorical variables as counts and percentages. Wilson 95% confidence intervals were calculated only for patient-level proportions. Consultation-level proportions were reported without confidence intervals because records were clustered within patients. Percentages below 0.1% with nonzero counts were displayed as <0.1%. Denominators were specified for each analysis; missing numerical values were not imputed. No hypothesis tests or multivariable models were used. Revised descriptive calculations were performed in Python using the de-identified workbook.

Results

Study population and demographic characteristics

Of the 3,476 records retrieved from the hospital information system, 54 were excluded because of data structure validation issues or missing patient identifiers or clinical assessments. The final study population comprised 2,356 unique patients with 3,422 consultation records (Figure 1). Median age was 65.9 years (IQR, 54.0–75.3). Sex was assigned in 2,318 patients, of whom 1,273 were male (54.9%; 95% CI, 52.9–56.9). Sex remained unassigned in 38 patients (1.6%) (Table 1).

Clinical topics addressed during consultation

The most frequent dominant clinical topics at the index consultation were pneumonia/lower respiratory tract infection (634 patients; 26.9%; 95% CI, 25.2–28.7) and evaluation for suspected pulmonary embolism (615 patients; 26.1%; 95% CI, 24.4–27.9).Together, these categories accounted for 1,249 patients (53.0%). They were followed by lung malignancy (10.5%), respiratory failure (8.1%), pleural effusion (8.0%), and hemoptysis (5.1%). At the consultation level, evaluation for suspected pulmonary embolism was the dominant clinical topic in 853 records (24.9%) and pneumonia/lower respiratory tract infection in 805 records (23.5%), together accounting for 48.5% of consultations.Administrative/procedure-related

consultations accounted for 0.9% of patients and 7.4% of consultation records (Table 2, Figure 2). Unclassified/other or insufficient-text categories included 41 patients (1.7%). CT pulmonary angiography was mentioned in the consultation narratives of 229 of the 615 patients (37.2%) whose index consultation concerned evaluation for possible pulmonary embolism. This percentage reflects narrative documentation rather than a verified imaging rate; the category does not indicate confirmed pulmonary embolism.

Documented clinical characteristics

The most frequently documented symptoms were dyspnea (1,718 patients; 72.9%), cough (1,321; 56.1%), fever (762; 32.3%), and chest pain (528; 22.4%). Frequently documented comorbidities included diabetes (25.8%), COPD (22.6%), and heart failure (14.3%). References to chest CT, CT pulmonary angiography, and bronchoscopy were present in 85.8%, 17.8%, and 13.8% of patients, respectively. COVID-19 positivity was documented in 183 patients (7.8%). SpO_2 <90% was documented in 875 patients (37.1%), and systolic blood pressure <90 mmHg in 60 patients (2.5%). Admission assessment was documented in 864 patients (36.7%) and bed unavailability in 247 (10.5%) (Table 3). These proportions reflect documentation and were not interpreted as verified disease prevalence, procedure performance, or actual admission rates.

Repeated consultations

A total of 1,644 patients (69.8%) had one consultation, 495 (21.0%) had two, and 217 (9.2%) had three or more. Overall, 712 patients (30.2%; 95% CI, 28.4–32.1) had more than one consultation. Their 1,778 records accounted for 52.0% of all consultations. Of all records, 1,066 (31.2%) were additional consultations beyond each patient's first recorded consultation. The maximum number of consultations per patient was 11 (Table 1).

Annual and seasonal distribution

During 2020–2025, when at least one record was available in every month, 2,855 consultations were recorded. Annual counts were 417 in 2020, 387 in 2021, 353 in 2022, 541 in 2023, 654 in 2024, and 503 in 2025, with the highest count observed in 2024. Winter accounted for the largest seasonal proportion (860 consultations; 30.1%), followed by spring (701; 24.6%), autumn (658; 23.0%), and summer (636; 22.3%) (Table 4, Figure 3).Records from 2018–2019 were excluded from volume and seasonal comparisons because of incomplete capture, and 2026 was excluded because it represented a partial calendar year.

Documentation of vital signs

At the consultation level, SpO_2 was documented in 2,536 records (74.1%), systolic blood pressure in 1,314 (38.4%), body temperature in 482 (14.1%), and heart rate in 213 (6.2%). Among records with the corresponding measurement, median SpO_2 was 91% (IQR, 85–96), systolic blood pressure was 126 mmHg

(IQR, 110–142), body temperature was 37 °C (IQR, 36–38), and heart rate was 96 beats/min (IQR, 84–107) (Table 5).

Sensitivity analysis by index period

Among 1,954 patients whose first recorded consultation occurred in 2020–2025, median age was 66.0 years (IQR, 54.0–75.4). Pneumonia/lower respiratory tract infection accounted for 544 patients (27.8%) and the pulmonary embolism clinical question for 504 (25.8%). The full comparison is provided in Supplementary Table S1.

Intensive Care Unit Admissions

Among 2,356 patients, 338 (14.3%) had a documented indication for intensive care unit (ICU) admission. Of these, 204 (60.4%) were admitted to the ICU, whereas 134 (39.6%) could not be admitted due to ICU bed unavailability. These patients represented 8.7% and 5.7% of the overall study population, respectively.

Discussion

This retrospective study describes the clinical profile and recorded volume of pulmonology consultations requested from an internal medicine emergency clinic over an eight-year period. Pneumonia/lower respiratory tract infection and the clinical question of pulmonary embolism accounted for more than half of the dominant topics at the index consultation. Approximately one-third of patients had repeated consultations, and their records constituted more than half of all consultation records. During 2020–2025, winter accounted for the largest seasonal proportion of consultations. These findings characterize a specific referral pathway and demonstrate the importance of distinguishing the patient population from the volume of recorded consultation activity.

The prominence of respiratory symptoms and chronic comorbidities is broadly consistent with previous studies of emergency respiratory presentations. In the Turkish multicenter PuPCEST study, dyspnea was the most frequent reason for pulmonology consultation, while COPD and pneumonia were the most commonly established diagnoses [4]. The AANZDEM study similarly identified lower respiratory tract infection, heart failure, COPD, and asthma among the leading diagnoses in patients presenting to emergency departments with dyspnea [1]. However, direct numerical comparisons require caution. Our study included only consultations requested from the internal medicine emergency clinic, and its categories represented dominant clinical topics extracted from both consultation requests and pulmonologist responses. These

categories therefore differ from presenting symptoms, original referral reasons, and final diagnoses reported in other studies.

The relatively large pulmonary embolism category warrants particular attention. This category reflects the consideration or assessment of pulmonary embolism during consultation and should not be interpreted as the prevalence of confirmed disease. CT pulmonary angiography was mentioned in 37.2% of patients in this category. However, imaging performance and results were not independently verified against radiology records. Absence of a reference in the consultation narrative therefore cannot establish that imaging was not performed, and these data cannot determine the appropriateness of imaging use or consultation requests. The final category was reviewed by physicians, but it did not separately quantify suspected, excluded, and confirmed pulmonary embolism. The prominence of consultations concerning possible pulmonary embolism may reflect a need for specialist input when diagnostic uncertainty remains. Seeking specialist input may be influenced by medicolegal concerns as well as the need to manage diagnostic uncertainty; a Turkish survey identified referral to consultants among reported defensive medical practices [9]. In this context, the high proportion of consultations concerning suspected pulmonary embolism in our study may reflect a need for specialist support in excluding this diagnosis rather than the burden of confirmed disease. However, the available data cannot distinguish the respective contributions of clinical need and medicolegal concerns to consultation decisions.

The difference between documented COPD and the COPD/asthma exacerbation category further illustrates the distinction between comorbidity and the dominant consultation topic. COPD was documented in 22.6% of patients, whereas COPD/asthma exacerbation accounted for 2.8% of index categories. These measures address different questions: a patient with COPD may have been classified under pneumonia, respiratory failure, or another dominant topic. Assigning a single category to each consultation also reduces the complexity of presentations involving several concurrent conditions. The category distribution should therefore be interpreted as a summary of consultation content rather than a complete description of the respiratory diseases affecting the population.

Patients with more than one consultation represented 30.2% of the cohort (712/2,356) and accounted for 52.0% of all consultation records (1,778/3,422), including their index consultations. Additional consultations beyond each patient’s index consultation accounted for 31.2% of all records (1,066/3,422). Thus, 52.0% describes the total consultation activity contributed by patients with repeated consultations, whereas 31.2% describes the proportion of records representing additional consultations.A systematic review and meta-analysis of frequent emergency department attendance similarly highlighted the contribution of repeatedly attending patients to service utilization, while identifying substantial variation in

definitions across studies [8]. However, repeated emergency attendance and repeated specialist consultation are different measures. Our data did not distinguish reassessment during the same hospitalization from consultations during separate visits, and patients had unequal observation periods. Consequently, these findings cannot be interpreted as readmission rates or evidence of avoidable attendance or inadequate outpatient care.

Administrative/procedure-related topics accounted for a larger proportion of all consultation records than of index consultations. This difference is compatible with these topics appearing later in patients' recorded consultation histories, but transitions between categories were not directly examined. It therefore does not establish that administrative activity caused repeated consultations or prolonged care. Linking consultation sequences to individual episodes could clarify whether these records reflect procedural planning, care coordination, or other documented tasks.

Winter accounted for 30.1% of consultations during 2020–2025. This observation is compatible with the EURODEM study, which reported seasonal differences in emergency dyspnea presentations and a higher proportion of lower respiratory tract infections during winter [7]. However, our analysis examined aggregate consultation counts rather than category-specific seasonal changes. It cannot establish that respiratory infections explained the winter predominance or demonstrate an increase in population-level disease incidence. Similarly, the higher annual count in 2024 represents an increase in recorded consultation volume and cannot be attributed to changes in disease burden, referral practices, staffing, or recording completeness. Restricting temporal analyses to years with records in every month reduced the influence of obvious recording gaps, although monthly availability did not independently confirm complete capture.

The relevance of consultation processes to emergency department patient flow has been demonstrated in previous research. In a prospective study, Brick and colleagues found that consultation decision time accounted for a substantial part of emergency department length of stay and that multiple consultations were associated with longer stays [10]. A systematic review of interventions to improve emergency department consultations also identified consultation responsiveness as a potential target for improvement [6]. These findings support measuring response and decision times alongside consultation counts. However, our dataset contained no validated consultation-duration or length-of-stay measures, so repeated consultations cannot be linked to delays in this cohort. The present findings describe consultation volume; additional information on time, staffing, and resource use would be required to quantify workload more fully.

An important finding of this study was the substantial demand for intensive care among patients undergoing pulmonology consultation. Overall, 338 patients (14.3%) were identified as requiring ICU admission, of whom 204 (8.7%) were admitted, while 134 (5.7%) could not be admitted because of ICU bed unavailability. Thus, 39.6% of patients identified as requiring intensive care could not be admitted. This finding highlights a potential mismatch between critical care demand and available capacity within this referral pathway. However, because subsequent clinical outcomes were unavailable, the consequences of non-admission could not be determined. These results underscore the importance of considering critical care capacity and patient disposition when evaluating specialist consultation services.

The documentation findings also suggest opportunities for more structured consultation records. Numerical SpO_2 values were available more frequently than blood pressure, temperature, or heart rate measurements. These differences concern documentation within the available consultation records and do not necessarily indicate that measurements were omitted during care. Similarly, imaging or bronchoscopy references do not confirm completed procedures, and admission assessment or bed unavailability does not establish final disposition. Separate structured fields for symptoms, suspected diagnoses, confirmed findings, recommendations, and completed actions could improve the clinical interpretability of future analyses.

Natural language processing offers a means of converting routine narrative records into structured research data. Hripcsak and colleagues demonstrated this approach in a large database of chest radiographic reports and evaluated automated extraction against manual coding [11]. Their findings support the potential value of narrative data while illustrating the importance of source-record validation. However, performance established in radiology reports cannot be assumed to apply to consultation narratives in another language or clinical setting. In this study, automatically assigned categories for all included records were reviewed and corrected by two physicians from complementary specialties. This review supports the clinical interpretation of the final categories but does not establish the accuracy of the uncorrected automated algorithm or validate extraction of every individual clinical indicator.

Strengths of this study include the extended observation period, separate analyses of unique patients and consultation records, the use of both referral requests and specialist responses, and physician review and correction of the automatically assigned categories for every included record. Restricting the sensitivity analysis to patients whose index consultation occurred in 2020–2025 produced similar proportions for the two leading categories. This suggests that their prominence was not solely attributable to patients first recorded during years with incomplete monthly availability. Nevertheless, this analysis did not reconstruct missing consultation histories or adjust repeated consultation frequency for unequal observation periods.

Several limitations should be considered. The single-center design and restriction to one referral pathway limit the generalizability of our findings. Clinical variables were derived from routine consultation narratives, and the absence of documentation could not be interpreted as the absence of a clinical finding. Although an internal medicine physician and a pulmonologist reviewed and corrected all automatically assigned clinical categories, this process did not provide independent estimates of classification performance or interobserver agreement. Furthermore, physician review of clinical categories did not establish the validity of individual extracted symptoms, comorbidities, physiological indicators, or procedure references.

Patient linkage could not be independently verified, particularly when different names were associated with the same hospital number. Assigning separate patient identifiers in such cases may have fragmented records belonging to the same individual, potentially overestimating the number of unique patients and underestimating repeated consultation frequency. Duplicate export records could not always be distinguished from separate clinical assessments. Methodological guidance emphasizes the importance of evaluating linkage quality and transparently reporting linkage procedures [12]. Additionally, sex assignment based partly on names introduced potential misclassification, while patient-level indicators extracted from multiple consultations may have been more frequently identified in patients with repeated records.

Finally, the absence of validated final diagnoses, hospital length of stay, and mortality data limited the assessment of clinical effectiveness and patient outcomes. Although ICU admission status was evaluated, the subsequent clinical course of patients who could not be admitted because of bed unavailability remained unknown. Consequently, the potential impact of ICU bed shortages on mortality, clinical deterioration, or hospital length of stay could not be determined. The observational design also precludes causal inferences regarding the relationship between ICU availability and patient outcomes.

The RECORD statement recommends transparent reporting of population selection, classification algorithms, data cleaning, and linkage methods in studies using routinely collected health data [13]. Supplementary Table S2 and Supplementary Methods S2 describe the final clinical topics and physician review process. The original machine-readable extraction rules and a quantified audit of physician corrections were not available for reporting, which limits reproducibility of the initial automated assignments. A separate evaluation against independent reference annotations could quantify automated extraction performance. Future work should link consultation records to verified diagnoses, individual episodes of care, response times, and clinical outcomes.

Conclusion

Pneumonia/lower respiratory tract infection and evaluation for suspected pulmonary embolism were the most frequently addressed clinical topics in pulmonology consultations requested from the internal medicine emergency clinic. Repeated consultations accounted for more than half of the total recorded consultation activity. A substantial proportion of patients identified as requiring intensive care could not be admitted because of ICU bed unavailability, suggesting a potential mismatch between critical care demand and available capacity. These findings may inform local service planning; however, further validation of clinical indicators and linkage to patient outcomes are needed.

Declarations

Abbreviations

COPD: Chronic obstructive pulmonary disease; CT: Computed tomography; ICU: Intensive care unit; IQR: Interquartile range; NLP: Natural language processing; PE: Pulmonary embolism; SpO_2: Peripheral oxygen saturation.

Ethics approval and consent to participate

This study was approved by the Non-Interventional Clinical Research Ethics Committee of Istanbul University, Istanbul Faculty of Medicine (Decision No: 02; Date: 17 September 2026; File No: 2026/1533). An official approval letter was issued on 14 October 2026 (Document No: E-35980450-050.04-4444511), confirming approval at the ethics committee meeting held on 17 September 2026. The official electronically signed ethics committee decision document is dated 21 October 2026 (No: 4444533).

Due to the retrospective nature of the study and the use of routinely collected clinical data, the requirement for obtaining informed consent to participate was waived by the Non-Interventional Clinical Research Ethics Committee of Istanbul University, Istanbul Faculty of Medicine. Therefore, individual informed consent was not obtained from the study participants.

All study procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki and relevant institutional and national guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' contributions

E.B.E. collected and curated the data and drafted the manuscript. M.S., A.C., and K.A. contributed to data collection and curation. H.S. contributed to data collection and performed the statistical analyses. A.P., C.K., and N.S. reviewed the data and analyses and guided manuscript preparation. M.E., N.S., M.K., and T.T. critically reviewed the manuscript for important intellectual content. All authors reviewed and approved the final version of the manuscript.

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Tables

Table 1 Demographics and repeated consultations

Variable	Value [95% CI]
Unique patients	2356
Consultations	3422
Age, median [IQR], years	65.9 [54.0–75.3]
Men	1,273 (54.9%) [52.9–56.9]
Women	1,045 (45.1%) [43.1–47.1]
Unassigned sex	38 (1.6%) [1.2–2.2]
One consultation	1,644 (69.8%) [67.9–71.6]
Two consultations	495 (21.0%) [19.4–22.7]
Three or more consultations	217 (9.2%) [8.1–10.4]
Patients with repeated consultations	712 (30.2%) [28.4–32.1]
Records from patients with repeated consultations	1,778 (52.0%)
Additional consultations beyond the first record	1,066 (31.2%)
Maximum consultations per patient	11

Sex proportions use 2,318 patients; other patient proportions use 2,356; the record proportion uses 3,422. Age was calculated from the patient-level data.

Table 2 Dominant clinical topics addressed during consultation

Category	Index category n (%) [95% CI]	All records n (%)
Pneumonia / lower respiratory tract infection	634 (26.9%) [25.2–28.7]	805 (23.5%)
Evaluation for suspected pulmonary embolism	615 (26.1%) [24.4–27.9]	853 (24.9%)
Lung malignancy	248 (10.5%) [9.4–11.8]	316 (9.2%)
Respiratory failure	190 (8.1%) [7.0–9.2]	297 (8.7%)
Pleural effusion	189 (8.0%) [7.0–9.2]	242 (7.1%)
Hemoptysis	119 (5.1%) [4.2–6.0]	176 (5.1%)
Unclassified dyspnea	88 (3.7%) [3.0–4.6]	119 (3.5%)
COPD / asthma exacerbation	66 (2.8%) [2.2–3.5]	88 (2.6%)
Pneumothorax	52 (2.2%) [1.7–2.9]	79 (2.3%)
Stable chronic airway disease	37 (1.6%) [1.1–2.2]	51 (1.5%)
Unclassified / other	34 (1.4%) [1.0–2.0]	49 (1.4%)
Interstitial lung disease	33 (1.4%) [1.0–2.0]	58 (1.7%)
Administrative / procedure-related	21 (0.9%) [0.6–1.4]	252 (7.4%)
Active tuberculosis	9 (0.4%) [0.2–0.7]	12 (0.4%)
Insufficient text	7 (0.3%) [0.1–0.6]	8 (0.2%)
Bronchiectasis	5 (0.2%) [0.1–0.5]	5 (0.1%)
Pulmonary hypertension	4 (0.2%) [0.1–0.4]	6 (0.2%)
Preoperative assessment	4 (0.2%) [0.1–0.4]	4 (0.1%)
Tuberculosis sequelae	1 (<0.1%) [0.0–0.2]	2 (<0.1%)

Patient-level categories reflect the index consultation; consultation-level categories include all records. Categories are not confirmed diagnoses. Record-level confidence intervals are omitted because records are clustered within patients.

Table 3 Documented clinical characteristics

Characteristic	Patients n (%) [95% CI]	Consultations n (%)
Dyspnea	1,718 (72.9%) [71.1–74.7]	2,116 (61.8%)
Cough	1,321 (56.1%) [54.1–58.1]	1,527 (44.6%)
Fever mentioned in consultation narratives	762 (32.3%) [30.5–34.3]	864 (25.2%)
Chest pain	528 (22.4%) [20.8–24.1]	601 (17.6%)
Diabetes	607 (25.8%) [24.0–27.6]	722 (21.1%)
COPD	532 (22.6%) [20.9–24.3]	659 (19.3%)
Heart failure	336 (14.3%) [12.9–15.7]	387 (11.3%)
Known lung cancer	294 (12.5%) [11.2–13.9]	349 (10.2%)
Atrial fibrillation	234 (9.9%) [8.8–11.2]	278 (8.1%)
Asthma	176 (7.5%) [6.5–8.6]	193 (5.6%)
Chronic kidney disease	174 (7.4%) [6.4–8.5]	203 (5.9%)
Previous tuberculosis	131 (5.6%) [4.7–6.6]	145 (4.2%)
Immunosuppression	115 (4.9%) [4.1–5.8]	127 (3.7%)
Documented SpO_2 <90%	875 (37.1%) [35.2–39.1]	1,071 (31.3%)
Documented systolic BP <90 mmHg	60 (2.5%) [2.0–3.3]	66 (1.9%)
Reference to chest CT	2,021 (85.8%) [84.3–87.1]	2,527 (73.8%)
Reference to CT pulmonary angiography	419 (17.8%) [16.3–19.4]	479 (14.0%)
Reference to bronchoscopy	325 (13.8%) [12.5–15.2]	375 (11.0%)
Admission assessment	864 (36.7%) [34.7–38.6]	1,101 (32.2%)
Bed unavailability	247 (10.5%) [9.3–11.8]	277 (8.1%)
COVID-19 positivity	183 (7.8%) [6.8–8.9]	201 (5.9%)

Patient-level indicators reflect documentation in any consultation. Lack of documentation does not establish clinical absence. Imaging/procedure references do not confirm performance. The broad malignancy indicator was omitted pending clarification of its definition. Hypoxemia denominators include all patients or records, not only those with a documented SpO_2 measurement. Fever indicates a narrative mention of the symptom or clinical finding and does not require a recorded numerical temperature. This differs from Table 5, which reports the availability of numerical body temperature measurements, regardless of whether the temperature was elevated.

Table 4 Annual volume and seasonal distribution

Period	Consultations n	%
A Annual volume		
2020	417	—
2021	387	—
2022	353	—
2023	541	—
2024	654	—
2025	503	—
B Seasonal distribution		
Winter	860	(30.1%)
Spring	701	(24.6%)
Summer	636	(22.3%)
Autumn	658	(23.0%)

2020–2025; n=2,855. Monthly record availability does not independently verify complete capture. Record-level confidence intervals are not reported.

Table 5 Numerical vital-sign documentation in consultation narratives

Vital sign	Recorded in consultation narratives, n (%)	Median [IQR]
SpO_2 (%)	2,536 (74.1%)	91 [85–96]
Systolic BP (mmHg)	1,314 (38.4%)	126 [110–142]
Body temperature (°C)	482 (14.1%)	37 [36–38]
Heart rate (beats/min)	213 (6.2%)	96 [84–107]

Percentages represent the proportion of the 3,422 consultation records containing a numerical value for each vital sign, rather than the proportion of encounters in which the vital sign was measured. Absence of a numerical value in the consultation narrative does not imply that the measurement was not performed. Medians and interquartile ranges were calculated only from records containing the relevant numerical value.

Supplementary Table S1 Sensitivity analysis by index period

Characteristic	Full period	Index in 2020–2025
Unique patients	2356	1954
Age median [IQR]	65.9 [54.0–75.3]	66.0 [54.0–75.4]
Pneumonia / lower respiratory tract infection	634 (26.9%)	544 (27.8%)
Evaluation for suspected pulmonary embolism	615 (26.1%)	504 (25.8%)
Lung malignancy	248 (10.5%)	198 (10.1%)
Respiratory failure	190 (8.1%)	160 (8.2%)
Pleural effusion	189 (8.0%)	148 (7.6%)
Hemoptysis	119 (5.1%)	98 (5.0%)
Unclassified dyspnea	88 (3.7%)	74 (3.8%)
COPD / asthma exacerbation	66 (2.8%)	61 (3.1%)
Pneumothorax	52 (2.2%)	45 (2.3%)
Stable chronic airway disease	37 (1.6%)	33 (1.7%)
Unclassified / other	34 (1.4%)	23 (1.2%)
Interstitial lung disease	33 (1.4%)	29 (1.5%)
Administrative / procedure-related	21 (0.9%)	18 (0.9%)
Active tuberculosis	9 (0.4%)	7 (0.4%)
Insufficient text	7 (0.3%)	1 (<0.1%)
Bronchiectasis	5 (0.2%)	4 (0.2%)
Pulmonary hypertension	4 (0.2%)	3 (0.2%)
Preoperative assessment	4 (0.2%)	3 (0.2%)
Tuberculosis sequelae	1 (<0.1%)	1 (<0.1%)

Restricted to patients with their first recorded consultation in 2020–2025; patients first recorded in earlier years were not included in this subset.

Figure Legend

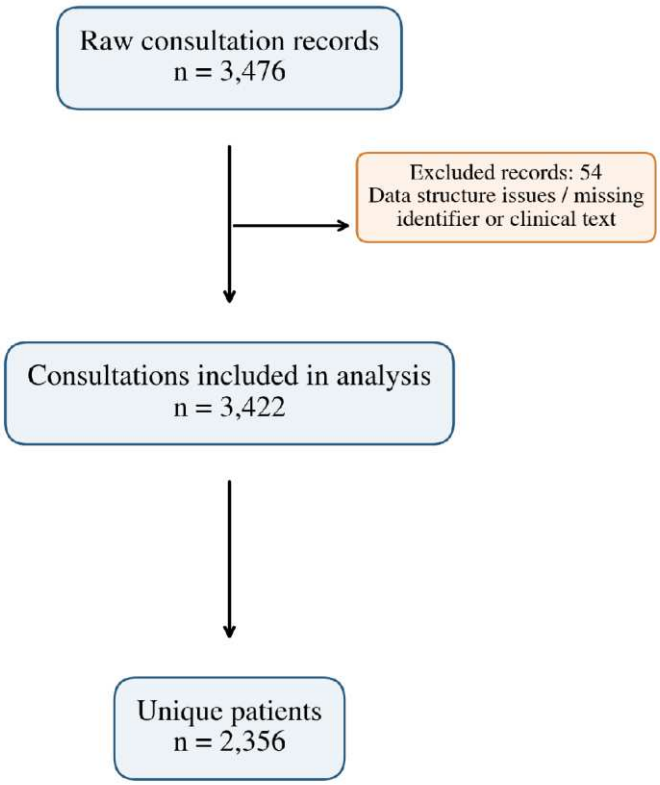


Figure 1 Study population flow

The 54 exclusions included 17 data structure validation issues, 31 missing patient numbers, 1 missing clinical assessment, and 5 other validation issues.

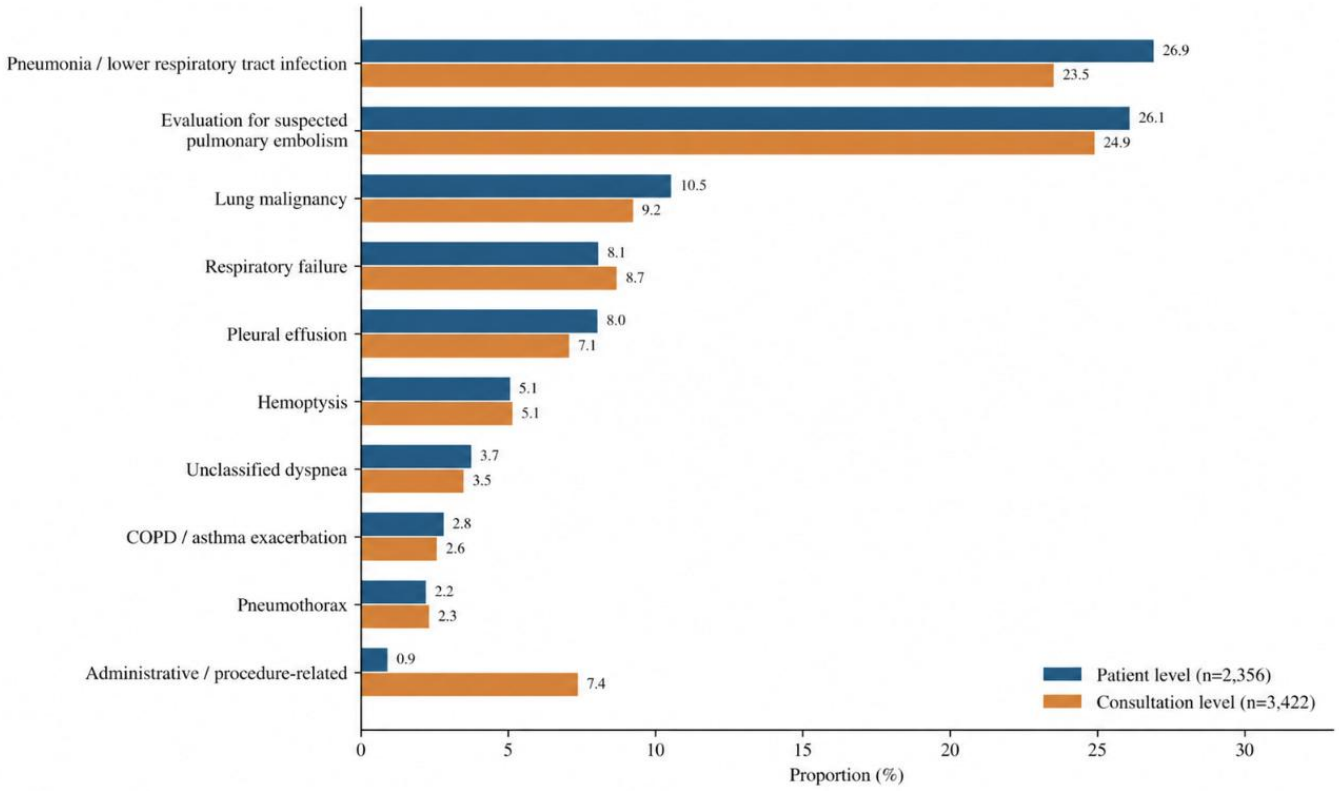


Figure 2 Distribution of leading clinical topics at the patient and consultation levels

The nine most frequent index categories and the administrative/procedure category are shown; all categories are listed in Table 2. Patient-level categories reflect the first recorded consultation. Denominators are 2,356 patients and 3,422 consultations.

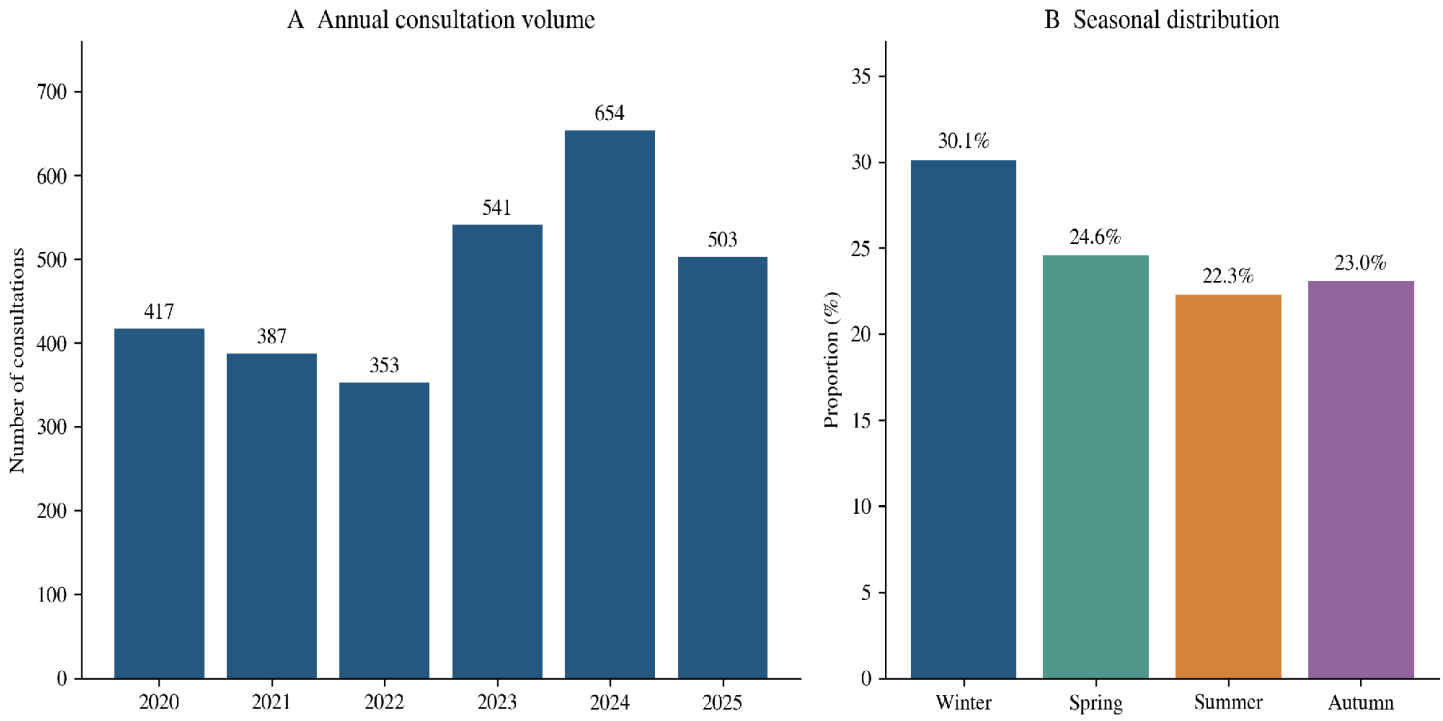


Figure 3 Annual consultation volume and seasonal distribution

Only 2020–2025 (n=2,855) is shown. A: annual record counts. B: seasonal proportions across the period.

Supplementary Methods S2 Physician review of clinical categories

An internal medicine physician and a pulmonologist jointly reviewed the automatically assigned clinical categories for all 3,422 included consultation records. The consultation request and pulmonologist's assessment and recommendations were considered together. Categories were corrected where necessary, and final assignments were determined by consensus. These final categories were used in patient-level and consultation-level analyses.

Scope of the review

The reported review covered the automatically assigned clinical categories. It must not be interpreted as confirmation that patient linkage, duplicate detection, or extraction of every individual symptom, comorbidity, vital-sign indicator, or procedure reference underwent the same review.

Contextual assignment rules

The dominant topic was the principal issue evaluated or managed in the consultation. A diagnosis mentioned only as a historical condition or background comorbidity did not by itself determine the category. Negated findings were not treated as positive diagnoses. An explicitly investigated clinical question, such as assessment for possible pulmonary embolism, could remain the dominant topic even when the condition was subsequently excluded; the category describes the consultation topic rather than a confirmed diagnosis. When multiple topics were present, the physicians interpreted the assessment and recommendations together and selected the principal issue by consensus, without a fixed hierarchy based solely on keywords or disease severity. Procedure-related or administrative wording did not supersede an active clinical problem that was the main focus. Preoperative assessment was distinguished from other administrative or procedure-related requests. Insufficient text was distinguished from adequately documented topics that did not fit a named category. No kappa, sensitivity, specificity, or other performance estimates were calculated from the joint review; neither independent annotations nor a quantified correction audit were available for reporting.

Supplementary Table S2 Operational definitions of clinical consultation topics

Definitions describe the final physician-reviewed clinical topics. Expressions are illustrative English equivalents of clinical wording, not an exhaustive list of implemented algorithm keywords. Assignment depends on the consultation context and the principal issue evaluated or managed. These categories do not establish confirmed diagnoses.

Category	Operational definition	Illustrative wording and distinctions
Pneumonia / lower respiratory tract infection	Evaluation or management of suspected or documented pneumonia or lower respiratory tract infection.	Pneumonia; lower respiratory tract infection; infective infiltrate. An infiltrate alone does not establish infection.
Evaluation for suspected pulmonary embolism	Assessment for possible pulmonary embolism, including its investigation or exclusion.	Suspected PE; rule out PE; CT pulmonary angiography for PE. A historical PE alone does not qualify.
Lung malignancy	Evaluation or management focused on suspected or known pulmonary malignancy.	Lung cancer; suspicious lung mass; malignancy work-up. Background cancer alone does not determine the topic.
Respiratory failure	Evaluation or management focused on respiratory failure or ventilatory support.	Respiratory failure; hypercapnic failure; ventilatory support. Oxygen use or isolated desaturation alone is insufficient.
Pleural effusion	Assessment or management of pleural fluid as the main consultation issue.	Pleural effusion; pleural fluid; thoracentesis for effusion. Incidental fluid alone does not determine the topic.
Hemoptysis	Evaluation or management of reported lower respiratory tract bleeding.	Hemoptysis; blood-stained sputum. Negated bleeding or a remote episode alone does not qualify.
Unclassified dyspnea	Dyspnea is the main issue without a more specific dominant clinical topic.	Dyspnea; breathlessness. Use a specific category when it better represents the main assessment.
COPD / asthma exacerbation	Assessment or management focused on an acute exacerbation of COPD or asthma.	COPD exacerbation; asthma attack; acute worsening of airway disease. Stable disease history alone does not qualify.
Pneumothorax	Assessment or management focused on suspected or documented pneumothorax.	Pneumothorax; pleural air. A negated incidental mention alone does not qualify.
Stable chronic airway disease	Consultation focused on COPD or asthma without a documented acute exacerbation as the main issue.	Stable COPD; asthma treatment review. Distinguish from acute exacerbation.
Unclassified / other	An adequately documented consultation topic that does not fit a named category.	Other respiratory issue; no suitable named category. Do not use merely because text is insufficient.
Interstitial lung disease	Assessment or management focused on suspected or known interstitial lung disease.	ILD; pulmonary fibrosis; interstitial disease evaluation. An incidental imaging phrase alone is insufficient.
Administrative / procedure-related	An administrative request or procedure-related task is the principal purpose, without another dominant active clinical topic.	Report request; procedural coordination; procedure-related consultation. Disease-directed procedures follow the dominant clinical problem; preoperative assessment is separate.

Category	Operational definition	Illustrative wording and distinctions
Active tuberculosis	Consultation focused on evaluation or management of suspected or documented active tuberculosis.	Suspected active TB; active pulmonary TB; TB treatment assessment. Remote treated TB alone is insufficient.
Insufficient text	Available narrative does not permit identification of a meaningful dominant consultation topic.	Absent, minimal, or uninterpretable clinical text. Distinguish from an adequately documented other topic.
Bronchiectasis	Assessment or management focused on bronchiectasis.	Bronchiectasis; bronchiectasis-related symptoms. A background diagnosis alone does not determine the topic.
Pulmonary hypertension	Assessment or management focused on suspected or known pulmonary hypertension.	Pulmonary hypertension; PH evaluation. A background diagnosis alone does not determine the topic.
Preoperative assessment	Respiratory assessment requested principally to evaluate suitability or risk before surgery.	Preoperative respiratory assessment; surgical risk assessment. Separate from other administrative or procedural requests.
Tuberculosis sequelae	Consultation focused on residual pulmonary effects of previous tuberculosis, without active TB as the main issue.	Post-TB changes; TB sequelae. Distinguish from evaluation of active tuberculosis.