

# CRT-D or CRT-P What To Do When The LV Systolic Function Has Improved?

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# Disclosures

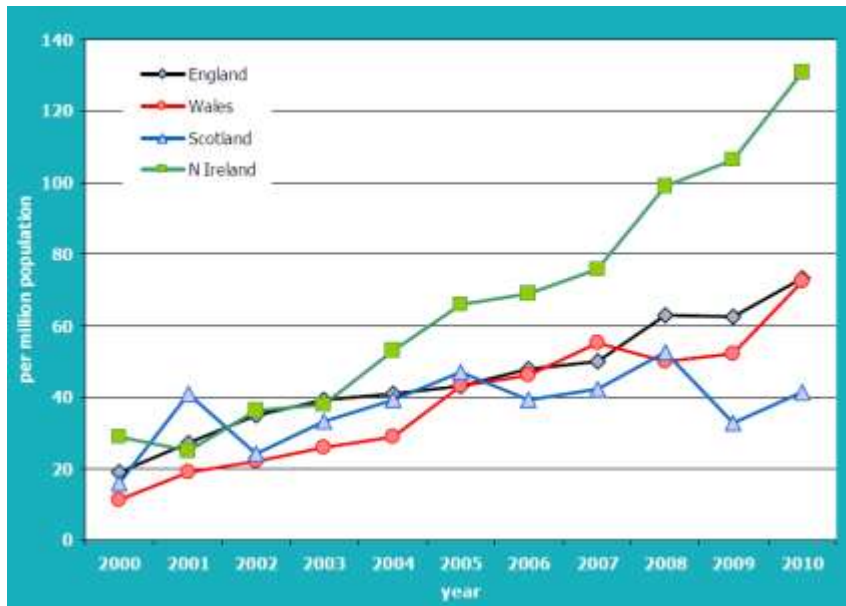
- Received support to attend training events and symposia
  - St Jude, Medtronic & Boston Scientific

# Overview

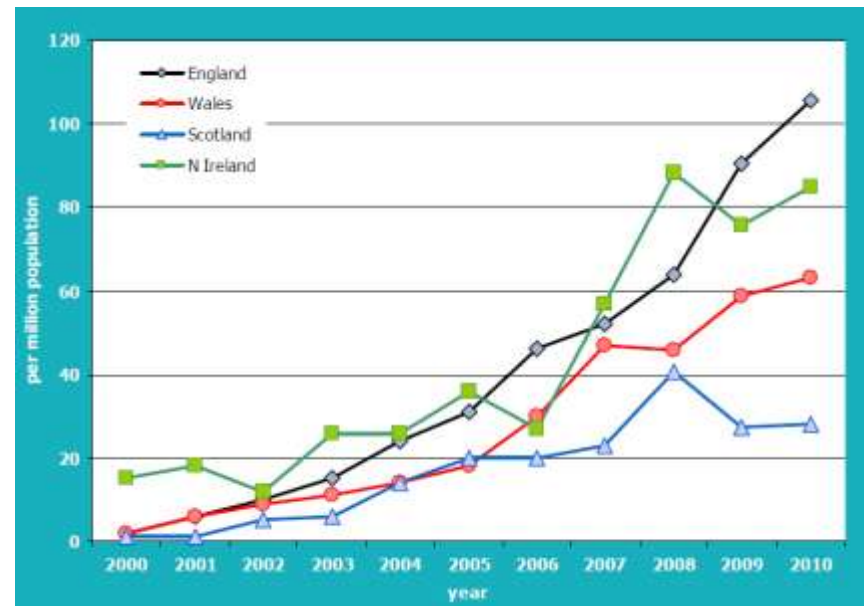
- Background/Scenario
  - Options
    - Do Nothing
    - Like for like
    - Downgrade
  - Technological considerations
  - Summary
- Pros and cons

# Why Does It Matter?

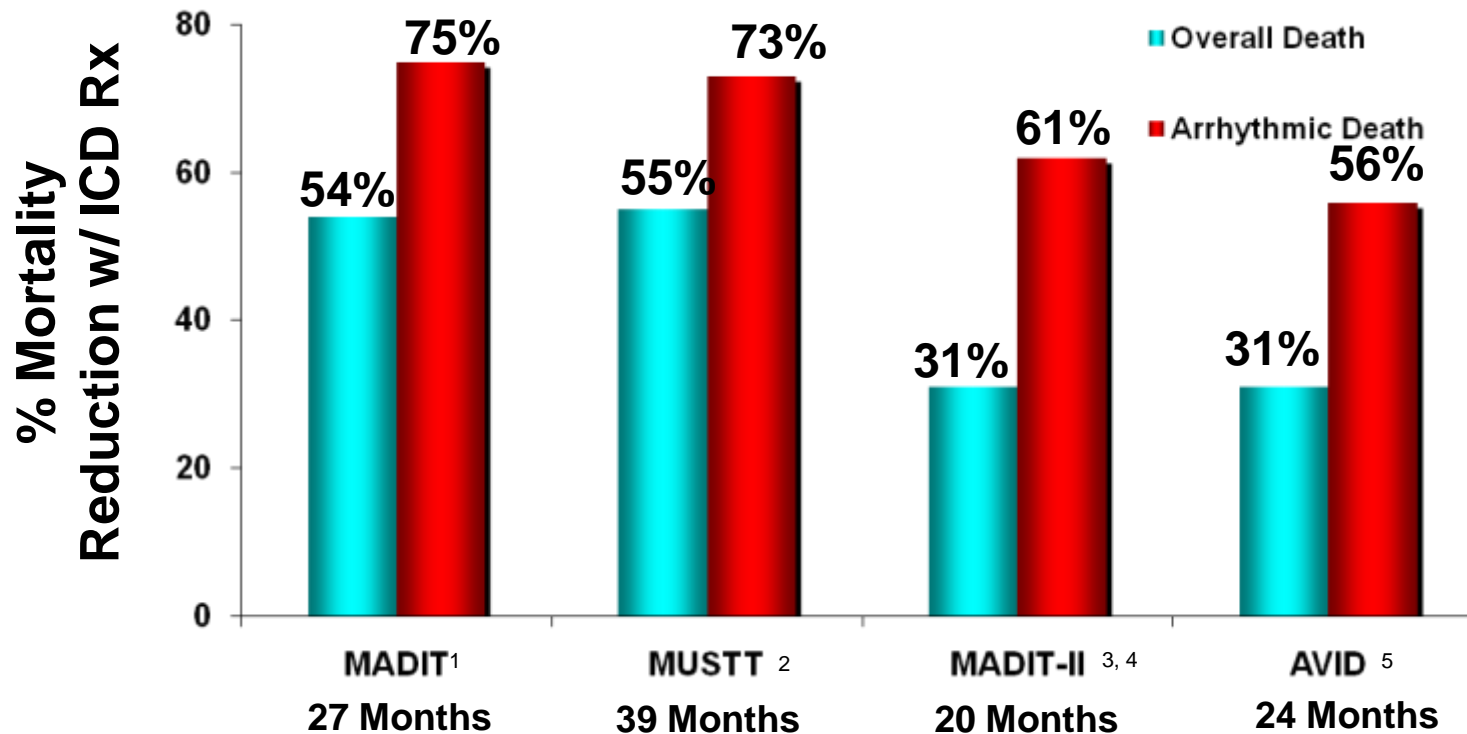
## ICD Implants



## CRT Implants



# Mortality Benefits in ICD Trials



<sup>1</sup> Moss AJ. *N Engl J Med.* 1996;335:1933-40.

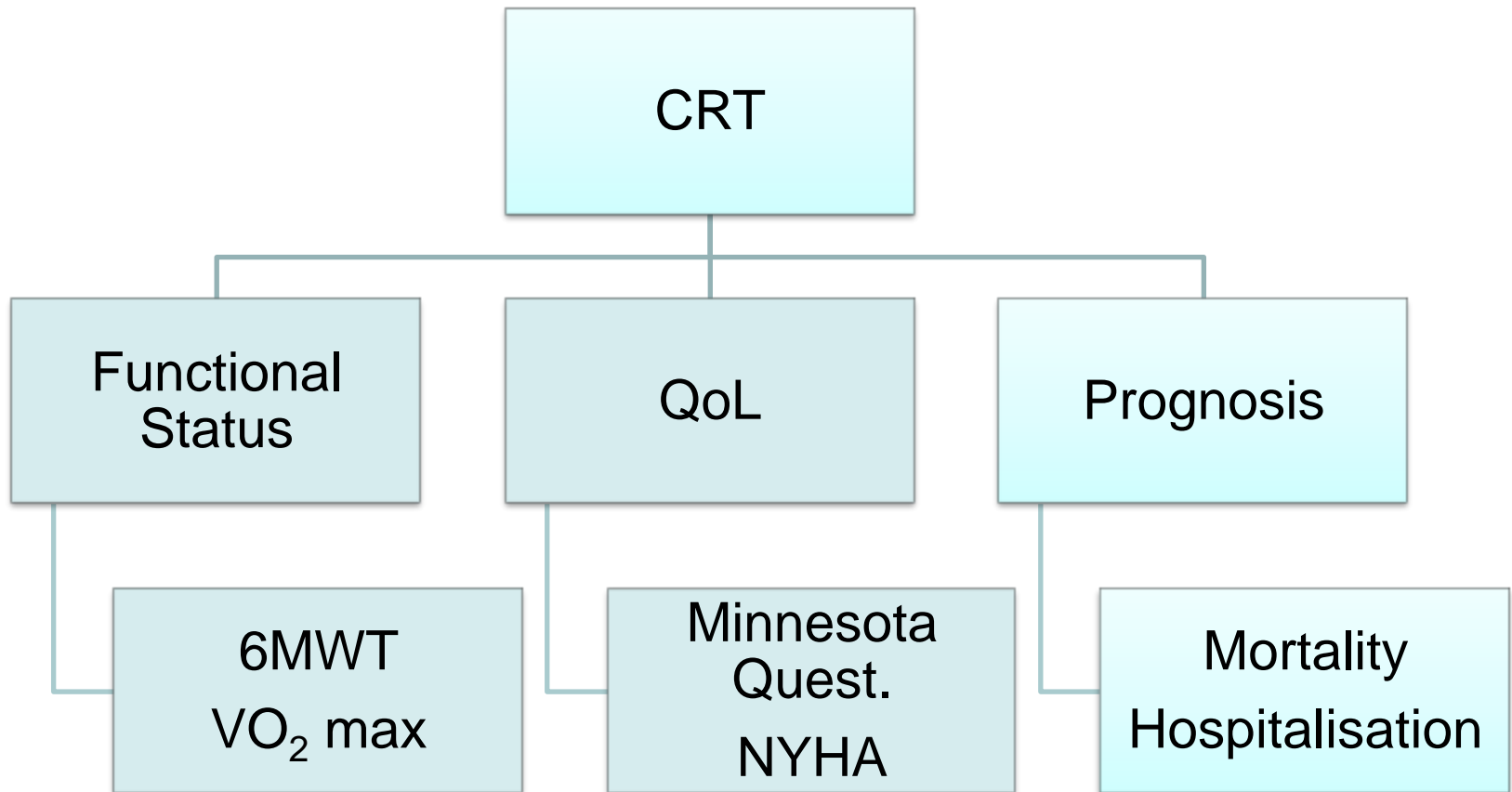
<sup>2</sup> Buxton AE. *N Engl J Med.* 1999;341:1882-90.

<sup>3</sup> Moss AF. *N Engl J Med.* 2002;346:877-83.

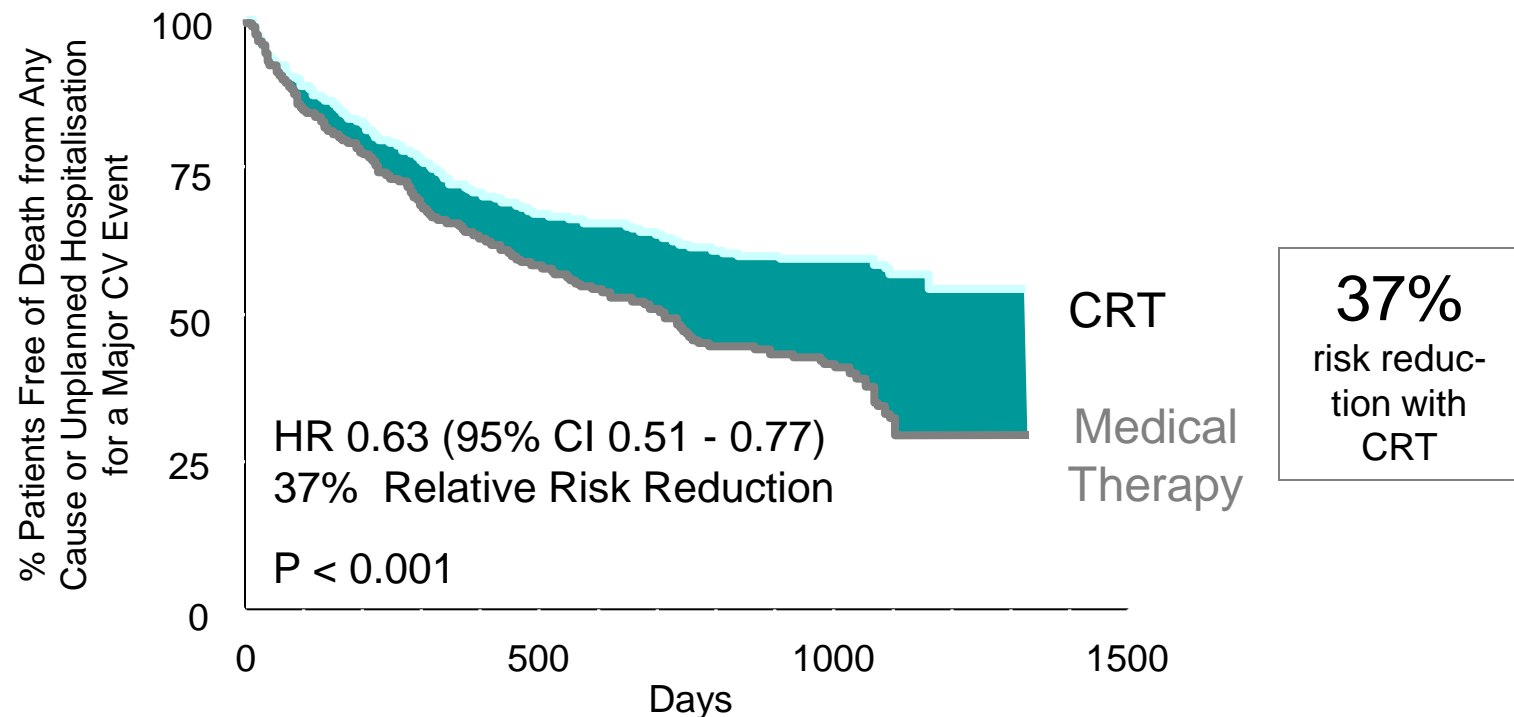
<sup>4</sup> Moss AJ. Presented before ACC 51st Annual Scientific Sessions, Late Breaking Clinical Trials, March 19, 2002.

<sup>5</sup> The AVID Investigators. *N Engl J Med.* 1997;337:1576-83.

# Evidence Base For CRT



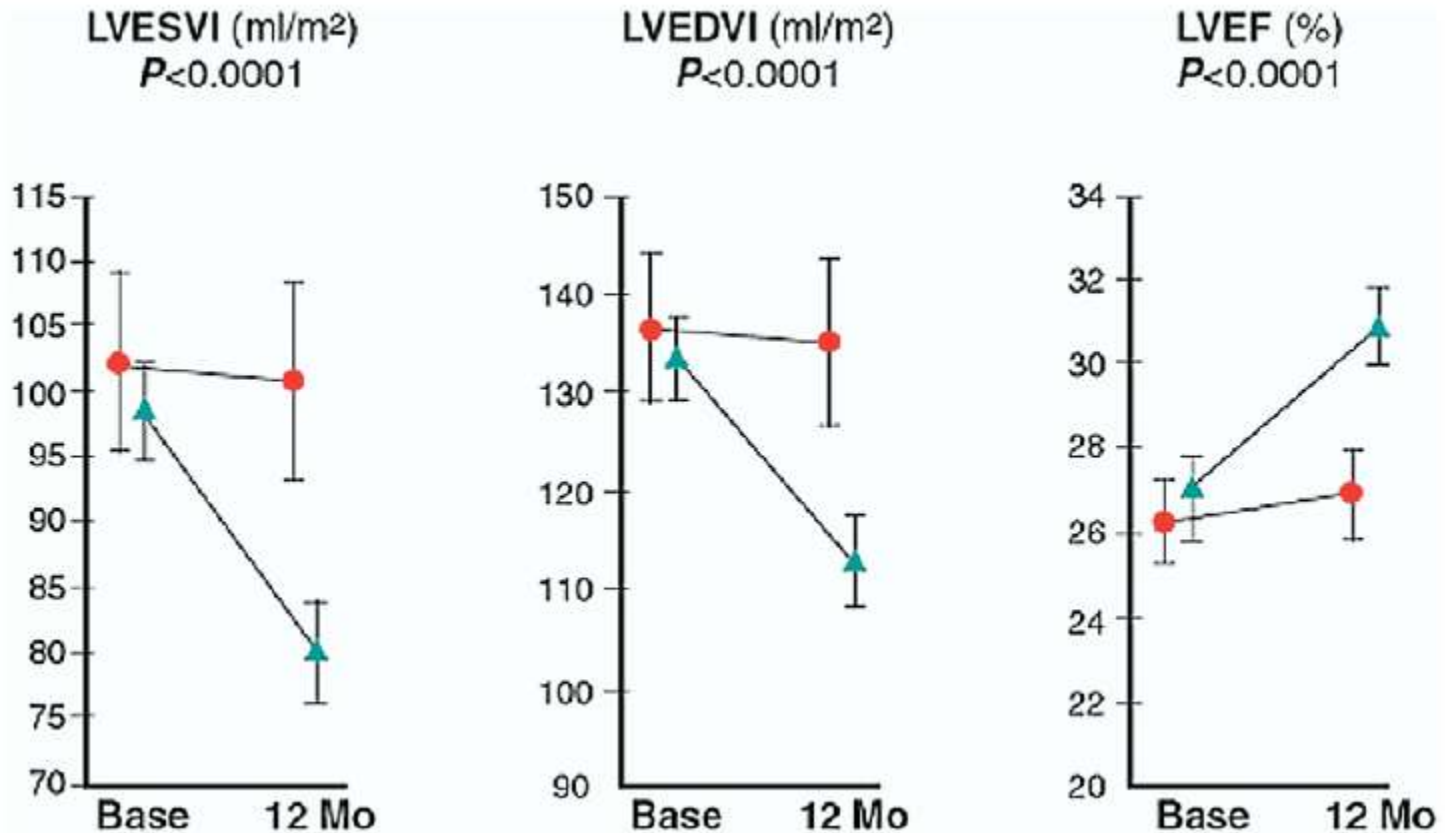
# CARE-HF: CRT reduces death or unplanned hospitalisation for CV events in NYHA III/IV



**At 3 and 18 months, the LVEF was significantly greater, the LVESVI was significantly lower and the area of mitral regurgitation was significantly smaller in the CRT group than in the medical therapy group**

# REVERSE (REsynchronization reVERses Remodelling in Systolic left vEntricular dysfunction)

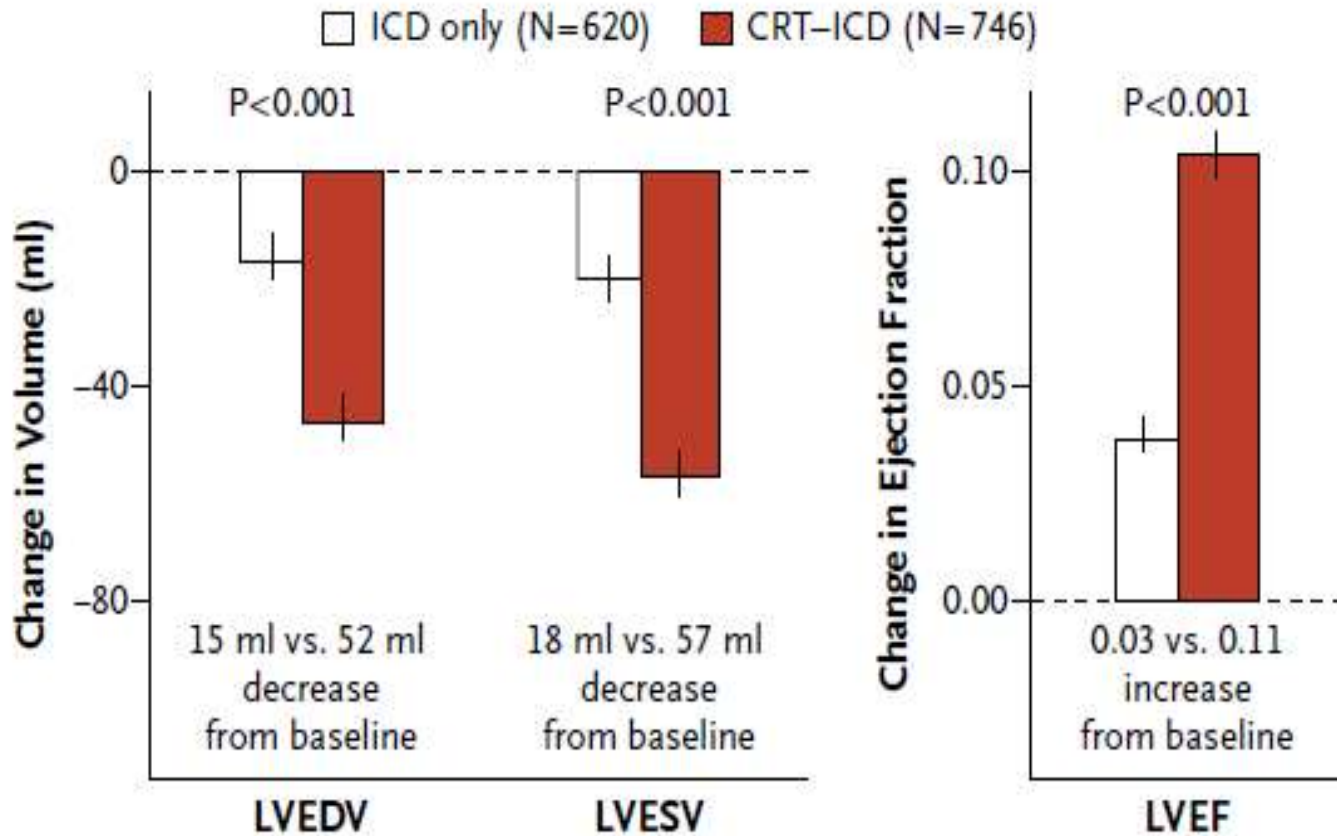
Mean LVESVI, LVEDVI, and LVEF at Baseline and **12 Months**



**RED: CRT-OFF (n=163)**  
**GREEN: CRT-ON (n=324)**

NYHA I/II cohort  
*J. Am. Coll. Cardiol.* 2008;52;1834-1843

# MADIT-CRT – Left Ventricular Volumes

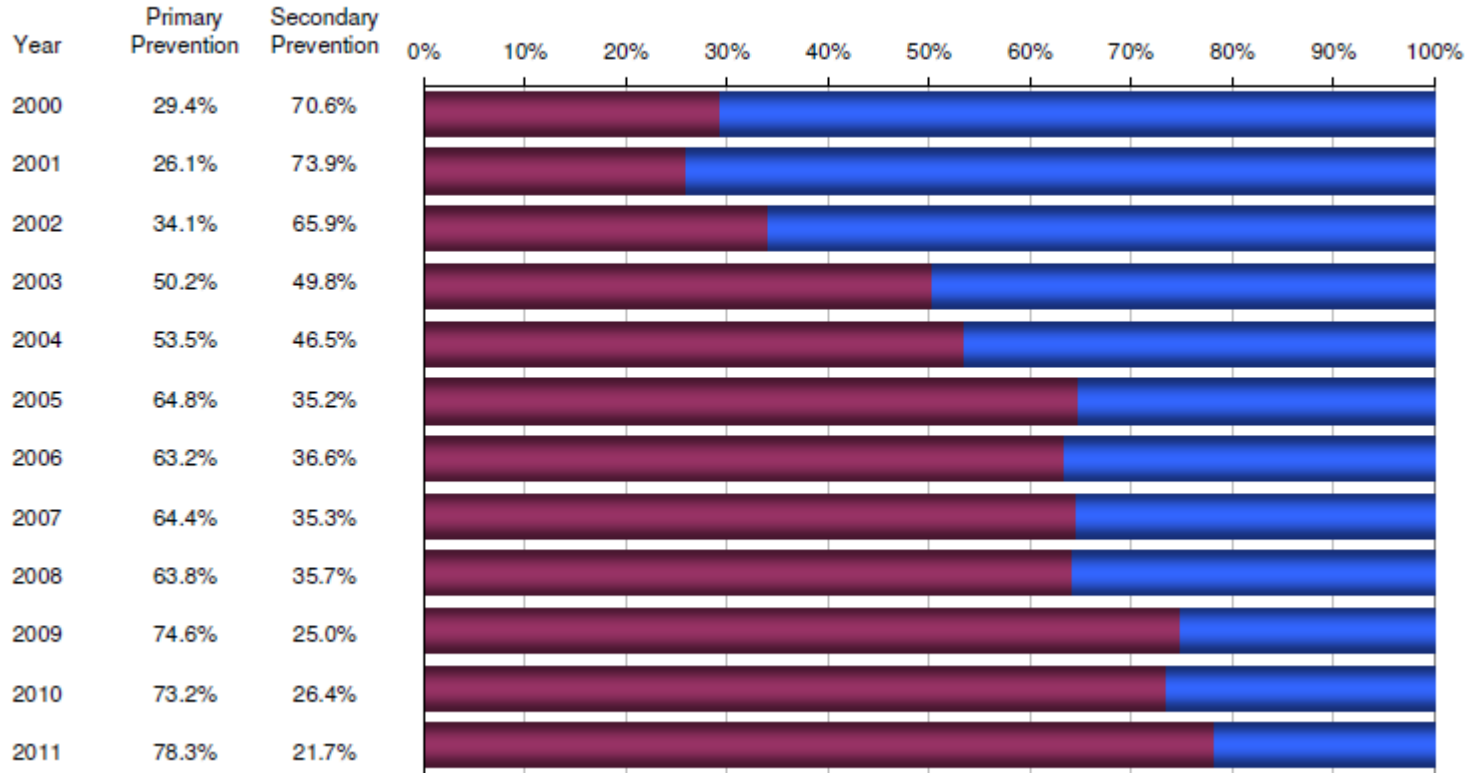


Paired sample t-tests  
Baseline and 12 month  
Echocardiograms  
1366/1820 (75%)

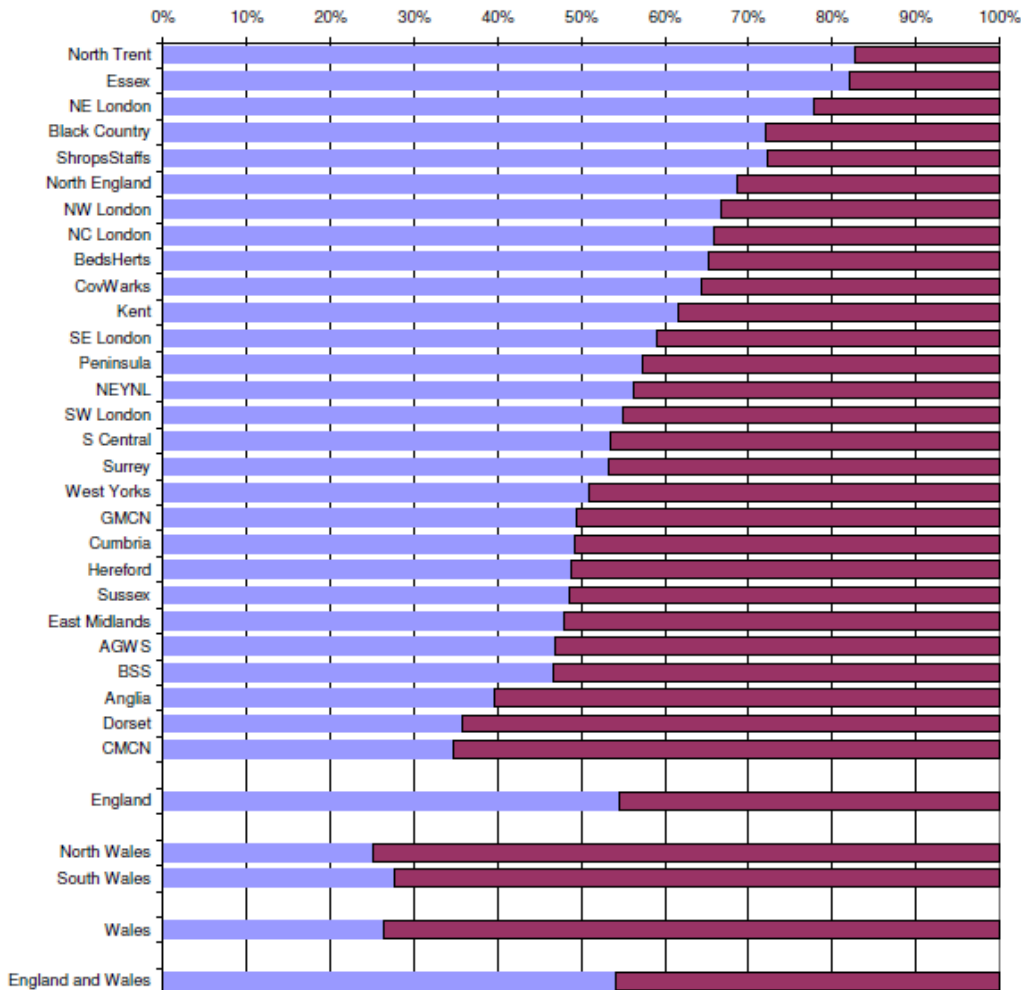
**CRT-D reduced left ventricular volumes greater than ICD**  
**CRT-D increased LVEF greater than ICD**

# Within The UK: Indications For CRT

## CRTD



# Regional Differences



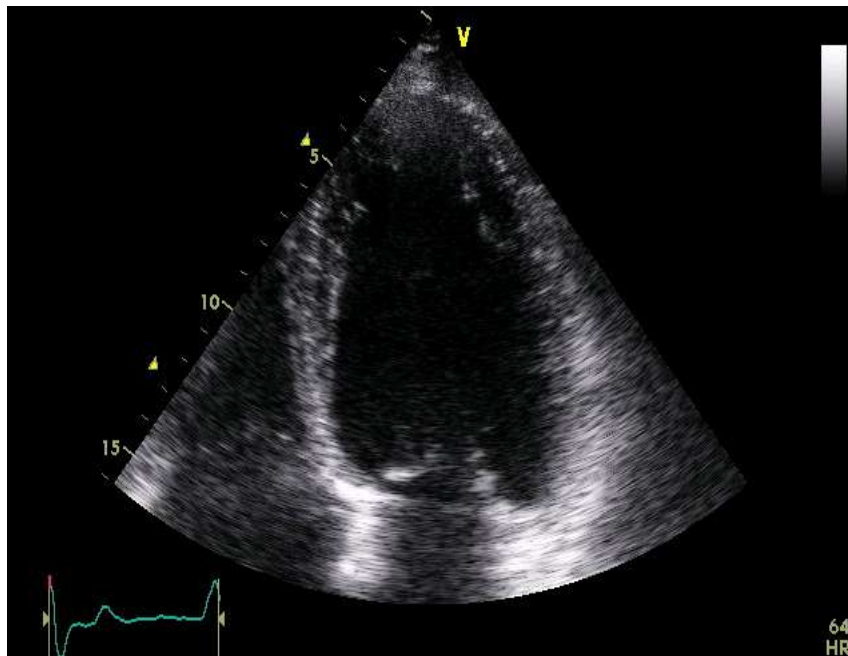
**Ratio CRT-D to CRT-P**



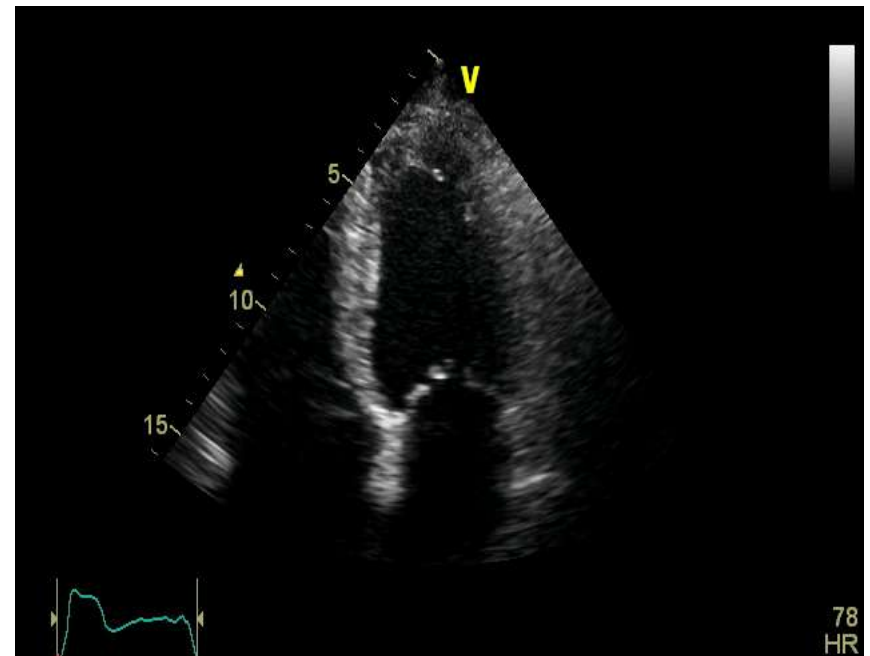
- Regional differences
  - Why?
- CRT-D: CRT-P
  - 1:2 in some regions
  - 4:1 in other regions
- ICD: CRT-D
  - 1:1 in some regions
  - 9:1 in some regions

# What To Do At Box Change.....

Pre CRT

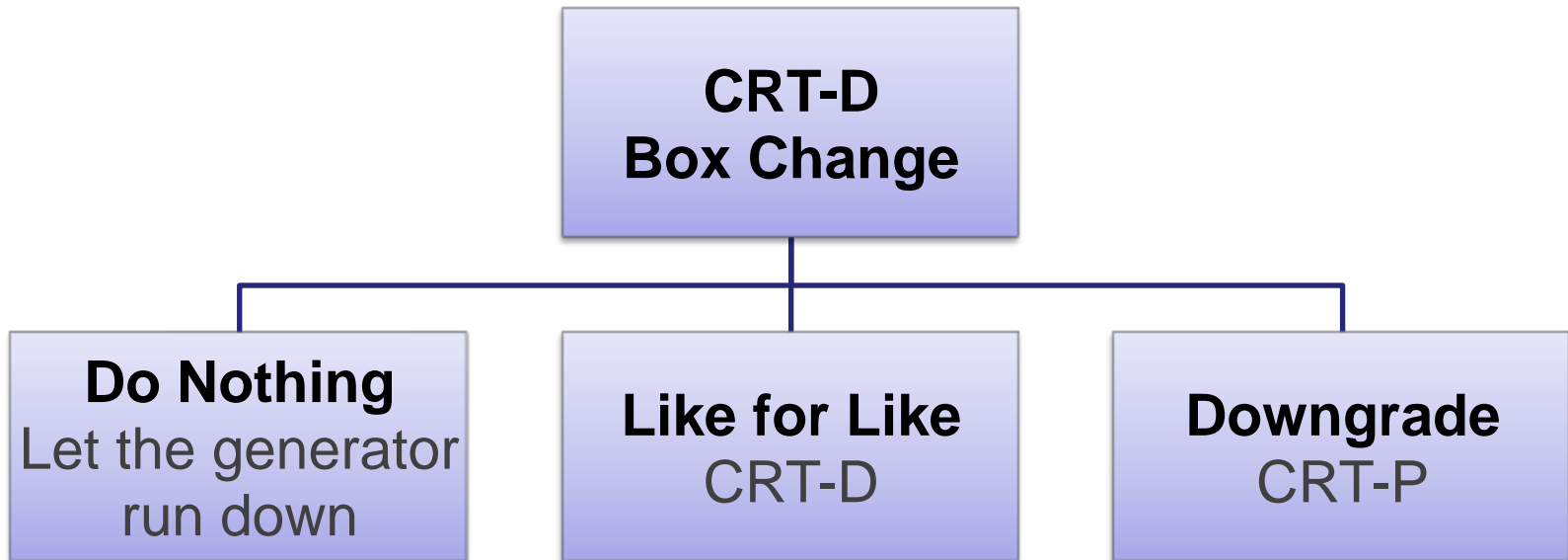


Post CRT



**CRT-D at initial implant: Primary prevention  
No VT/VF LVEF improved**

# What To Do?



*(can not must)*

# Do Nothing

- Theoretically: Any indication for a device?
  - The evidence
    - What do the guidelines say?
  - Would they have received a device in the 1<sup>st</sup> place?
  - If not pacing dependent remove the box?

# ICD Criteria (Primary Prevention)

	NICE (criteria 1)	NICE (criteria 2)	AHA/ACC/ESC
Aetiology	MI > 4 weeks ago	MI > 4 weeks ago	MI > 40d ago
Symptoms	NYHA ≤ III	NYHA ≤ III	NYHA ≤ III
<b>LV Systolic Function</b>	<b>LVEF ≤ 35%</b>	<b>LVEF ≤ 30%</b>	<b>LVEF ≤ 30%-40%</b>
Cardiac Rhythm	NSVT on 24- hour Holter electrocardiogram monitoring	N/A	
ECG	N/A	QRS duration ≥ 120ms	
EPS	Inducible VT on EP testing	N/A	

**CRT-D at initial implant: Primary prevention  
No VT/VF LVEF normalised**

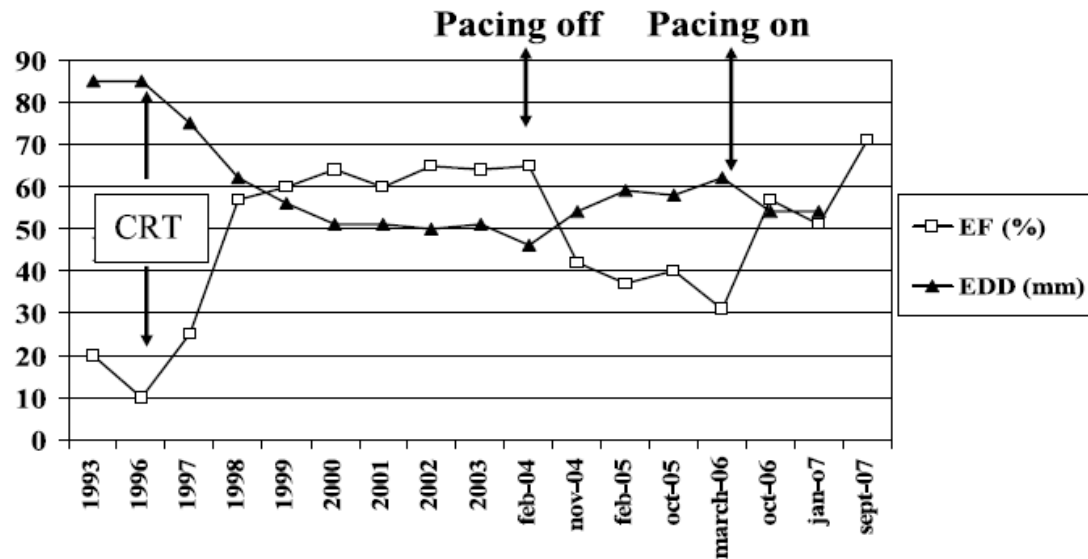
# The CRT Guidelines

	NICE	ESC 2007	AHA/ACA/HRS 2008
<b>Symptoms</b>	NYHA III or IV	NYHA III or IV	NYHA III or IV
<b>Medical Management</b>	Optimal	Optimal	Optimal
<b>LV Systolic Function</b>	<b>LVEF <math>\leq</math> 35%</b>	<b>LVEF <math>\leq</math> 35%</b>	<b>LVEF <math>\leq</math> 35%</b>
<b>Left Ventricular Dimension (LV Dilatation)</b>	Not applicable	LVEDD >55mm LVEDD >30mm/m <sup>2</sup> LVEDD >30mm/m (height)	Not applicable
<b>Cardiac Rhythm</b>	Sinus rhythm	Sinus rhythm (AF Class II)	Sinus rhythm (AF Class II)
<b>Dysynchrony</b>	QRS $\geq$ 150ms QRS 120-149ms plus Echo evidence of dysynchrony	QRS > 120ms	QRS > 120ms

**CRT-D at initial implant: Primary prevention  
No VT/VF LVEF normalised**

# Is CRT Response Durable?

- Limited data
- N=11
  - DCM (Non-Isch)
    - S/R, NYHA III/IV
    - LBBB
  - Over 10 yr period
  - All had normalisation of LV function (LVEF) 26±9 vs. 59±6 (P<0.0001)
  - F/up 65±30 mths



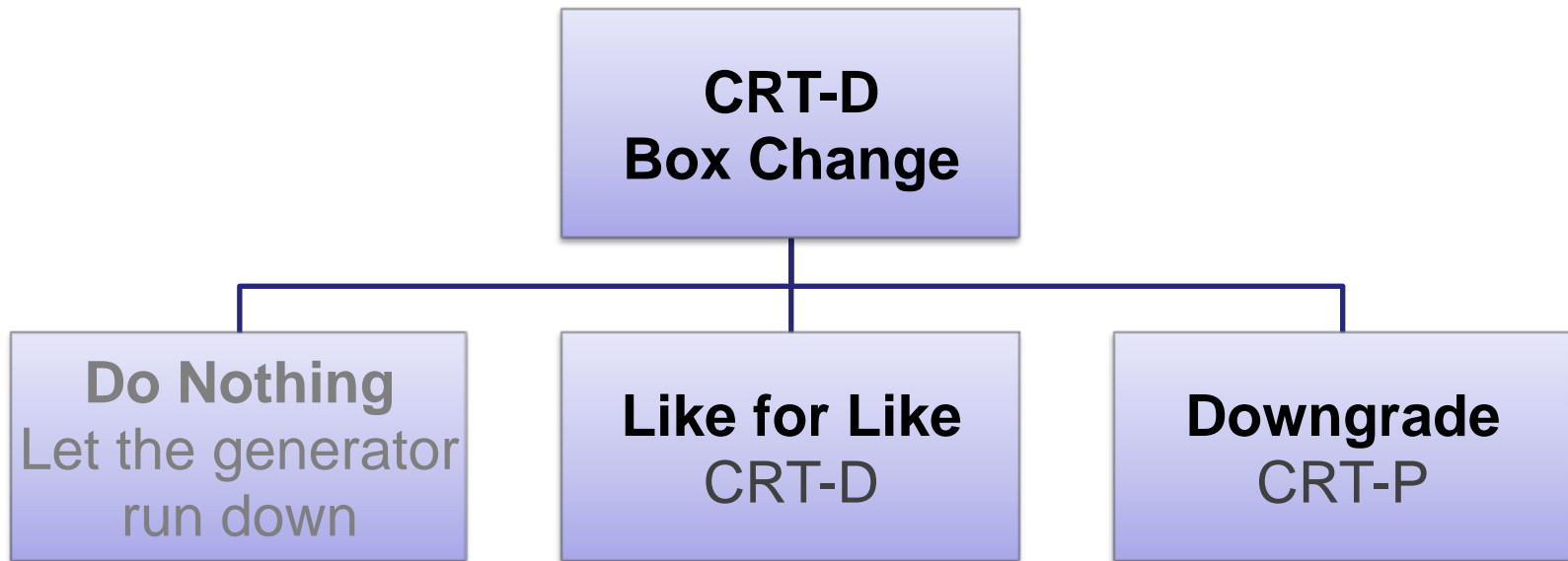
LVEF 65% → 31% Pacing off

**Conclusion: In hyper responder patients, “normalization” of LV function after CRT persists as long as pacing is maintained with an excellent survival.**

Is “Hyper Response” to Cardiac Resynchronization Therapy in Patients with Nonischemic Cardiomyopathy a Recovery, a Remission, or a Control?

Ann Noninvasive Electrocardiol 2010;15(4):321–327

# Like for Like or Downgrade?

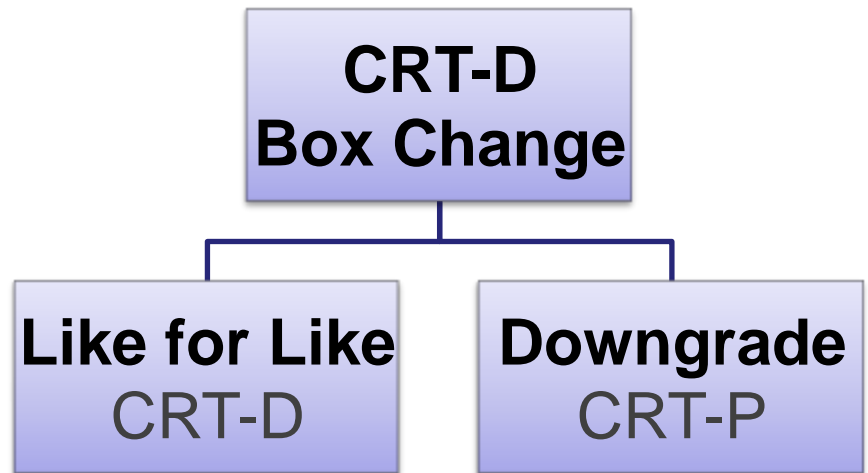


“It is much easier to turn a tachycardia device off than not to have the benefit of prompt defibrillation should a tachycardia event occur”  
*Bruce L. Wilkoff*

# Should We Downgrade?

## Issues

- Patient choice/EoL
- Age and co-morbidities
- Economic considerations
- Impact of scar
- Quality of life
- CRT and arrhythmic risk
  - Responders and arrhythmic risk
- Technical considerations



# End of Life and Patient Choice

# End of Life (EoL)/Patient Choice

- EHRA on-line survey
  - May 2010
  - 2/47 UK centres
- Institutes
  - 94% >50 ICD implants/yr
  - Majority >500/yr F/up visits

- 62% would consider deactivating ICD at EoL
- 6% routinely deactivated at EoL
- 47 European centres
  - Deactivation only actively discussed pre-implant in 4% centres



Europace (2010) 12, 1176–1177  
doi:10.1093/europace/eqq272

EP WIRE

Deactivation of implanted cardioverter-defibrillators at the end of life: results of the EHRA survey

# End of Life (EoL)/Patient Choice

- 6 scenarios
  - Would you deactivate?
- Important
  - Patient choice
  - Patients mode of death
  - Significant co-morbidity
  - End stage
    - No LV improvement

Clinical case	Yes	No	Don't know
Man with severe chronic obstructive pulmonary disease who reports a poor quality of life	17.0% (8)	70.2% (33)	12.8% (6)
Man with advanced dementia who is agitated by doctor's appointments and medical tests	46.8% (22)	31.9% (15)	21.3% (10)
Woman with stage 4 ovarian cancer who requests palliative care	76.6% (36)	12.8% (6)	10.6% (5)
Man with end-stage renal failure who refuses dialysis	61.7% (29)	23.4% (11)	14.9% (7)
Woman with a massive stroke whose family has requested ventilator withdrawal	89.4% (42)	4.3% (2)	6.4% (3)
Patient with end stage heart failure	48.9% (23)	27.7% (13)	23.4% (11)





Europace (2010) 12, 1480–1489  
doi:10.1093/europace/euq275

**CONSENSUS STATEMENT**

## **EHRA Expert Consensus Statement on the management of cardiovascular implantable electronic devices in patients nearing end of life or requesting withdrawal of therapy**

**Luigi Padeletti<sup>1\*</sup>, David O. Arnar<sup>2</sup>, Lorenzo Boncinelli<sup>3</sup>, Johannes Brachman<sup>4</sup>, John A. Camm<sup>5</sup>, Jean Claude Daubert<sup>6</sup>, Sarah Kassam<sup>6</sup>, Luc Deliens<sup>7</sup>, Michael Glikson<sup>8</sup>, David Hayes<sup>9</sup>, Carsten Israel<sup>10</sup>, Rachel Lampert<sup>11</sup>, Trudie Lobban<sup>12</sup>, Pekka Raatikainen<sup>13</sup>, Gil Siegal<sup>14</sup>, and Panos Vardas<sup>15</sup>**

Reviewers: Paulus Kirchhof<sup>16</sup>, Rüdiger Becker<sup>17</sup>, Francisco Cosio<sup>18</sup>, Peter Loh<sup>19</sup>, Stuart Cobbe<sup>20</sup>, Andrew Grace<sup>21</sup>, and John Morgan<sup>22</sup>

**‘The primary aim behind the rationale for deactivation must always be to respect the patient’s right to live, or at least to die with dignity, while limiting any therapeutic action that increases the patient’s level of stress, pain or anxiety’**

**Do you routinely discuss deactivation at box change?**

Can You Be Too Old Or Frail  
For An ICD?

# ICDs In The Elderly

What do the major trials tell us?

Trial	Age (ICD arm)
MADIT I	62 yrs ( $\pm 9$ )
MADIT II	64 yrs ( $\pm 10$ )
MUSTT	67 yrs (60-72)*
CABG-Patch	64 yrs ( $\pm 9$ )
DINAMIT	61.5 yrs ( $\pm 10.9$ )
DEFINITE	58.4 yrs (20.3-83.9)**
SCD-HeFT	60.1 yrs (51.9-69.2)*
COMPANION	66 yrs*

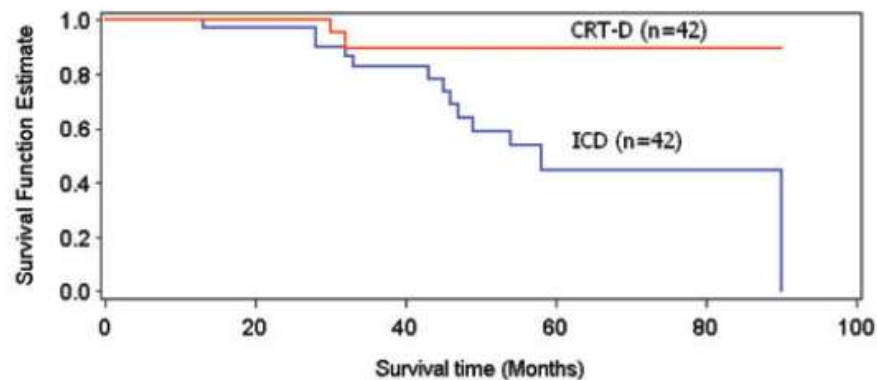
Mean  $\pm$  SD unless specified. \* median (Range). \*\* Mean (Range)

# Safety and Effectiveness of Primary Prevention Cardioverter defibrillators in Octogenarians

WILLIAM STRIMEL, D.O.,\* SHERI KOPLIK, M.D.,\* H. ROBERT CHEN, M.D.,\*  
JUHEE SONG, Ph.D.,† and SHOEI K. STEPHEN HUANG, M.D.\*

From the \*Section of Cardiac Electrophysiology and Pacing, Division of Cardiology; and †Department of Clinical Data and Analytics, Scott & White Healthcare, Texas A&M University Health Science Center, College of Medicine, Temple, Texas

- Non-randomised registry
  - Looked at what happened in those implanted between 1995-2010 (84/380pts)
    - (selection bias)
    - Age 80 at time of implant
    - Excluded box changes
  - Findings
    - Complication rate (<10%)
    - CRT-D Improved survival vs. ICD (P=0.042)



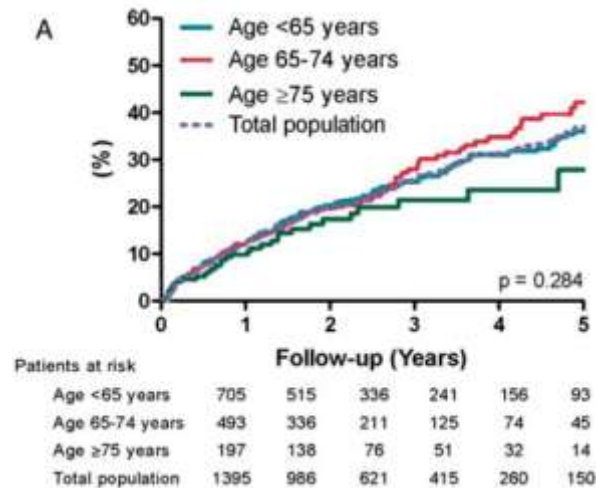
Mean age 82.7yrs  
>75% Ischaemic cardiomyopathy  
ICD:CRT-D % 50:50 NYHA II/III (88%)  
**5-year survival estimate of 60%.**

# Prophylactic implantable cardioverter–defibrillator treatment in the elderly: therapy, adverse events, and survival gain

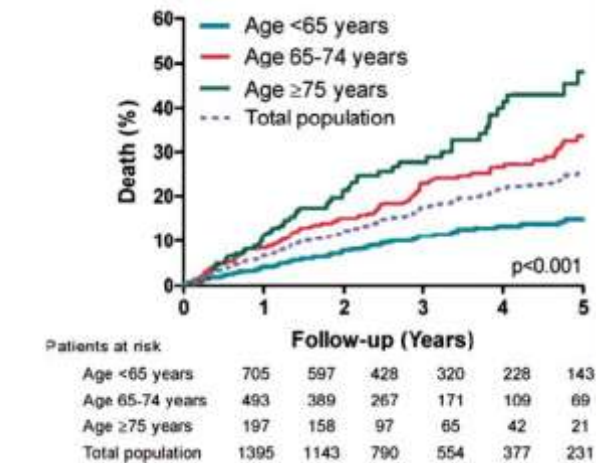
Johannes B. van Rees<sup>1</sup>, C. Jan Willem Borleffs<sup>1</sup>, Joep Thijssen<sup>1</sup>, Mihály K. de Bie<sup>1</sup>, Lieselot van Erven<sup>1</sup>, Suzanne C. Cannegieter<sup>2</sup>, Jeroen J. Bax<sup>1</sup>, and Martin J. Schalij<sup>1\*</sup>

- Non-randomised registry
  - 1395 pts primary prevention
    - Period 1996-2009
    - 197/1395 (14%)  $\geq 75$  yrs
  - At 1-year following appropriate shock, cumulative incidence for death was:
    - 35% for patients  $\geq 75$  years
    - 7% for patients  $< 65$  years ( $P < 0.01$ )

**Life prolongation by ICD is significantly less in elderly as compared to younger patients**



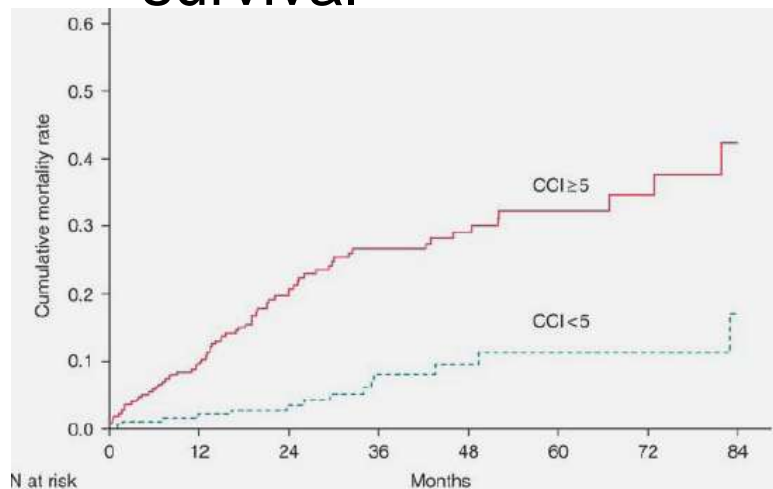
Approp. ICD Therapy



All Cause Mortality

# Too Sick To Benefit?

- N=463
  - CRT-D (1999-2008)
  - Charlson co-morbidity index (CCI)
  - Aim: Is the Independent effect of co-morbidity on survival

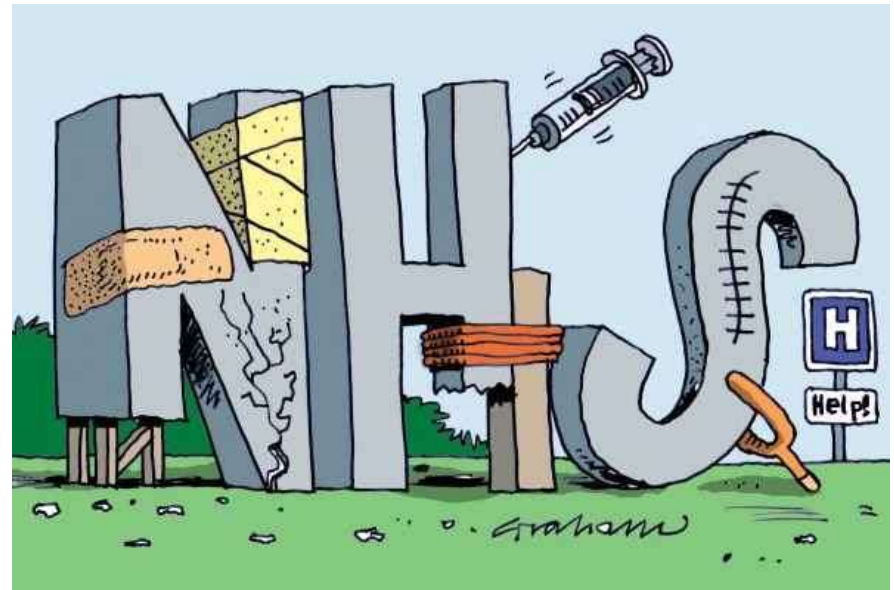


- Patients who died had a significantly higher CCI score compared with survivors ( $3.9 \pm 1.5$  vs.  $2.9 \pm 1.5$ ;  $P < 0.001$ ).
- An age-adjusted CCI score  $\geq 5$  was a significant predictor of mortality
  - HR 3.69, 95% CI 2.06–6.60;  $P < 0.001$ )
  - Independent from indication for ICD therapy
  - Co-morbidity cannot predict appropriate ICD therapy

# Economic Considerations

# Financial Aspect

- In clinical practice, it is of interest to identify patients who might not benefit from ICD implantation
- At present it is still a personal decision about how high the risk of death from non-cardiac co-morbidity should be before ICD therapy is no longer justified.



## **Salukhe principle:**

Measurable benefit from a defibrillator to patients' life span (life-years gained) is dramatically dependent on the time window over which the benefit is assessed. MADIT II follow up vs. 8yr follow up

# Impact of Scar

# Some Of The Issues

- Do you routinely do MRI±CT pre-implant for all CRT patients?

Van de Veire NR *et al* Europace 2008;10:110-3

- Effect of scar on response to CRT

Bleeker GB *et al* Circulation 2006;113:969-76

- Scar substrate for ventricular arrhythmias (VA)  
Scar burden predicts VA

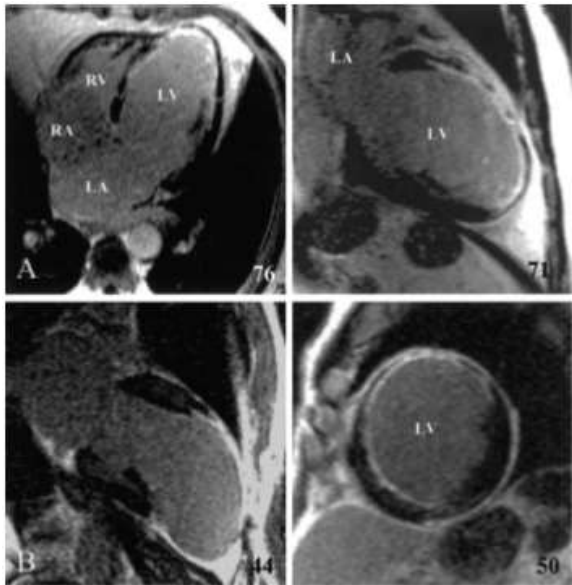
Bernhardt P *et al* Int J Cardiovasc Imaging 2011;27(6):893-900

- Normal coronaries ≠ no scar

McCrohon *et al*. Circulation 2003;108:54-59

# Dilated Cardiomyopathy

CMR is the imaging modality of choice for the differentiation of ischaemic from idiopathic DCM

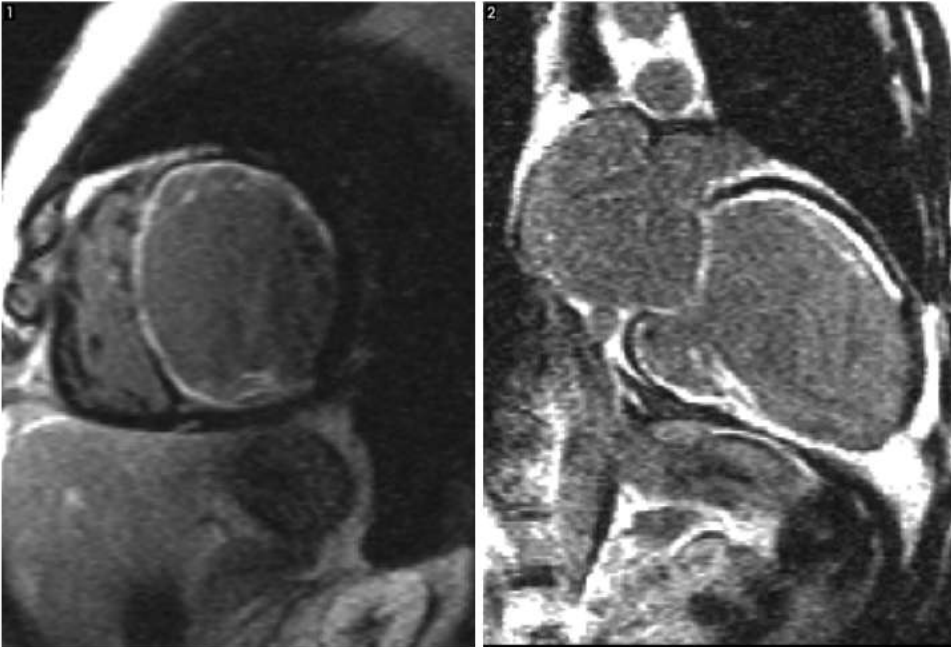


90 patients with heart failure and LV systolic dysfunction

- 63 had unobstructed coronaries at LHC\*
- 27 had significant coronary disease
- 15 healthy volunteers no scar on LGE

- \*In the normal LHC group, there were 3 patterns with LGE imaging

# Dilated Cardiomyopathy



Subgroup 1  
No Scar  
(59% of patients)

Subgroup 2  
**Ischaemic Pattern of Scar**  
**(13% of patients)**

Subgroup 3  
Midwall scar on LGE  
(28% of patients)

Do you routinely do MRI±CT pre-implant for all CRT patients?  
If no how do you know your patient does not have scar?  
Normal coronaries ≠ no scar

# Quality of Life (Shocks Good or Bad)

# Inappropriate Shocks

## Therapy cascade

 Sensing (must be accurate)

Detection criteria (must be met)

- Ventricular rate cutoff
- Number of intervals
- Diagnosis (VT, VT-1, VT-2, VF)

 Discrimination

Therapy

- Inappropriate shocks occur
- In AVID, **22% patients received inappropriate therapy**
- Shocks are painful and distressing to patients and their family and those who receive frequent shocks report feeling less healthy and having increased concerns about their health
- Commonest reason inappropriate shocks
  - AF/SVT

# MADIT II-Inappropriate Shocks

Inappropriate shocks 83/719 pts (11.5%)

**Table 6** Predictors of All-Cause Mortality by Cox Proportional Hazards Regression Analysis

Variable	Hazard Ratio	95% Confidence Interval	p Value
<b>Baseline characteristics</b>			
Blood urea nitrogen >25	2.07	1.38-3.11	<0.01
No beta-blocker	1.64	1.09-2.47	0.02
<b>Interim events</b>			
Interim CHF hospitalization	4.23	2.70-6.62	<0.01
Appropriate and Inappropriate shock	4.08	1.71-9.75	<0.01
Appropriate shock only	3.36	2.04-5.55	<0.01
Inappropriate shock only	2.29	1.11-4.71	0.02
Appropriate and Inappropriate therapy	3.12	1.38-7.03	<0.01
Appropriate therapy only	2.53	1.54-4.15	<0.01
Inappropriate therapy only	2.01	0.97-4.13	0.06
Appropriate ATP but not shock	0.412	0.148-1.150	0.0903
Inappropriate ATP but not shock	0.729	0.213-2.496	0.6145

Other covariates that were evaluated but not found significant predictors included atrial fibrillation, smoking, congestive heart failure, New York Heart Association class at baseline  $\geq 2$ , prior non-coronary artery bypass graft revascularization, diastolic blood pressure  $\geq 80$  mm Hg, QRS duration  $>0.12$  s, prior angina, history of atrial arrhythmia, diabetes mellitus, age  $\geq 65$  years, ejection fraction  $<0.25$ , systolic blood pressure  $\geq 130$  mm Hg, left bundle branch block, and interim myocardial infarction/unstable angina. The effect of a second appropriate shock episode, when present, is not adjusted for in this model.

ATP = antitachycardia pacing; CHF= congestive heart failure.

# MADIT II-Inappropriate Shocks

Inappropriate shocks 83/719 pts (11.5%)

Shock Type	Shock Episodes (n)	Percent
Appropriate	393	66.6
Inappropriate	184	31.2
Atrial fibrillation/flutter	81	13.7
SVT	67	11.4
Abnormal sensing	36	6.1
Unclassified	13	2.2
Total	590	100.0

## Why are inappropriate shocks associated with increased mortality?

- Potential direct mechanical, arrhythmic, or hemodynamic adverse effect of the shocks themselves, such as fatal proarrhythmia
- And/or baseline characteristics or interim events, such as AF, causing both inappropriate shocks and an increased risk of mortality.

# Is It The Same In The Real World?

## Predictors of Inappropriate Shocks

	Univariate			Multivariate		
	HR	95% CI	p Value	HR	95% CI	p Value
Female	0.8	0.6-1.2	0.34			
Age <70 yrs	1.7	1.1-2.3	<0.01*	1.8	1.3-2.5	0.01
History of AF	2.0	1.5-2.7	<0.01*	2.0	1.5-2.7	<0.01
History of smoking	1.2	0.9-1.6	0.32			
Secondary indication for ICD	1.1	0.8-1.5	0.48			
Nonischemic heart disease	1.3	1.0-1.8	0.04*			
No statins at baseline	1.4	1.0-1.8	0.03*	1.3	1.0-1.7	0.09
Beta-blocker	0.8	0.6-1.1	0.22*			
NYHA functional class III to IV	1.0	0.7-1.3	0.96			
Interim appropriate shocks	1.6	1.0-2.7	0.04*	1.6	1.0-2.6	0.06

>1500 ICD patients 1996-2006 (Non clinical trial cohort)  
Netherlands. F/up>40mths  
F/up 41±18mths 13% inappropriate shock  
18% inappropriate shocks at 5 yrs

# Is It The Same In The Real World?

## Predictors of all cause mortality

	Univariate			HR	Multivariate	
	HR	95% CI	p Value		95% CI	p Value
<b>Baseline variables</b>						
History of atrial fibrillation*	1.3	1.0-1.7	0.11	1.4	1.0-1.7	<0.01
Age >70 yrs*	2.7	2.2-3.4	<0.01	1.9	1.5-2.5	<0.01
NYHA functional class >II*	2.0	1.6-1.5	<0.01	1.5	1.1-1.9	0.03
Renal clearance <90 ml/min*	2.7	2.0-3.7	<0.01	1.7	1.2-2.4	0.02
QRS duration >120 ms*	2.0	1.6-2.5	<0.01	1.4	1.1-1.8	0.02
No use of beta-blockers*	1.3	1.0-1.7	0.01			
<b>Interim events</b>						
Inappropriate shock	1.4	1.0-2.0	0.07	1.6	1.1-2.3	0.01
Per inappropriate shocks ( $\leq 5$ )†	1.3	1.1-1.6	<0.01	1.4	1.2-1.7	<0.01
Interim appropriate shocks*	2.5	1.9-3.3	<0.01	1.6	1.2-2.1	<0.01

Mortality risk increases with each inappropriate shock  
 Inappropriate shock = 60% increase in risk of mortality  
 F/up 41±18mths 13% inappropriate shock  
 18% inappropriate shock rate at 5 yrs

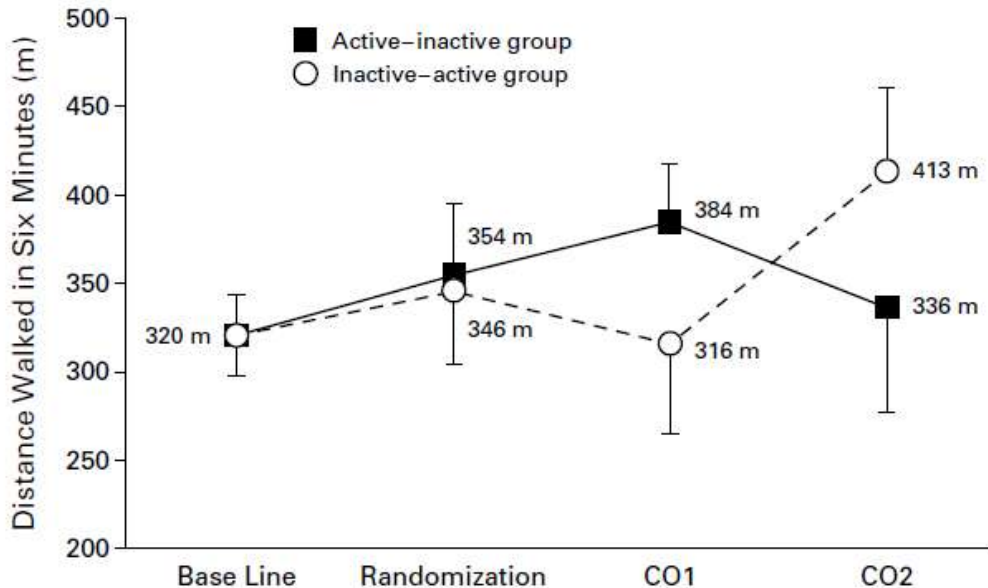
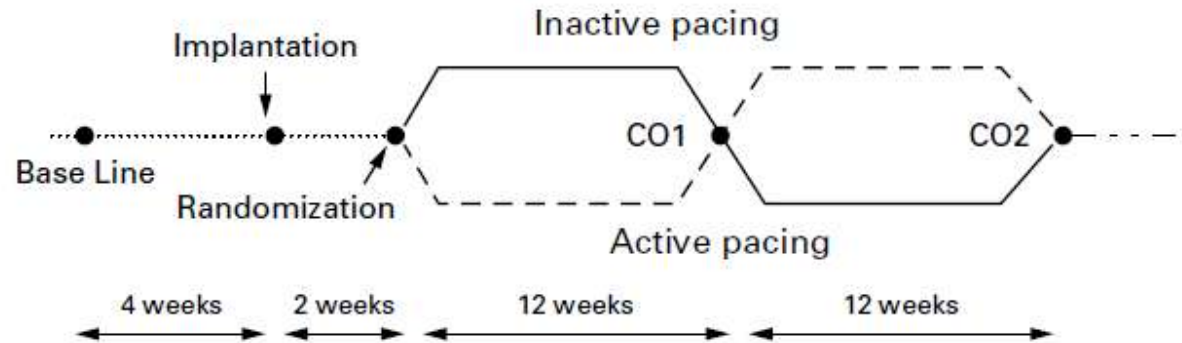
# CRT and Arrhythmic Risk

# Background?

- Conflicting early reports regarding potential arrhythmic effects of CRT
  - Potential for epicardial pacing induced proarrhythmic effect
  - Inversion of depolarisation and repolarisation occurring during LV and biventricular pacing and the dispersion of refractoriness has been evaluated. Not be discussed any further.

# Early Concerns - MUSTIC

N=67  
48 completed  
study



2 deaths occurred early (<24hrs) after cross over from conventional (inactive) pacing (vvi 40bpm) to CRT

? Why ? Pro-arrhythmic

# Cardiac Resynchronization Therapy for the Treatment of Heart Failure in Patients With Intraventricular Conduction Delay and Malignant Ventricular Tachyarrhythmias

- N=490
  - Secondary prevention
- ICD vs CRT-D
  - CRT On or Off
  - Initial 30 days post implant CRT off
  - F/up 6 mths
- Primary outcomes
  - Progression of HF
  - All cause mortality
  - Hospitalisation for HF
  - ***VT/VF requiring intervention***

## VT/VF requiring intervention

- **No significant difference between groups**

	CRT-D	ICD
Appropriate shock	36/245 (15%)	39/245 (16%)
VT only	25/36	27/36
VF only	7/36	6/36
VT & VF	4/36	6/36

# MIRACLE-ICD

- 369 patients
  - 182 CRT off, 187 CRTD on
    - NYHA III/IV
    - QRS  $\geq$ 130ms
    - LVEF  $\leq$ 35%
- Numerous outcomes
  - Incidence of ventricular arrhythmias
- 6 mth F/up
- No significant differences were observed in changes in left ventricular size or function
- During the 6-month follow up period,
  - 47/182 (**26%**) CRT-Off
  - 42/187 (**22%**) CRT-Dexperienced  $\geq$ 1 spontaneous episode of VT/VF ( $P=0.47$ ).

**“No pro-arrhythmia was observed”  
Absence of CRT-associated  
anti-arrhythmic benefit**

# Impact of Upgrade to Cardiac Resynchronization Therapy on Ventricular Arrhythmia Frequency in Patients With Implantable Cardioverter-Defibrillators

- Upgrade to CRT-D from ICD
  - N=18
  - Enrollment upto Dec 2003
  - At least 8mth f/up from upgrade
  - Patient acted as own control
  - Compared VT/VF pre and post upgrade
- During the baseline period 13/18 (72%) patients had at least one VT±VF event.
- After CRT-ICD placement, 2/18 (11%) had VT±VF event.
- The total number of events before upgrade was  $32 \pm 80.5$  compared with  $0.7 \pm 2.2$  after the upgrade ( $p = 0.01$ )
- No significant correlation between event rate and change in LVEF

**Arrhythmia frequency and number of appropriate ICD treatments were reduced after upgrade to CRT-ICD for HF treatment.**

# But.....

## Ventricular Tachycardia Storm After Initiation of Biventricular Pacing: Incidence, Clinical Characteristics, Management, and Outcome

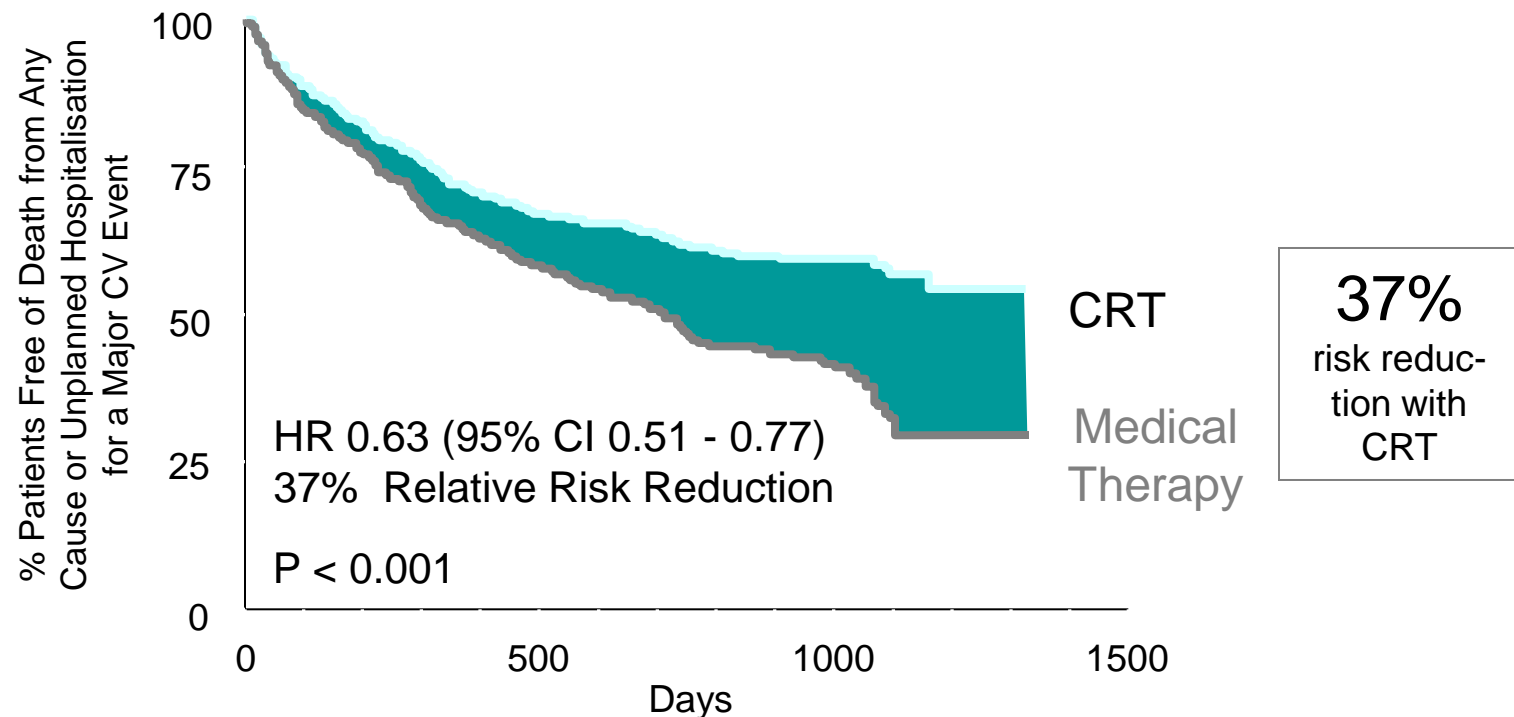
- Prospective single centre US study.
  - All patients had CRT-D
    - No VT in 3 months prior to implant
- Incidence VT storm 4% (8/191 pts)
  - All had monomorphic VT
    - 7 IHD, 1 DCM (all male)
    - Mean EF  $17 \pm 6\%$ . Mean QRS  $193 \pm 23$  ms
  - VT developed a mean of  $16 \pm 12.5$  days after initiation of CRT
- Refractory to IV anti-arrhythmic medication
- Management: Turn LV lead off or RFA

# Responders and Arrhythmic Risk

# What Is Response To CRT?

- Heart failure is a progressive condition
  - No deterioration in symptoms?
  - Slowing natural disease progression?
- Improved symptoms?
- Objective evidence functional improvement?
- Echocardiographic evidence of improvement in LV function
  - Reverse Re-modelling
    - (how do you define remodelling?)

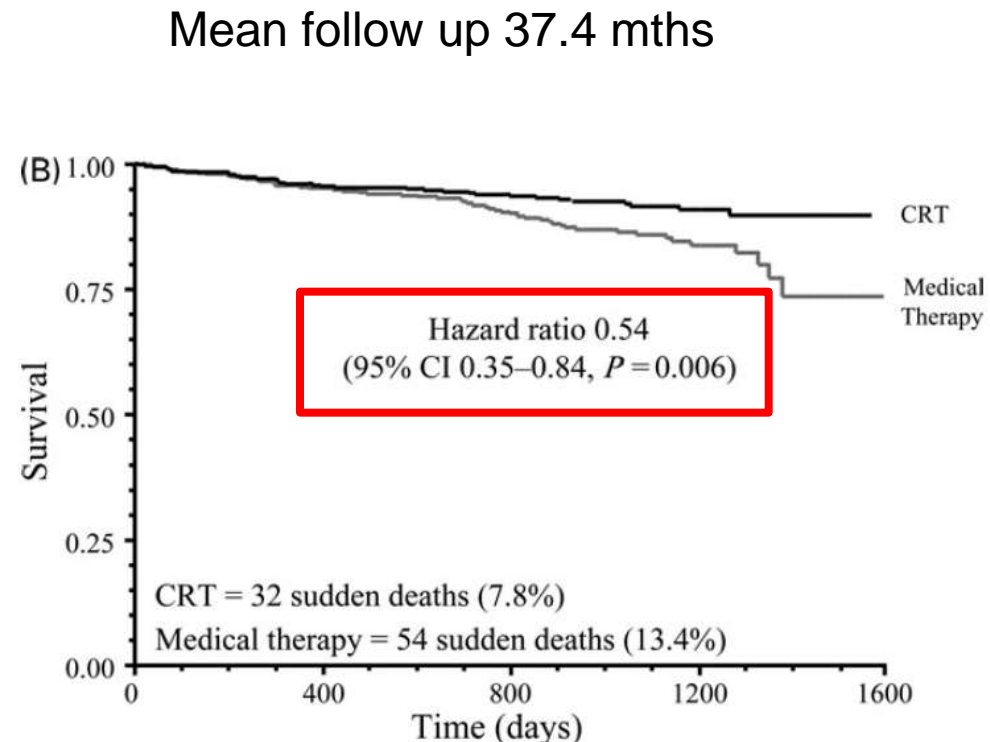
# CARE-HF: CRT reduces death or unplanned hospitalisation for CV events in NYHA III/IV



**At 3 and 18 months, the LVEF was significantly greater, the LVESVI was significantly lower and the area of mitral regurgitation was significantly smaller in the CRT group than in the medical therapy group**

# Care HF Extension Phase

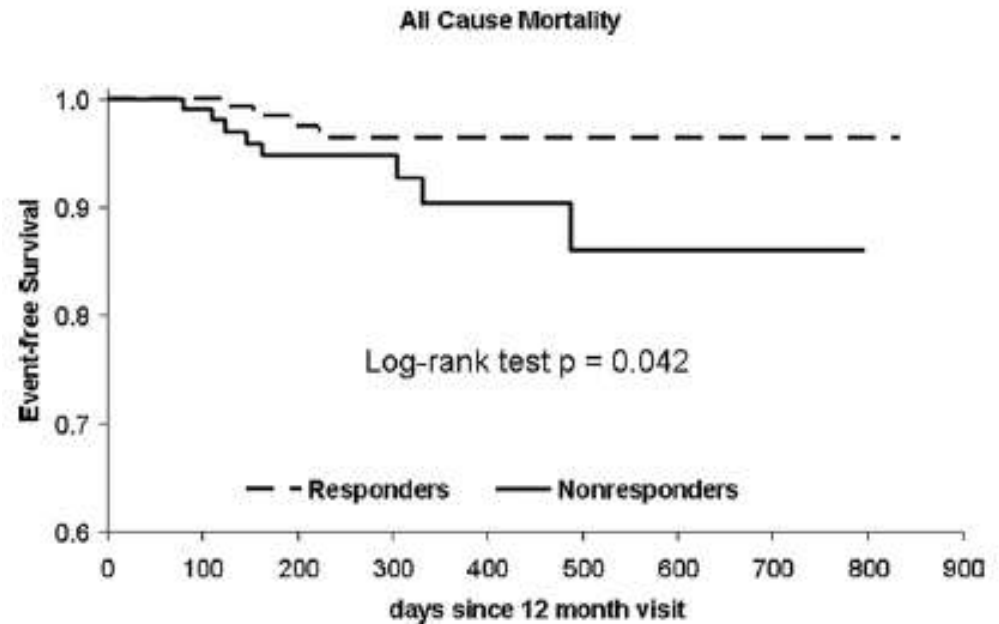
- Time dependent effects?
  - Reduction in “*pump failure*” deaths initially
  - Reduction in SCD occurs later
    - Hypothesized that it could be potentially dependent on improvements in cardiac function and beneficial ventricular remodelling.



## Time to death from sudden death

# The InSync ICD (Implantable Cardioverter-Defibrillator) Italian Registry

- N=398
  - CRT-D
    - 175 primary prev
    - 223 secondary prev
  - ≥12 month follow up
- Aim:
  - Does reverse re-modelling after CRT ↓ occurrence of ventricular arrhythmias
- Responder
  - LVESV ↓10% responder



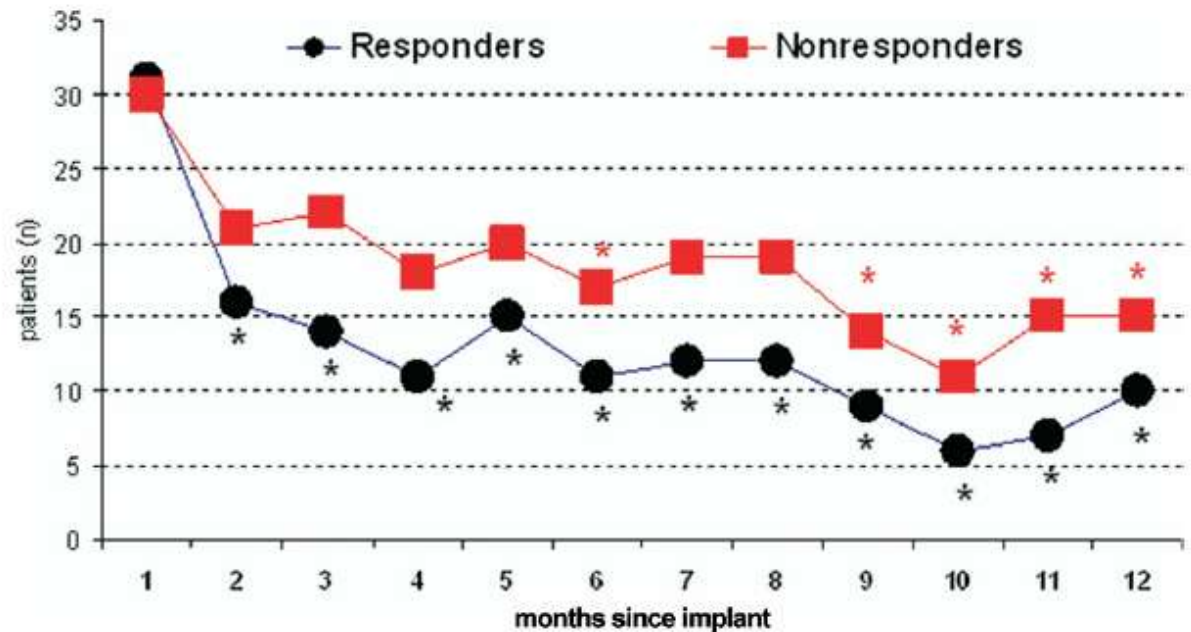
**Responders had lower rate all cause mortality**

# The InSync ICD (Implantable Cardioverter-Defibrillator) Italian Registry

## Re-modelling and Arrhythmias (VA)

LVESV ↓10% responder  
227 (57%) responders

No baseline factors  
Predicted response  
to CRT



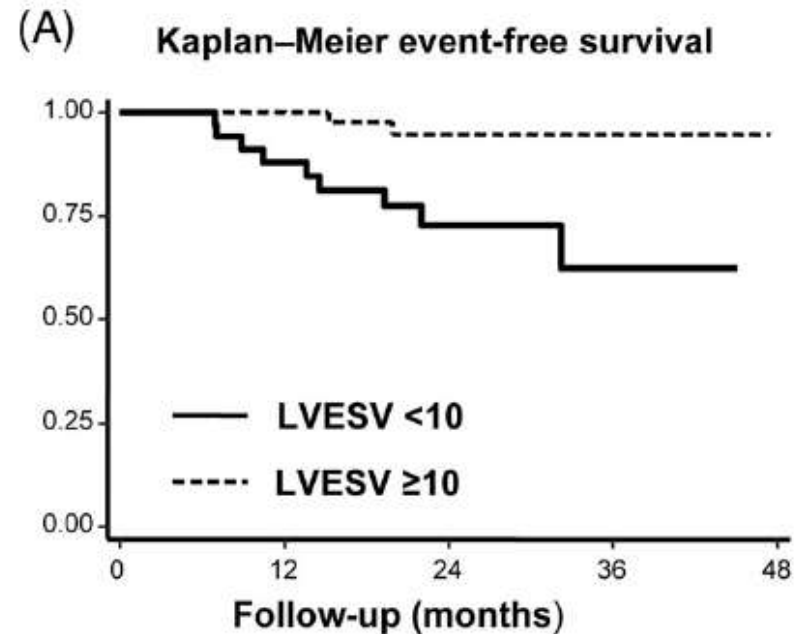
**1<sup>st</sup> study to show LVESV improvement is associated with a reduction in VAs**

# Does Aetiology Matter?

- Prospective, observational study
- N=398 (80% CRT-D)
  - 179 DCM/219 IHD
  - 40% significant improvement in LV

## Other studies

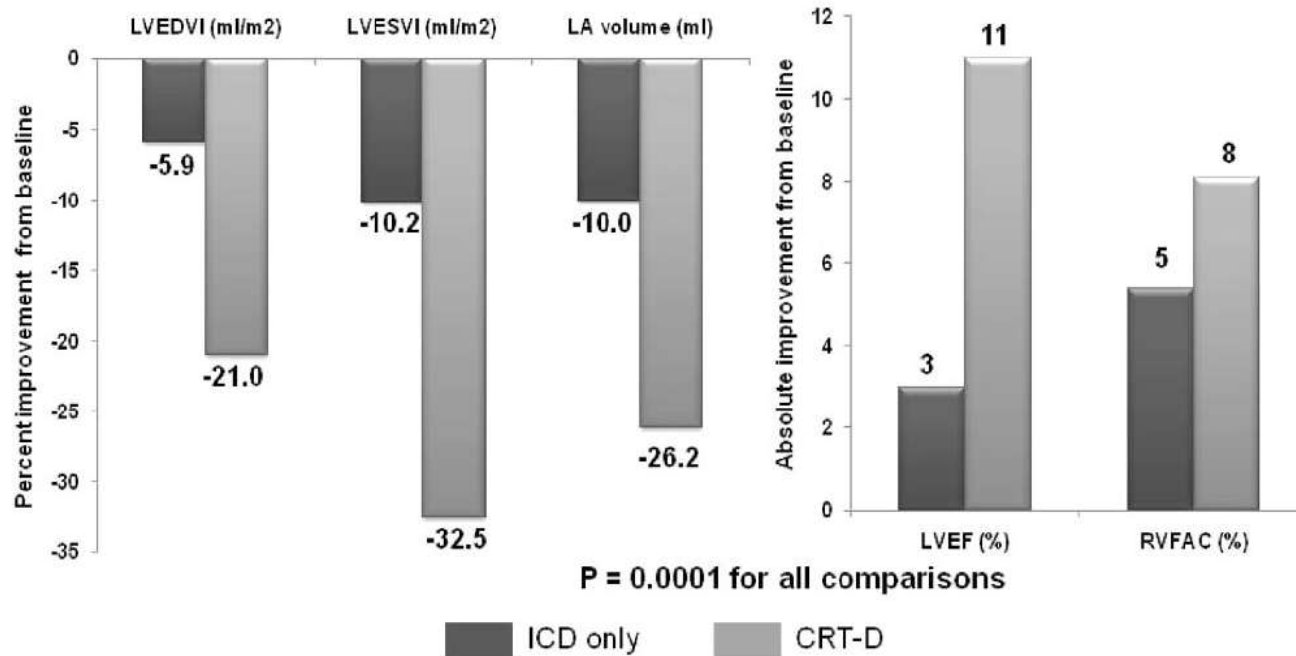
The underlying cardiomyopathy influenced the magnitude of reverse remodelling  
DCM>IHD



**Survival is related to extent of remodelling  
Irrespective of aetiology  
(IHD vs. DCM)**

# MADIT-CRT

## Reverse remodelling and outcome

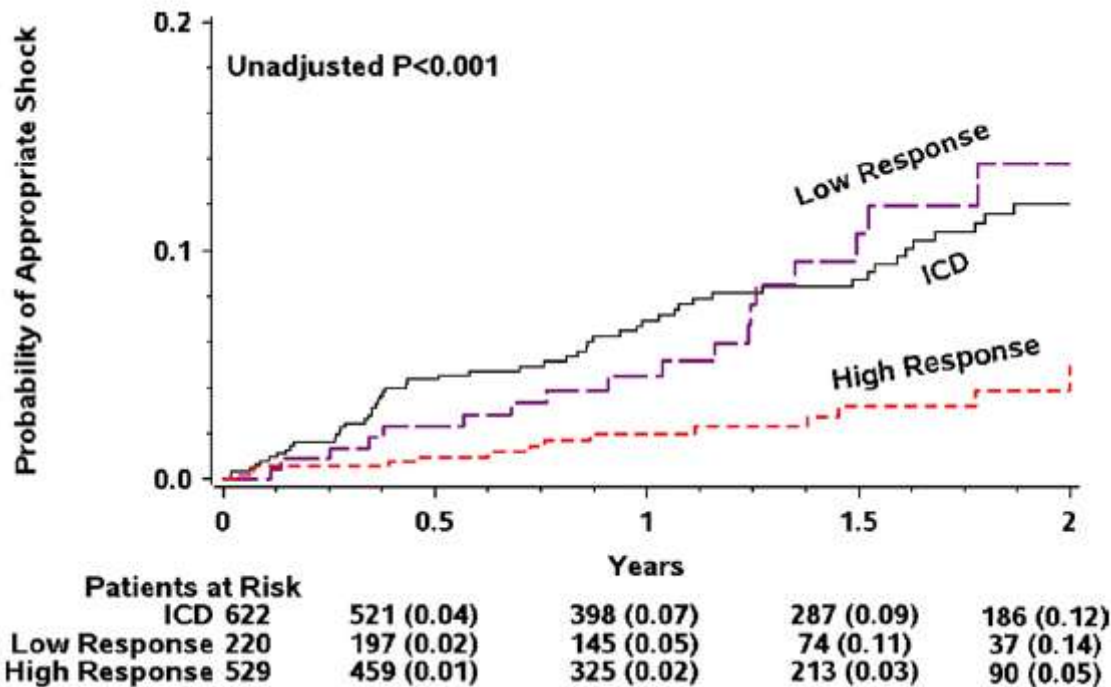


**CRT-D ↓ LV volumes > ICD, CRT-D ↑ LVEF > than ICD**  
**A 10% ↓ in LVEDV over the 12-month period was associated with a 40% ↓ in the primary outcome (death or heart failure event)**

# MADIT-CRT

## Reverse Remodelling and Arrhythmias

The risk of a first appropriate ICD therapy for VTA in relation to remodelling  
 Cumulative probability of a first VTA at 2 years, 12% amongst high responders

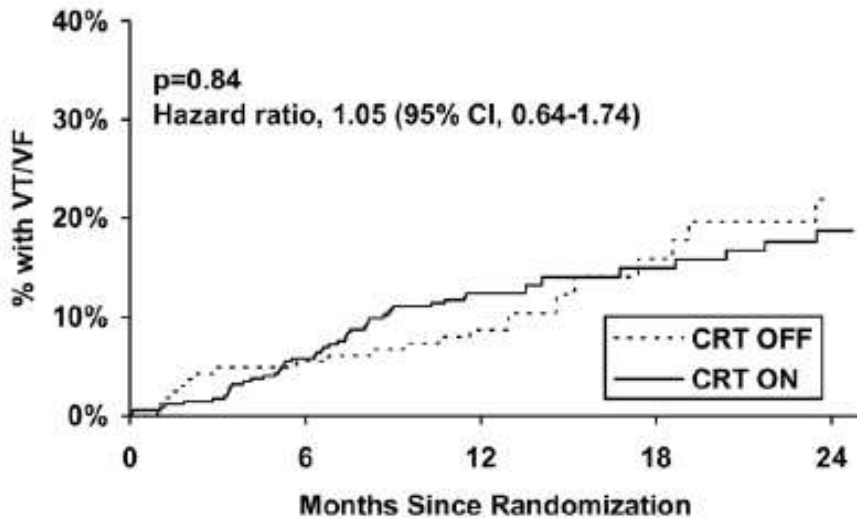


Response:  
 Echo response  
 $\geq 25\%$   $\downarrow$  LVESV at 1yr  
 post randomisation

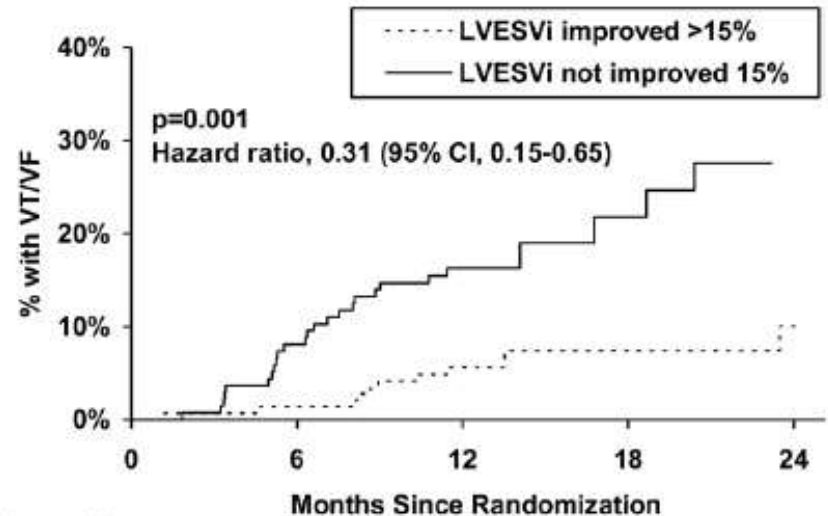
**High responders to CRT-D experienced a significant 55% reduction in the risk of VTA compared with ICD only patients**

# Re-Modelling and Arrhythmias

Effect of re-modelling on ventricular arrhythmias  
Analysis of REVERSE study.



**CRT ON does not increase  
VT/VF episodes  
20% occurrence at 2 yrs**



**Re-modelling associated with  
Less VT/VF episodes.**

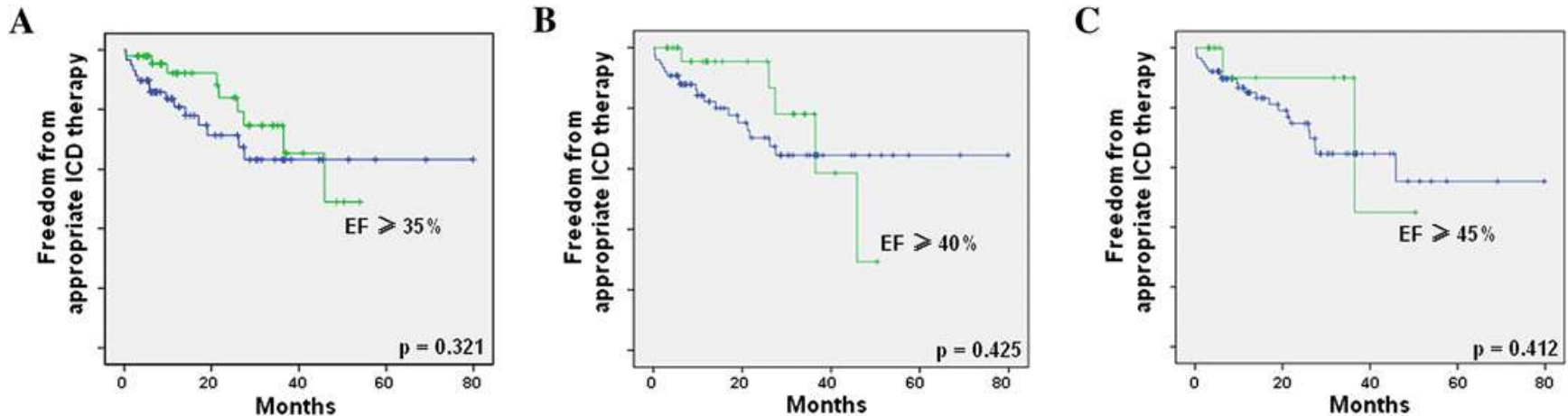
# What About *Super-Responders*?

Retrospective European registry  
51/110 patients “*super-responders*”  
LVEF, LVESV, LVEDV  
IHD ~ 44% patients

## Definitions

↑ LVEF ≥ 10%  
↓ LVESV ≥ 30%  
↓ LVEDV ≥ 20%

## Secondary end-point: Time to 1<sup>st</sup> ICD discharge



**Patients with pronounced reverse left ventricular remodelling  
Still experience appropriate ICD discharges during follow-up.**

# Technical Considerations

# Technical Considerations

- LV lead compatibility
  - Quadripolar leads
    - PNS
    - Improved thresholds
    - Improved vectors
  - Lead header mismatch
- ICD DF4 leads
  - DF4 leads in CRT-P generators
- Adapters?



**Elimination of phrenic nerve stimulation occurring during CRT**

Follow-up in patients implanted with a novel quadripolar pacing lead

Paresh A. Mehta • Anoop K. Shetty • Mark Squirrel •  
Julian Bostock • C. Aldo Rinaldi

# Thank you

## Issues

- Patient choice/EoL
- Age and co-morbidities
- Economic considerations
- Impact of scar
- Quality of life
- CRT and arrhythmic risk
  - Responders and arrhythmic risk
- Technical considerations

