Severe heart failure
Patient tailored approach

LV function and size?

CAD: yes or no?

CAD: ischemia? viability?

Severe MR?
LV function and size?

mortality

Adapted from White et al. NEJM 1986
LV function and size? 
First choice: echo
LV function and size? 
Towards 3D imaging?
Advanced LV function assessment

Longitudinal strain
From regional to global LV strain
Global strain maps: HF, infarction, and normal

GLPSS Avg: -7.3 ± 3%

GLPSS Avg: -13.8 ± 3.3%

GLPSS Avg: -19.1 ± 3.1%

P<0.001
LV function and size?
Other techniques?
LV function and size?
Other techniques?
Center-line method to quantify LVEF and volumes
Center-line method to quantify LVEF and volumes

End-diastole

End-systole

Epicardial contour

Endocardial contour
RV function and size

<table>
<thead>
<tr>
<th>ESV</th>
<th>34.3</th>
<th>ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDV</td>
<td>78.9</td>
<td>ml</td>
</tr>
<tr>
<td>EF</td>
<td>56.6</td>
<td>%</td>
</tr>
<tr>
<td>SV</td>
<td>44.7</td>
<td>ml</td>
</tr>
</tbody>
</table>
RV function and size
LV function and size?

- We need:
- Highest resolution images in every patient
- Assessment of LVEF but also
  - LV dimensions: LVESD, LVEDD
  - LV volumes: LVESV, LVEDV
- Exact quantification – prognosis but also for justification of ICD therapy
CAD: yes or no?
First choice: invasive angio
CAD: yes or no?
Other options?
CAD: yes or no?
Other options?
Meta-analysis 64-slice CT

Patient-based detection (n=1286)

- Sensitivity: 99%
- Specificity: 89%
- PPV: 93%
- NPV: 100%

Rule out CAD

Mowatt et al. *Heart* 2008
CAD: no

• We need information:

• On the myocardium:
  – edema, inflammation, fibrosis: myocarditis, amyloidosis?
Myocardial disease: MRI makes the difference

Mahrholdt, Eur Heart J 2005
Dyspnea

Female 65 years

- History M Waldenstrom
- Progressive dyspnea, NYHA class 3
- Coronary angiography: normal
Suggestive of cardiomyopathy
2-chamber  4-chamber
AL amyloidosis. Pt died 3 months after diagnosis
DE Patterns

Mahrholdt, Eur Heart J 2005
Male 25 years

Out of hospital cardiac arrest: ventricular fibrillation

Resuscitation, defibrillation, intubation

Medical history

• Riskfactor CAD: smoking
• 5-6 days before not feeling well, gastro-enteritis?
ECG at IC
Echocardiography day 1
Coronary angiography:

No significant stenosis, 30% stenosis on proximal LAD
MRI DE

DE SAX

DE SA basal
Echo at 5 months

- Positive IgG and IgM for HHV-6 (previous gastroenteritis)
- No biopsy
DE Patterns

**Ischemic**

A. Subendocardial Infarct
- Idiopathic Dilated Cardiomyopathy
- Hypertrophic Cardiomyopathy
- Myocarditis
- Right ventricular pressure overload (e.g., congenital heart disease, pulmonary HTN)

B. Transmural Infarct

**Nonischemic**

A. Mid-wall HE
- Sarcoïdosis
- Myocarditis
- Anderson-Fabry

B. Epicardial HE
- Sarcoïdosis, Myocarditis, Anderson-Fabry, Chagas Disease

C. Global Endocardial HE
- Amyloidosis, Systemic Sclerosis, Post cardiac transplantation

Mahrholdt, Eur Heart J 2005
Prognostic value of LGE-CMR in myocarditis

N = 222 patients with biopsy proven myocarditis

Grun JACC 2010
CAD: yes

- We need ischemia demonstration to justify revascularization
- We need viability demonstration to justify revascularization
Is there ischemia?

- Angina
- ECG changes
- Systolic dysfunction
- Diastolic dysfunction
- Hypoperfusion

Systolic wall motion imaging

Perfusion imaging

Time from onset of ischemia

Schinkel et al. EHJ 2003
Nuclear perfusion imaging, SPECT

POLAR MAP TO QUANTIFY EXTENT AND SEVERITY OF ISCHEMIA
Is there viability?

**PRE-OPERATIVE**

Single Vessel Disease
Occluded L.A.D.

- LVEDV: 128 ml
- LVESV: 81 ml
- LVSV: 47 ml
- LVEF: 0.37

**8 MONTHS POST-OPERATIVE**

Patent Coronary By-Pass Graft to L.A.D.

- LVEDV: 104 ml
- LVESV: 25 ml
- LVSV: 79 ml
- LVEF: 0.76
Revascularization versus change in LVEF

N=355 pts with LVEF <35%

Schinkel et al. AJC 2004
Clinical goal:

- identify patients:
  - with dysfunctional but viable tissue
  - with potential to recover function
  - to justify enhanced surgical risk
Nuclear: thallium-201

- Early uptake is perfusion
- Late uptake is cell membrane integrity
Nuclear: MIBI

Rest

Nitrates

Courtesy A Cuocolo
Echo: low-dose dobutamine

rest  low-dose  post-revasc

Courtesy JH Cornel
Nuclear: FDG
MRI: DE ---- scar!
## Myocardial revascularisation in chronic heart failure (CHF)

### Recommendations for patients with CHF and systolic LV dysfunction (EF < 35%), presenting predominantly with HF symptoms (no or mild angina: CCS 1-2)

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Class</th>
<th>Level</th>
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<tbody>
<tr>
<td>LV aneurysmectomy during CABG is indicated in patients with a large LV aneurysm.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>CABG should be considered in the presence of viable myocardium, irrespective of LVESV.</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>CABG with SVR may be considered in patients with a scarred LAD territory.</td>
<td>IIb</td>
<td>B</td>
</tr>
<tr>
<td>PCI may be considered if anatomy is suitable, in the presence of viable myocardium.</td>
<td>IIb</td>
<td>C</td>
</tr>
<tr>
<td>Revascularisation in the absence of evidence of myocardial viability is not recommended.</td>
<td>III</td>
<td>B</td>
</tr>
</tbody>
</table>

SVR: surgical ventricular reconstruction.
Severe MR?

Lancellotti et al. Circ 2003
Severe MR?
First choice: echo
Severe MR?
3D Flow Quantification in All Valves

3D volume scan /w 3-dir velocity encoded MRI

MV & TV
AV
PV
3D Flow Quantification in All Valves

MV flow

$V_{\text{forward}} = 116 \text{ ml}$

$V_{\text{back}} = 32 \text{ ml}$

$V_{\text{eff}} = 84 \text{ ml}$

Regurg. Fraction $= 27\%$
Importance of MV anatomy
Is surgical repair feasible?

3D TEE
ICD shocks in primary prevention

N=720 pts, MADIT II
Follow-up 21 months

Shocks:

- 65%
- 35%

Moss et al. Circ 2004
What is the pathophysiological substrate for SCD in CAD?
MRI to assess arrhythmogenic substrate:

- Late-gadolinium enhancement: scar area and peri-infarct zone
Value of border zone to predict VTs

HR (95% CI): 1.47 (1.04 to 2.08)  
P = 0.003
Severe heart failure patient

Complex information is needed to determine therapy

Can be provided by multi-modality imaging