“... In recognition of the need for a document on special considerations for cancer patients in the CCL, the Society for Cardiovascular Angiography and Interventions (SCAI) commissioned a writing committee to define the landscape and to provide recommendations (level of evidence C) based on published medical literature and expertise of operators with accumulated experience in the cardiac catheterization of cancer patients. ...”
Coronary angiography is indicated for symptomatic patients with a history of radiotherapy, risk factors for RIHD, and noninvasive testing (i.e., stress MPI/echo/MRI, CCTA) that suggest a high likelihood of severe ischemic heart disease.

Coronary angiography is reasonable for the evaluation of LV systolic dysfunction after chest radiation and to evaluate for radiation-induced ischemic heart disease.

Right and left heart catheterization is reasonable to evaluate the presence of pericardial constriction and restrictive cardiomyopathy if noninvasive imaging (echocardiography, CT, MR) is insufficient to provide a diagnosis.

Right and/or left heart catheterization and coronary angiography is reasonable as per ACC/AHA guidelines for preoperative planning for patients with severe RIHD.
There is **no minimum platelet count** to perform a **diagnostic coronary angiogram**.

Aspirin administration may be used when platelet counts are >10,000/mL.

DAPT with clopidogrel may be used when platelet counts 30,000–50,000/mL. Prasugrel, ticagrelor and IIB-III A inhibitors should not be used in patients with platelet counts <50,000.

If platelets are <50,000, the duration of DAPT may be restricted to 2 weeks following PTCA, 4 weeks after bare-metal stent (BMS), and 6 months after 2nd or 3rd generation drug-eluting stents (DES) if optimal stent expansion was confirmed by IVUS or OCT.

For platelet counts <30,000/mL, revascularization and DAPT should be decided after a preliminary multidisciplinary evaluation (interventional cardiology/oncology/hematology) and a risk/benefit analysis.
Thrombocytopenia

30–50 U/kg unfractionated heparin is the initial recommended dose for patients undergoing PCI who have platelets <50,000/mL. ACT should be monitored.

Prophylactic platelet transfusion is not recommended in patients undergoing cardiac catheterization with thrombocytopenia, unless recommended by the oncology/hematology team for: 1. **Platelet count <20,000/mL and one of the following:** (a) high fever, (b) leukocytosis, (c) rapid fall in platelet count, (d) other coagulation abnormality, or 2. Platelet count <20,000/mL in solid tumor patients receiving therapy for bladder, gynecologic, or colorectal tumors, melanoma, or necrotic tumors.

Therapeutic platelet transfusions are recommended in thrombocytopenic patients who develop bleeding during or after cardiac catheterization.

Repeat platelet counts are recommended after platelet transfusions.

Access Considerations

For cancer patients who are excellent candidates for both access types, the radial artery is preferred. Femoral access is the preferred approach for cancer patients on hemodialysis, those with abnormal Allen's tests in both arms, multiple radial procedures or a-lines, bilateral mastectomy or when a complex intervention is anticipated.

The use of smaller sheath sizes, prompt removal of sheaths and early ambulation is recommended.

A lower dose of intra-arterial or intravenous unfractionated heparin at a dose of 50 U/kg or 3,000 units is recommended for cancer patients with thrombocytopenia and platelet count <50k undergoing cardiac catheterization via radial access.

A femoral angiogram is recommended after transfemoral access to promptly identify and address potential access complications.

### Special Considerations

Decision making regarding revascularization in patients with active cancer must take into consideration the **overall prognosis** of the patient.

**For cancer patients with an acceptable prognosis**, the general revascularization criteria for appropriate use must be carefully evaluated and only the most **appropriate indications** (scores 7 and above) should be considered.

For cancer patients with an expected survival <1 year, percutaneous revascularization may be considered for patients with acute STEMI and high-risk NSTEMI. For patients with stable angina, every effort must be made to maximally optimize medical therapy before resorting to an invasive strategy. This approach must include addressing other cancer-related comorbidities that potentially exacerbate ischemia, such as anemia, infection, hypoxia, etc. Should the patient continue to experience persistently severe angina (CCS Class III or IV), consideration may be given to percutaneous revascularization as a palliative option.

Special Considerations

<table>
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<tr>
<th>FFR is recommended before non-urgent PCI to justify the need for revascularization.</th>
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<tr>
<td><strong>When invasive approach is indicated:</strong> a. Balloon angioplasty should be considered for cancer patients who are not candidates for DAPT (Platelets &lt;30,000/mL) or when a non-cardiac procedure or surgery is necessary as soon as possible. b. BMS should be considered for patients with platelet counts &gt;30,000/mL who need a non-cardiac procedure, surgery or chemotherapy which can be postponed for &gt;4 weeks. c. Newer generation DES should be considered for patients with platelet counts &gt;30,000/mL who are not in immediate need for a non-cardiac procedure, surgery or chemotherapy. d. Bivalirudin and/or radial approach should be considered to minimize the risk of bleeding.</td>
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Intravascular imaging such as IVUS or optical coherence tomography (OCT) is recommended after stent placement to ensure optimal expansion and an absence of complications given the potential for early DAPT interruption.

Management of Cancer Patients with ACS

ACS + PLT <100,000 (no active bleeding or sepsis)

TIMI Risk Score*

<3 Medical management ASA (if PLT >10,000), b-blocker, statin, ischemic evaluation

≥3

Early Invasive Approach

Medical therapy
Cardio-Onc Team ASA if PLT > 10,000

BMS vs. DES DAPT if PLT >30,000

CABG if PLT > 50,000

Stress-induced CM (Takotsubo)

Resume cancer therapy in 2-4 weeks

*TIMI Risk Score Standard TIMI risk score for UA/NSTEMI or STEMI + additional points for
• h/o chest radiation
• Ongoing prothrombotic chemo or Phase 1 drug

Risk factors
- Coronary artery disease (CAD)
- MI history
- Hypertension
- Diabetes mellitus
- Hyperlipidemia
- Smoking
- Obesity
- Sedentary lifestyle
- Family history of premature CAD
- Stroke/TIA history
- Thromboembolism history
- Raynaud’s history
- Concomitant or prior radiation therapy

Define CV risk

Cancer therapy with vasotoxicity potential*
- Yearly HPI and physical

Assess and optimize modifiable cardiovascular risk factors

Drugs with persistent vascular risk
- ABI yearly (part of physical exam)
- Carotid U/S every 2 years
- Cardiac tests (see Figure 2)

Radiation therapy (RT)
- ABI yearly (abdomen/pelvis/lower extremity)
- Carotid U/S every 2 years (head/neck)
- Cardiac tests (chest, see Figure 2)

Coronary angiography
- Coronary artery disease

Carotid US +/- MRA
- Cerebrovascular disease

CT aortography w/distal run-off
- Peripheral arterial disease

Ultrasound, venogram
- Thromboembolic disease

5-FU/capecitabine
- Paclitaxel
- Cisplatin
- VEGF inhibitors
- Erlotinib/Nilotinib/Ponatinib

Nilotinib
- Ponatinib

Nilotinib
- Ponatinib

Thalidomide
- Lenalidomide
- Cisplatin
- Erlotinib
- Nilotinib/Ponatinib

* Vasotoxic drugs by vascular territories
(in bold drugs with persistent risk even after therapy)

Risk factors for RIHD
- Age <15 and >60
- Anterior or left chest radiation therapy
- Presence and extent of tumor in or next to the heart
- Lack of shielding
- High dose RT fractions (>2 Gy/day) and/or high cumulative RT dose (>30 Gy) - a “safe” dose cutoff is not defined
- Concomitant chemotherapy
- Any cardiovascular risk factor
- Pre-existing cardiovascular disease, especially known CAD and prior myocardial infarction

Define Cardiac Risk

Mediastinal/thoracic Radiation Therapy

Yearly HPI and physical

Signs or symptoms of cardiovascular disease?

Yes

No

Assess and optimize modifiable CV risk factors

Screening TTE
- every 5 years, starting 5 years after RT in patients with one RIHD risk factor and 10 years after RT in patients with no RIHD risk factor

Screening stress test
(exercise echo +/- Oₐ consumption study preferred, may consider CCTA)
- every 5 years after RT
- additional early evaluation at 2 years after RT if >60 yrs, ≥1 CV risk factor, known CAD, or vasotoxic cancer drugs

Pericardial effusion or constriction
TTE ± CT, MRI, or hemodynamic cath

Valvular heart disease
TTE ± hemodynamic cath

Cardiomyopathy
TTE ± hemodynamic cath

Arrhythmia
EKG, Holter, event monitor

Coronary artery disease
Coronary angiography

Gated chest CT for assessment of mediastinal fibrosis, porcelain aorta, internal mammary arteries, etc.

For interventional planning (catheter-based and/or surgical Heart Team approach)