Valore prognostico dell’area di miocardio salvato stimata con la gated-SPECT nello STEMI

Dott.ssa Laura Turchetta
UOC Medicina Nucleare AORN A CARDARELLI

L'obiettivo primario della terapia di ***riperfusione*** nei pazienti con ***occlusione coronarica*** acuta è di ottenere il massimo ***salvataggio miocardico ed il minor infarto miocardico*** (IM) possibile.

- *MIOCARDIO SALVATO*
- *DIMENSIONE DELL'IM*
- *FUNZIONE VENTRICOLARE SINISTRA*

} ***Imaging Cardiaco***

variabili di esito e *endpoint primari* dopo la terapia di riperfusione

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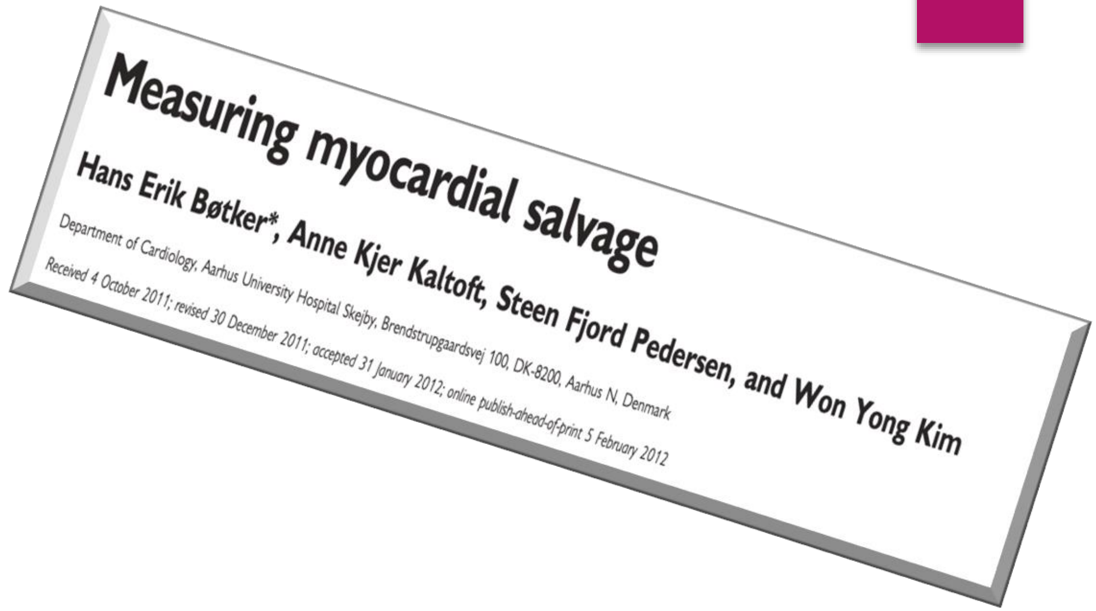
MIOCARDIO SALVATO

DIFETTO REVERSIBILE NEL SETTING DI MIOCARDIO ISCHEMICO O INFARTUATO CHE SCOMPARE DOPO RIPERFUSIONE.

- ESPRESSO DALLA DIFFERENZA TRA DIMENSIONI ATTUALI E POTENZIALI * DELL'AREA INFARTUATA
- MISURA EFFICACIA APPROCCIO TERAPEUTICO (RIPERFUSIONE CORONARICA E TERAPIA MEDICA)
- VALORE PROGNOSTICO DEL VOLUME SALVATO A BREVE E LUNGO TERMINE – *outcome - sopravvivenza*

**AREA A RISCHIO DURANTE OCCLUSIONE CORONARICA ACUTA*

MIOCARDIO SALVATO



Measuring myocardial salvage

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Received 4 October 2011; revised 30 December 2011; accepted 31 January 2012; online publish-ahead-of-print 5 February 2012

- RM
- SPECT-TC
- 82RB-PET-TC
- METODI ANGIOGRAFICI
- MARKERS ISCHEMIA

Table 1 Capability, merits, disadvantages, and utility of methods used for assessment of myocardial salvage

Technique	Capability: Area at risk	Capability: Final infarct size	Advantage	Disadvantage	Suitability
Radionuclide myocardial perfusion imaging SPECT	Gold standard	Achievable	Well validated Paired imaging Can be performed in almost every patient Assessment of AAR prior to intervention Visualizes perfusion regardless of anatomy	Logistically demanding set-up as tracer has to be available 24/7 Radiation exposure Tissue attenuation Low spatial resolution No distinction between new and old perfusion defects Requires two examinations Radiation exposure	Well validated in several clinical trials and in proof-of-concept studies
Radionuclide myocardial perfusion and metabolism imaging PET	Achievable	Achievable	FIS is consistent with histopathology	Low spatial resolution Logistical challenges due to tracer production that requires cyclotron facilities	
Magnetic resonance					
T2-weighted CMR	Achievable		Logistically easy AAR and FIS in one examination No radiation No attenuation High resolution Able to detect small defects Additional information (motion, flow, tissue characteristics) within the same examination	Limitations in evaluation of patients with pacemakers, internal defibrillators, claustrophobia or haemodynamic and electrical instability. Gadolinium-based contrast agents should be avoided in patients with renal failure in patients with renal failure due to the risk of nephrogenic systemic fibrosis. Imaging and quantification remain in evolution	T2-weighted methods are currently the best validated CMR method for quantification of salvage in clinical trials and in proof-of-concept studies, but other methods have shown potential Comprehensive protocols necessary to secure reliable assessment
Precontrast T1-weighted CMR	Achievable				
Early gadolinium enhancement	Achievable				
Late gadolinium enhancement	Achievable	Gold standard			
Radiographic					
Ventriculogram	Achievable	Not achievable	Easily achievable	Estimates only AAR. FIS has to be estimated by different methods Inaccuracy of salvage due to diverging alignment between methods	Used for AAR in combination with other imaging modalites and biochemical ischaemia markers
Angiogram	Achievable	Not achievable	Readily available		
Cardiac CT	Theoretically achievable	Theoretically achievable	Not known	Radiation exposure	Not validated
Ultrasound					
Echocardiography	Theoretically achievable	Theoretically achievable	Availability	Low specificity and sensitivity Semiquantitative	Not validated

SPECT, single-photon emission computerized tomography; PET, positron emission tomography; CMR, cardiac magnetic resonance; CT, computerized tomography; AAR, area at risk; FIS, final infarct size.

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Cardiovascular Research (2012) **94**, 266–275
doi:10.1093/cvr/cvs081

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SPECT-TC

Traccianti tecneziati di perfusione che si accumulano sulla superficie mitocondriale

AAR rappresenta l'iniziale *disfunzione mitocondriale* che risulta reversibile con correzione ischemia

Myocardial Salvage Index = $\frac{\textbf{AAR-FIS}}{\textbf{AAR}}$

FATTORE INDIPENDENTE DI PREVISIONE DI OUTCOME

LIMITI LOGISTICI, ORGANIZZATIVI

of the IRA.[3] The perfusion defects after the PCI procedure were of the same size as the defects before PCI, indicating that myocardial perfusion was either not normalized by the PCI procedure despite achievement of normal flow in the IRA, or the extraction and fixation of ^{99m}Tc-Sestamibi in the myocytes were reduced due to loss of cell viability. Consequently, we evaluated the reliability of ^{99m}Tc-Sestamibi

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doi:10.1093/cvr/cvs081

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Optimized gated a SPECT-derived myocardial salvage index: its prognostic significance in predicting major adverse cardiac events following acute myocardial infarction percussion

Ting Li[1,2,7] · Jing Dou[3] · Hong Zhang[4] · Xuexiao Su[2] · Yin Liu[3] · Mingdong Gao[3] · Jianyong Xiao[3] · Wengui Xu[1] · Jing Gao[5,6]

Received: 24 September 2023 / Accepted: 26 November 2023 / Published online: 4 January 2024
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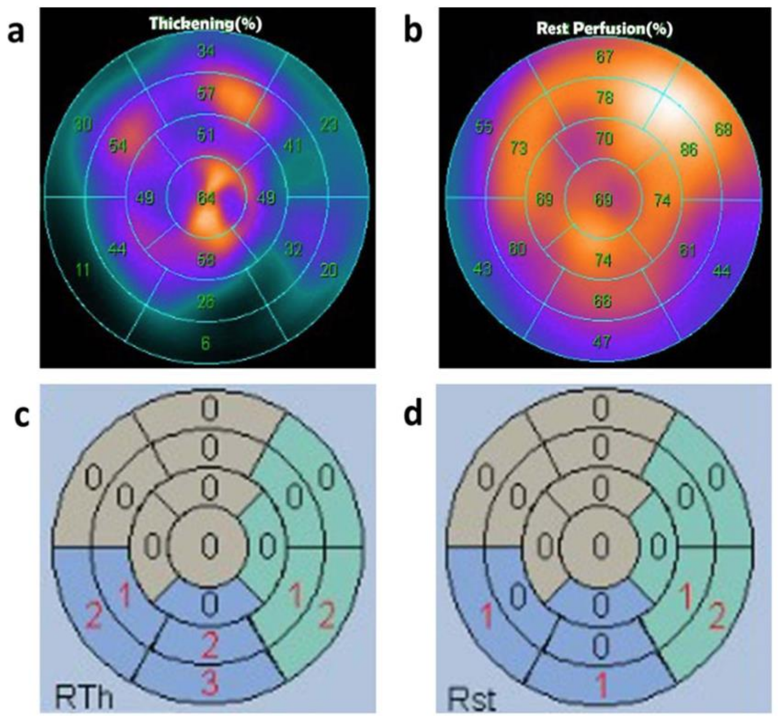
$$\frac{number\ \ of\ \ abnormal\ \ segments \times 100}{17}$$

- Wall-thickening polar map
- Perfusion polar map
- Wall-thickening scores
- Perfusion scores

Fig. 2 A representative example of a patient with a large myocardial salvage index (MSI) and subsequent LVEF improvement. Wall-thickening polar map (**a**), perfusion polar map (**b**), wall-thickening scores (**c**), and perfusion scores (**d**) in a patient with inferior acute myocardial infarction (AMI). Using the scoring evaluation method, the wall-thickening abnormality was approximately 21.6% [11/3 × 17) × 100%] of the LV wall area, together with a relatively limited perfusion defect, approximately 7% [5/4 × 17) × 100%], with an estimated MSI of 0.68. LVEF after AMI was impaired at 45%, and LVEF at 3-month follow-up after PCI increased to 64%. LV, left ventricle; LVEF, left ventricular ejection fraction



Anomalie thickening= stordimento miocardico

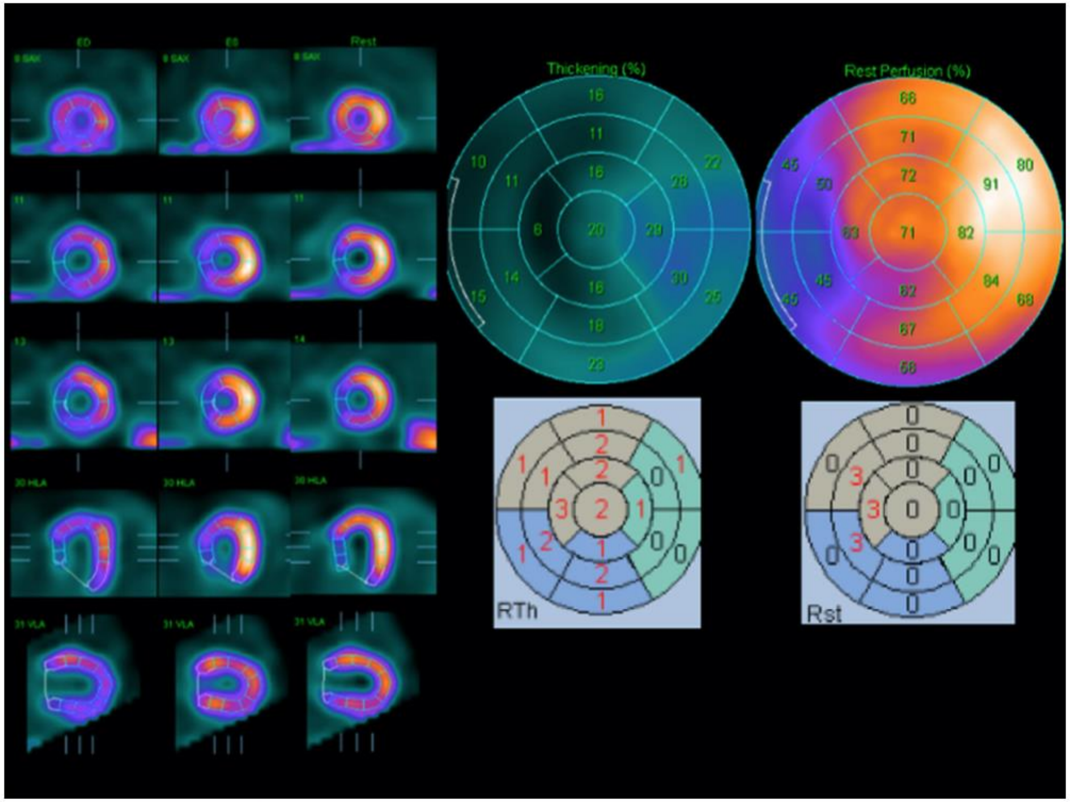


Fig. 5 Same image disposition as in Fig. 4. A very large wall thickening abnormality is present together with a relatively limited septal perfusion defect, with estimated 65% MS. LVEF after AMI was impaired at 39%, and at follow-up had increased to 56%

European Journal of Nuclear Medicine and Molecular Imaging
https://doi.org/10.1007/s00259-017-3891-1

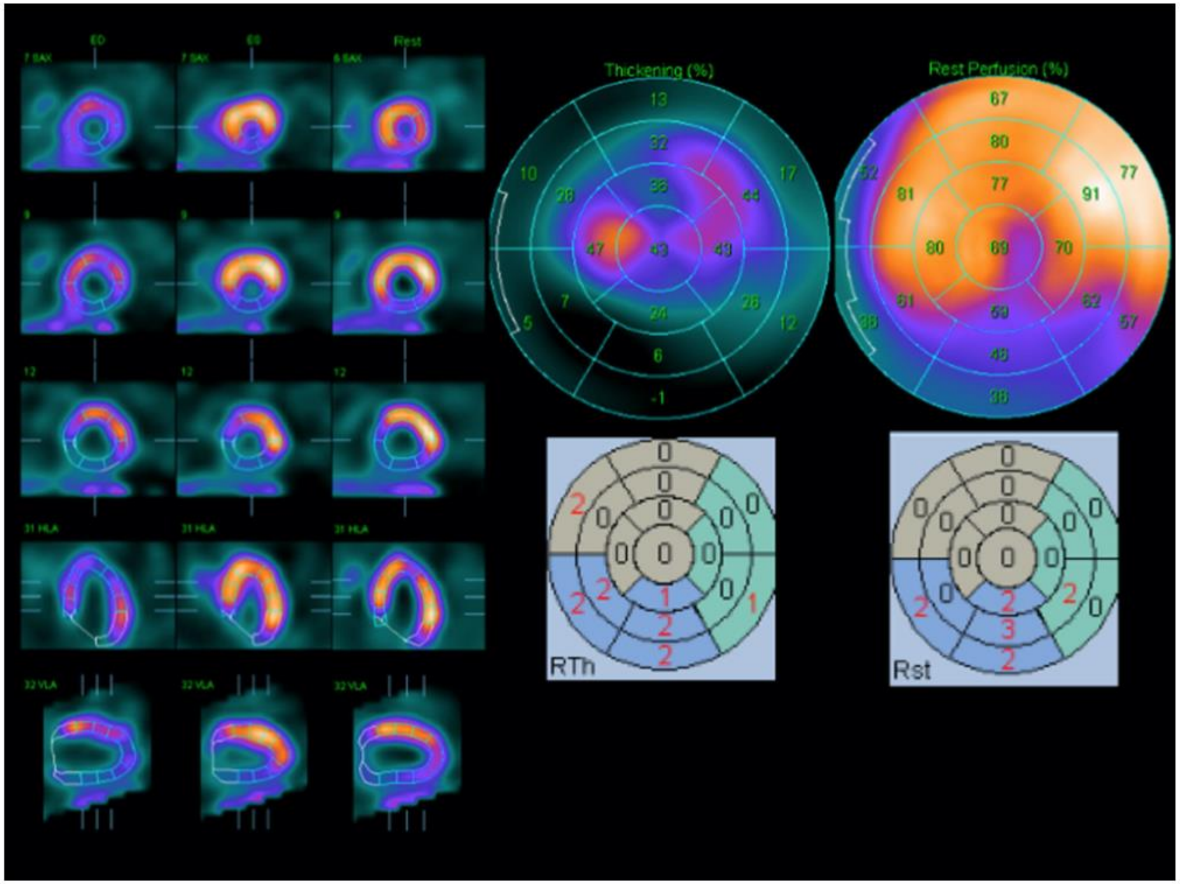


Fig. 4 Columns from left to right: gated SPECT end-diastolic (ED) and end-systolic (ES) frames, and summed (Rest) perfusion images (from top to bottom: representative short axis slices and midventricular horizontal and vertical long-axis slices), wall thickening polar map (top), wall thickening scores (RTh, bottom), perfusion polar map (top), perfusion scores (Rst, bottom) in a patient with inferior acute myocardial infarction (AMI). There is an inferior uptake defect with corresponding impaired thickening; in accordance with the extent of abnormalities, there is 12% MS (two segments). LVEF after AMI was 40%, and at follow-up had increased to only 42%

European Journal of Nuclear Medicine and Molecular Imaging
https://doi.org/10.1007/s00259-017-3891-1

SPECT-DERIVED MYOCARDIAL SALVAGE INDEX

Fig. 1 Receiver operating characteristic curve (ROC) demonstrating the prognostic value of myocardial salvage index (MSI) in predicting LVEF improvement acquired using the scoring and number evaluation methods with Gated SPECT myocardial perfusion imaging (GSMPI)

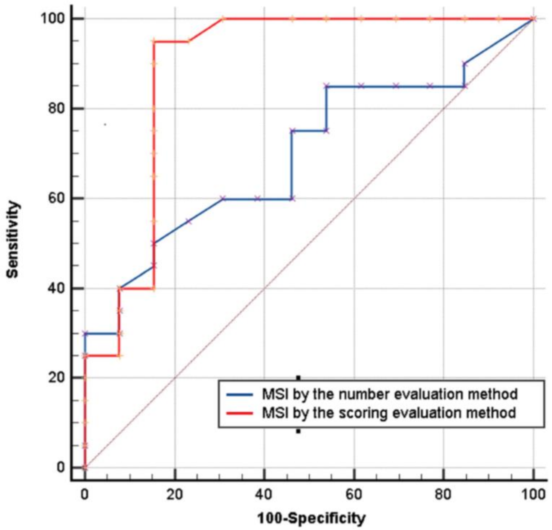
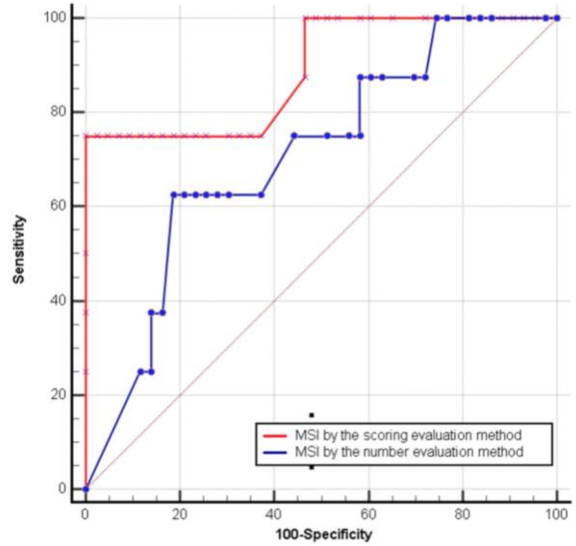
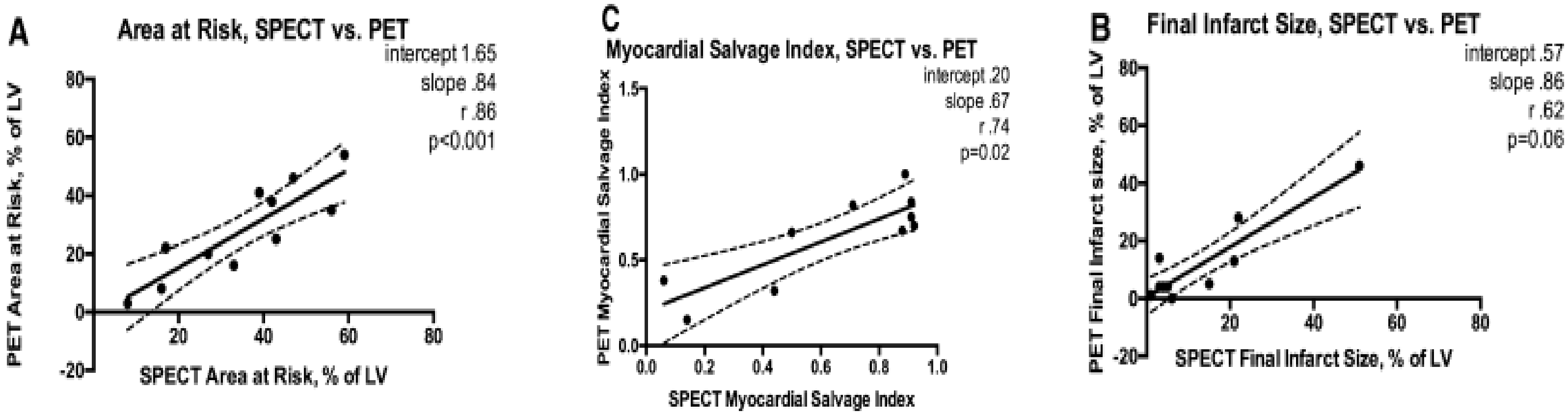


Fig. 3 Receiver operating characteristic curve (ROC) revealing the prognostic value of myocardial salvage index (MSI) in predicting MACEs acquired using the scoring and number evaluation methods with Gated SPECT myocardial perfusion imaging (GSMPI)



Annals of Nuclear Medicine (2024) 38:219–230
https://doi.org/10.1007/s12149-023-01894-1

PET-TC vs SPECT-TC



Conclusions. ^{82}Rb-PET underestimates area at risk in patients with STEMI when compared to SPECT and CMR. However, our findings suggest that PET imaging seems feasible when assessing the clinical important parameters of final infarct size and myocardial salvage index, although with great variability, in a selected STEMI population with large infarcts. These findings should be confirmed in a larger population. (J Nucl Cardiol 2018;25:970–81.)

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RM-cardiaca

Anatomia/Funzione/Flusso

Elevata RS RT

No radiazioni ionizzanti

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SPECT, single-photon emission computerized tomography; PET, positron emission tomography; CMR, cardiac magnetic resonance; CT, computerized tomography; AAR, area at risk; FIS, final infarct size.

RM VS SPECT

Alto costo
Poco fruibile
Presenza di dispositivi non compatibili
Grave insufficienza Renale
Qualità immagine ridotta con alterazioni del ritmo
Edema --- sovrastima AAR

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Cardiovascular Research (2012) **94**, 266–275
doi:10.1093/cvr/cvs081

There are relatively few direct comparisons between CMR and SPECT for quantification of AAR. In selected STEMI patients with a totally occluded coronary artery at arrival to the catheterization laboratory, a reasonable agreement was found between T2-weighted CMR and SPECT for the assessment of AAR[63] and also between contrast-enhanced CMR and SPECT.[49] Our own data in consecutive STEMI patients suggest that CMR in comparison with SPECT shows a systematic overestimation of AAR, which means that the two techniques should not be used interchangeable in studies. This discrepancy in AAR estimation may reflect both fundamental differences between the two imaging modalities and also the fact that the tracer injection was given before primary PCI, while the CMR detection of myocardial oedema was done several days after the infarction.

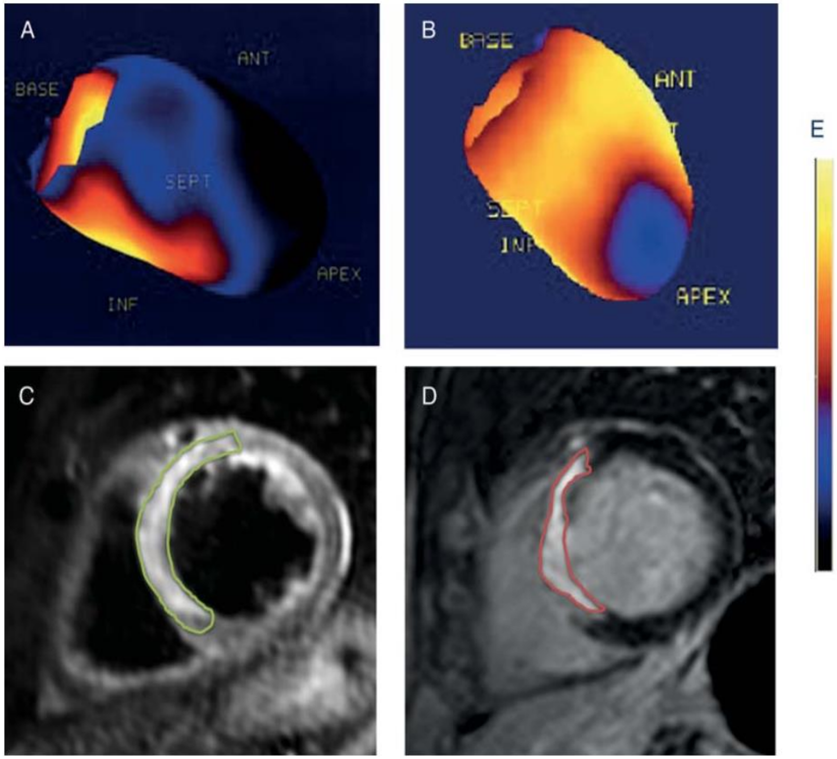

Figure 1 Area at risk (AAR) and final infarct size (FIS). Upper pictures show SPECT with myocardial AAR as blue and black (*A*) and FIS as blue (*B*). Myocardial salvage index (MSI) is calculated as the difference between AAR and FIS divided by the AAR. In this example, MSI = 60 (% of LV volume)−23 (% of LV volume)]/60(% of LV volume) = 0.61, where LV, left ventricle. Lower panel shows CMR with T2-weighted assessment of AAR (*C*) and FIS measured by the late gadolinium enhancement technique (*D*). In this example, MSI = 52 (g)−21 (g)]/52 (g) = 0.6. E represents the color scaling of SPECT where yellow represents normal perfusion, blue reduced and black absent perfusion.

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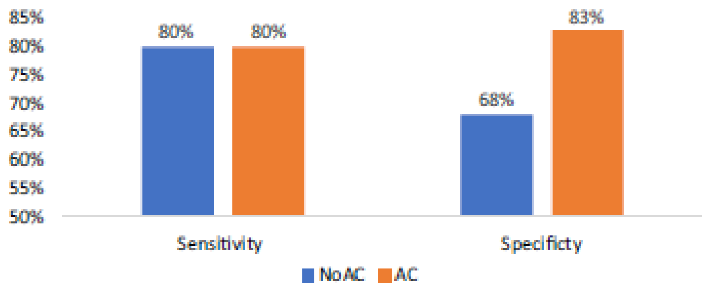
Compared with SPECT, LGE CMR has higher spatial resolution, allowing delineation of the transmural extent of myocardial infarction. In contrast to SPECT, the CMR technology enables homogenous tissue signal from the entire field of view alleviating tissue attenuation as a limitation. Consequently, both anterior and inferior myocardial infarctions are equally well depicted.

Table 1. Summary of studies evaluating the impact of attenuation correction on the sensitivity and specificity of SPECT myocardial perfusion imaging

Reference	n	Age (years) (SD)	% Male	Tracer	CAD definition	AC sensitivity	AC specificity	NAC sensitivity	NAC specificity
Sharma[15]	171	55 (10)	82	^{99m}Tc	> 50%	0.57	0.89	0.65	0.83
Genovesi[12]	104	64 (10)	79	^{99m}Tc	> 70% LM > 50%	0.75	0.81	n/a	n/a
Huang[22]	99	62 (12)	56	^{99m}Tc	> 70%	0.92	0.79	0.95	0.63
Masood[14]	118	61 (12)	67	^{99m}Tc	> 50%	0.94	0.59	0.93	0.56
Utsunomiya[16]	30	68 (-)*	60	^{201}Tl	> 50%	0.76	0.93	0.67	0.86
Arsanjani[19]	463	64 (12)	57	^{99m}Tc	≥ 70%	0.84	0.88	0.83	0.81
Summary	525	60	n/a	n/a	n/a	0.80	0.83	0.73	0.68

Adapted in part from Huang et al[13]
AC, attenuation correction; *CAD*, coronary artery disease; *LM*, left main coronary artery; *NAC*, non-attenuation correction; *SD*, standard deviation
*No available information in included study



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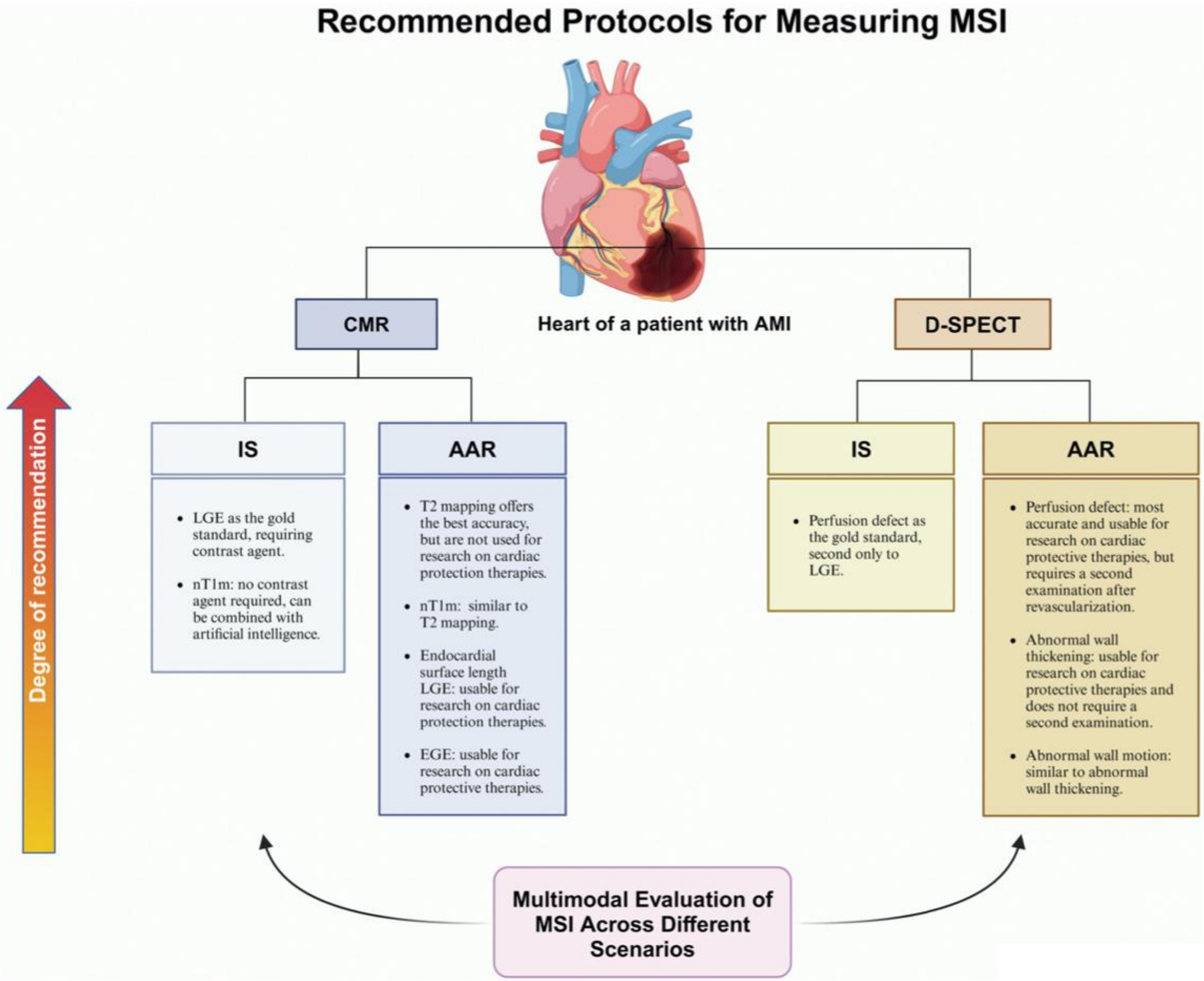

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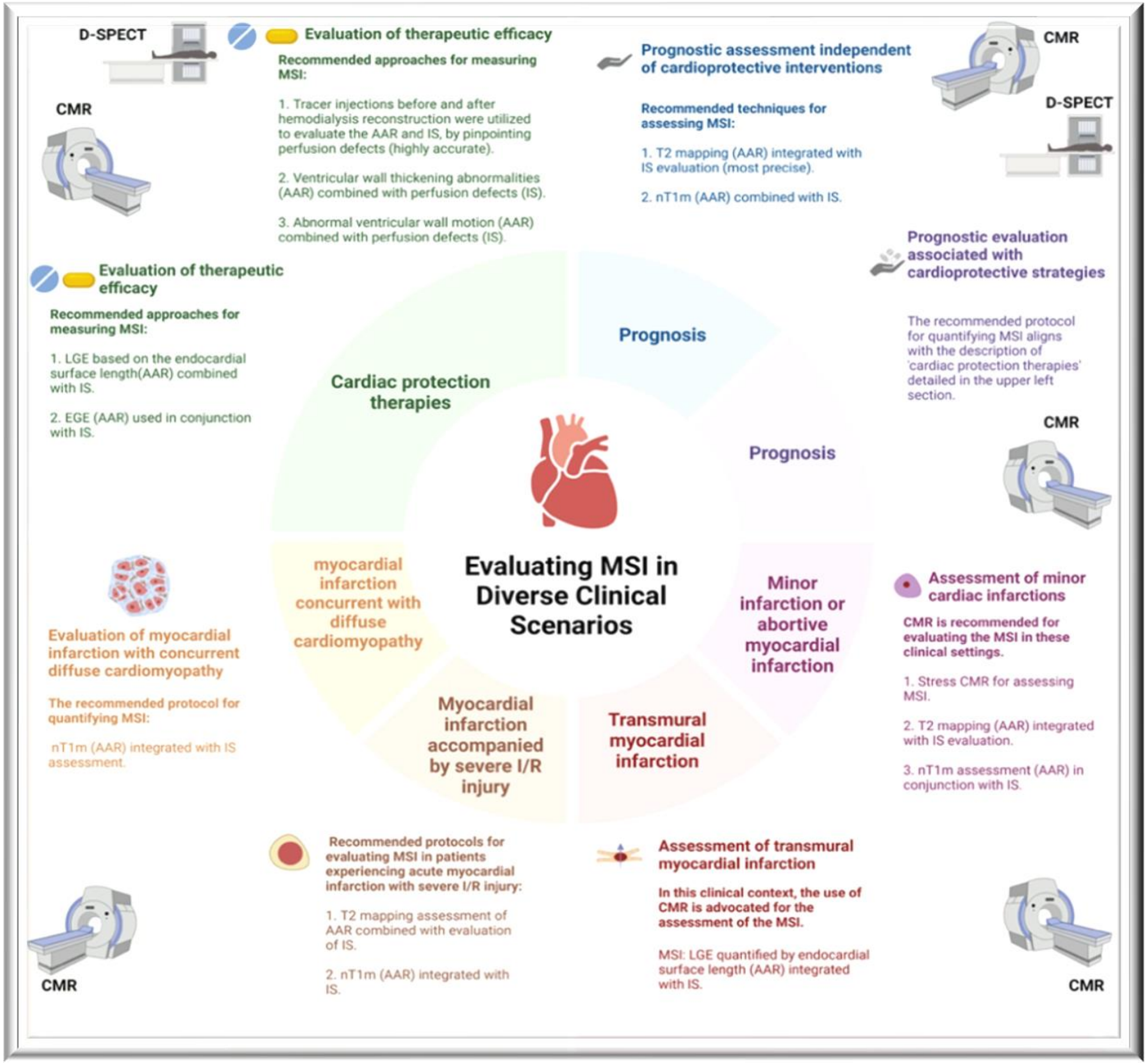

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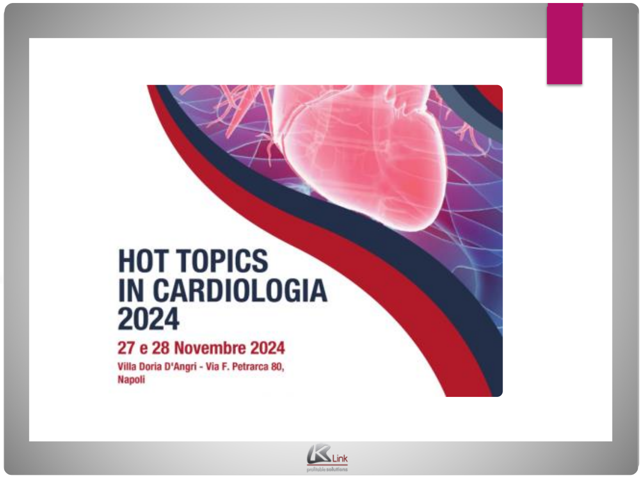

Thank you

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