



Medical Imaging
UNIVERSITY OF TORONTO



Sunnybrook
HEALTH SCIENCES CENTRE

Cardio-pulmonary Complications of Cancer Therapeutics

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Background

- ▶ Cardiopulmonary toxicities are significant adverse effects associated with various cancer treatments.
- ▶ Incidence is related to the type of therapeutic agent and patient-related factors.
- ▶ **Risk Factors:**
 - ▶ Pre-existing cardio-pulmonary conditions.
 - ▶ Concurrent use of multiple cardiotoxic agents.
 - ▶ Higher cumulative doses of chemotherapy and radiotherapy.

Overview of chemotherapeutics

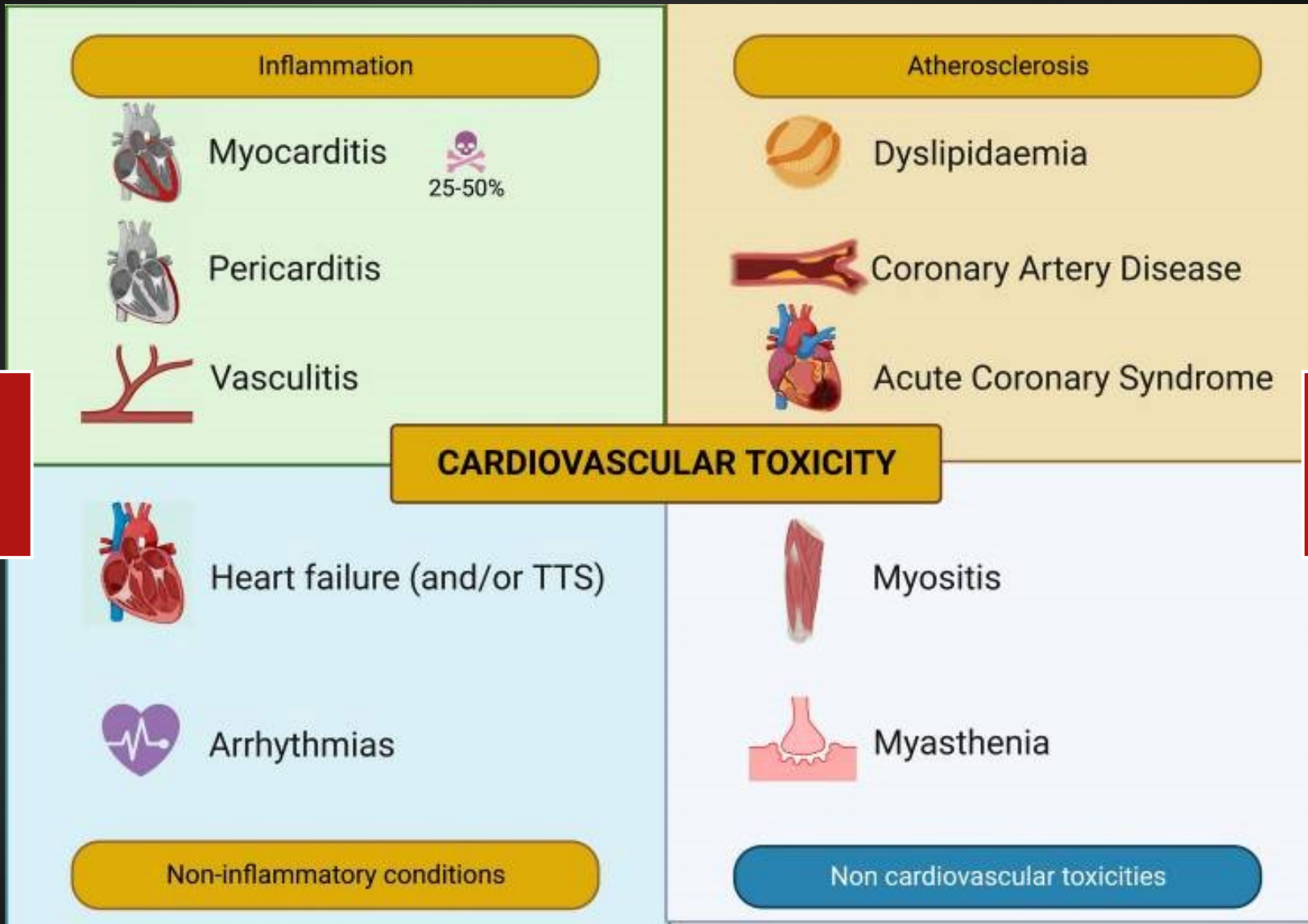
Conventional chemotherapeutics

- Alkylating agents: Cyclophosphamide, Cisplatin
- Antimetabolites: Methotrexate, 5-FU
- Alkaloids: Paclitaxel, Vincristine
- Anthracyclines: Doxorubicin, Daunorubicin
- Topoisomerase Inhibitors: Topotecan, Etoposide

Immune-checkpoint inhibitors

- PD-1 Inhibitors: Pembrolizumab, Nivolumab
- PD-L1 Inhibitors: Atezolizumab, Durvalumab
- CTLA-4 Inhibitors: Ipilimumab

Role of
CT / MRI



Case
Review

Conventional Chemotherapies adverse effects

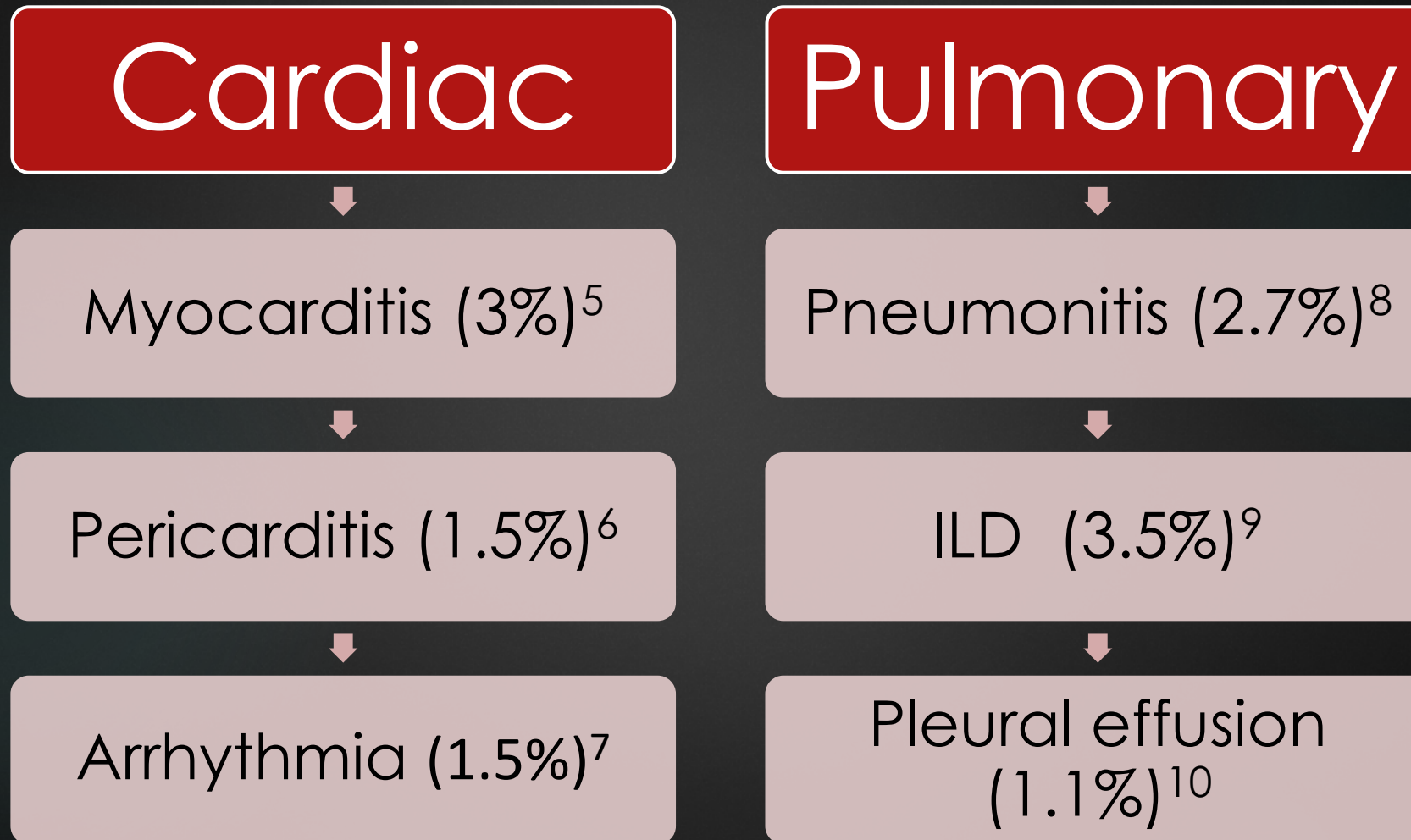
Cardiotoxicity

- Heart failure (0.9%-26%)¹
- Myocardial-dysfunction (30%)²

Vascular Toxicity

- Hypertension (30%)³
- Arterial thrombosis (4%)⁴

Immune Checkpoint Inhibitors (ICI) adverse effects



Value of Imaging

CT

Pneumonitis

ILD

MRI

Cardiac
Function

Myocardial
inflammation

Pericardium

Early Detection

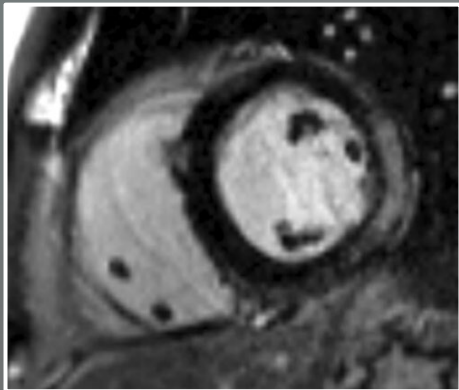
Monitoring
progression

Guiding
treatment

Role of CMR

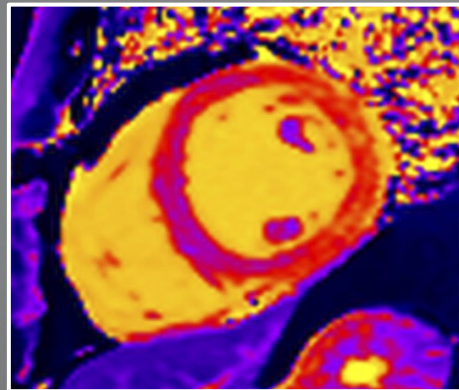
- ▶ Myocarditis following ICIs is rare (~1%), but has a high mortality rate if untreated.
- ▶ CMR plays a critical role in the diagnosis, providing detailed insights into inflammation, necrosis, and fibrosis.

CMR Techniques



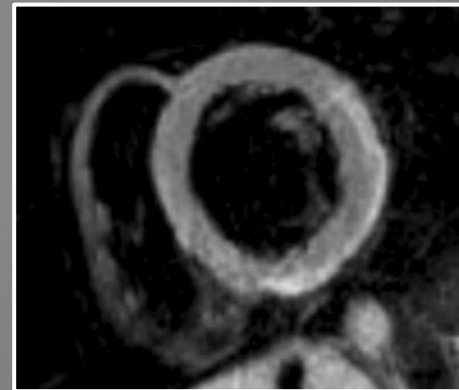
LGE

(Fibrosis, Scar, Infiltration)



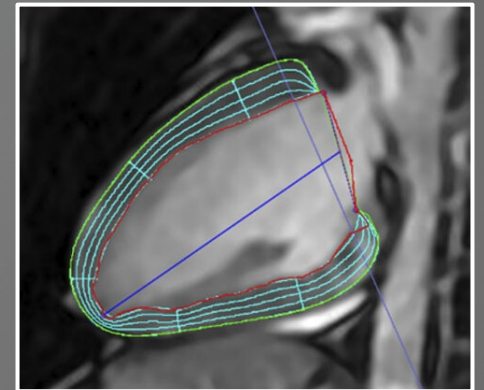
T1 Mapping

(Fibrosis, Edema, Infiltration)



T2

(Edema)



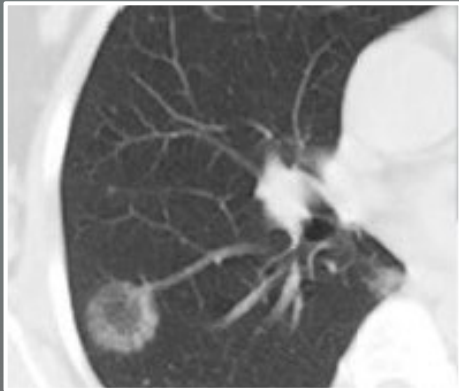
MRI Cine

(Regional and Global function)

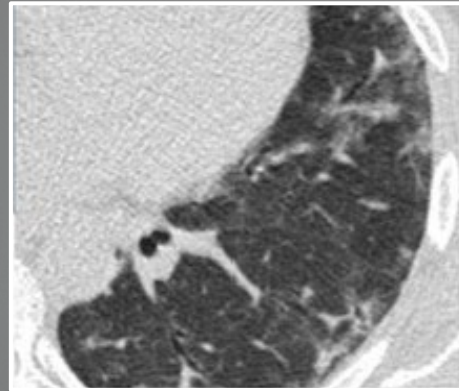
Role of CT

- ▶ Imaging *modality of choice* for diagnosing and monitoring pneumonitis.
- ▶ Regular CT follow-up is necessary to track progression and recovery.

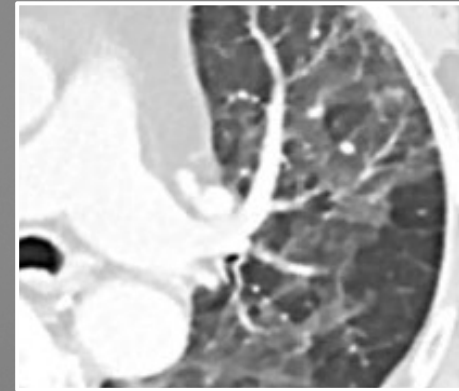
Specific CT Patterns



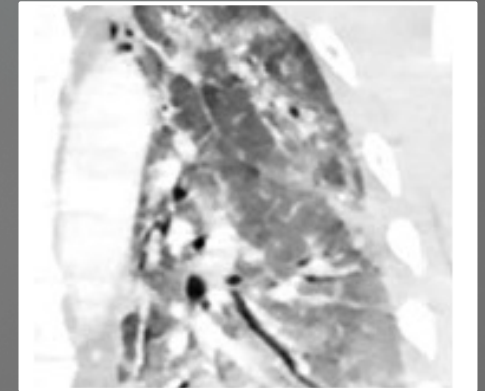
**Organizing pneumonia
pattern**



**Non-specific Interstitial
pneumonia pattern**

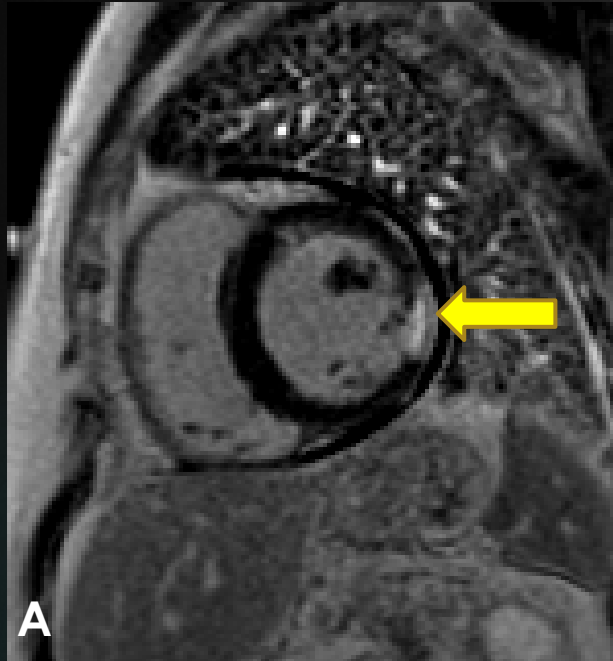


**Hypersensitivity
Pneumonitis Pattern**

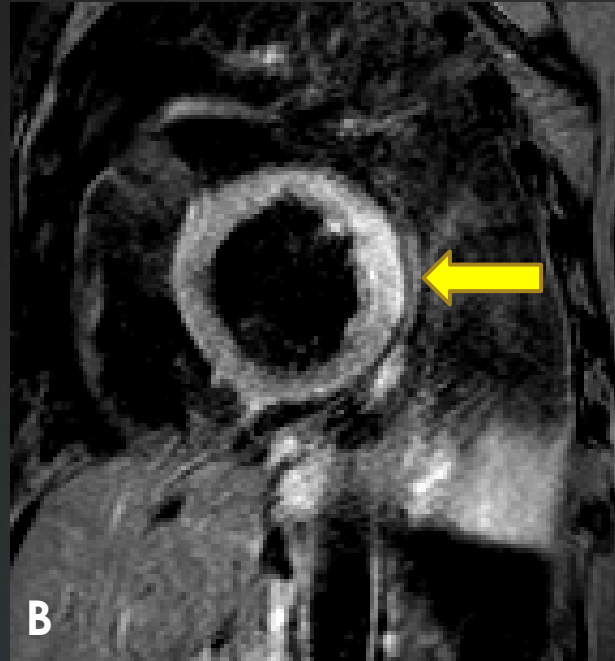


**Diffuse Alveolar Damage
pattern**

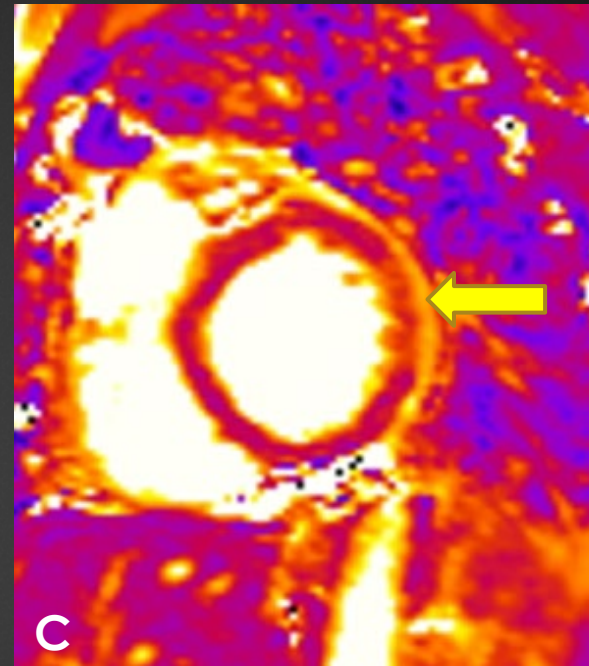
70y female NSCLC on Pembrolizumab



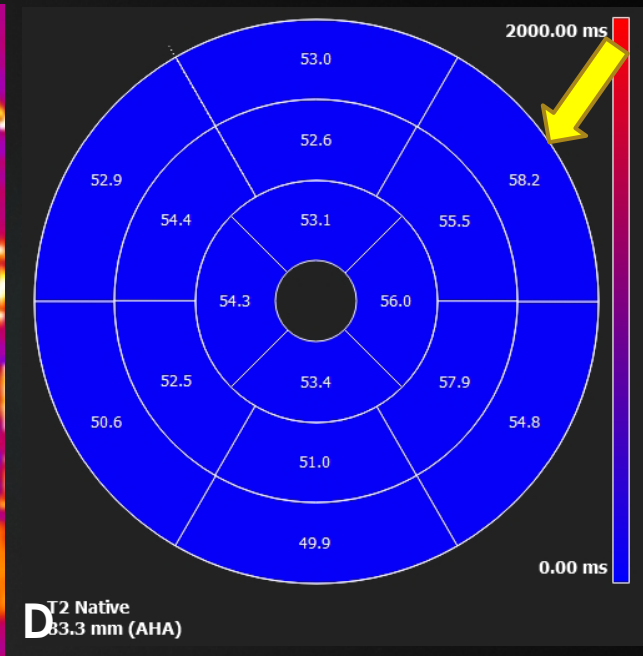
LGE



T2-TSE



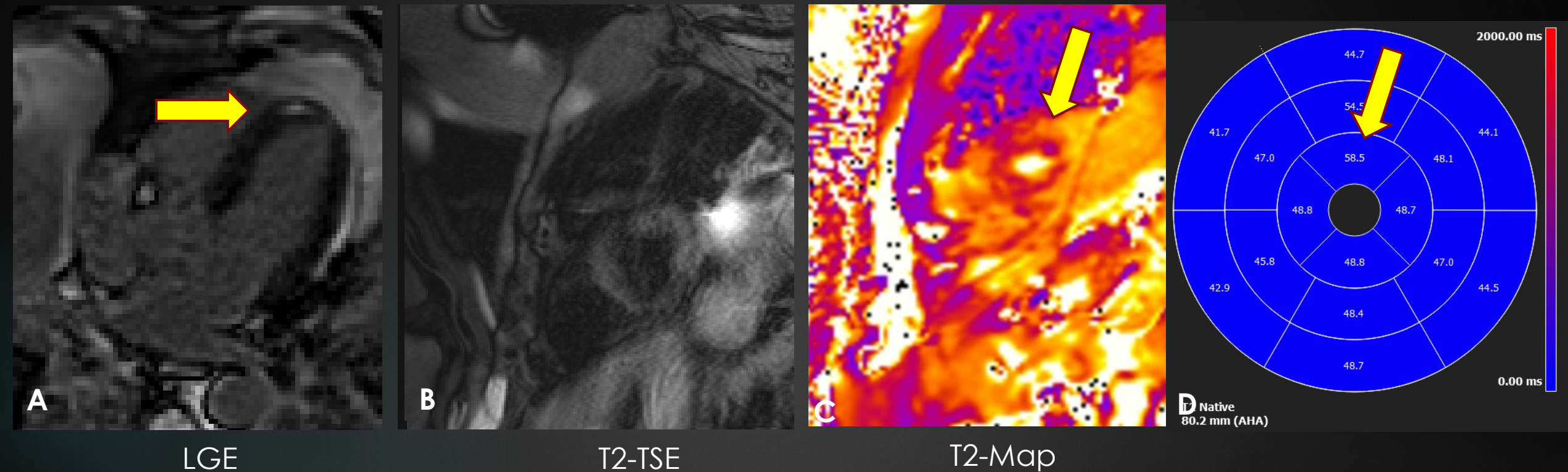
T2-Map



Clinical: Chest pain, hemoptysis, and elevated troponin.

CMR: Transmural late gadolinium enhancement (LGE) in the basal to mid inferolateral wall with adjacent epicardial LGE (A) and associated myocardial edema (B), fulfilling the Lake Louise Criteria for **Acute myocarditis**. Elevated T2 values in the T2 map (C, D)

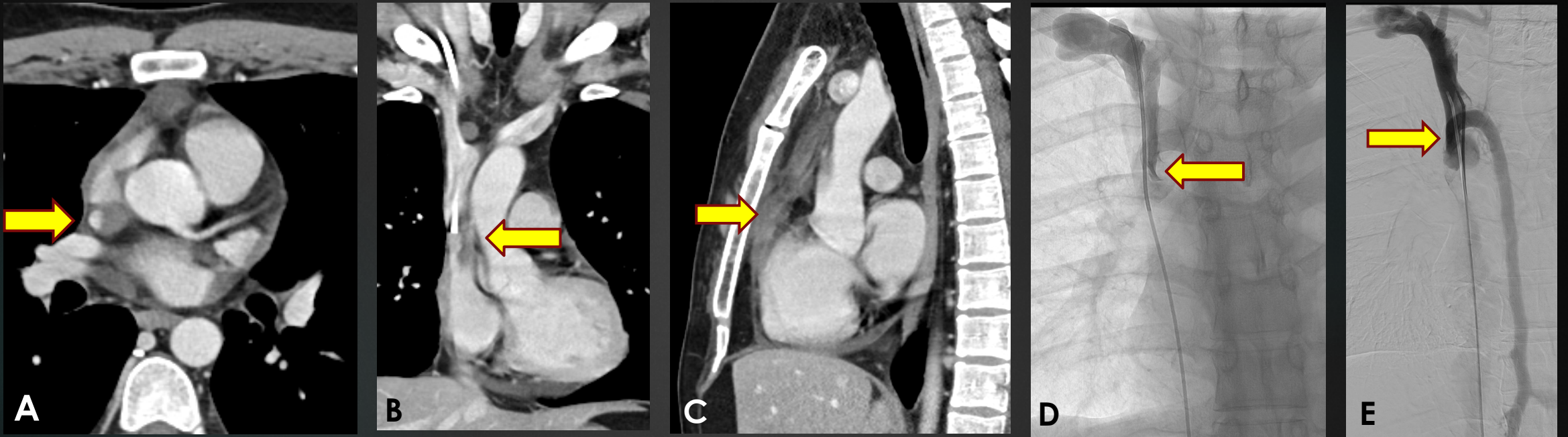
59y male with RCC on Nivolumab



Clinical: Severe generalized immune reaction and elevated troponin (2900 ng/L).

CMR: Subtle epicardial linear and patchy late gadolinium enhancement at the left ventricular apex (A), without any myocardial edema (B) and normal T2 values on the map (C, D), representing nonischemic myocardial injury, most likely representing **immune myocarditis**.

23y male with ALL on Steroid treatment

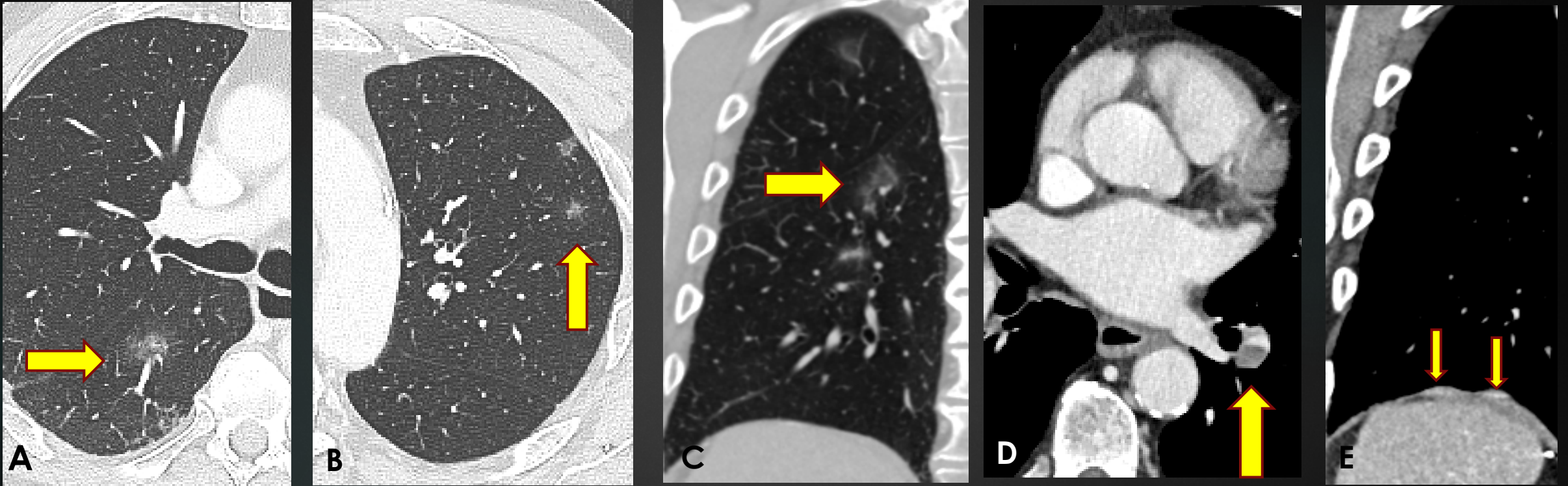


Clinical: Neck and chest swelling.

CT Chest: Hypodense area adherent to the medial wall of the lower superior vena cava (SVC), indicative of **catheter-related thrombosis** (A, B). The anterior mediastinal mass is also seen (C).

Venogram: confirmed SVC occlusion by an intraluminal clot and mild to moderate distal SVC stenosis (D). Subsequent clot lysis was performed (E).

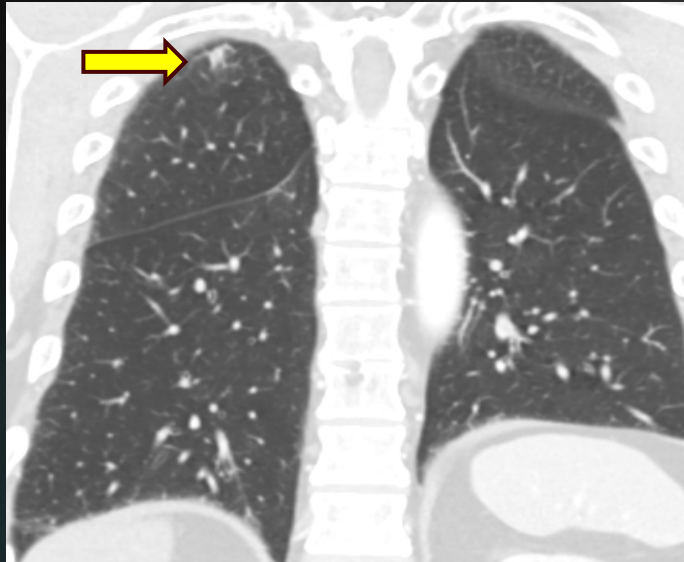
80y Male with RCC on Cabozantinib



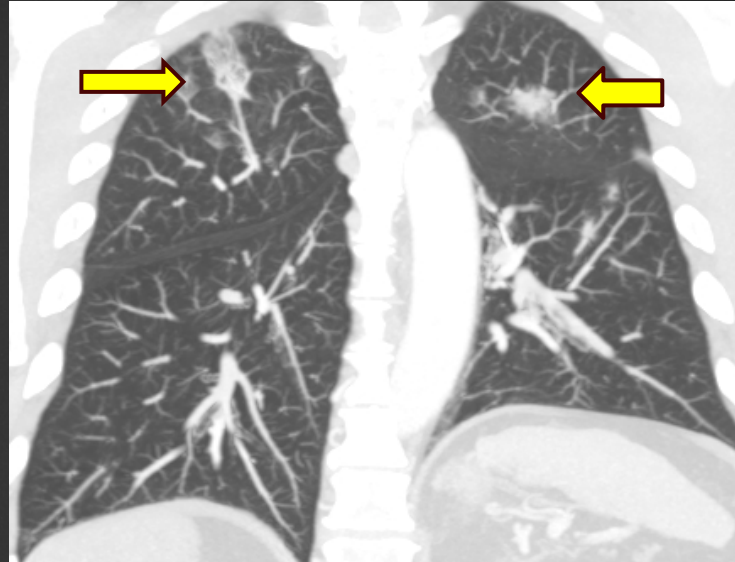
Clinical: Pleuritic chest pain, dyspnea.

CT chest: New patchy areas of ground-glass opacity, likely related to immunotherapy (A, B, C), along with **pulmonary embolism** in the left lower lobe pulmonary artery (D) and stable pleural metastatic disease (E).

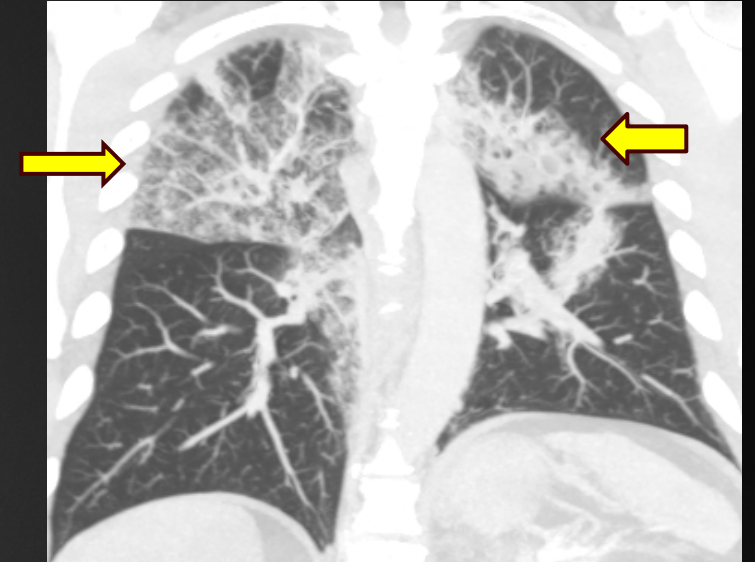
63y male SCC larynx on Pembrolizumab



March 2024



May 2024



June 2024

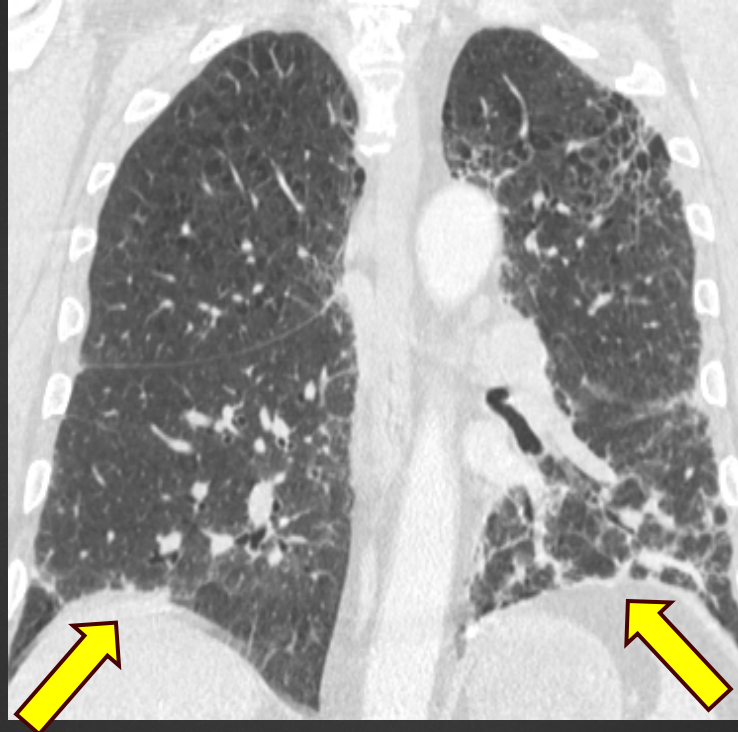
Clinical: Chest pain, shortness of breath.

CT Chest: Evolution of bilateral ground-glass opacities and consolidations over a period of 3 months following the initiation of chemotherapy, consistent with **drug-induced pneumonitis**.

74y Male with Lymphoma on Bleomycin



Baseline



1 month post treatment



1 year follow-up

Clinical: Shortness of breath.

CT Chest: Evolution of bilateral, symmetric and predominantly peripheral and lower lobe distribution of the predominantly interstitial pulmonary parenchymal findings are suggestive of **bleomycin toxicity**, of moderate degree (A, B). The findings resolved on 1 year follow up (C).

Conclusion

Precision oncology --> Complex cardiopulmonary diagnostic challenges.

Radiologists --> Key role in early detection.

Improving diagnostics --> Impact cancer survivors' outcomes.

Thank you for your attention.

