The Role of Nuclear Imaging in Heart Failure

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Goals of Imaging in Heart Failure

• Assessment of LV function

• Determining etiology of cardiomyopathy

• Guiding management

• Outcomes and Prognosis
Prevalence of CAD in Heart Failure Treatment Trials

68 % CAD

32 % Non-CAD

Data from 13 randomized, multicenter HF trials in NEJM since 1986

Total = 20,190 patients

Gheorghiade and Bonow, Circ 1998
Assessment of Etiology: Myocardial Perfusion Imaging

50 M typical angina

A

B
Making the Diagnosis
Adjusted Risk of Cardiac Death vs Ischemia

Revascularization vs Medical Rx

†Adjusted for predictors of revascularization as well as clinical, hx, stress SPECT data

* p<0.001

Myocardium Ischemic


Medical Rx

Revasc*
Prognostic Value of Gated SPECT

2,686 consecutive patients, stress 99mTc-MIBI SPECT (known or suspected CAD)

![Graph showing the relationship between LVEF and cardiac death rate](chart.png)
Comprehensive Cardiac PET/CT Protocol for CAD Evaluation

<6 mSv

Rb-82 25-30 mCi
Dipy 0.56 mg/kg
Rb-82 25-30 mCi
Gated rest
Gated stress
CAC

IV contrast (75cc)
Timing Bolus (15 cc)
Gated CTCA

FDG 15 mCi

Gated FDG

5 sec 30-50 mA

5 sec 320 mA 320 mA 400 mA

35 min

~ 10 min

15 min
Stress-Induced Ischemia

Short Axis (Apex→Base)

Horiz Long Axis (Post→Ant)

Vert Long Axis (Sep→Lat)
## Rest-Stress Gated Rb-82 PET/CT Imaging

**Stress Rb**  
5/27/2004

<table>
<thead>
<tr>
<th>EF (%)</th>
<th>EDV (ml)</th>
<th>ESV (ml)</th>
<th>SV (ml)</th>
<th>Mass (gm)</th>
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<tbody>
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<td>43</td>
<td>119</td>
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**Estimated % Thickening**
- > 40%
- 25% => 40%
- 10% => 25%
- 0% => 10%
- -10% => 0%
- < -10%
Viability Imaging
Thallium Redistribution

Stress

4h-Rdst

24h-Rdst
$^{99m}$Tc SPECT and Contrast Enhanced MRI

- Basal SA
- Mid SA
- Apical SA
The Healthy Heart Metabolizes Fatty Acid as its Primary Source of Energy
Ischemia Depresses Fatty Acid Metabolism
FDG Uptake and Metabolism

Blood Capillary

Glucose

18F-FDG

Cell

Glycogen

Glycolysis

Glucose-6-P

hexokinase

18F-FDG

hexokinase

18F-FDG-6-P

Phelps et al, JNM 1978
Rest MPI + FDG (PET Match)
Rest MPI + FDG (PET Mismatch)
Long-Term Prognosis of Patients With LV Dysfunction by PET Pattern of Viability and Mode of Treatment

With PET Mismatch

Without PET Mismatch

Survival Probability

Time (months)

CABG

Medicine

P = 0.007

P = 0.12

Di Carli et al, JTCVS 1998
PARR-2
PET-guided Therapy vs. Standard Care

Event-free survival

Days

0 100 200 300

PET arm
Standard arm

430 patients
p = 0.15
218 PET vs. 212 Standard of Care

Adherence Rate in PARR-2

A

Adherence Rates

% of patients

High
n=58

Moderate
n=103

Low
n=46

Viability
PARR-2 Trial: Standard of Care vs. Adherent Group

P = 0.019
Cardiac Autonomic Innervation Imaging
Cardiac Autonomic Innervation

- Heart is richly innervated by autonomic fibers that play a crucial role in regulating normal cardiac function.
- Cardiac pathology disrupts balance between sympathetic and parasympathetic function.
- Imaging of the cardiac autonomic innervation shows powerful potential for effective risk stratification.
MIBG IMAGING
Parameters Assessed

• Global cardiac uptake of tracer
  – (planar, delayed images)
  – Heart/mediastinal ratio. 2.2 ± 0.3 (<1.6 is 2 SD below normal mean).

• Global washout
  – (planar, from initial to delayed images)
  – Measures ability of myocardium to retain MIBG.
  – Normal pts: 10% ± 9%. Higher values correlate with disease, such as CHF. (>27%: dramatically increased mortality).

Myocardial $^{123}$I mIBG Imaging and Cardiac Events in Heart Failure

961 pts with NYHA Class II-III CHF and LVEF ≤ 35%: 2 yr FU

ENDPOINTS (n=237)

- CHF progression (n=163)
- Potentially life threatening arrhythmias (n=50)
- Cardiac death (n=24)

Short Axis (Apex->Base)

Horiz Long Axis (Post->Ant)

Vert Long Axis (Sep->Lat)
In Conclusion…

• Multiple tools are available for assessment of heart failure patients

• Defining coronary anatomy and degree of ischemia is essential in the management of these patients

• Nuclear Imaging is an excellent tool for the assessment of viability
  – Further data is needed

• MIBG imaging is a promising tool to assess cardiac outcomes in CHF patients