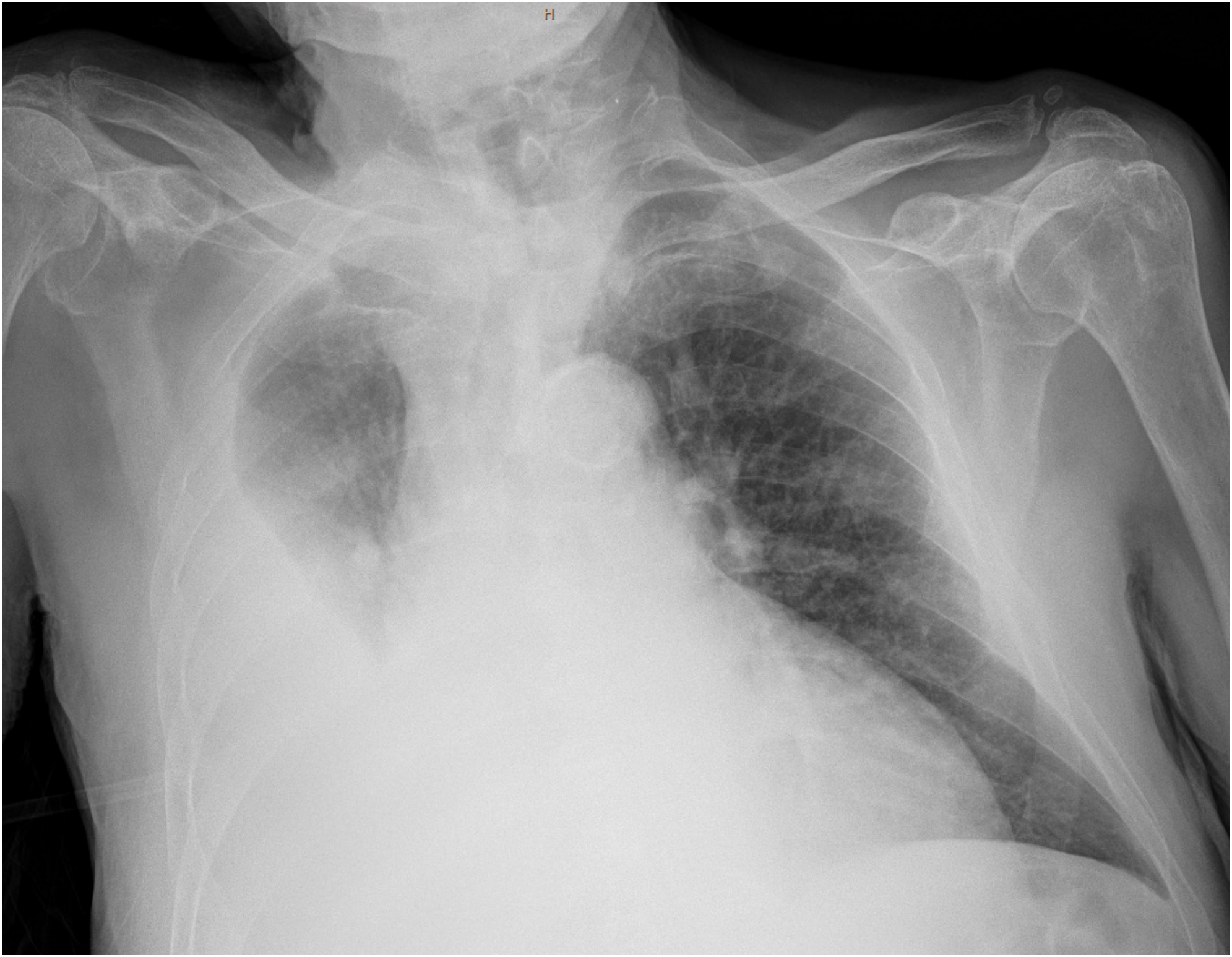
Predicción de la causa de un derrame pleural: generación de modelos de diagnóstico etiológico

Unidad de Medicina Pleural

HUAV

Unidad de medicina pleural

- Se atienden a todos los pacientes con derrame pleural
- 3 médicos, 1 enfermera, 2 auxiliares
- 2025
  - Primera visita 1033 pacientes
  - 3256 ecografías
  - 851 toracocentesis (extracción líquido pleural)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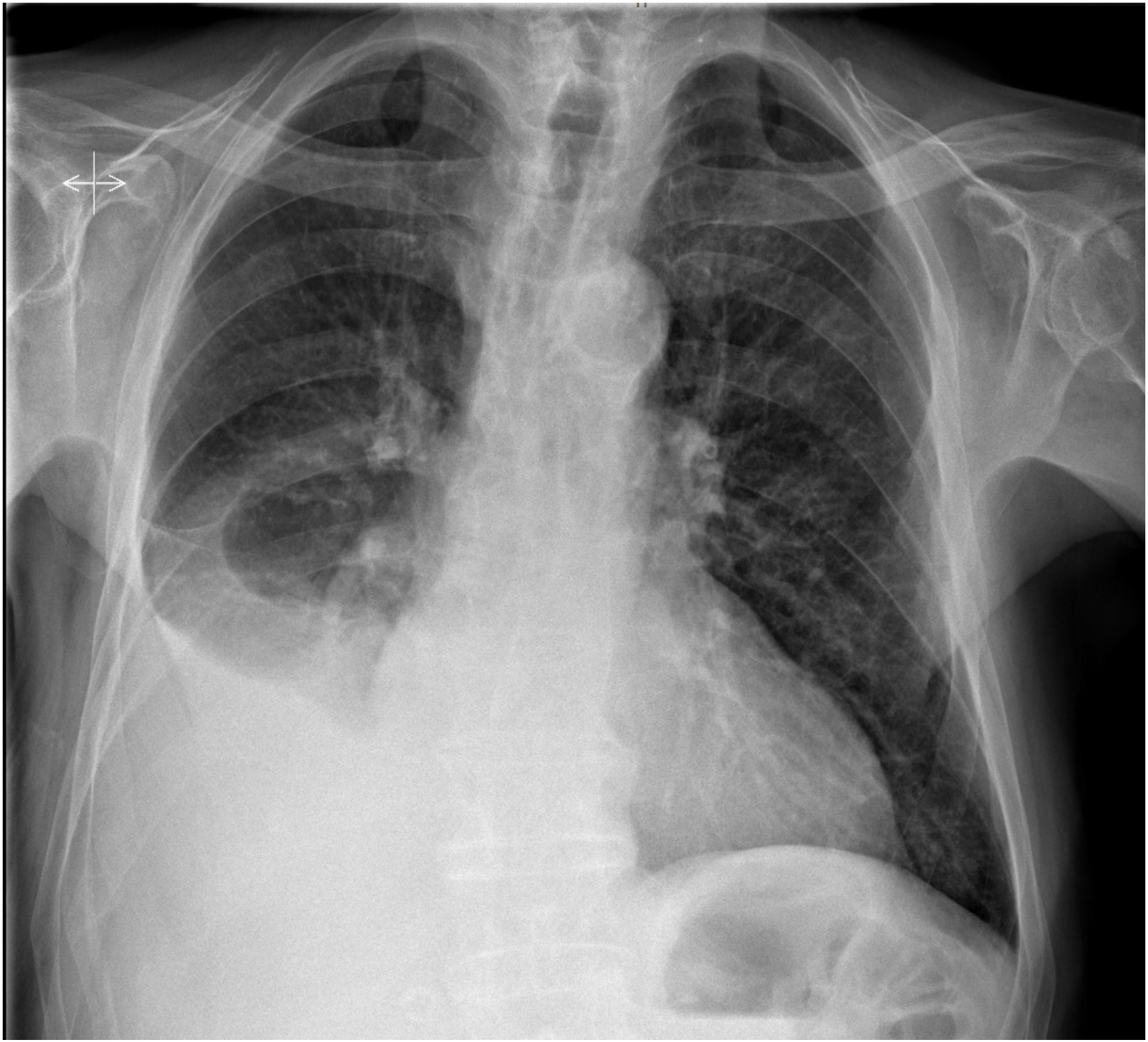


Diagnóstico derrame pleural

- Más de 60 causas de derrame pleural

TABLE 1

Causes and Types of Pleural Effusions

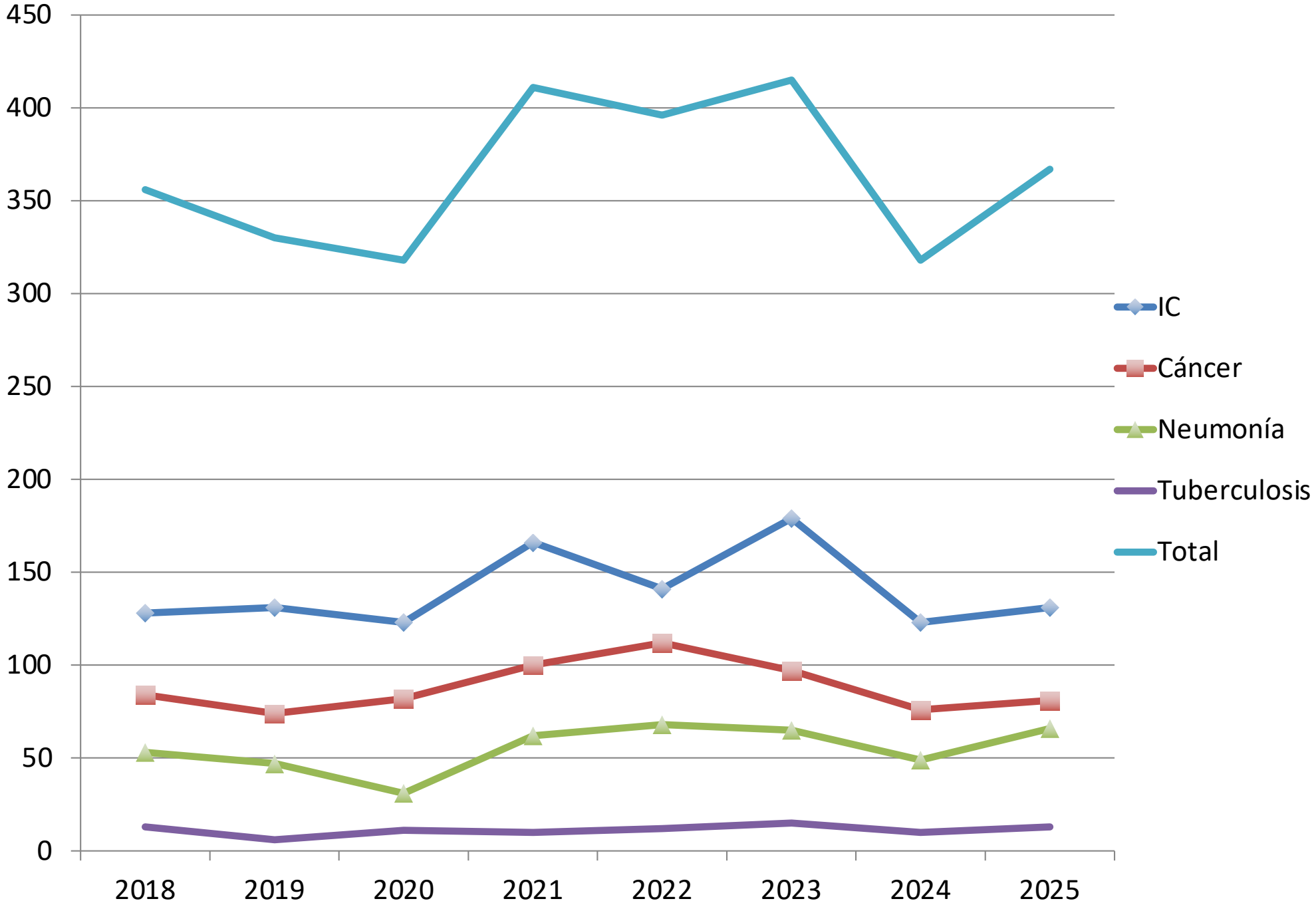
Causes	Transudative	Exudative	
Common[5]	Cirrhosis	Bacterial pneumonia	Postcardiac bypass surgery
	Heart failure	Idiopathic	Pulmonary embolism
	Hepatic hydrothorax	Malignancy	Trauma
		Lung cancer	Tuberculosis
		Lymphoma	Viral disease
		Metastasis (e.g., breast, colon)	
Less common[4]	Cardiovascular	Cardiovascular	Pulmonary
	Superior vena cava obstruction	Pericardial disease	Benign asbestos effusion
	Genitourinary	Post myocardial infarction	Mesothelioma
	Nephrotic syndrome (high risk for pulmonary embolism)	Gastrointestinal	Other
	Peritoneal dialysis	Abdominal surgery	Chylothorax (e.g., idiopathic, lymphangioleiomyomatosis, neoplasm, trauma, tuberculosis)
	Urinothorax	Esophageal rupture	Medication induced*[3]
	Other	Intra-abdominal infection	Amiodarone
	Cerebrospinal fluid leak to pleura	Pancreatic disease	Clozapine (Clozaril)
	Myxedema	Genitourinary	Dantrolene (Dantrium)
		Catamenial hemothorax (thoracic endometriosis)	Ergot alkaloids
		Meigs syndrome (benign ovarian tumor with ascites and pleural effusion)	Methotrexate
		Ovarian hyperstimulation syndrome	Nitrofurantoin
		Postpartum effusion	Phenytoin
		Infectious	Tyrosine kinase inhibitors
		Fungal infection	Pseudochylothorax (e.g., rheumatoid arthritis, tuberculosis)
		Parasitic infection (lung fluke, amoebiasis, and echinococcus/ruptured hydatid cyst)[6]	Rheumatologic disorders
			Lupus
			Rheumatoid arthritis
			Yellow nail syndrome

*–See https://www.pneumotox.com.

Adapted with permission from Saguil A, et al. Diagnostic approach to pleural effusion. Am Fam Physician. *2014;90(2):100, with additional information from references 3 and 5-7.*

Diagnóstico

- 75% de los casos: 4 causas
  - Insuficiencia cardiaca
  - Cáncer
  - Neumonía
  - Tuberculosis


450
400
350
300
250
200
150
100
50
0
2018
2019
2020
2021
2022
2023
2024
2025
IC
Cáncer
Neumonía
Tuberculosis
Total

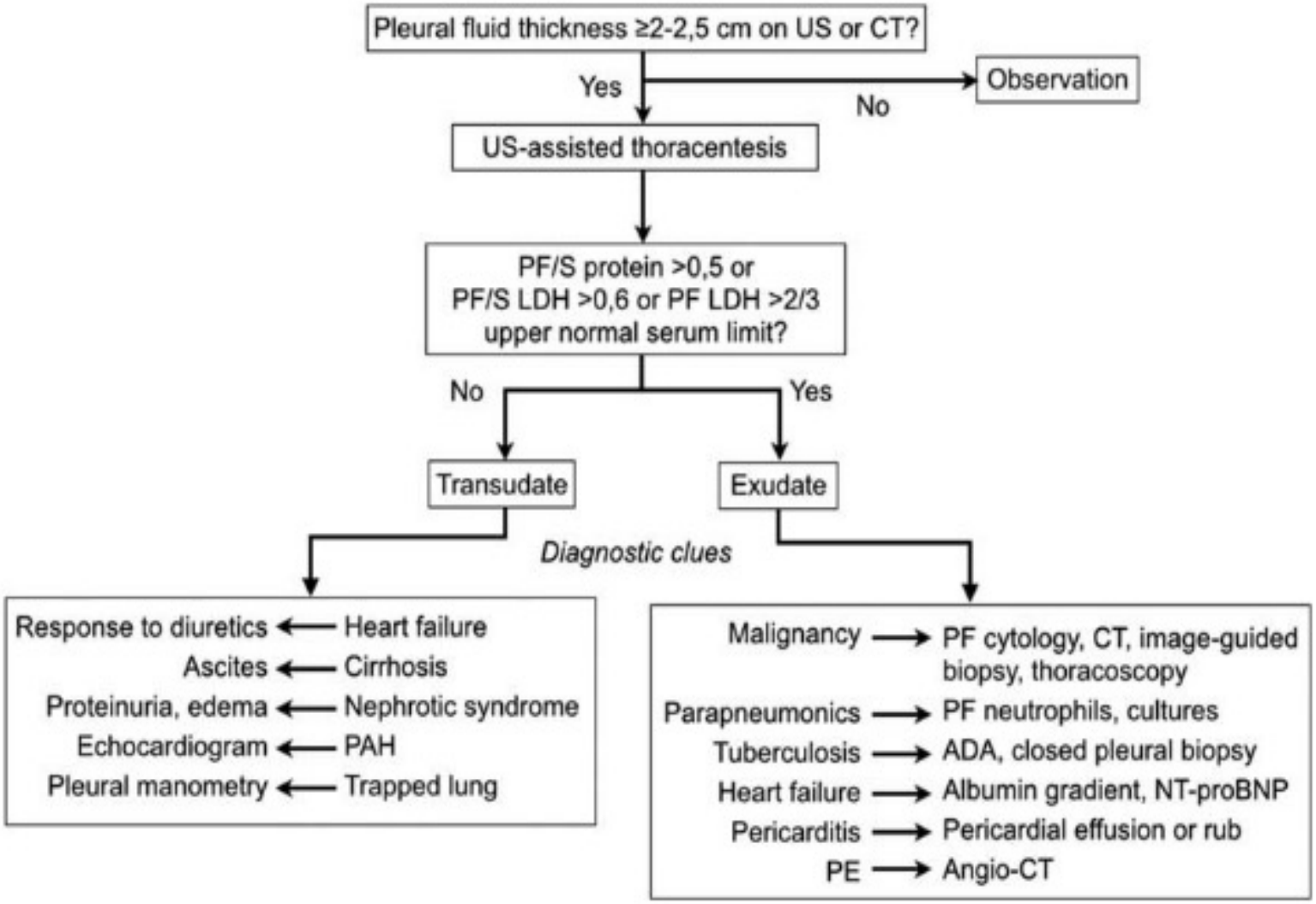
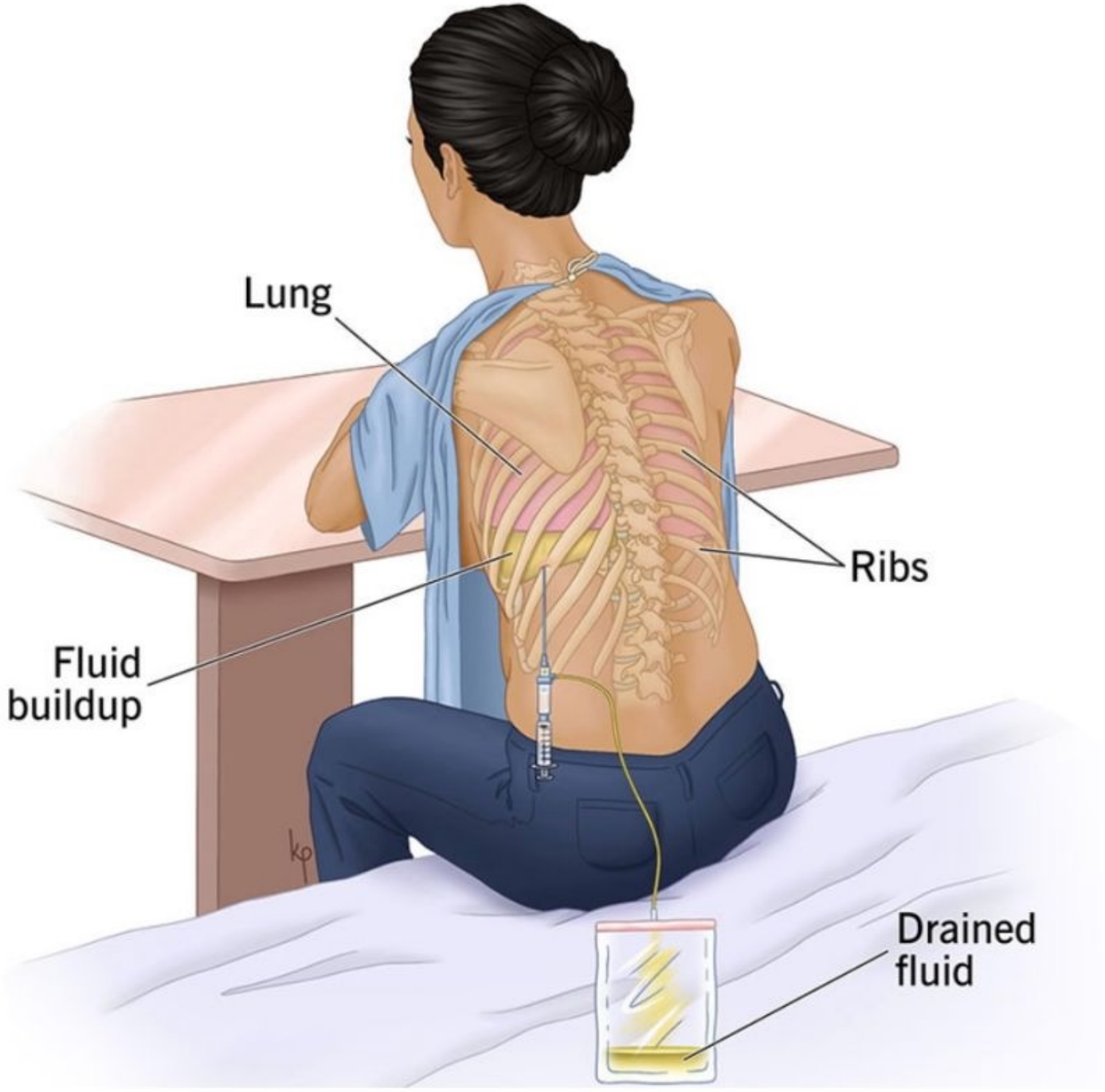


Figure 1. Approach to the diagnosis of pleural effusions.[1,6]
ADA, adenosine deaminase; CT, computed tomography; LDH, lactate dehydrogenase; NT-proBNP, amino terminal fraction of pro-brain natriuretic peptide; PAH, pulmonary arterial hypertension; PE, pulmonary embolism; PF, pleural fluid; PF/S, pleural fluid to serum; US, ultrasonography.

Porcel el al. Expert Rev Respir Med. 2015;9:801-15.

Thoracentesis



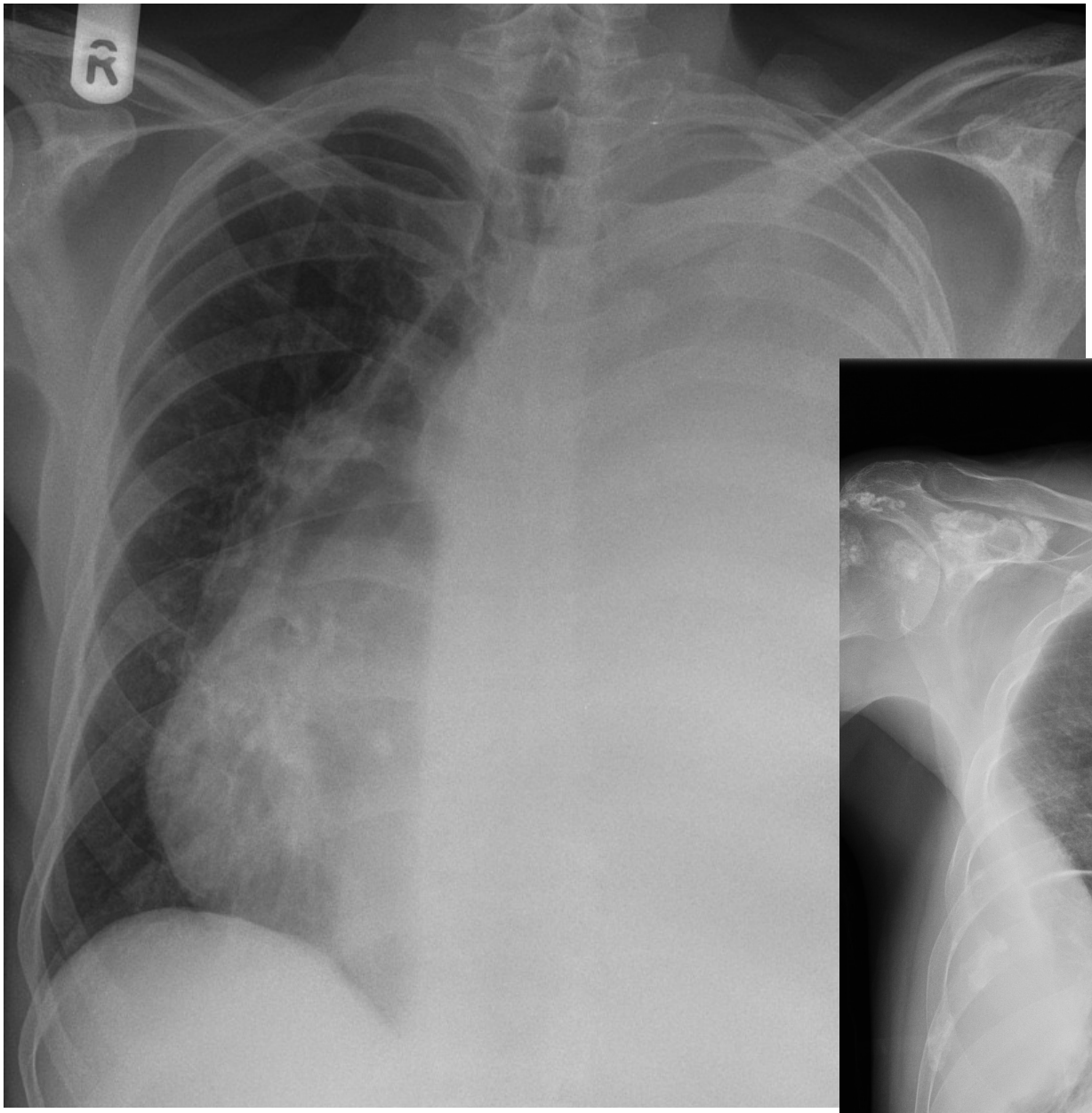
NT- Propèptid natriurètic tipus B (NT-proBNP) L.Pleural Immunoassaig d'electroquimioluminiscència "ECLIA"	**	**2101.0**		pg/mL	.0	- 1500.0

ANALISI DE LÌQUID PLEURAL

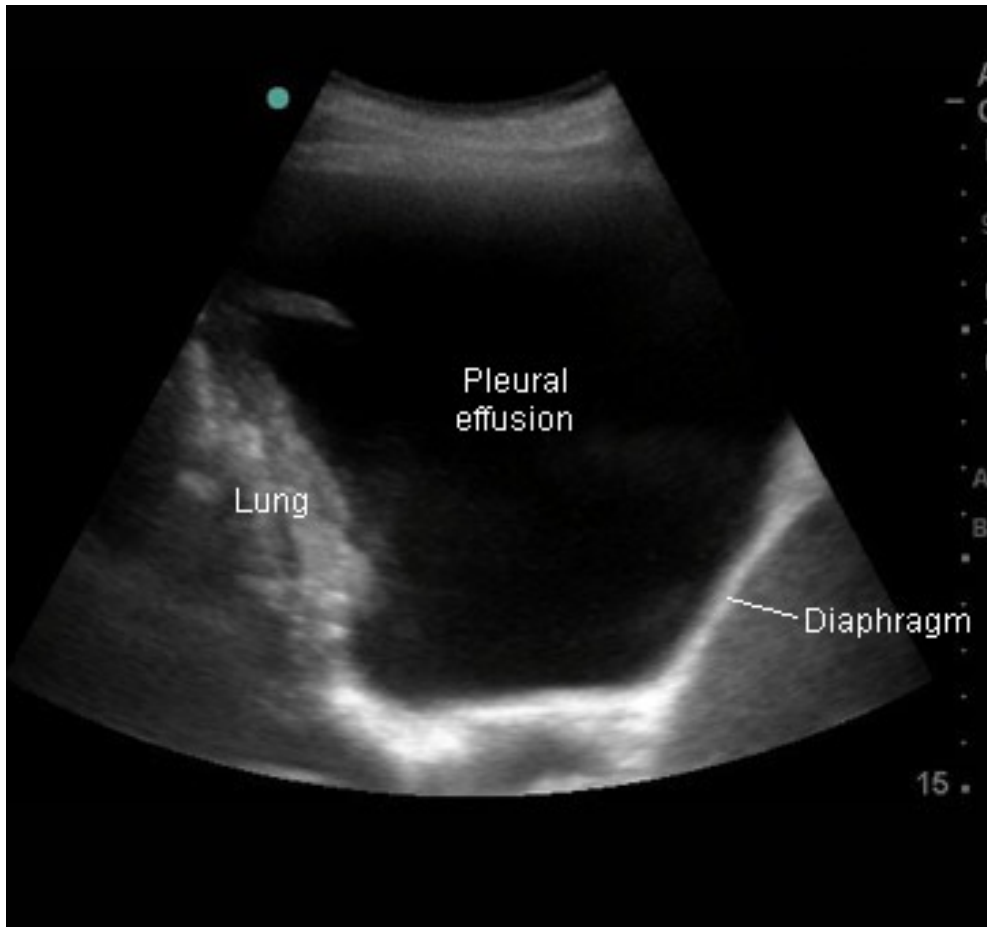
Aspecte líquid pleural		**Clar**			
Hematies líquid pleural Comptador automàtic		**200**		cel / mm3	
Leucòcits líquid pleural Comptador automàtic		**52**	cel / mm3 No procedeix realitzar la fòrmula		
Glucosa líquid pleural		**114.8**	**mg/dL**		
Proteïnes líquid pleural		**3.3**	**g/dL**		
LDH líquid pleural	**	**353.0**	**U/L**		
ADA líquid pleural		**8.4**	**U/L**		
Colesterol líquid pleural		**61.0**	**mg/dL**		
Albúmina líquid pleural		**1.8**	**g/dL**		
PCR líquid pleural		**17.7**	**mg/L**		
pH líquid pleural		**7.54**			
CEA líquid pleural Quimioluminiscència (Lumi-phos 530)		**0.9**		ng/mL	
			Per a valorar aquest resultat es recomana comparar-lo amb el obtingut en sèrum.		
CA-15.3 líquid pleural Immunoassaig electroquimioluminiscència "ECLIA"		**9.5**		UI/mL	
			Per a valorar aquest resultat es recomana comparar-lo amb el obtingut en sèrum.		

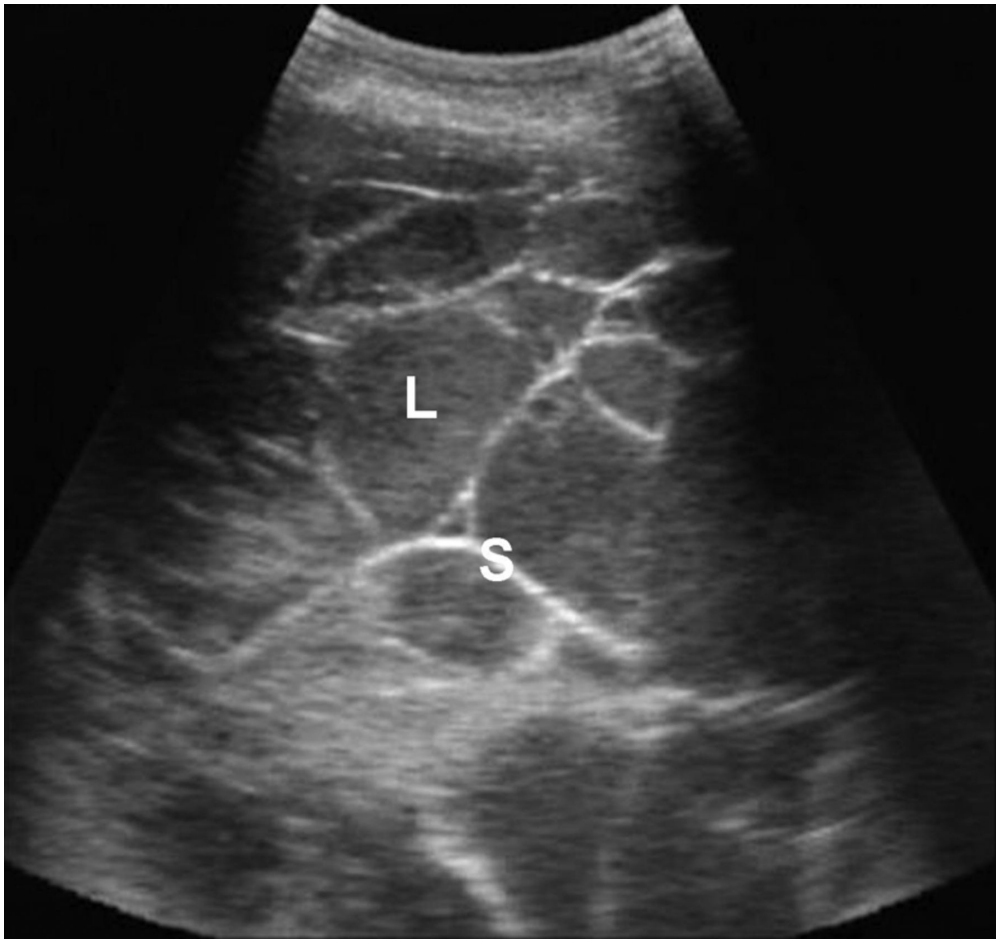
Base de datos

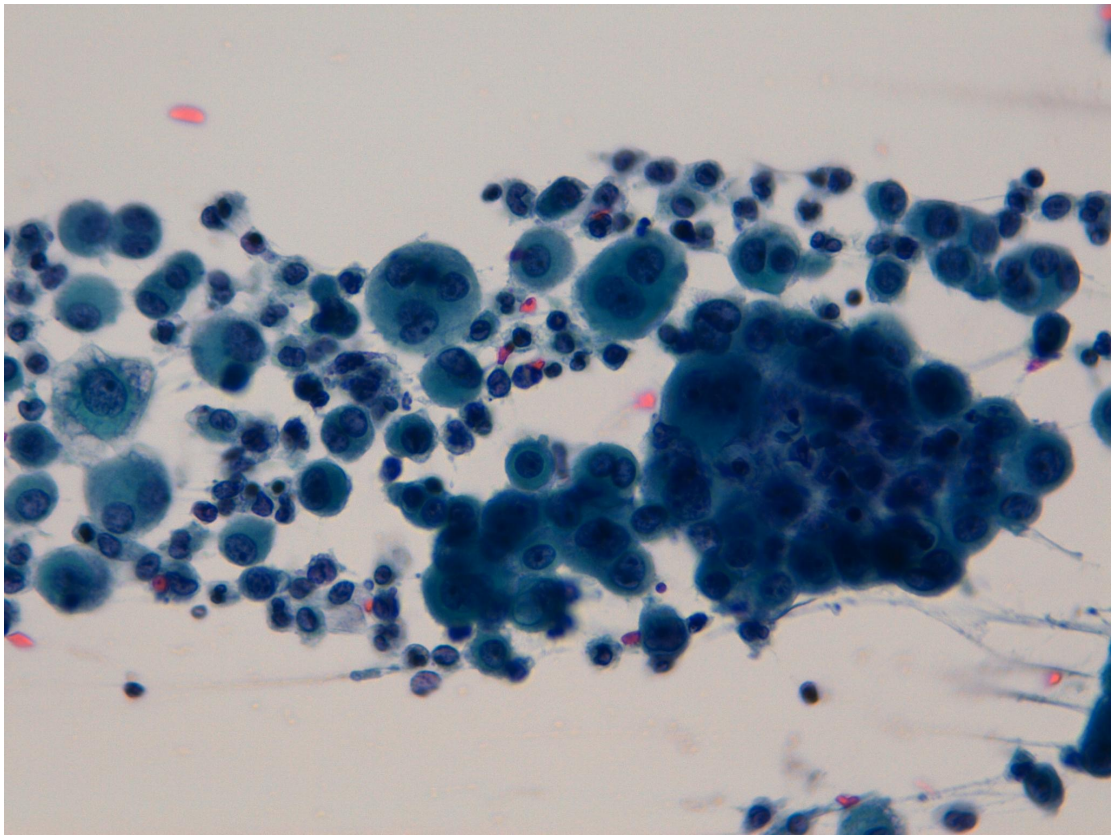
- Más de 7000 pacientes
- Sexo/edad
- Radiológicos
- Bioquímicos
- Citológicos / microbiológicos
- Diagnóstico

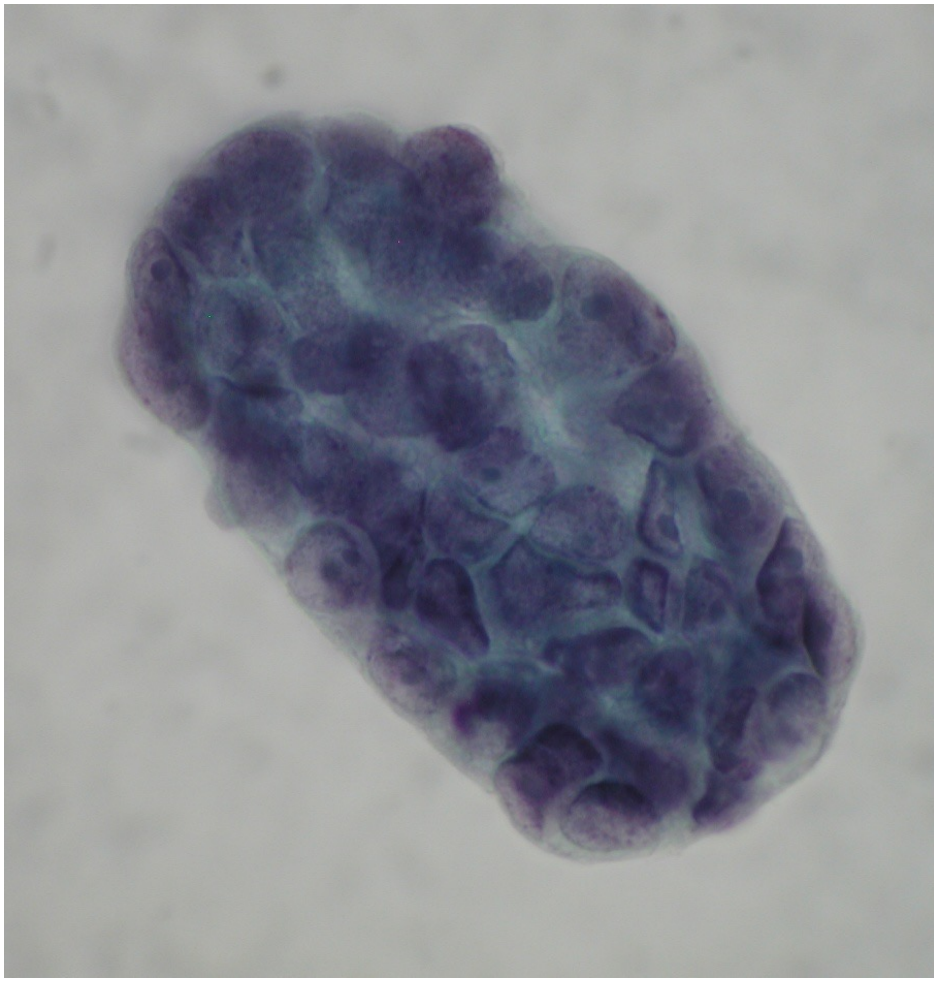

R


L


Pleural
effusion
Lung
Diaphragm
15


L
S





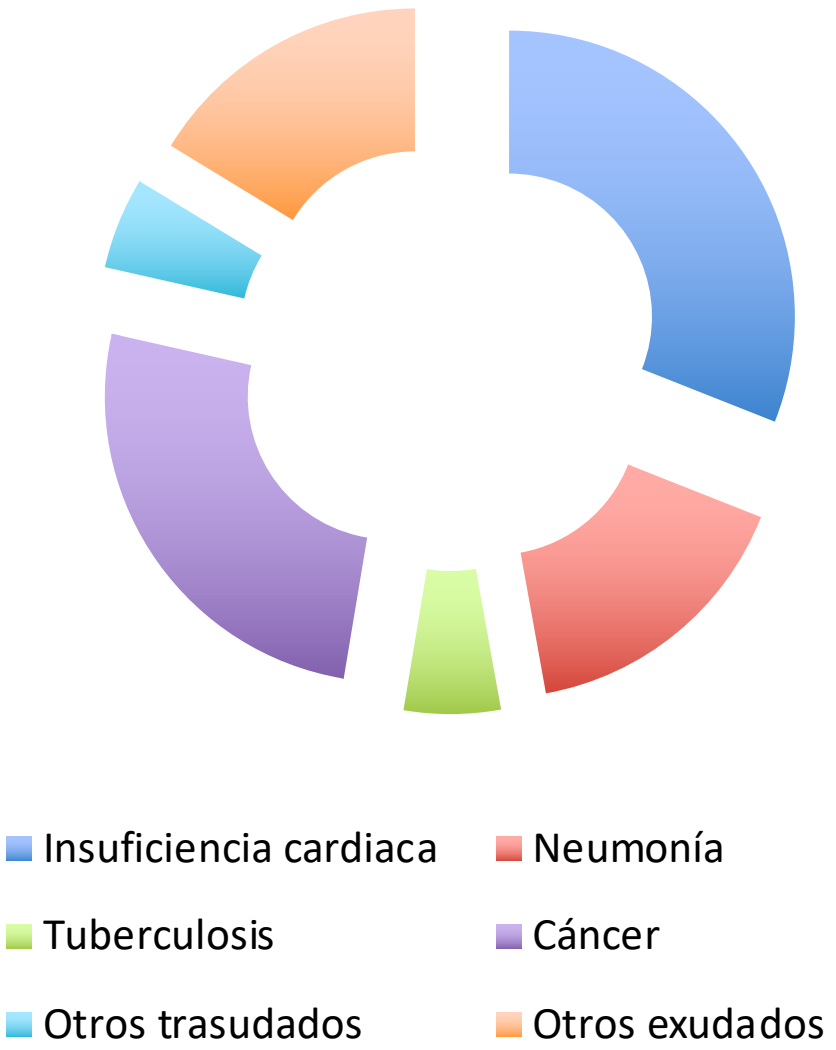
¿Se puede predecir la probabilidad de un diagnóstico en un paciente?

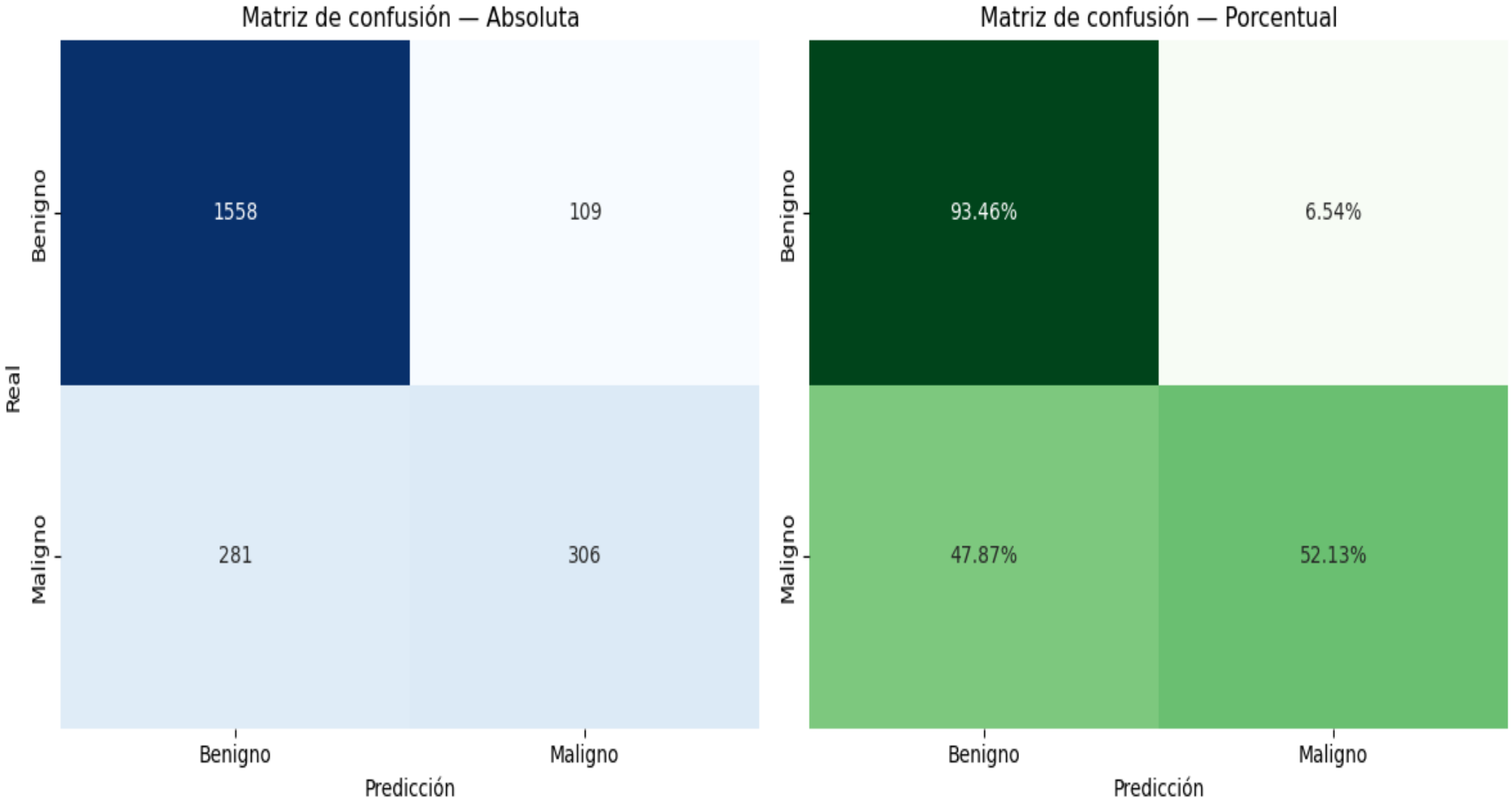
Objetivos

- Identificar datos o conjuntos de datos del paciente o del líquido pleural que se relacionan con una etiología concreta de derrame pleural
- Generar modelos predictivos para grupos diagnósticos de derrame pleural
  - Maligno vs Benigno
  - IC, maligno, neumonía, tuberculosis

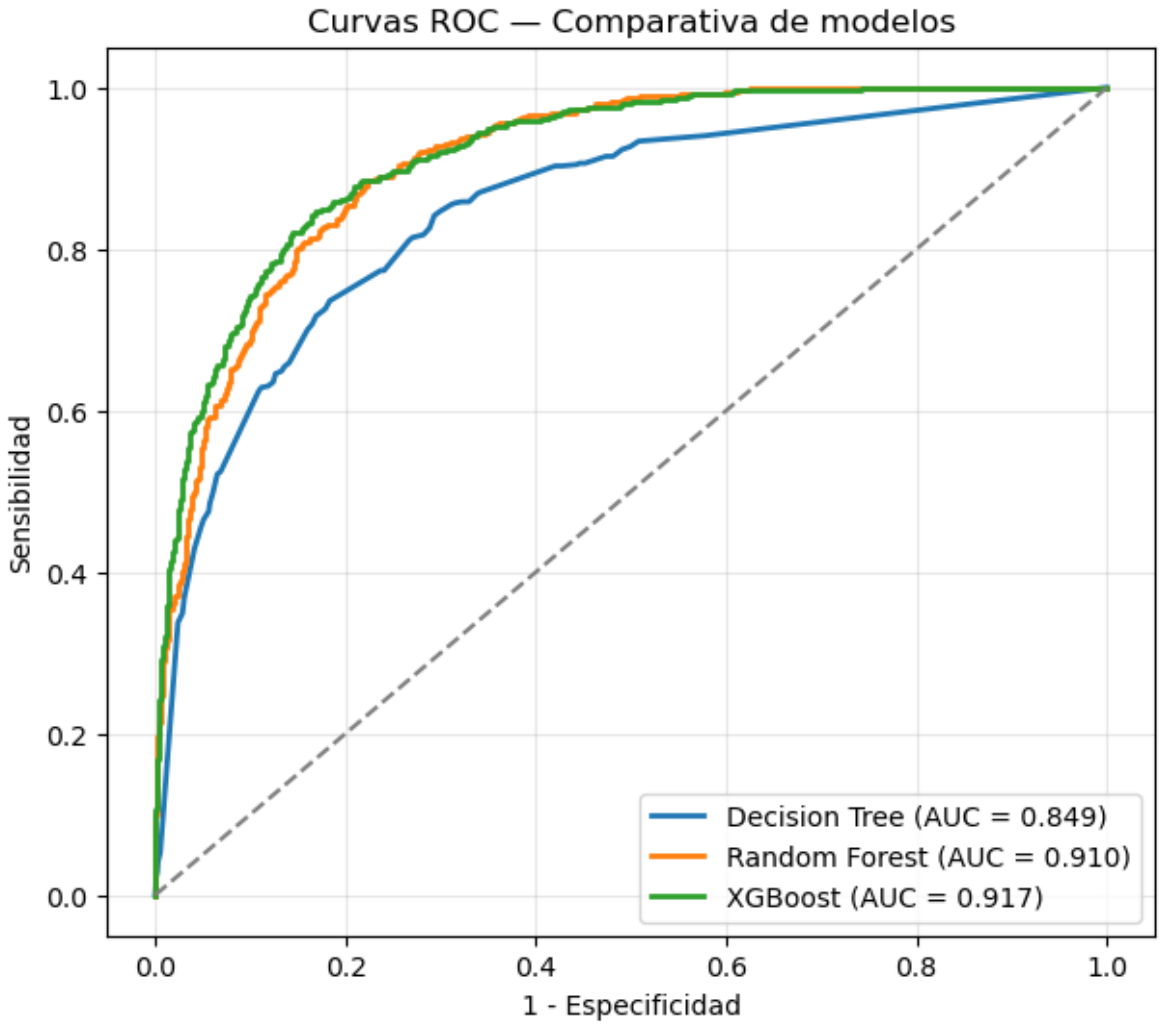
Pacientes

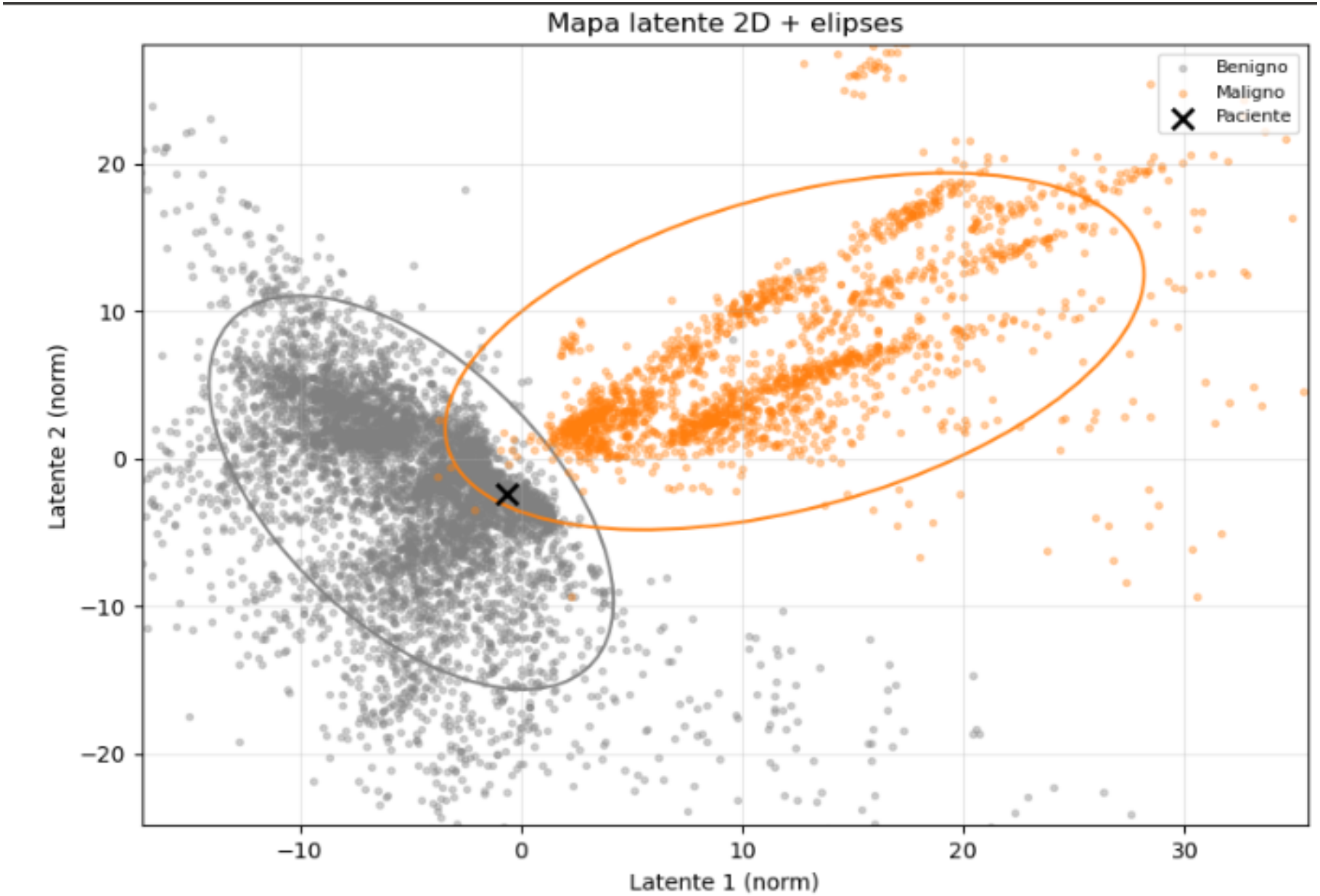
Diagnóstico	Pacientes
Insuficiencia cardiaca	2364 (31%)
Neumonía	1233 (16%)
Tuberculosis	417 (6%)
Cáncer	1975 (26%)
Otros trasudados	395 (5%)
Otros exudados	1243 (16%)
Total	7627 (100%)

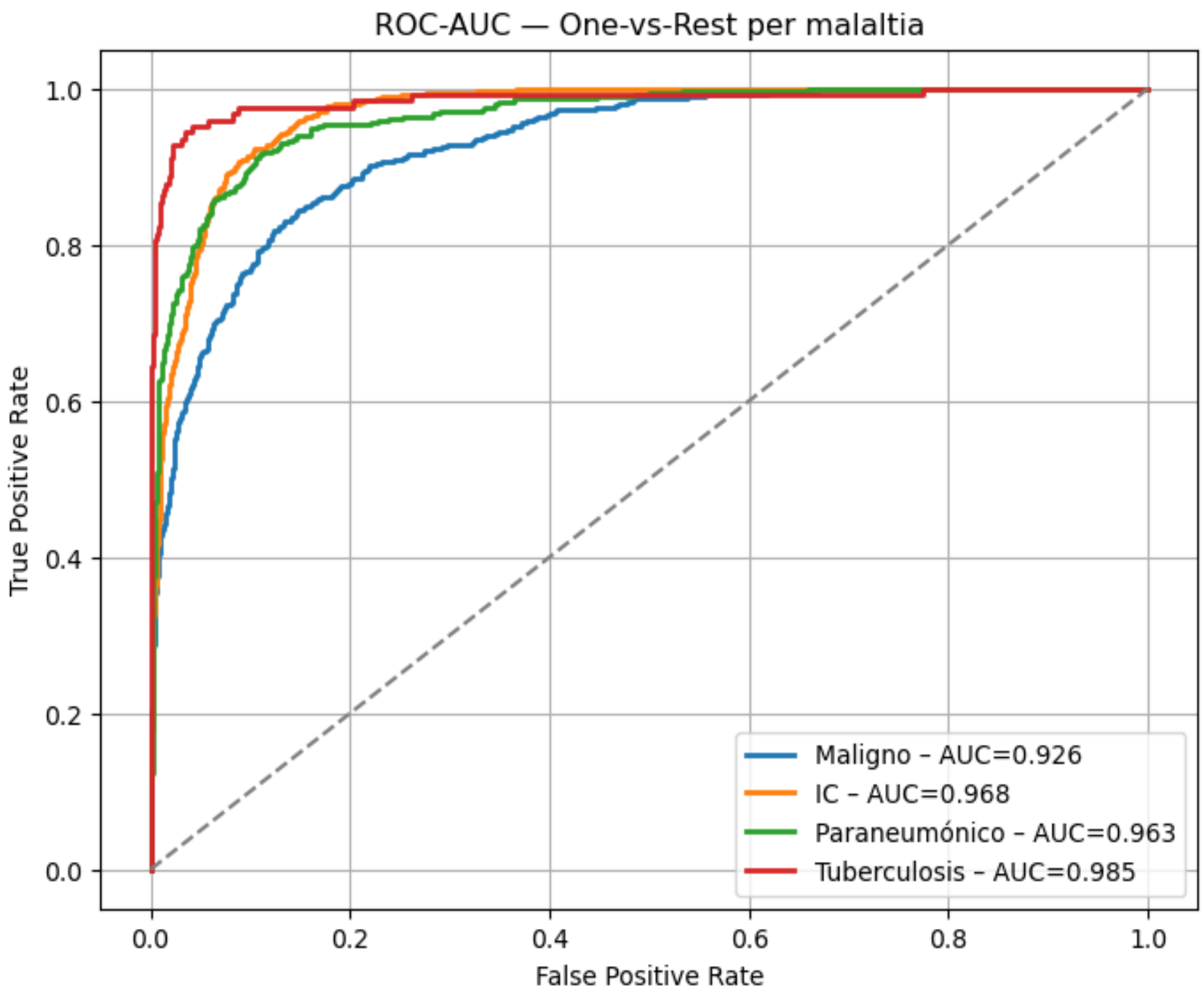


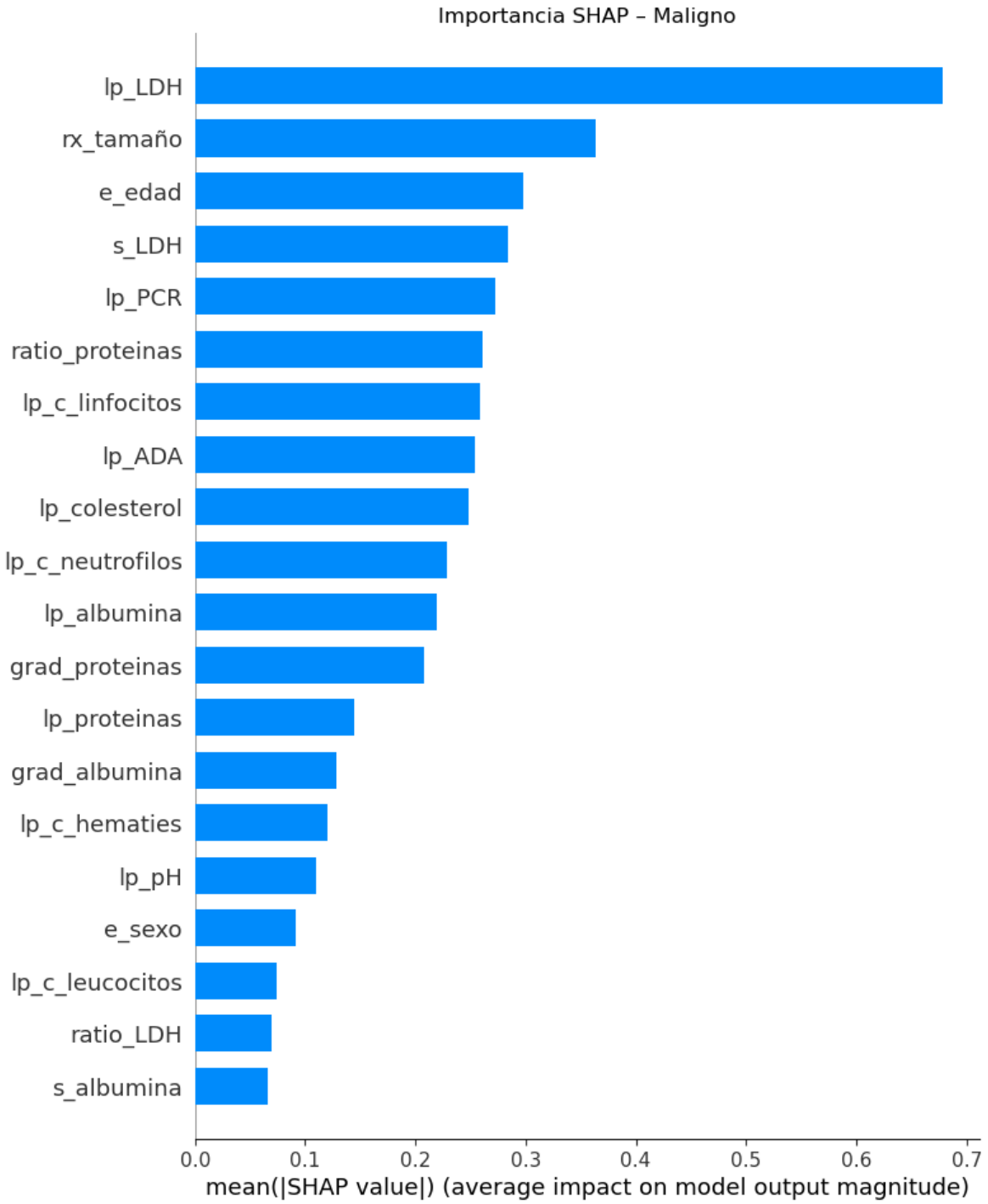

Matriz de confusión — Absoluta
Real
Benigno
Maligno
1558
109
281
306
Benigno
Maligno
Predicción
Matriz de confusión — Porcentual
Benigno
Maligno
93.46%
6.54%
47.87%
52.13%
Benigno
Maligno
Predicción

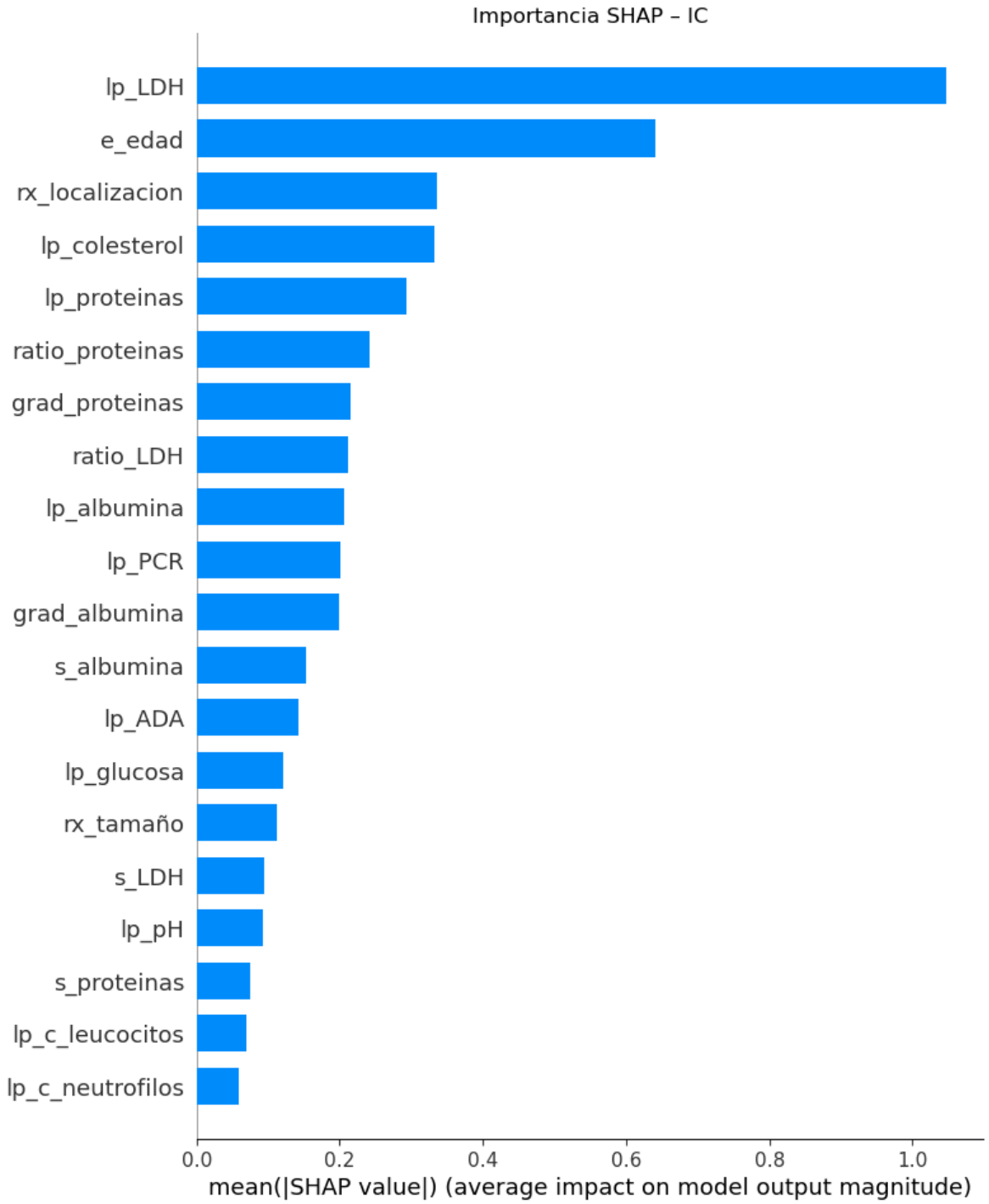
Modelo	Accuracy	ROC	Sensibilidad	Especificidad	Precisión
XGBoost	0.8602	0.9168	0.6695	0.927415	0.764591
Random forest	0.8372	0.9097	0.7956	0.851830	0.654062
Decision tree	0.827	0.8487	0.5213	0.934613	0.737349

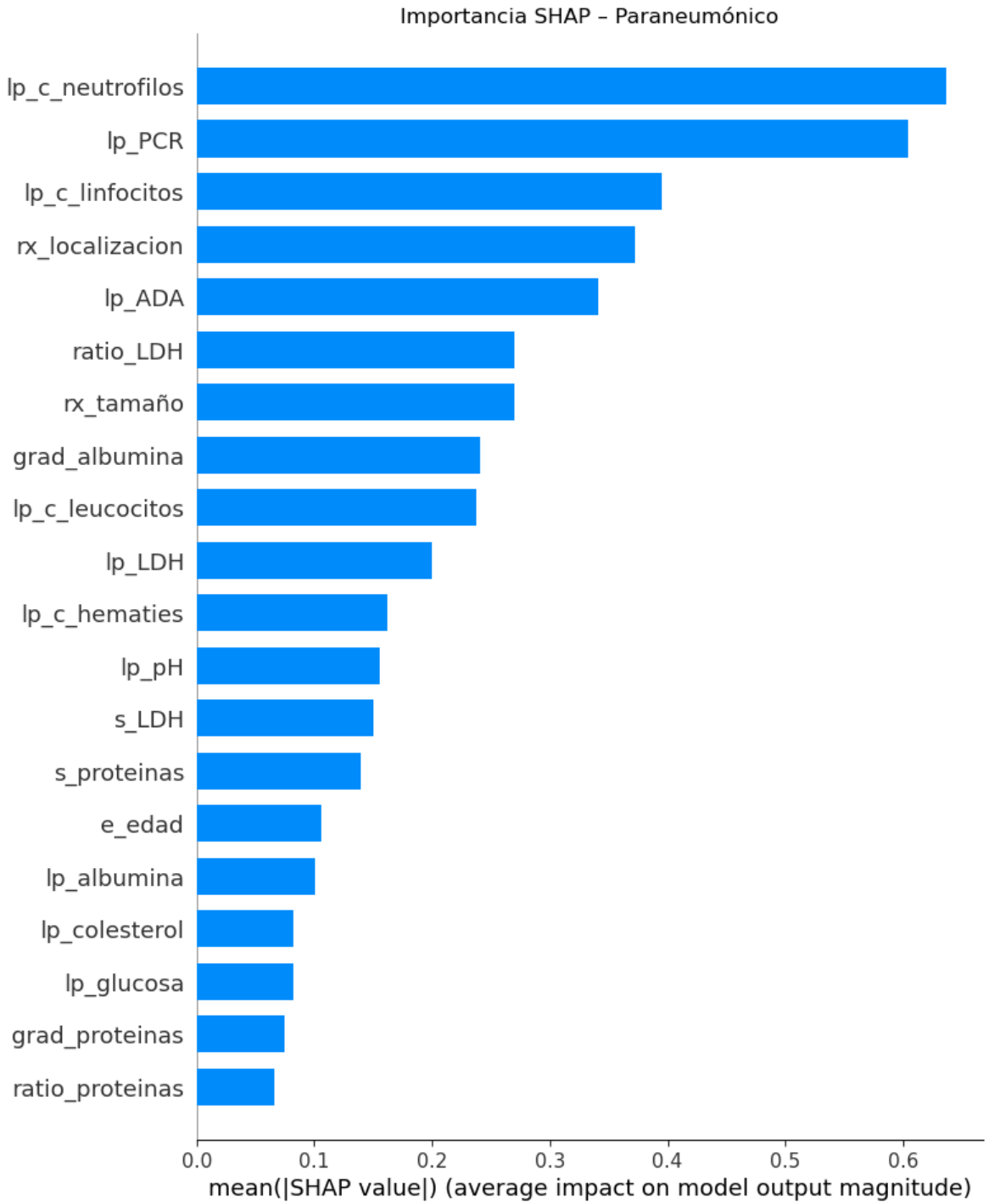


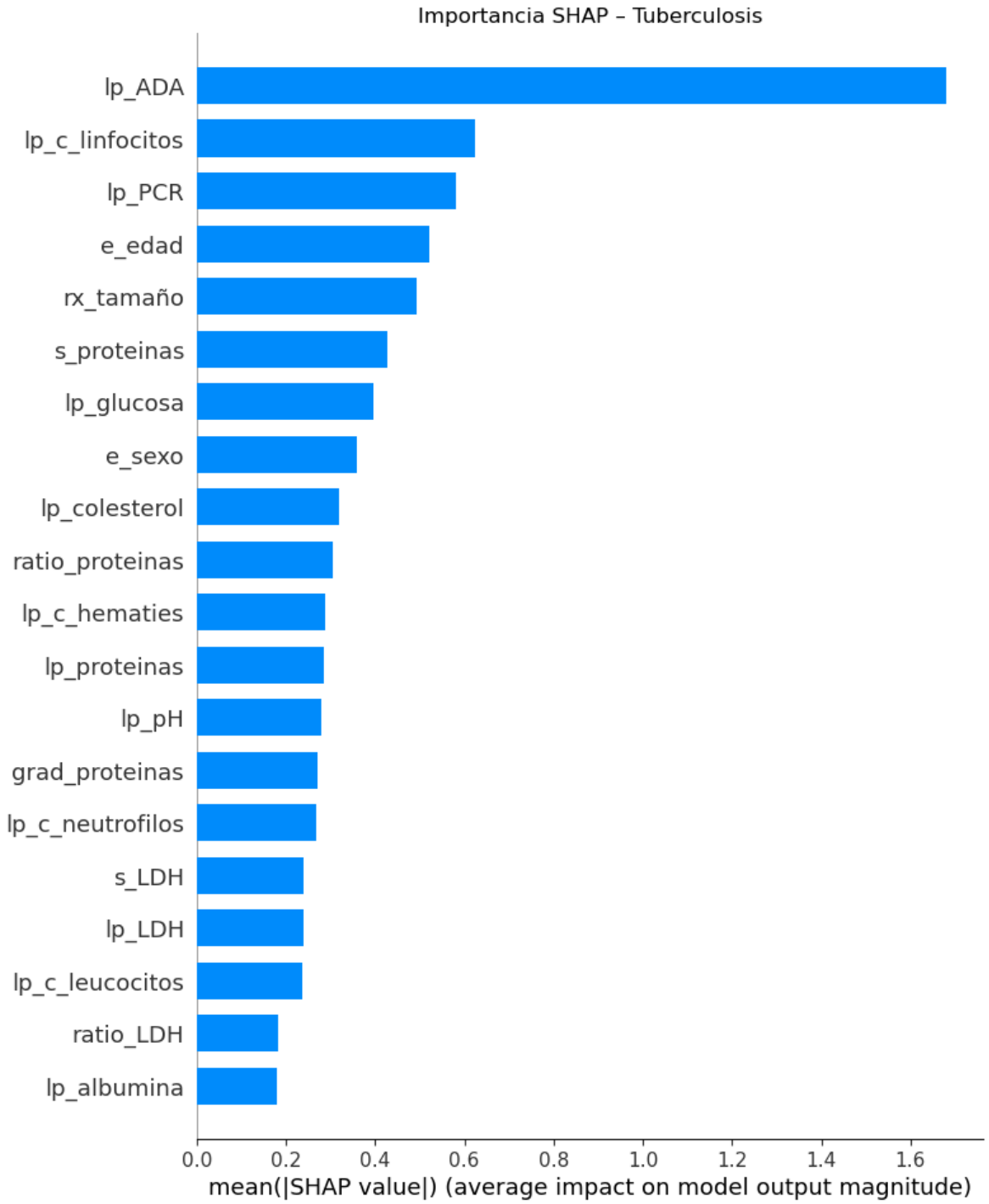

Mapa latente 2D + elipses
Benigno
Maligno
Paciente
Latente 2 (norm)
Latente 1 (norm)
20
10
0
−10
−20
−10
0
10
20
30

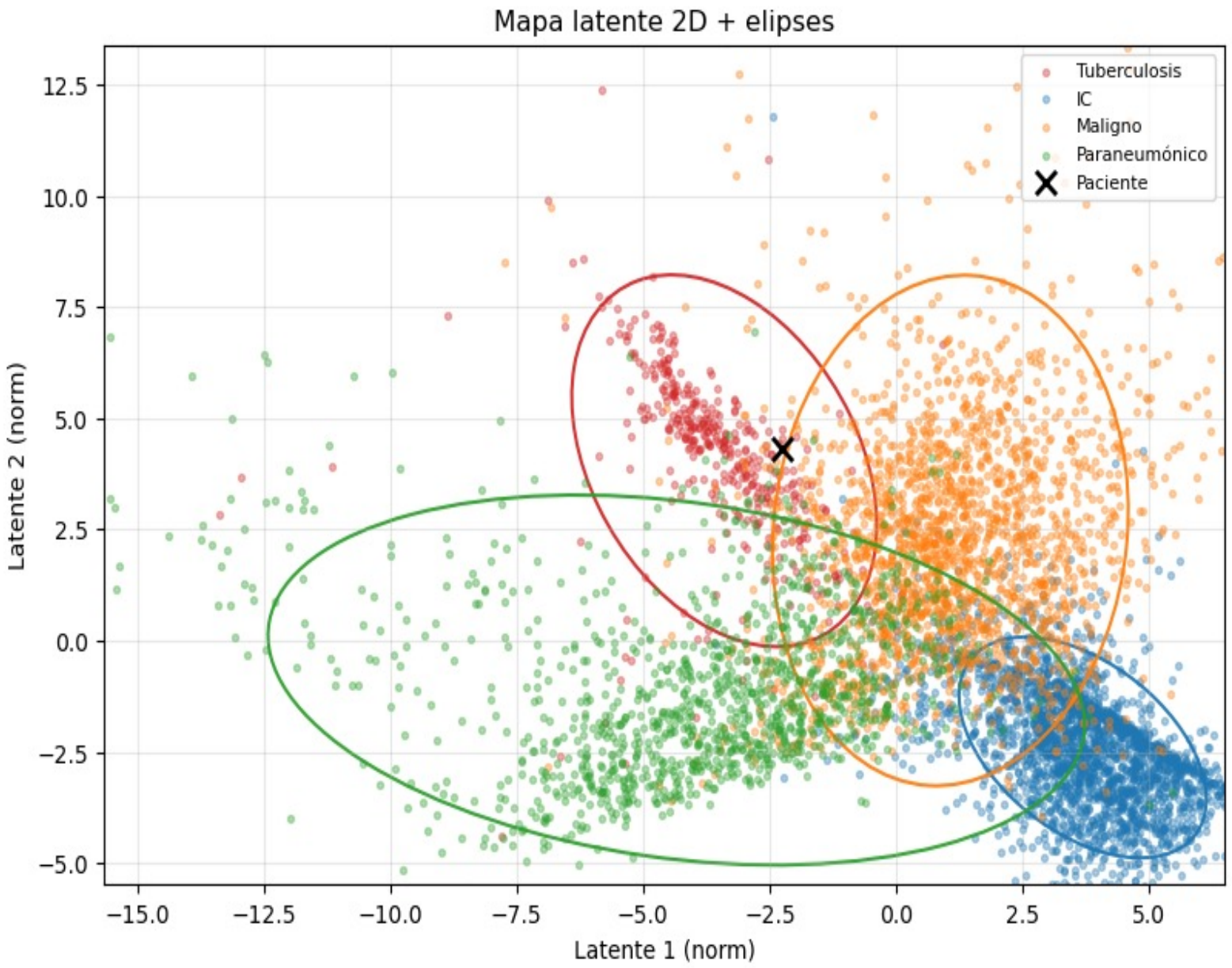

ROC-AUC — One-vs-Rest per malaltia
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
Maligno – AUC=0.926
IC – AUC=0.968
Paraneumónico – AUC=0.963
Tuberculosis – AUC=0.985

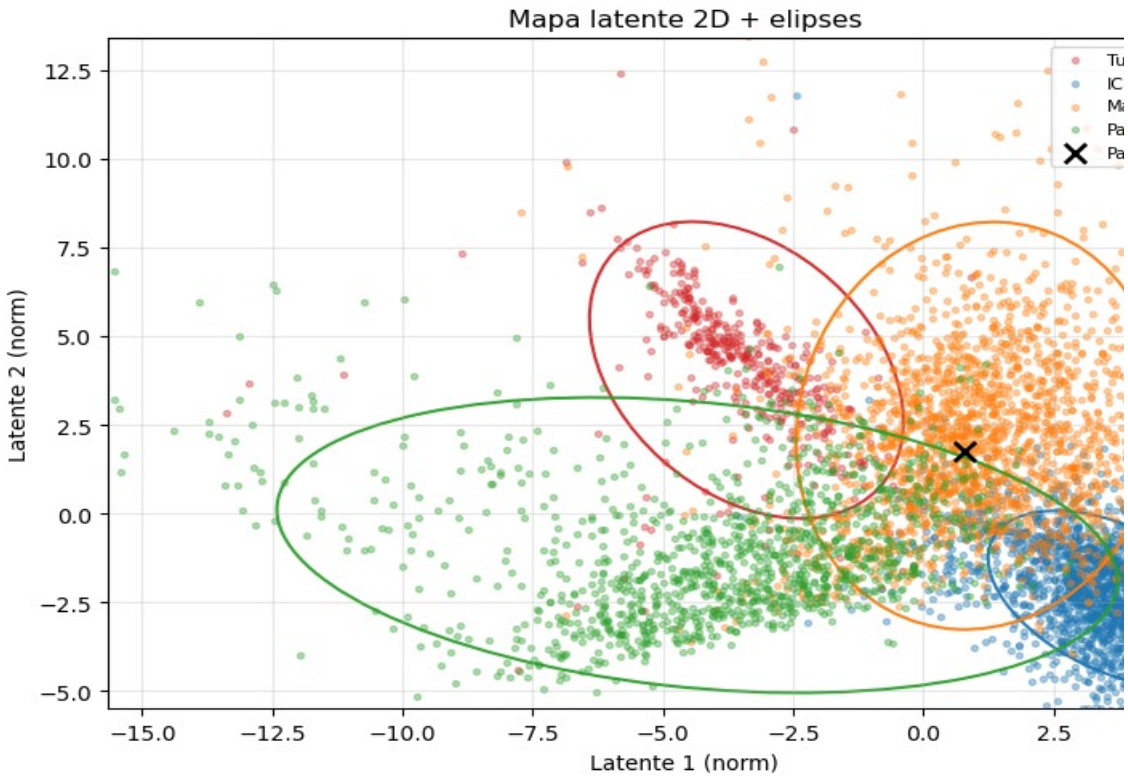

Importancia SHAP – Maligno
lp_LDH
rx_tamaño
e_edad
s_LDH
lp_PCR
ratio_proteinas
lp_c_linfocitos
lp_ADA
lp_colesterol
lp_c_neutrofilos
lp_albumina
grad_proteinas
lp_proteinas
grad_albumina
lp_c_hematies
lp_pH
e_sexo
lp_c_leucocitos
ratio_LDH
s_albumina
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
mean(|SHAP value|) (average impact on model output magnitude)


Importancia SHAP – IC
lp_LDH
e_edad
rx_localizacion
lp_colesterol
lp_proteinas
ratio_proteinas
grad_proteinas
ratio_LDH
lp_albumina
lp_PCR
grad_albumina
s_albumina
lp_ADA
lp_glucosa
rx_tamaño
s_LDH
lp_pH
s_proteinas
lp_c_leucocitos
lp_c_neutrofilos
0.0
0.2
0.4
0.6
0.8
1.0
mean(|SHAP value|) (average impact on model output magnitude)


Importancia SHAP – Paraneumónico
lp_c_neutrofilos
lp_PCR
lp_c_linfocitos
rx_localizacion
lp_ADA
ratio_LDH
rx_tamaño
grad_albumina
lp_c_leucocitos
lp_LDH
lp_c_hematies
lp_pH
s_LDH
s_proteinas
e_edad
lp_albumina
lp_colesterol
lp_glucosa
grad_proteinas
ratio_proteinas
0.0
0.1
0.2
0.3
0.4
0.5
0.6
mean(|SHAP value|) (average impact on model output magnitude)


Importancia SHAP – Tuberculosis
lp_ADA
lp_c_linfocitos
lp_PCR
e_edad
rx_tamaño
s_proteinas
lp_glucosa
e_sexo
lp_colesterol
ratio_proteinas
lp_c_hematies
lp_proteinas
lp_pH
grad_proteinas
lp_c_neutrofilos
s_LDH
lp_LDH
lp_c_leucocitos
ratio_LDH
lp_albumina
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
mean(|SHAP value|) (average impact on model output magnitude)


Mapa latente 2D + elipses
Tuberculosis
IC
Maligno
Paraneumónico
Paciente
Latente 2 (norm)
Latente 1 (norm)
12.5
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−15.0
−12.5
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0



Diagnóstico real: Maligno | ACIERTO_TOTAL

Probabilidades por modelo

```
Maligno      : Positivo  [POS]
IC           : Negativo
Paraneumónico : Negativo
Tuberculosis  : Negativo
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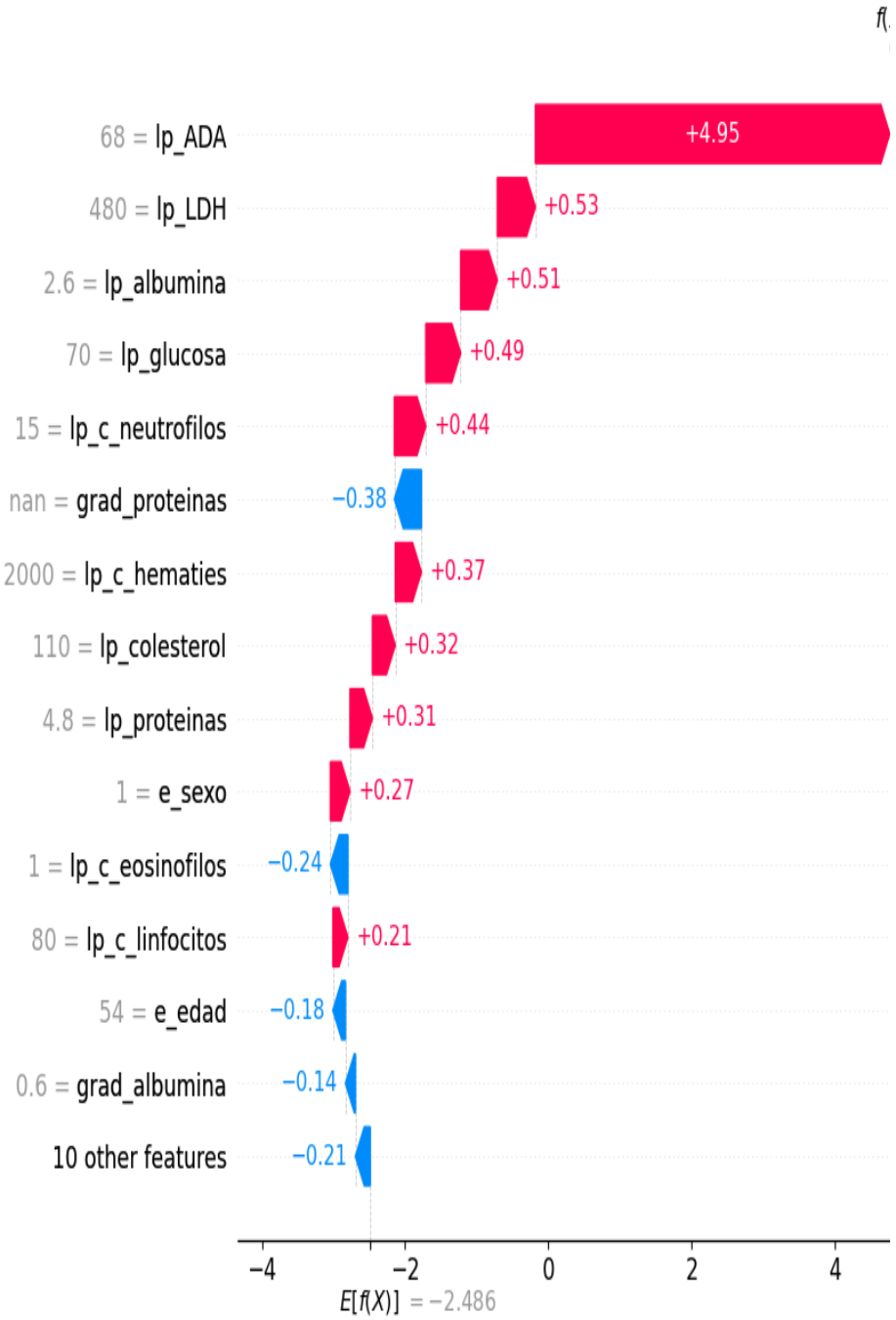


Diagnóstico de Derrame Pleural (v.1.6.0)
Caso
Datos epidemiológicos
Sexo
Varón
Mujer
Edad
Radiografía de tórax
Localización
Tamaño
>2/3
<1/3
1/3
2/3
1/2
Suero
Diagnosticar

Objetivo final

- Crear una herramienta diagnóstica que ayude al clínico

- Cuantificar el riesgo de cada grupo etiológico