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# From basic to advanced cardiac imaging to identify the benefits of revascularization in ischemic heart disease

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**Abstract**

Myocardial viability imaging plays a pivotal role in evaluating patients with ischemic cardiomyopathy who may benefit from revascularization. Despite recent trials questioning its prognostic value, imaging continues to shape therapeutic decisions. This comprehensive review explores the underlying pathophysiological basis, diagnostic modalities, and clinical evidence on myocardial viability. We compare contemporary imaging tools and outline a practical framework for individualized patient assessment. Advanced modalities such as cardiac magnetic resonance, positron emission tomography, and dobutamine stress echocardiography provide robust insights into myocardial viability. Findings from key clinical trials, including STICH and REVIVED-BCIS2, reveal the nuanced role of viability in guiding revascularization strategies. We propose that myocardial viability testing remains a valuable adjunct in selected clinical scenarios, emphasizing integration with ischemia assessment, anatomical context, and symptom burden.

**Key words:** myocardial viability, ischemic cardiomyopathy, STICH, revascularization, heart failure.

## Introduction

Ischemic cardiomyopathy is a major contributor to heart failure and cardiovascular mortality worldwide [1]. In patients with reduced left ventricular ejection fraction (LVEF), a key clinical challenge is determining which myocardial segments are viable and may recover function after revascularization. Viable myocardium—stunned or hibernating tissue—can regain contractility with restored perfusion. Accurate assessment of viability informs revascularization strategies such as coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI). Over the past decades, several non-invasive imaging techniques have been developed to evaluate myocardial viability, including CMR, PET, single-photon emission computed tomography (SPECT), and DSE. These tools are instrumental in distinguishing viable tissue from irreversible scar, thereby optimizing therapeutic decisions. This review critically appraises the biological basis, diagnostic modalities, and clinical evidence underlying myocardial viability assessment, with a focus on its practical application in the era of contemporary heart failure management.

## Pathophysiological basis of myocardial viability

The distinction between viable and non-viable myocardium is central to the management of ischemic cardiomyopathy. Non-viable myocardium is characterized by irreversible myocyte loss and replacement with fibrotic tissue, which lacks contractile capacity and is incapable of contributing to systolic function. Histopathologic studies have consistently demonstrated that segments with extensive transmural fibrosis—common in chronic infarction—do not recover function even when perfusion is restored [2,3].

## Challenges in conducting randomized controlled trials

Conducting RCTs to assess myocardial viability and its role in revascularization is fraught with challenges. As a result, many studies have relied on observational data and non-randomized trials. It is indeed challenging, if not impossible, to conduct randomized controlled trials (RCTs) in this area for several reasons: Ethical constraints: It may be unethical to randomize patients to no treatment or placebo if they have clear evidence of viable myocardium and a potentially reversible condition. Heterogeneity in Patients: The variability in patient populations, with differences in the extent of coronary artery disease, comorbidities, and overall heart function, makes it difficult to design a single RCT that could universally answer the question of viability. Complexity of Procedures: The logistical and technical complexity of performing high-quality

imaging and ensuring uniform interpretation across centers adds another layer of difficulty in conducting large-scale randomized studies.

**Impact of medical therapy and revascularization in hibernating myocardium**

While revascularization has traditionally been viewed as the cornerstone of therapy for hibernating myocardium, several studies have demonstrated that contemporary medical therapy can lead to meaningful improvement in left ventricular (LV) function, even in the absence of revascularizatio [4]. In the CHRISTMAS trial, Cleland et al. showed that beta-blocker therapy improved LV ejection fraction (LVEF) in patients with viable myocardium identified via SPECT imaging [5]. Similarly, Bello et al. used contrast-enhanced cardiac magnetic resonance (CMR) and observed functional recovery in patients treated medically, highlighting the role of medical optimization in hibernating segments [6]. Additionally, Seghatol et al. demonstrated favorable outcomes using dobutamine stress echocardiography (DSE) to assess contractile reserve in patients undergoing medical therapy [7]. Medical therapy with revascularization in patients with ischemic cardiomyopathy has been shown to decrease mortality compared to medical therapy alone [8]. Viability testing can predict improvement of heart failure symptoms and exercise capacity after revascularization [9,10].

A comprehensive 2024 meta-analysis by Arjomandi Rad et al. provides updated and compelling evidence favoring the assessment of myocardial viability in patients undergoing coronary artery bypass grafting (CABG) [11]. This analysis pooled data from 15 studies involving over 2,000 patients and found that the presence of viable myocardium was associated with a 58% reduction in adverse outcomes compared to non-viable myocardium (OR: 0.42; 95% CI: 0.29–0.61; $p < 0.00001$). Subgroup analyses confirmed the consistency of this benefit, with modest heterogeneity ($I^2 = 34–53\%$). These findings reinforce the concept that viability is a meaningful prognostic marker and may help identify patients most likely to benefit from surgical revascularization. Unlike the REVIVED trial [12], which focused on PCI and found no benefit of revascularization over optimal medical therapy regardless of viability, the population in this meta-analysis primarily underwent CABG, a more comprehensive revascularization approach. This distinction is critical, as STICH also showed that the benefit of CABG emerges over time, particularly in patients with more extensive coronary disease—many of whom likely had viable myocardium [13].

## Evidence from clinical trials and its limitations: STICH and REVIVED

Over the past two decades, randomized controlled trials (RCTs) have attempted to clarify the role of myocardial viability testing in guiding revascularization decisions for patients with ischemic cardiomyopathy. Two famous landmark studies—STICH (Surgical Treatment for Ischemic Heart Failure) and REVIVED-BCIS2—have significantly shaped current understanding but also generated ongoing debate due to methodological limitations and evolving clinical contexts.

### *The STICH trial: CABG in ischemic cardiomyopathy*

The original STICH trial enrolled 1,212 patients with ischemic cardiomyopathy and left ventricular ejection fraction (LVEF)  35%, randomizing them to receive either coronary artery bypass grafting (CABG) or optimal medical therapy (OMT). A predefined substudy investigated whether the presence of myocardial viability predicted a differential benefit from surgical revascularization.

### *STICHES 10-year follow-up*

A subsequent extension study (STICHES) evaluated outcomes over 10 years. It demonstrated that CABG significantly reduced cardiovascular mortality in patients with viable myocardium (HR 0.65; 95% CI, 0.49–0.85), but not in those without viability (HR 0.93; 95% CI, 0.53–1.63) While the interaction p-value was 0.07 (not statistically significant), the numerical trends suggested that viable patients derive long-term survival benefit from CABG. These results support the selective use of viability imaging, particularly in evaluating surgical candidates with potential for durable recovery [8,13].

### *Methodological limitations of the STICH Trial*

Several limitations have been identified that may have diluted the predictive value of viability testing in STICH:

### *Limitations of the STICH trial and their clinical implications*

The STICH trial is one of the most widely recognized studies evaluating the role of revascularization in patients with ischemic heart failure. However, several important limitations have been identified that may have reduced the predictive value of viability testing.

***Narrow focus on viability alone***

A key limitation of STICH—and many similar studies—is the treatment of myocardial viability as a binary variable (either viable or non-viable), rather than as a continuum. This approach is inherently problematic, as it oversimplifies the complex pathophysiology of myocardial tissue. Moreover, it remains uncertain what threshold or extent of viable myocardium is necessary to achieve a meaningful clinical benefit from revascularization.

***Viability not part of randomization***

In the STICH trial, viability testing was not used to randomize patients. Out of the total cohort (n=1212), only 601 patients underwent viability imaging. This raises a major methodological concern: any observed association between viability and outcomes could reflect selection bias, not a true causal relationship. Additionally, because only half the patients were imaged, the power to detect an interaction between viability and treatment allocation (medical therapy vs. CABG) was significantly limited. Ideally, a study testing the hypothesis that viability modifies response to revascularization would mandate treatment strategies based on viability status, which was not the case here [8].

***High prevalence of viability***

Among those tested, 81% were classified as having viable myocardium, which may reflect overly liberal or non-specific criteria. This limits the power of the study to detect differential outcomes between viable and nonviable groups, especially if the "nonviable" group is small and heterogeneous.

***Atypical viability criteria***

The criteria used in STICH were atypical and highly specific, diverging from protocols in earlier viability studies. STICH trial used unusual and highly specific viability criteria that differ from those traditionally employed in previous landmark studies. For DSE, viability was defined by the presence of five or more dysfunctional myocardial segments with evidence of contractile reserve. For SPECT imaging, the threshold was eleven or more viable segments, even if those segments were not dysfunctional. This led to potentially counterintuitive classifications. For instance, a patient with a non-viable LAD infarction but viable basal/inferior segments might still be labeled "viable" in STICH, even if the infarcted LAD territory was the clinical concern.

***Use of suboptimal imaging modalities***

STICH relied solely on SPECT and DSE. CMR (cardiac MRI) and PET, which provide superior tissue characterization and sensitivity for scar detection and myocardial hibernation, were not used [14]. The imaging tools used may have underestimated true scar burden or overestimated viability. This limits generalizability and may lead to inappropriate management decisions in clinical practice, where more precise modalities are available.

***Medical therapy era***

STICH was conducted before modern guideline-directed medical therapy (GDMT) — including ARNIs, SGLT2 inhibitors, ICDs/CRTs. This means that the "optimal medical therapy" (OMT) in the control arm is outdated by today's standards.

***Incomplete revascularization***

Not all patients in the CABG group received complete revascularization of all viable zones. This compromises the intended goal of restoring perfusion to all viable areas.

A large meta-analysis of 35 studies [15], including 89,883 patients compared complete revascularization (CR) to incomplete revascularization (IR) and demonstrated that CR was associated with a 30% reduction in long-term mortality, a 22% reduction in myocardial infarction, and a 26% reduction in repeat revascularization procedures. The benefit was consistent across both PCI- and CABG-treated patients and was independent of study design or definition of CR. These findings are supported by multiple studies [8,16]. These studies collectively emphasize that achieving complete revascularization, particularly with CABG, is associated with superior clinical outcomes.

***Quality of life (QoL) data***

While STICH did report some QoL outcomes, these were limited and underpowered. Symptom burden, functional improvement, and patient satisfaction — which are central to decision-making — were not sufficiently emphasized. Decisions about CABG should be informed not only by mortality data but also by patient-centered outcomes, especially in advanced heart failure patients where survival gains may be marginal, but QoL gains could be meaningful.

***The REVIVED-BCIS2 trial: PCI in ischemic cardiomyopathy***

The REVIVED-BCIS2 trial was designed to test the hypothesis that percutaneous coronary intervention (PCI) improves outcomes in patients with ischemic LV dysfunction and demonstrable myocardial viability. Unlike STICH, viability imaging was required for enrollment. 700 patients with LVEF 35% and 4 viable myocardial segments randomized to PCI + OMT vs. OMT alone. Performed locally using various modalities (CMR, DSE, PET, SPECT). No significant difference in all-cause mortality or heart failure hospitalization between PCI and medical therapy

***Strengths of REVIVED-BCIS2 trials:***

The REVIVED-BCIS2 trial was a well-designed, multicenter randomized controlled study that investigated whether percutaneous coronary intervention (PCI) provides benefit over optimal medical therapy (OMT) in patients with ischemic cardiomyopathy and reduced ejection fraction ( 35%) who had evidence of myocardial viability. The study enrolled a high-risk population and utilized modern imaging modalities such as cardiac MRI, SPECT, and dobutamine stress echocardiography to assess viability. Importantly, both treatment arms received contemporary guideline-directed medical therapy, including ARNI and SGLT2 inhibitors, ensuring that all patients were managed according to current standards of care.

Despite the use of viability testing as an inclusion criterion, the trial found no significant difference in all-cause mortality or hospitalization for heart failure between the PCI and OMT groups. These findings challenge the traditional assumption that revascularizing viable myocardium in the context of ischemic cardiomyopathy leads to improved survival or clinical outcomes. A notable secondary observation was that scar burden, rather than myocardial viability, was a stronger predictor of adverse outcomes; specifically, each 10% increase in scar volume was associated with an 18% higher risk of death or heart failure hospitalization. This highlights the prognostic importance of the extent of irreversible myocardial damage in this patient population. While PCI did not improve hard endpoints, it was associated with improvements in quality of life, suggesting a potential role for PCI in selected patients where symptom burden remains high despite optimal therapy. Overall, the REVIVED-BCIS2 trial provides strong evidence that routine PCI in patients with ischemic cardiomyopathy and viable myocardium does not confer survival benefit and that decisions regarding revascularization should consider scar burden and focus on individualizing care based on symptoms and overall clinical context [12].

***Interpretation and limitations***

The REVIVED-BCIS2 trial is one of the most widely recognized studies evaluating the role of revascularization in patients with ischemic heart failure. However, several important limitations have been identified that may have reduced the predictive value of viability testing.

*Only 40% of patients underwent CMR despite its superiority*

Limitation: In REVIVED, although myocardial viability was a requirement for enrollment, only ~40% of patients underwent cardiac magnetic resonance (CMR) imaging — widely regarded as the gold standard for viability assessment due to its superior spatial resolution and late gadolinium enhancement for scar detection. The rest underwent SPECT or dobutamine stress echocardiography, which have lower sensitivity and specificity. Therefore, if revascularization did not show benefit, it might be due to suboptimal identification of truly viable myocardium. Future trials should prioritize CMR or PET to improve patient selection and more confidently test the value of viability-guided interventions.

*Exclusion of CABG candidates and incomplete PCI in ~29% of patients*

Limitation: REVIVED only included patients deemed unsuitable for CABG and assigned them to either optimal medical therapy (OMT) alone or OMT + PCI. Moreover, about 29% of patients did not receive complete revascularization via PCI, either due to complex anatomy or procedural challenges. These factors severely limit generalizability. The results cannot be extrapolated to patients who are surgical candidates — i.e., those with multivessel disease or extensive ischemia may still benefit from CABG, as seen in STICH-ES. Furthermore, incomplete PCI weakens the therapeutic effect — if viable segments are not revascularized, the procedure is unlikely to improve outcomes, regardless of viability.

*Median follow-up of 3.4 years may be insufficient*

The median follow-up in REVIVED was only 3.4 years, whereas in STICH, the survival benefit of CABG did not emerge until after 5 years. Early procedural risks often offset benefits in the short term. Chronic remodeling, reverse hibernation, or arrhythmia reduction may take years to manifest. Thus, longer follow-up is needed to fully assess the true impact of PCI in ischemic LV dysfunction.

*Exclusion of patients with acute coronary syndromes (ACS)*

REVIVED excluded patients with recent acute coronary syndromes, focusing instead on stable ischemic cardiomyopathy. The findings do not apply to the large group of patients who present with post-ACS myocardial dysfunction — a group that may have different pathophysiology and potential for myocardial recovery. ACS patients often have more salvageable myocardium and may derive greater benefit from timely revascularization. Separate trials are needed to address this subgroup.

*Final synthesis: REVIVED in context*

The REVIVED-BCIS2 trial provides valuable insights but must be interpreted in the context of its:

- Patient selection (low symptom burden, no CABG candidates, chronic stable disease)
- Use of older imaging techniques (limited CMR)
- Short follow-up
- High prevalence of GDMT use

These limitations mean the absence of benefit from PCI in this group does not imply futility of revascularization in all patients with ischemic LV dysfunction. Revascularization is not obsolete — but its role has shifted. It is no longer reflexive but nuanced, and trials like REVIVED help refine which patients benefit and which do not.

**Viability indicators**

***Clinical value of myocardial viability testing***

Myocardial viability testing plays a critical role in guiding clinical decision-making for patients with heart failure and coronary artery disease. Current European guidelines and expert consensus documents emphasize that myocardial viability and advanced cardiac imaging should be integrated into clinical decision-making for revascularization, particularly in complex coronary anatomy, advanced heart failure, uncertain aetiology of left ventricular dysfunction, and when procedural planning such as CRT implantation or ventricular tachycardia ablation is considered. These recommendations are supported by the ESC/EACTS myocardial revascularization guidelines, the EACVI expert consensus on multimodality viability imaging, contemporary reviews addressing the evolving role of viability testing in the STICH and REVIVED era, and current heart failure and cardiovascular imaging guidelines, which highlight the complementary role of cardiac magnetic resonance and multimodality imaging in patient selection and procedural planning [17-

23]. See Table 1 and Figure 1 (algorithm of practical step wise approach for revascularization in CAD).

***Angina and severe inducible ischemia***

According to Miller et al. [24], the presence of inducible ischemia affecting >15% of the LV mass is associated with worse prognosis and greater potential for benefit from revascularization. As shown in Ling et al. [25], inducible ischemia independently predicts adverse outcomes and identifies patients who may benefit from revascularization.

In patients with angina and large ischemic burden, there is strong pathophysiologic justification for revascularization to improve symptoms and possibly prevent future myocardial damage.

***Significant left main CAD***

Such patients were excluded from trials like STICH and REVIVED due to ethical concerns, as left main disease is a class I indication for revascularization [26]. These patients are automatically candidates for CABG, independent of viability, due to the prognostic implications of left main stenosis. Hence, viability testing adds limited incremental value in this subgroup. Excluding these high-risk patients narrows applicability of trial results to real-world practice, where such anatomy is frequently encountered.

***Acute CAD (recent MI) and myocardial stunning***

Gerber et al. demonstrated that myocardial stunning and dynamic tissue healing post-MI mean that even segments with intermediate scar burden can recover over time [27].

Revascularizing soon after MI may show functional improvement in stunned but viable myocardium — even if scar imaging appears ambiguous. Timing of viability assessment matters — assessing too early may misclassify stunned tissue as nonviable; too late, and the opportunity to reverse remodeling is lost.

***Chronic heart failure with non-ischemic or mixed etiologies***

Recovery after revascularization is not guaranteed, particularly in patients with mixed cardiomyopathy etiology. While viability imaging may detect dysfunctional but viable myocardium, underlying non-ischemic factors—such as diffuse fibrosis or metabolic remodeling—can limit recovery. In mixed pathology, the contribution of non-revascularizable or

intrinsically diseased myocardium may blunt the benefit of intervention. Therefore, treatment decisions should consider the broader myocardial substrate beyond viability alone.

***Absence of Q waves on ECG***

Jeon et al. associated absence of Q waves with preserved myocardial integrity, often correlating with viable myocardium [28]. While not a definitive test, surface ECG can aid bedside suspicion of viability — particularly useful in resource-limited settings. However, this remains a weak surrogate and cannot replace imaging-based assessments.

***Indicators viability in cardiovascular imaging***

Various non-invasive imaging modalities are employed to evaluate myocardial viability before considering surgical interventions such as coronary artery bypass grafting (CABG), each with distinct diagnostic performance and interpretation criteria. The diagnostic performance and imaging criteria for myocardial viability across SPECT, dobutamine stress echocardiography, cardiac magnetic resonance, and positron emission tomography summarized in Table 2 are based on from contemporary scientific statements and comprehensive reviews [29,30].

***Radionuclide uptake >50–60%***

According to Garcia and Bax, SPECT or PET uptake above this threshold reliably indicates preserved cell membrane integrity and viability [29,30].

***Single photon emission computed tomography (SPECT)***

(SPECT) is one of the most widely available methods for viability assessment. It has a reported sensitivity of 83% and specificity of 59%, and it is considered reasonable to use according to clinical guidelines (Class IIa, Level B). In this modality, myocardial segments that show more than 50% tracer uptake are considered viable, indicating preserved cellular integrity and perfusion. Segments with 25–50% uptake are considered partially viable, reflecting moderate scarring, while less than 25% uptake indicates non-viable tissue with likely transmural infarction [4].

***Dobutamine stress echocardiography (DSE)***

DSE provides a dynamic assessment of myocardial contractile reserve. It has a sensitivity of 81% and specificity of 78%, and carries a Class IIa, Level B recommendation. Viability is demonstrated by improvement in regional wall motion or increased wall thickening during low-dose

dobutamine infusion. Specific viability markers include an end-diastolic wall thickness greater than 5 mm and an improvement in left ventricular ejection fraction (LVEF) by 5% or more. Segments with wall thickness between 2.5 and 5 mm or LVEF improvement below 5% are considered potentially viable, while severely thinned segments with no response are classified as non-viable [31].

Afridi et al. established that contractile reserve during low-dose dobutamine stress is a strong predictor of recovery. A 10% heart rate increase or contractility in 5 segments had high predictive accuracy [32].

***Echocardiographic regional longitudinal strain***

Echocardiographic regional longitudinal strain was compared in a cross-sectional study of 90 patients with ischaemic cardiomyopathy with wall thickening and contrast enhancement by CMR. A cut-off for regional longitudinal strain of 4.5% differentiated between fully transmural and partially transmural scar on CMR with a sensitivity of 81% and a specificity of 82% [33].

***Minimal late gadolinium enhancement (LGE) on CMR and low dose dobutamine CMR***

Garcia and others have shown that scar burden 25% of wall thickness on LGE-CMR correlates with high recovery potential [31]. CMR offers the most precise assessment of myocardial viability, fibrosis, and distribution. Patients with little or no LGE in dysfunctional segments are excellent candidates for revascularization.

LGE assessment has been found useful in cases of regional wall thinning, for predicting functional recovery after revascularization [34]. Shah et al. showed that in thinned segments (wall thickness <_5.5 mm) but transmural scar extent of <_50% recovery of function and restoration of normal wall thickness after revascularization are likely [35].

Results suggest that low-dose dobutamine CMR is superior to both LGE CMR and wall thickness (using a cut-off value of 4 mm) in predicting recovery after revascularization.

The combined use of LGE and low-dose dobutamine stress CMR, has a higher specificity (91%) and a lower sensitivity (81%) according to a meta-analysis [36], Cardiac Magnetic Resonance Imaging (CMR), particularly with late gadolinium enhancement (LGE), offers high spatial resolution and tissue characterization. It has the highest reported diagnostic performance among non-invasive tests, with a sensitivity of 96% and specificity of 91%, also falling under Class IIa, Level B in guidelines. Myocardial segments with less than 50% transmural extent of LGE and an end-diastolic wall thickness of more than 5.5 to 6 mm are deemed viable. Segments with 50–75%

LGE are considered partially viable, while those with more than 75% enhancement are likely irreversibly scarred and non-viable [14].

***PET mismatch (perfusion–metabolism)***

As shown in Garcia's and Di Carli work [29,37], PET mismatch (reduced perfusion but preserved FDG uptake) represents viable but hibernating myocardium and strongly predicts functional recovery post-revascularization.

Fluorodeoxyglucose Positron Emission Tomography (FDG-PET) evaluates both perfusion and metabolism, offering a sensitivity of 92% and specificity of 63%, and is similarly endorsed as Class IIa, Level B. Viability is suggested when perfusion is normal or only mildly reduced, with preserved glucose metabolism and reversible perfusion defects. Segments with reduced metabolism or perfusion mismatch are considered potentially viable, while areas lacking both perfusion and metabolism are non-viable. The clinical importance of FDG-PET in this context is highlighted in the PARR-2 study led by Beanlands RS et al., published in Circulation in 2007 [38].

Ultimately, the interpretation of these imaging tests must take into account patient-specific limitations such as subendocardial infarcts, renal dysfunction, contrast allergy, obesity, prior surgeries, and diabetes. Imaging findings should be integrated into a multidisciplinary team discussion that includes assessment of the feasibility and completeness of revascularization, coronary anatomy, left ventricular geometry, and coexisting valvular disease, to guide optimal treatment decisions.

**Conclusions**

Myocardial viability testing remains a cornerstone in the management of ischemic cardiomyopathy. While randomized trials like STICH and REVIVED have raised important questions regarding its predictive value for survival, a large body of evidence supports its role in identifying myocardial segments that may benefit from revascularization.

When used appropriately, viability imaging can guide tailored treatment plans, especially in patients with severe LV dysfunction, multivessel disease, or uncertainty regarding benefit from invasive therapy. It's true value lies not in isolation, but in integration—with ischemia evaluation, anatomical assessment, patient symptoms, and shared decision-making.

Future directions should focus on standardized imaging protocols, and prospective trials evaluating outcomes of viability-guided treatment strategies in the era of contemporary guideline-directed medical therapy.

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**Table 1. Clinical Scenarios Where Viability and Advanced Cardiac Imaging May Guide Management in Heart Failure and Coronary Artery Disease. Based on: Neumann *et al.* [17], 2018 ESC/EACTS guidelin; and Almeida et al. [23], 2021 EACVI expert consensus.**

| Clinical Scenario | ESC Recommendation | Reference |
|---|---|---|
| Assessing patients with heart failure, known coronary artery disease, and wall motion abnormalities to determine the need for revascularization. | Class IIb, Level B | Neumann et al., 2018 [32] |
| Evaluating patients who present with heart failure late after an acute coronary syndrome to guide revascularization decisions. | Expert consensus | Almeida et al., Eur Heart J Cardiovasc Imaging 2021 [33] |
| Choosing between PCI and CABG in complex multivessel coronary artery disease based on viability findings. | Heart Team decision | Neumann et al., 2018 [32] |
| Guiding revascularization versus medical therapy in patients with chronic total occlusions (CTO). | Expert opinion | Rahimi K et al., Eur Heart J [34] |
| Understanding the cause of ischaemic mitral regurgitation and planning surgical intervention in patients with LVEF <30%. | Class IIa, Level C | McDonagh et al., 2021 [35] |
| Determining contractile reserve using low-dose dobutamine echocardiography in low-flow aortic stenosis. | Class IIa, Level C | Bax JJ et al., Heart [36] |
| Improving quality of life and reducing symptoms in patients with chronic stable angina and left ventricular dysfunction when viability is present. | Class IIa, Level C | Neumann 2018; McDonagh 2021[32,35] |
| Evaluating revascularization potential in end-stage heart failure to potentially delay or avoid heart transplantation or LVAD placement. | Individualized decision | McDonagh et al., 2021[35] |
| Differentiating ischaemic versus non-ischaemic cardiomyopathy in patients with dilated ventricles and uncertain aetiology using scar imaging | Class IIa, Level C | Almeida et al., Eur Heart J Cardiovasc Imaging 2021 [33], Karamitsos TD et al. [37] |
| Optimizing CRT lead placement and planning VT ablation through non-invasive CMR scar imaging. | Expert consensus | Almeida et al., Eur Heart J Cardiovasc Imaging 2021 [33] Voigt JU et al. [38] |

**Table 2. Diagnostic performance and imaging criteria for myocardial viability across modalities (SPECT, DSE, CMR, and PET). Based on Garcia *et al.* [29] and Bax *et al.* [30].**

| Modality | Sensitivity/Specificity (class) | Viable myocardium | Potentially viable | Non-viable |
|---|---|---|---|---|
| **SPECT** | 83% / 59% (IIa, B) | - >50% tracer uptake<br>- Low scar tissue | - 25–50% tracer uptake<br>- Moderate scar tissue | <25% uptake |
| **DSE** | 81% / 78% (IIa, B) | - EDWT >5 mm<br>- LVEF increase 5% | -EDWT 2.5–5 mm<br>-LVEF increase <5% | Severely thinned myocardium with no contractile reserve |
| **CMR** | 96% / 91% (IIa, B) | - <50% transmural LGE<br>- EDWT >5.5–6 mm | 50–75% LGE | >75% LGE |
| **PET** | 92% / 63% (IIa, B) | - Normal or mildly reduced perfusion<br>- Reversible perfusion defects<br>- Preserved glucose metabolism | Some reduced metabolism or perfusion mismatch | Absent metabolism and perfusion |

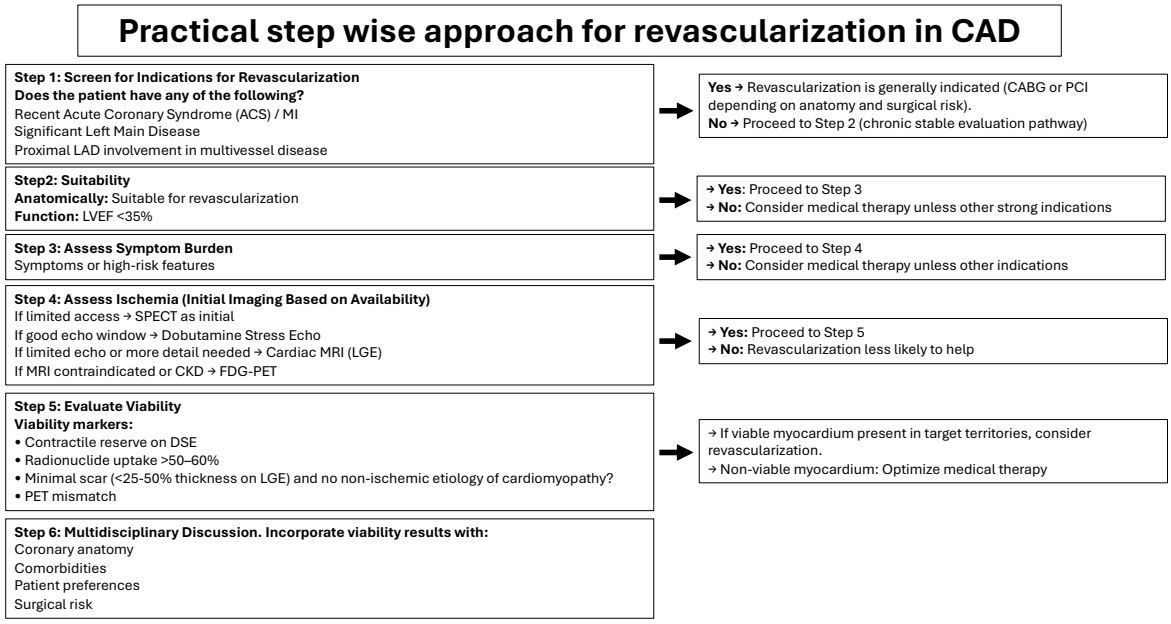


**Figure 1. Practical stepwise algorithm for evaluating patients with coronary artery disease for revascularization.**