ICD and CRT – Who?

Nicholas S. Peters

Professor of Cardiology
Cardiac Electrophysiology
Imperial College Healthcare NHS Trust

Summary of NICE guidance (2006)

CRT with a pacing device (CRT-P)

A treatment option for people with heart failure who fulfil **all** the criteria in the box below

CRT with a defibrillator device (CRT-D)

May be considered for people who fulfil the criteria for CRT-P and who also fulfil the criteria for the use of an ICD.

Implantable cardioverter defibrillators (ICD)

ICDs are recommended for people with arrhythmias in the groups below. (Note this guidance does not cover the use of ICDs for non-ischaemic dilated cardiomyopathy.)

CRT with a pacing device

- They are currently experiencing or have recently experienced New York Association (NYHA) class III-IV symptoms.
- They are in sinus rhythm:
  - **either** with QRS duration of 150ms or longer estimated by standard electrocardiogram (ECG)
  - **or** with a QRS duration of 120-149 ms estimated by ECG **and** mechanical dyssynchrony that is confirmed by echocardiography.
- They have left ventricular ejection fraction of 35% or less.
- They are receiving optimal pharmacological therapy.

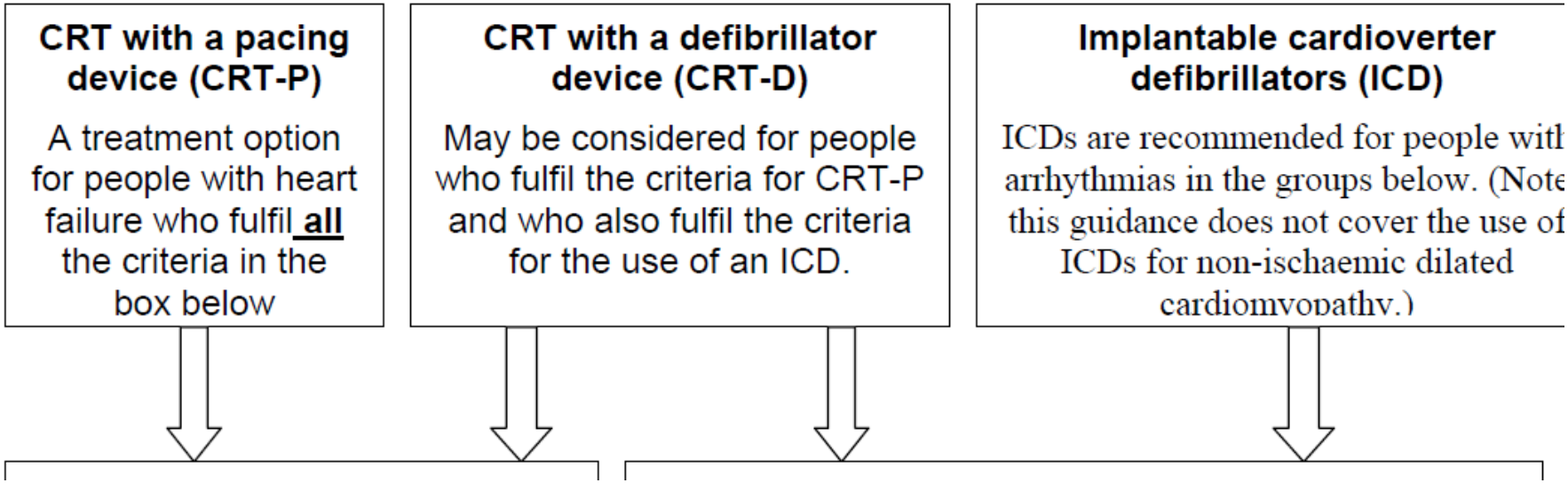
Implantable cardioverter defibrillator

- For secondary prevention, that is, for patients who present, in the absence of a treatable cause, with one of the following:
  - having survived a cardiac arrest due to either ventricular tachycardia (VT) or ventricular fibrillation
  - spontaneous sustained VT causing syncope or significant haemodynamic compromise
  - sustained VT without syncope or cardiac arrest, and who have an associated reduction in ejection fraction (LVEF of less than 35%) (no worse than class III of the New York Heart Association functional classification of heart failure).
- For primary prevention of arrhythmias, that is, for patients who have:
  - a history of previous (more than 4 weeks) myocardial infarction and:
    either
    - ◊ left ventricular dysfunction with an LVEF of less than 35% (no worse than class III of the New York Heart Association functional classification of heart failure), **and**
    - ◊ non-sustained VT on Holter (24-hour electrocardiogram) monitoring, **and**
    - ◊ inducible VT on electrophysiological testing

    or
    - ◊ left ventricular dysfunction with an LVEF of less than 30% (no worse than class III of the New York Heart Association functional classification of heart failure) **and**
    - ◊ QRS duration of equal to or more than 120 milliseconds
  - a familial cardiac condition with a high risk of sudden death, including long QT syndrome, hypertrophic cardiomyopathy, Brugada syndrome or arrhythmogenic right ventricular dysplasia, or have undergone surgical repair of congenital heart disease.

Further information

- The guidance on CRT is from NICE technology appraisal guidance 120, available from www.nice.org.uk/TA120
- The guidance on ICDs is from NICE technology appraisal guidance 95, available from www.nice.org.uk/TA095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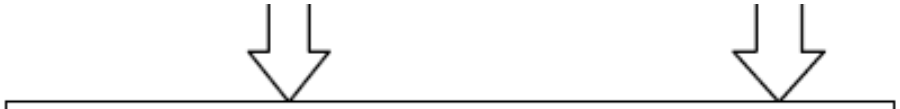

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Why the urgent need for education

Recent Survey (2012) of hospital and primary care physicians in US:

- 28% said they **never refer** patients for consideration of primary-prevention ICD
- 15% said an ICD is **never** indicated in the absence of a ventricular arrhythmia.
- 36% said an LVEF >40% **can** warrant a primary prevention ICD.
- 25% would refer for consideration of such an ICD **within 40 days** of an MI

Family practitioners were **most likely** and general cardiologists were least likely to answer survey questions in ways that were **"discordant" with the guidelines**

Rhythm Management in the 21st Century: Synchronicity and Stability

- Heart Failure
  - Optimal Medical Therapy
  - Cardiac Resynchronisation Therapy
  - Implantable Cardioverter Defibrillator

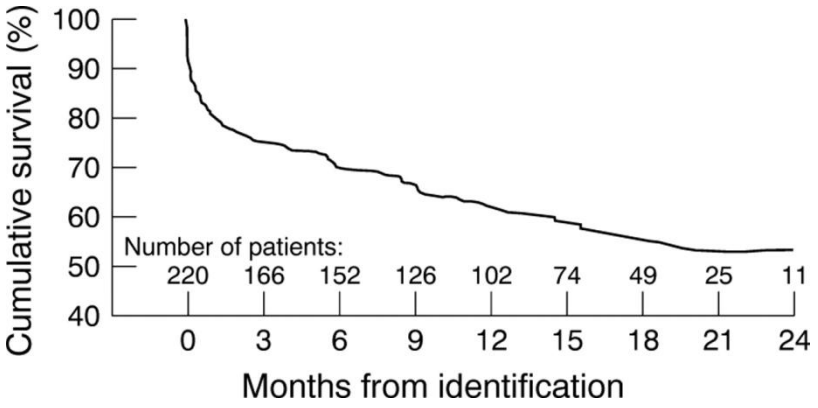
- Inherited Arrhythmic Syndromes
  - Long QT, Brugada, HCM, DCM, ARVC,

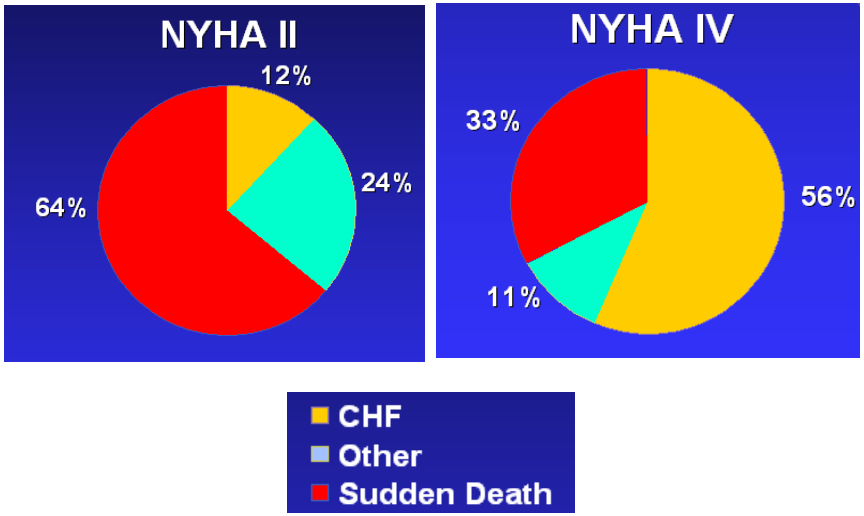
- Tachyarrhythmias
  - Presentation
  - Treatments of Choice
  - Atrial Fibrillation
    - Anticoagulation
    - Antiarrhythmic drugs
    - Ablation

What you and your patients can expect

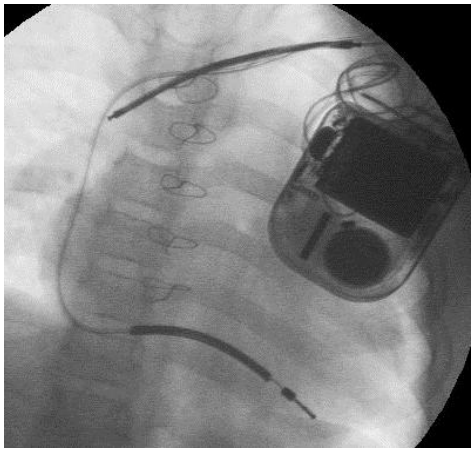
Heart Failure

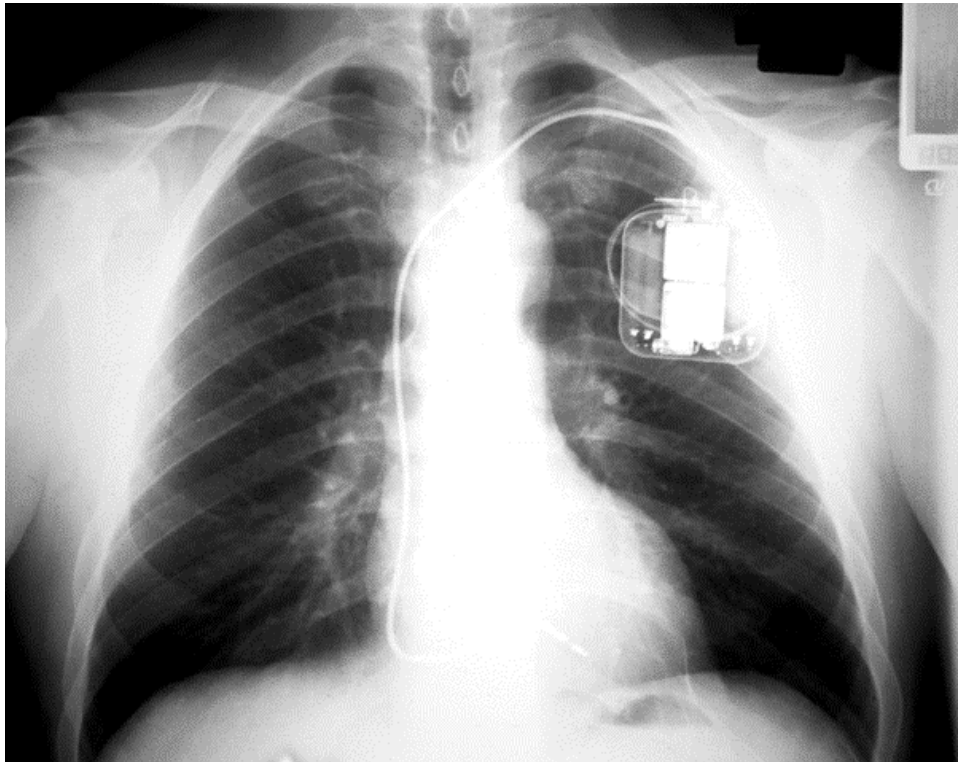
- Morbidity
  - Hemodynamic disruption
  - Arrhythmias
  - Fatigue, SOB, syncope, palpitations
- Mortality
  - 50% pump failure (↑NYHA III/IV)
  - 50% sudden arrhythmic (↑NYHA I/II)
  - Up to 50% 1 yr mortality





ICD





209 cc

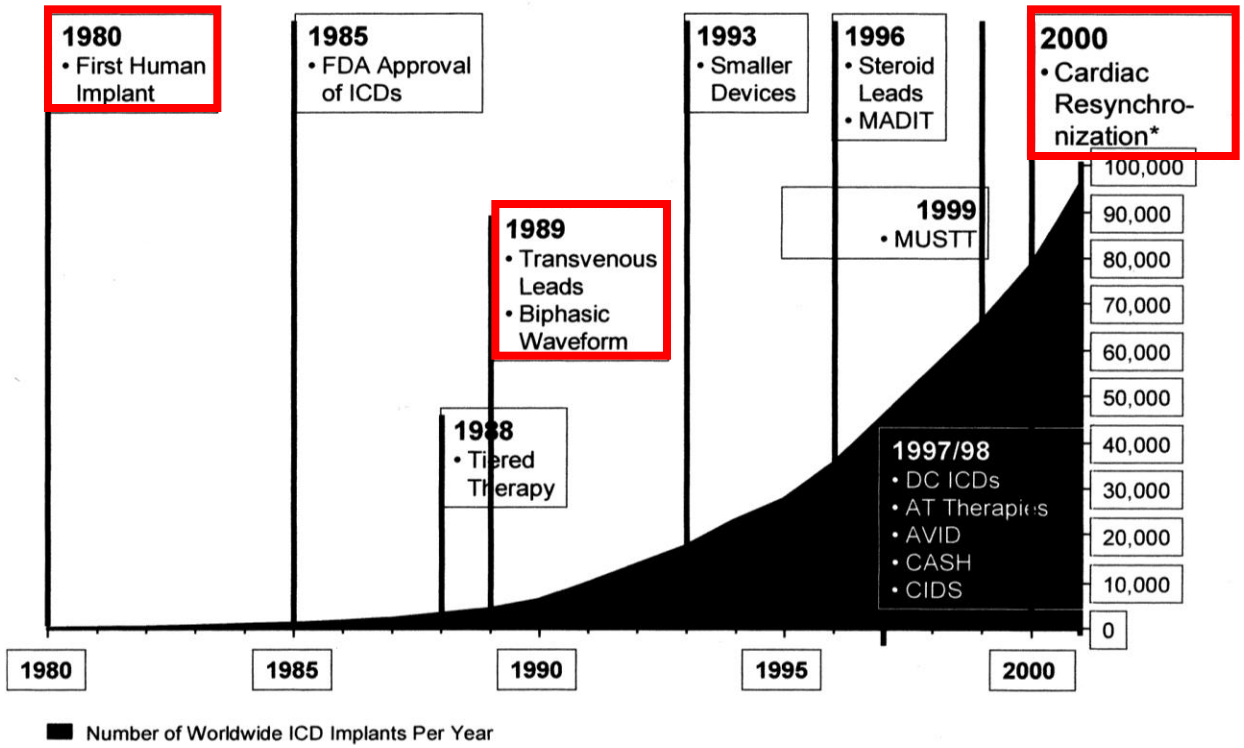
113 cc

80 cc

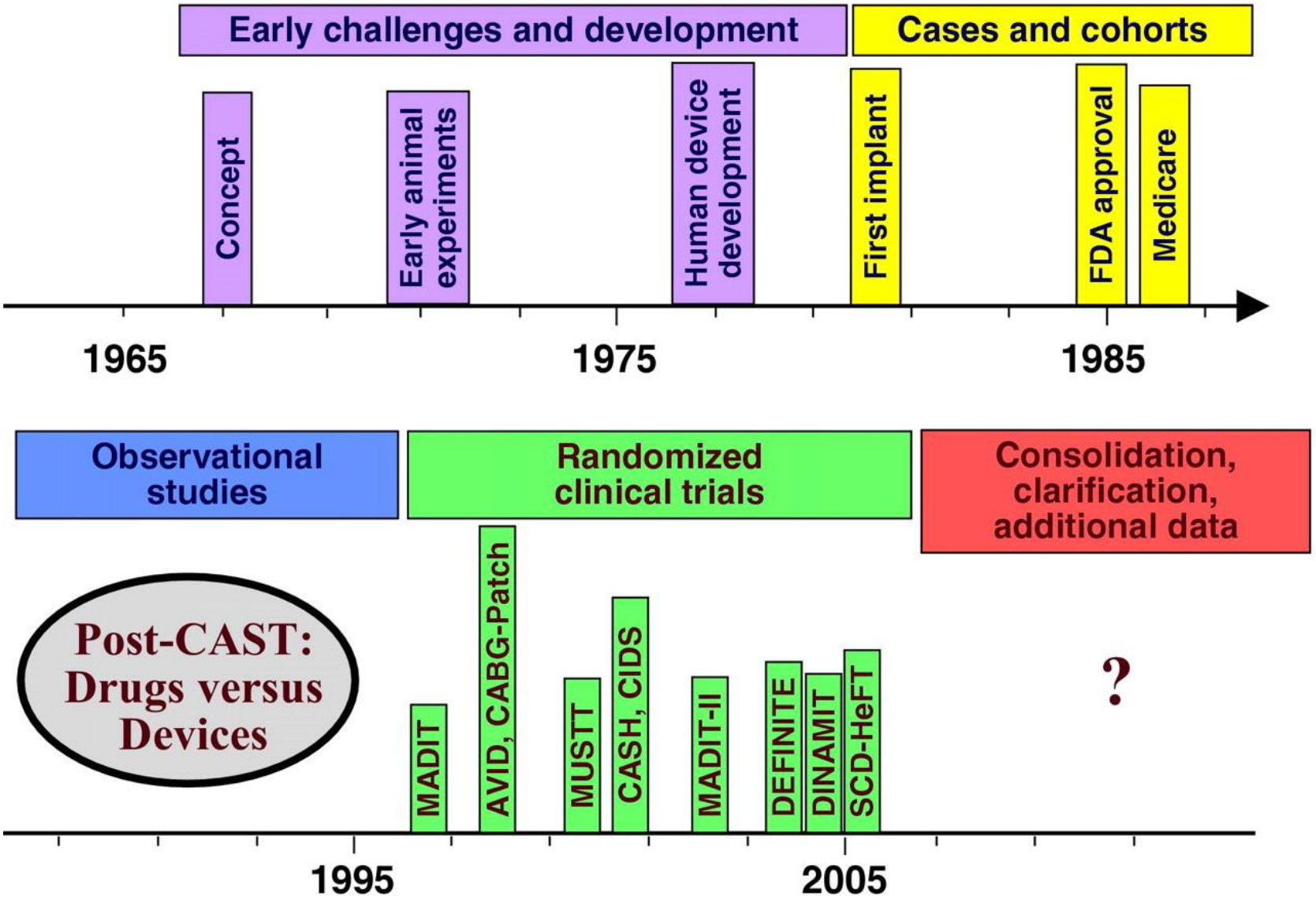
80 cc

72 cc

40 cc

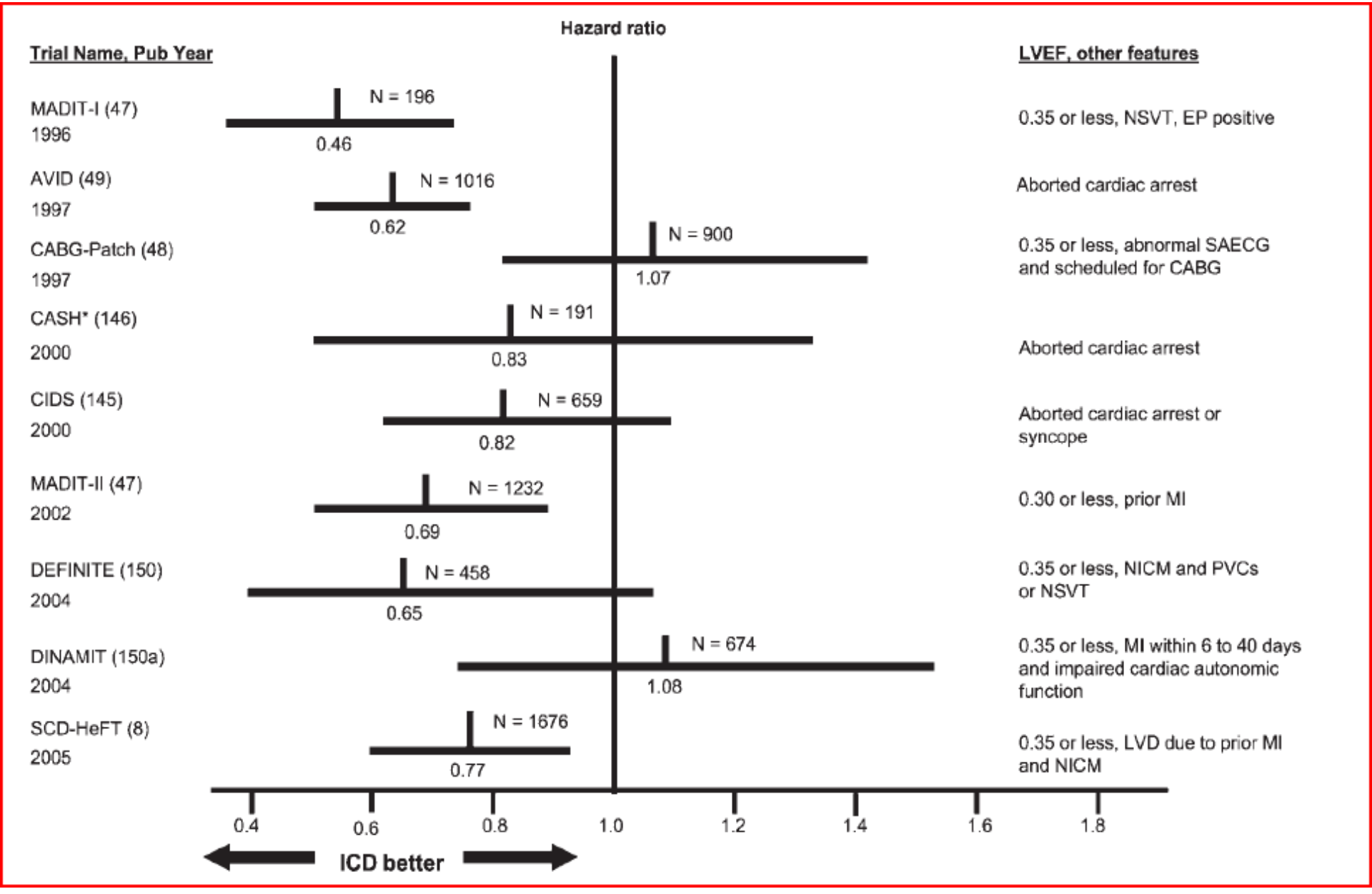

1980
• First Human Implant
1985
• FDA Approval of ICDs
1988
• Tiered Therapy
1989
• Transvenous Leads
• Biphasic Waveform
1993
• Smaller Devices
1996
• Steroid Leads
• MADIT
1999
• MUSTT
1997/98
• DC ICDs
• AT Therapies
• AVID
• CASH
• CIDS
2000
• Cardiac Resynchro-nization*
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1980
1985
1990
1995
2000
Number of Worldwide ICD Implants Per Year

Historical perspective

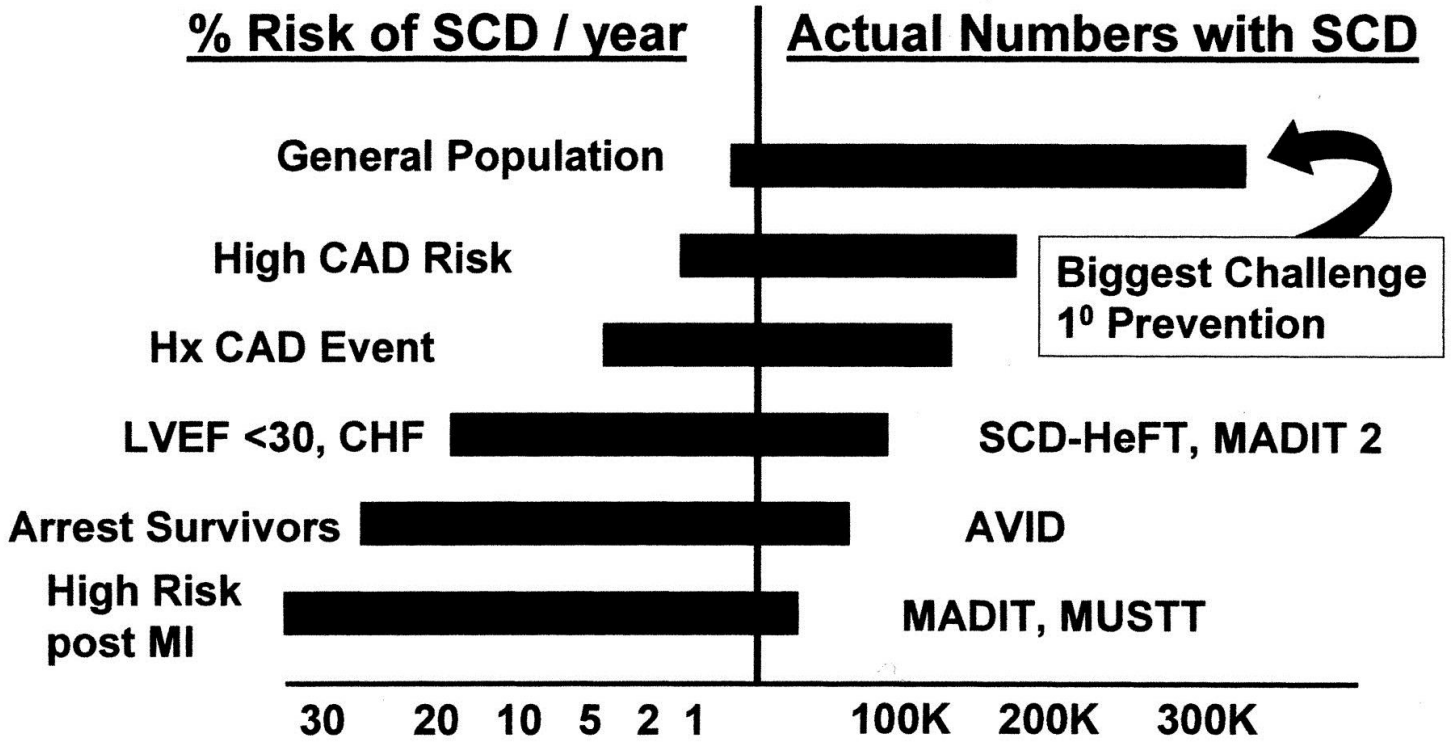


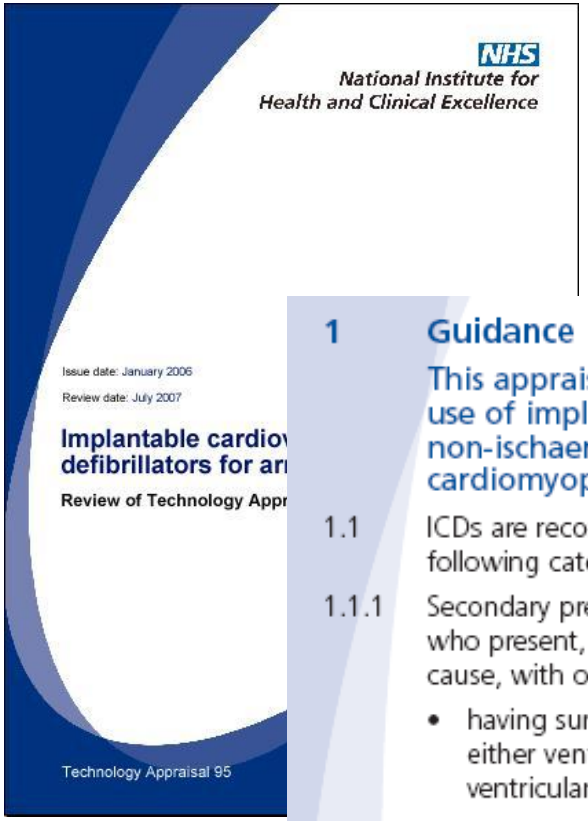
Timeline of Evolution of ICDs From Original Concept to Present

Major ICD Trials



Sudden Cardiac Death





1 Guidance

This appraisal does not cover the use of implantable defibrillators for non-ischaemic dilated cardiomyopathy.

1.1 ICDs are recommended for patients in the following categories.

1.1.1 Secondary prevention[1], that is, for patients who present, in the absence of a treatable cause, with one of the following:

- having survived a cardiac arrest due to either ventricular tachycardia (VT) or ventricular fibrillation (VF)
- spontaneous sustained VT causing syncope or significant haemodynamic compromise
- sustained VT without syncope or cardiac arrest, and who have an associated reduction in ejection fraction (LVEF of less than 35%) (no worse than class III of the New York Heart Association functional classification of heart failure).

1.1.2 Primary prevention[2], that is, for patients who have:

- a history of previous (more than 4 weeks) myocardial infarction (MI) and:

  either

  – left ventricular dysfunction with an LVEF of less than 35% (no worse than class III of the New York Heart Association functional classification of heart failure) **and**

  – non-sustained VT on Holter (24-hour electrocardiogram [ECG]) monitoring **and**

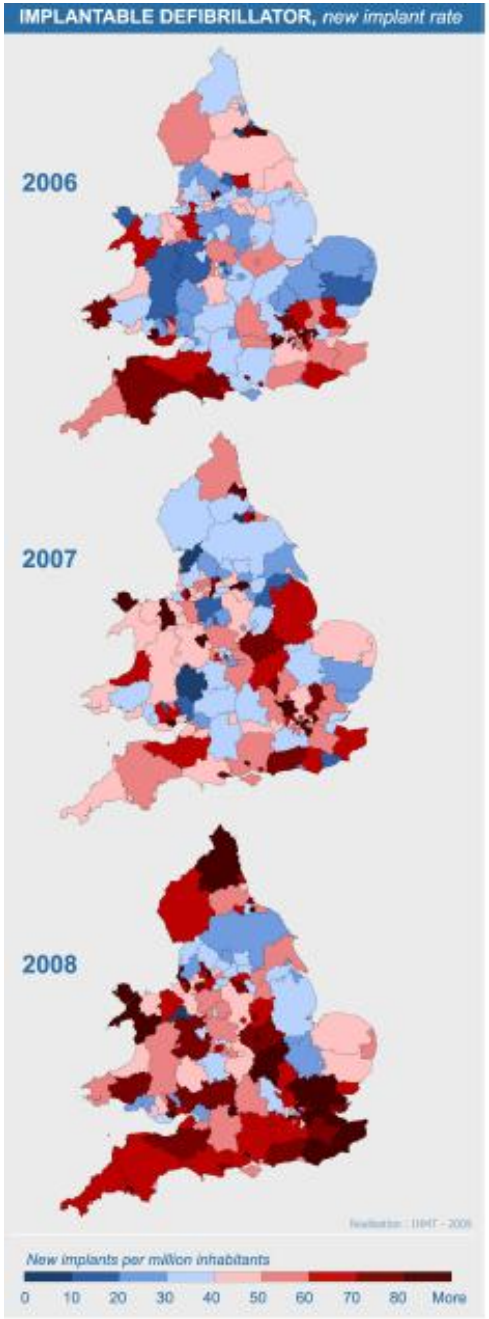
  – inducible VT on electrophysiological (EP) testing

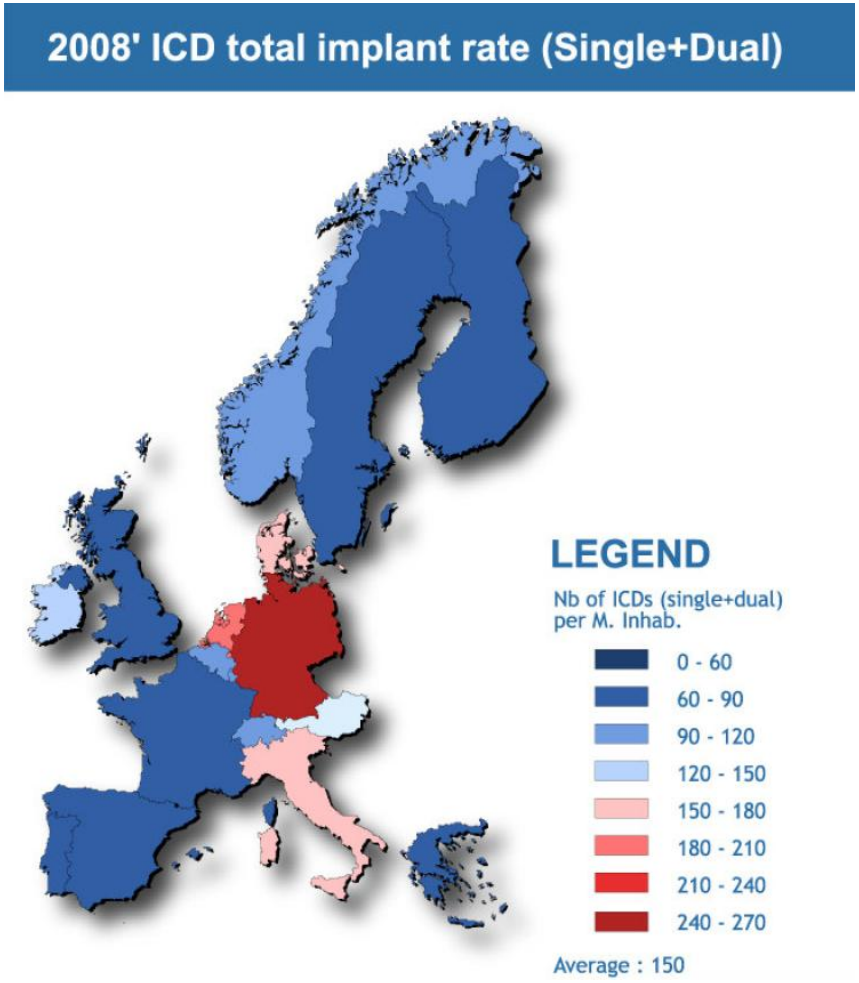
  or

  – left ventricular dysfunction with an LVEF of less than 30% (no worse than class III of the New York Heart Association functional classification of heart failure) **and**

  – QRS duration of equal to or more than 120 milliseconds

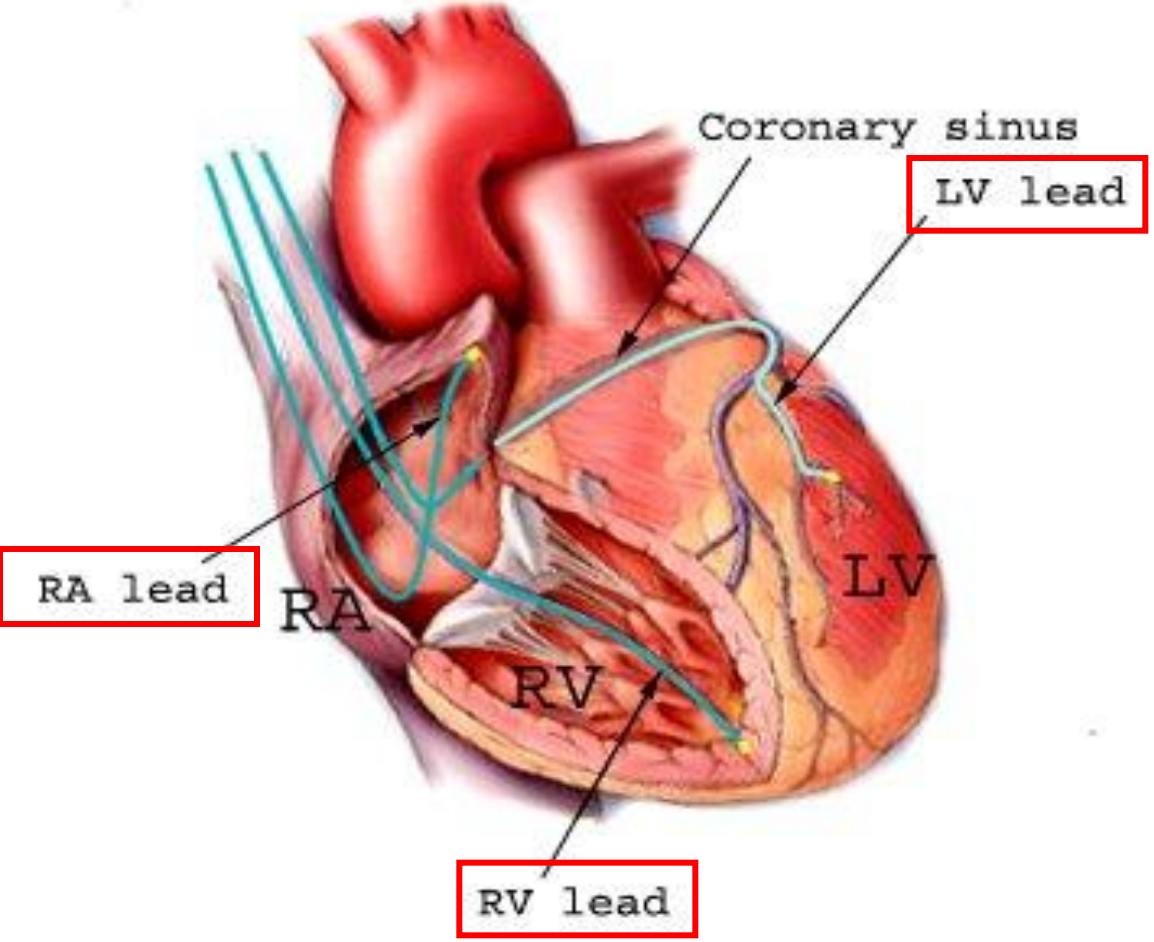
ICD implant rates

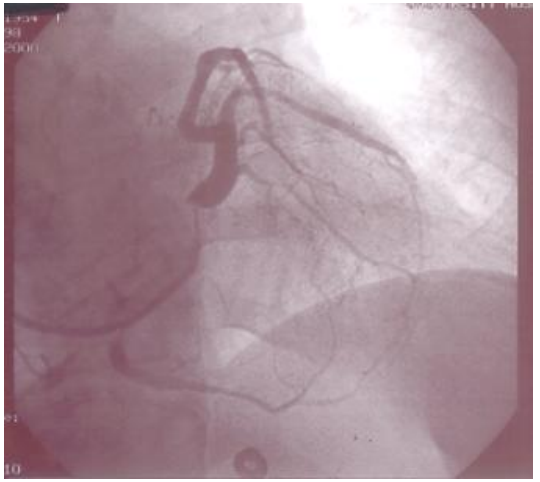


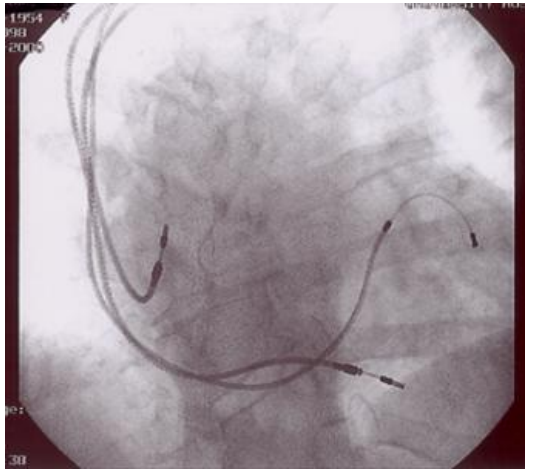


Cardiac Resynchronisation

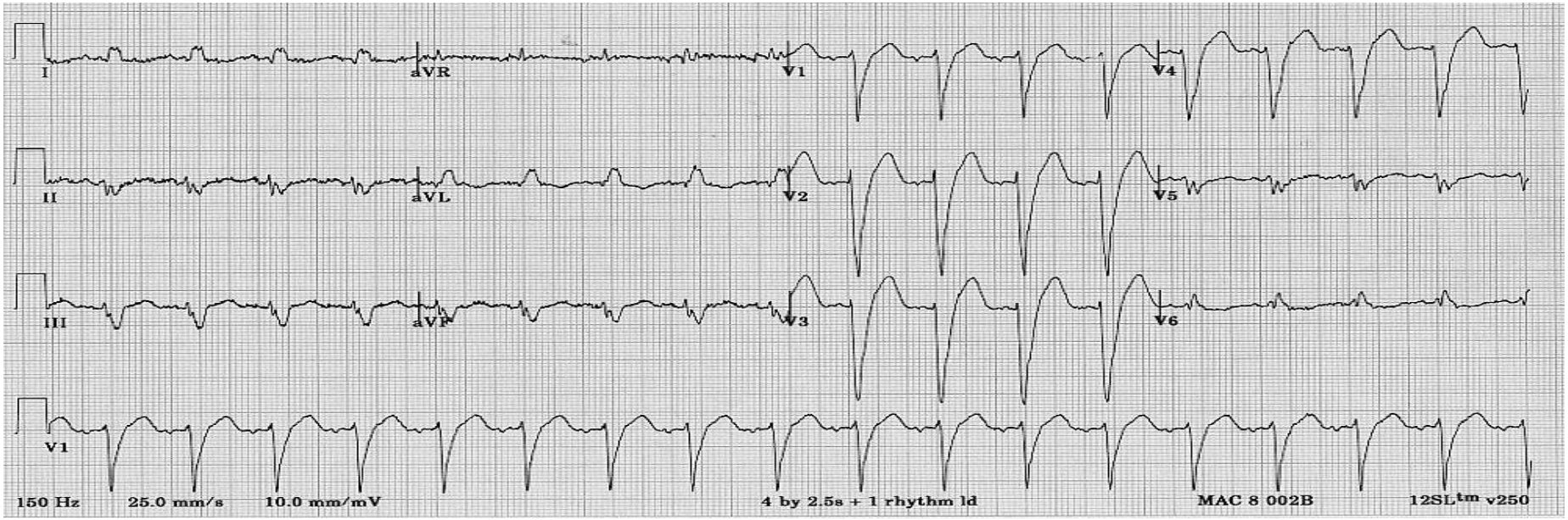
Biventricular Pacing



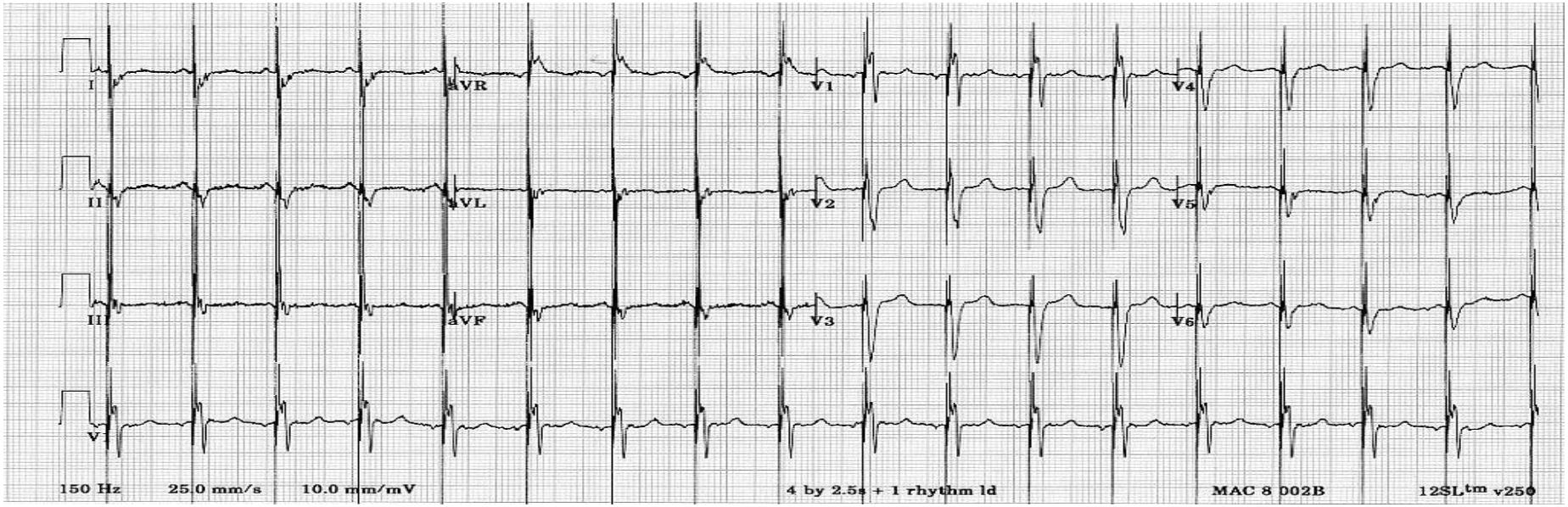


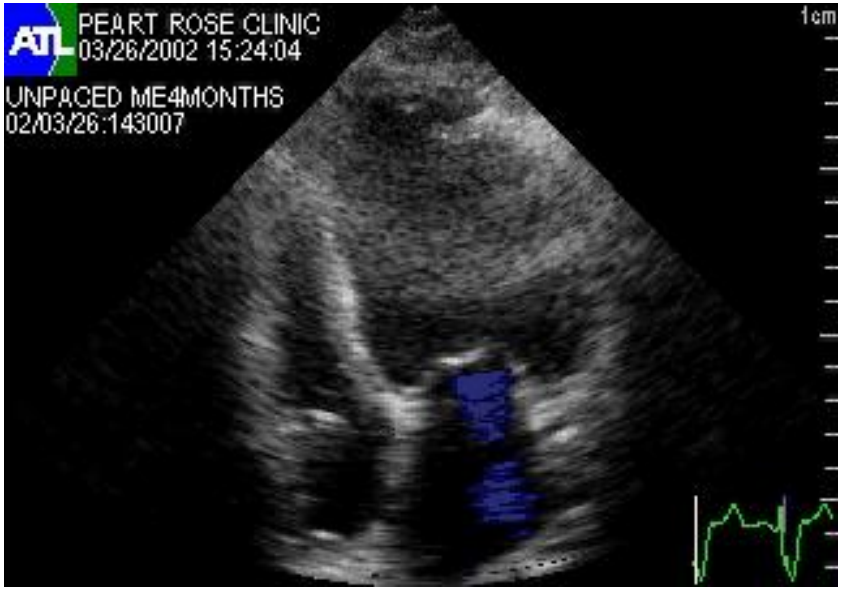


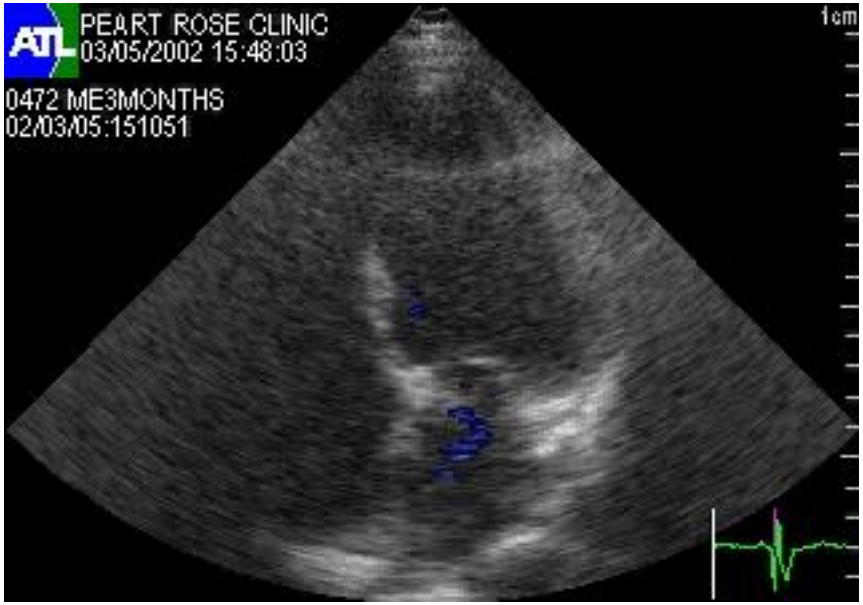
Baseline



Synchronised biventricular pacing




PEART ROSE CLINIC
03/26/2002 15:24:04
UNPACED ME4MONTHS
02/03/26:143007
1cm

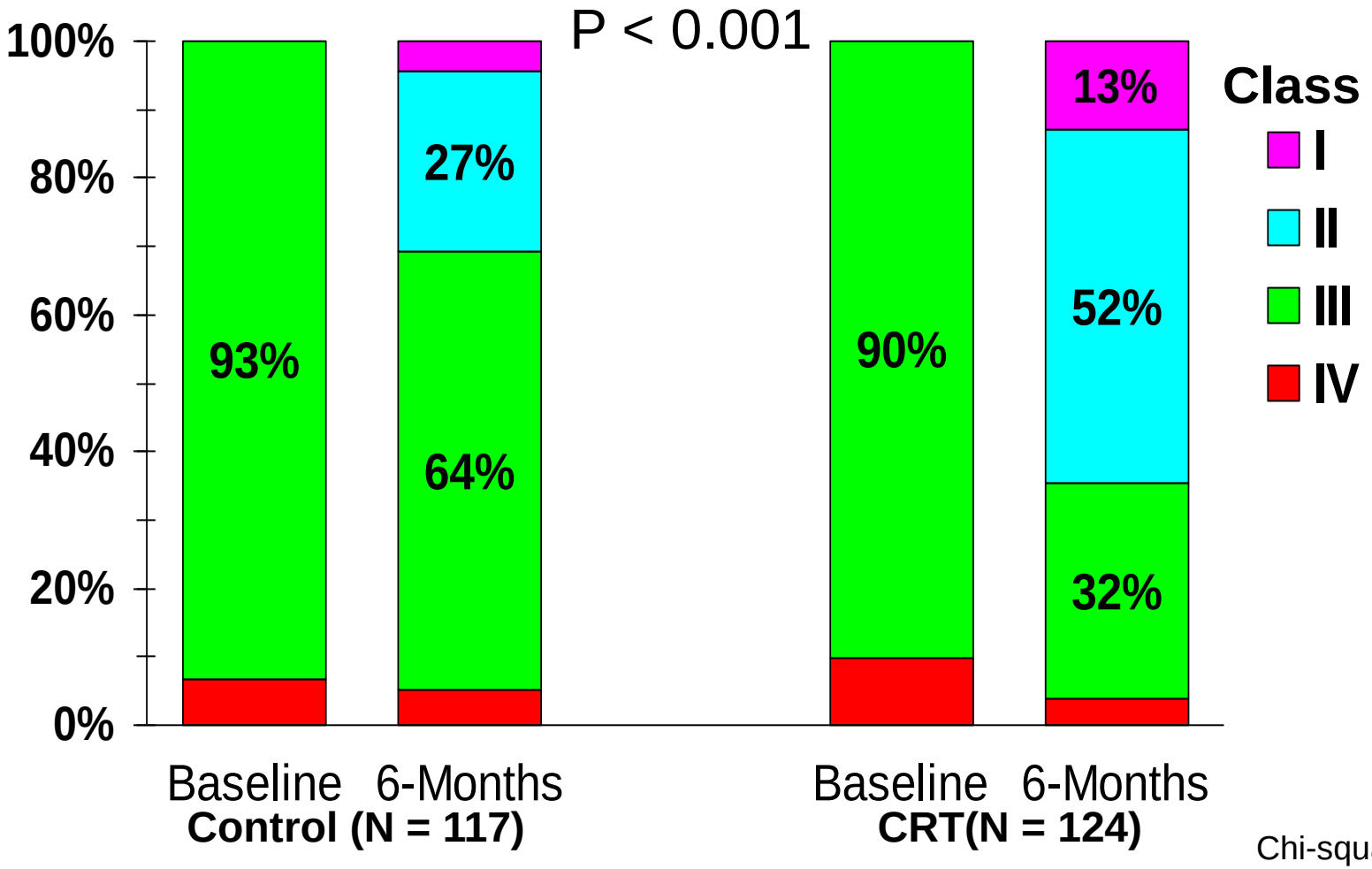

PEART ROSE CLINIC
03/05/2002 15:48:03
0472 ME3MONTHS
02/03/05:151051
1cm

Evidence of CRT benefit (morbidity)

Bi-ventricular stimulation (CRT) › CRT randomized controlled trials

Study	Design	Inclusion criteria	Subgroups	Results
MUSTIC N Engl J Med 344;873-880,2001 (N=48)	Single blind Cross-over Randomized	NYHA III QRS>150 ms Sinus Rhythm	CRT vs Back up pacing (40/min)	6 min Wd +23% QOL score +32% VO2 max +8% Hospitalization rate -66%
MIRACLE N Engl J Med 346;1845-1853,2002 (N=453)	Double blind Randomized Parallel	NYHA III/IV QRS>130 ms LVEF≤35% LVEDD≥55mm	3-month period CRT vs Control	6 min Wd +29 m QOL score +9 P NYHA ↘ LVEF +4.8% LVEDD -3.5 mm MR ↘
CONTAK CD J Am Coll Cardiol 2003;42:1454-1459 (N=490)	Double blind Randomized All cause mortality+ HF hospitalizations+ VA requiring ICD	NYHA II-IV QRS>120 ms LVEF≤35%	CRT vs Control	I end point: -15% (NS) 6 min Wd +35m QOL score ↗ VO2 max +0.8ml/kg/min
MIRACLE-ICD JAMA 2003;289:2685-2694 (N=369)	Randomized	NYHA III/IV QRS>130 ms LVEF≤35% LVEDD≥55mm	CRT vs Control	6 min Wd = QOL score +17.5 P VO2 max +1.1ml/kg/min LVEF = Hospitalization =

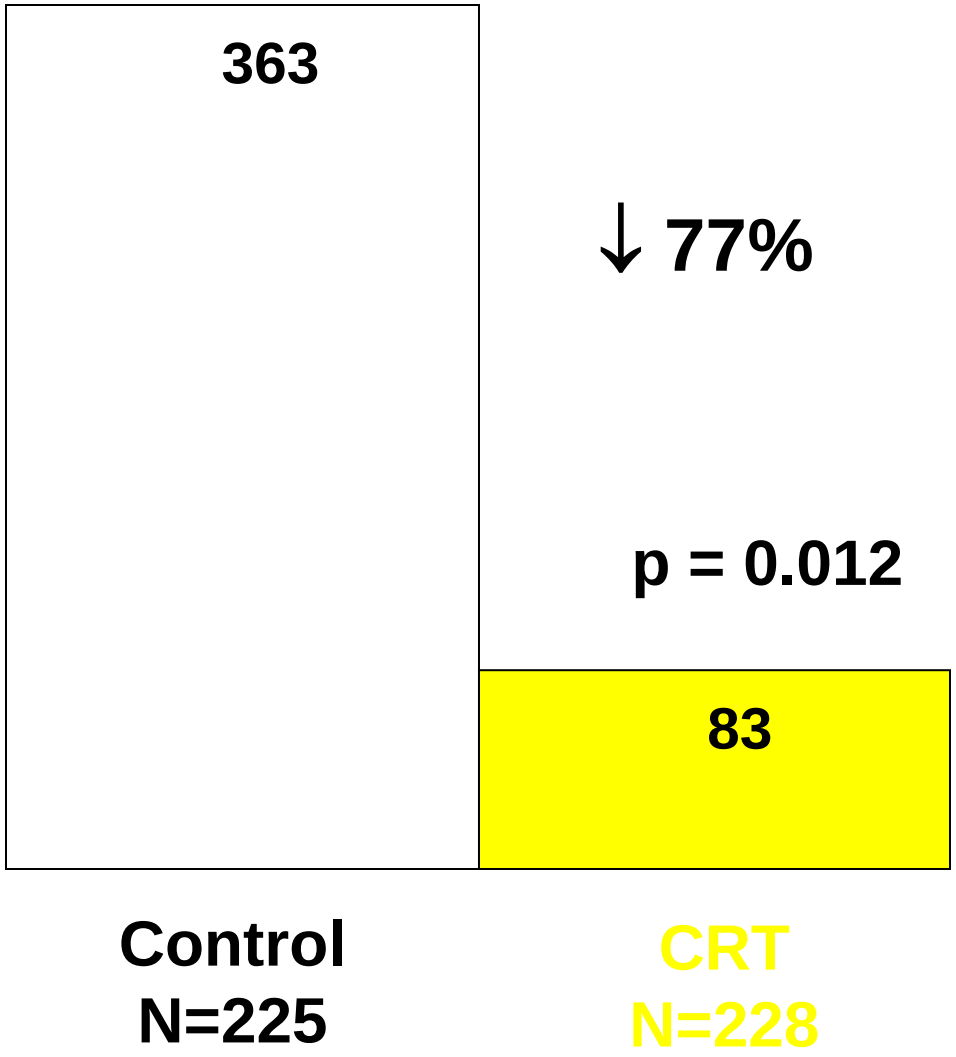
CRT Improves NYHA Class



Chi-square test

Abraham WT, et al. MIRACLE Trial Results; ACC 2001.

CRT: Total Days Hospitalized for Heart Failure



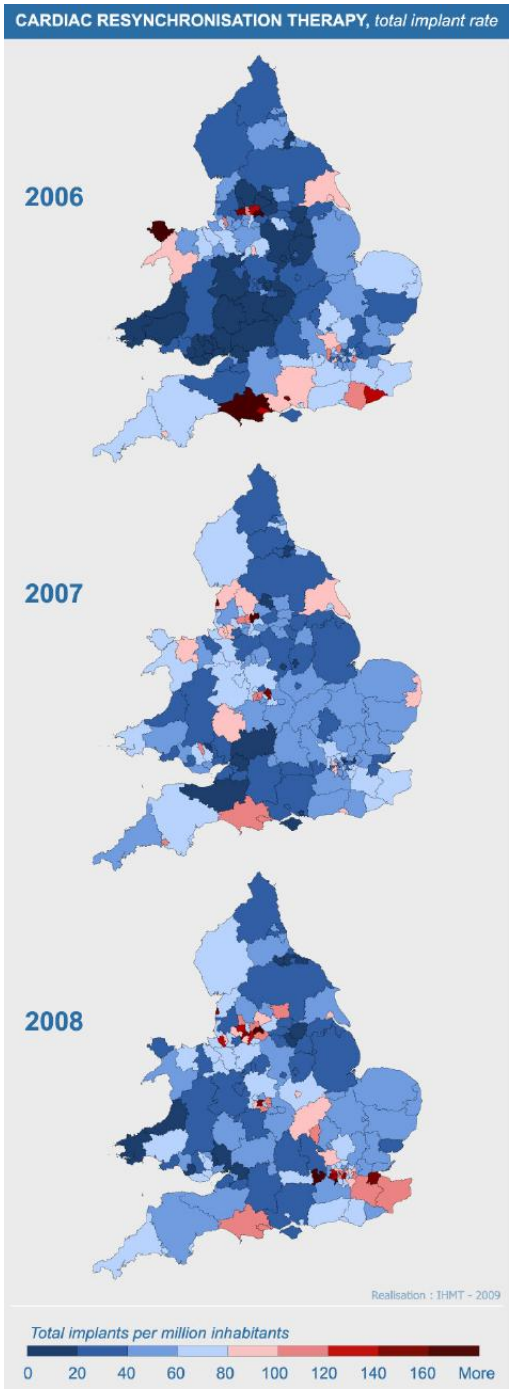
Abraham WT, et al. MIRACLE Trial Results; AHA 2001.

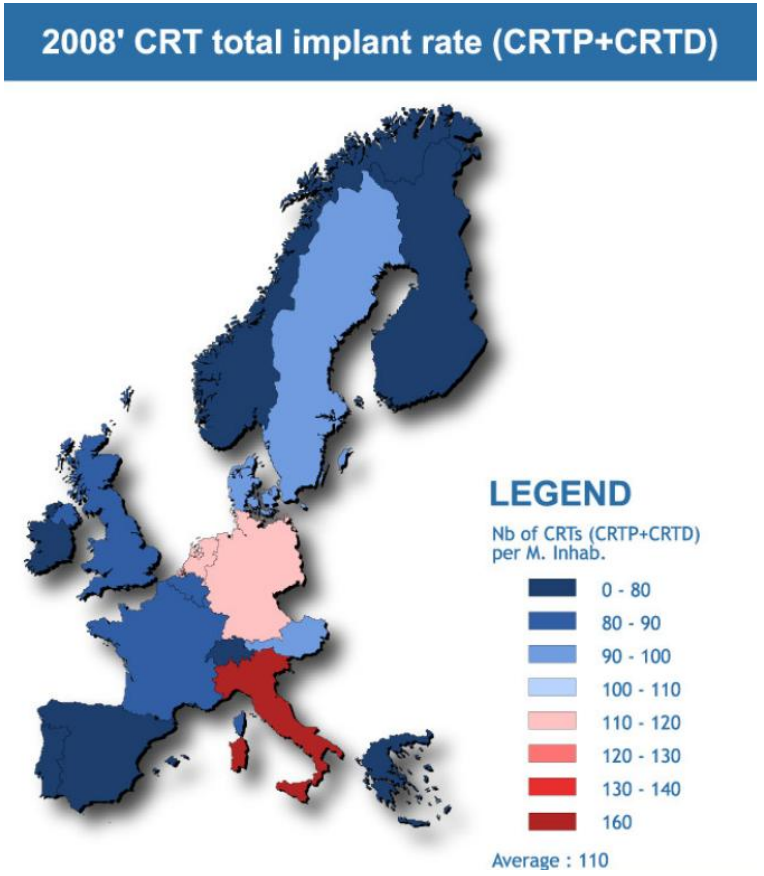
Evidence of CRT benefit (morbidity and mortality)

Bi-ventricular stimulation (CRT) › Trials on mortality and morbidity

Study	Design	Inclusion criteria	Subgroups	Results
COMPANION N Engl J Med 350;21,2004 (N=1520)	Randomized Controlled	NYHA III-IV LVEF≤35% QRS≥120ms PR≥150ms	OMT vs OMT + CRT vs OMT + CRT +ICD	CRT with ICD reduces the risk of death (p=0.003) as compared with optimal medical therapy. CRT reduces by 20% the rate of hospitalization or death in addition to OMT.
CARE-HF N Engl J Med 352;15,2005 N Engl J Med 352;15,2005 (N=813)	Randomized Multicenter	NYHA III-IV LVEF<35% QRS>150ms or 120<QRS<150ms + 2/3 criteria for dyssynchrony i+	OMT vs OMT + CRT	CRT reduces all cause mortality by 20% (p=0.0019) and hospitalizations by 80% (p<0.0001) in addition to OMT.

CRT


CARDIAC RESYNCHRONISATION THERAPY, total implant rate
2006
2007
2008
Realisation : IHMT - 2009
Total implants per million inhabitants
0 20 40 60 80 100 120 140 160 More


2008' CRT total implant rate (CRTP+CRTD)
LEGEND
Nb of CRTs (CRTP+CRTD) per M. Inhab.
0 - 80
80 - 90
90 - 100
100 - 110
110 - 120
120 - 130
130 - 140
160
Average : 110

More evidence of CRT benefit

- Recent trials (MADIT CRT, RAFT, REVERSE) 2009 -2012
- Morbidity and mortality benefits in **NYHA II** patients
- **NICE** guidance **out of date** by **6** years!

European Society of Cardiology 2012

Recommendations for the use of CRT where the evidence is strong—patients in sinus rhythm with NYHA functional class III and ambulatory class IV heart failure and a persistently reduced ejection fraction, despite optimal pharmacological therapy

Recommendations	Class[a]	Level[b]	Ref[c]
LBBB QRS morphology CRT-P/CRT-D is recommended in patients in sinus rhythm with a QRS duration of ≥120 ms, LBBB QRS morphology, and an EF ≤35%, who are expected to survive with good functional status for >1 year, to reduce the risk of HF hospitalization and the risk of premature death.	I	A	156, 157
Non-LBBB QRS morphology CRT-P/CRT-D should be considered in patients in sinus rhythm with a QRS duration of ≥150 ms, irrespective of QRS morphology, and an EF ≤35%, who are expected to survive with good functional status for >1 year, to reduce the risk of HF hospitalization and the risk of premature death.	IIa	A	156, 157

European Society of Cardiology 2012

Recommendations for the use of CRT where the evidence is strong—patients in sinus rhythm with NYHA functional class II heart failure and a persistently reduced ejection fraction, despite optimal pharmacological therapy

Recommendations	Class[a]	Level[b]	Ref[c]
LBBB QRS morphology CRT, preferably CRT-D is recommended in patients in sinus rhythm with a QRS duration of ≥130 ms, LBBB QRS morphology, and an EF ≤30%, who are expected to survive for >1 year with good functional status, to reduce the risk of HF hospitalization and the risk of premature death.	I	A	154, 155
Non-LBBB QRS morphology CRT, preferably CRT-D should be considered in patients in sinus rhythm with a QRS duration of ≥150 ms, irrespective of QRS morphology, and an EF ≤30%, who are expected to survive for >1 year with good functional status, to reduce the risk of HF hospitalization and the risk of premature death.	IIa	A	154, 155

ICD and CRT

- Heart Failure Device Therapy
  - what you and your patients can expect
    - Infection
    - Lead dislodgement
    - Interrogation and Reprogramming
    - Inappropriate ICD shocks
    - Non-response to CRT (<30%)
    - Box change (lead)

Other Indications for ICD

Sudden Cardiac Death

- Cardiomyopathies
  - Hypertrophic cardiomyopathy (1 in 500)
  - Dilated cardiomyopathy
  - Arrhythmogenic cardiomyopathy (1 in 1,000)
    (arrhythmogenic right ventricular dysplasia/ cardiomyopathy)
- Inherited arrhythmia syndromes
  - Long QT syndrome
  - Familial catecholaminergic polymorphic VT
  - Brugada syndrome
  - Short QT syndrome
  - Familial atrial fibrillation

- Sudden Cardiac Death
  - What you and your patients can expect
    - Screening relatives
    - Anxiety and Concern
    - Disrupted lives
    - Denial
    - Acceptance of risk
      - Difficulty quantifying
      - Discussion re ICD – Implanted pathology
      - ? Drugs (beta-blockers)

What should a Primary Care physician do?

- Symptom history:

  Palpitations – Pre/syncope – SOB – CP
- Family history
- Initial investigations:

  ECG – Holter – ETT – ECHO

Please **REFER** to arrhythmia clinic **ASAP**

Summary of NICE guidance (2006)

CRT with a pacing device (CRT-P)

A treatment option for people with heart failure who fulfil **all** the criteria in the box below

CRT with a defibrillator device (CRT-D)

May be considered for people who fulfil the criteria for CRT-P and who also fulfil the criteria for the use of an ICD.

Implantable cardioverter defibrillators (ICD)

ICDs are recommended for people with arrhythmias in the groups below. (Note this guidance does not cover the use of ICDs for non-ischaemic dilated cardiomyopathy.)

CRT with a pacing device

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  - **either** with QRS duration of 150ms or longer estimated by standard electrocardiogram (ECG)
  - **or** with a QRS duration of 120-149 ms estimated by ECG **and** mechanical dyssynchrony that is confirmed by echocardiography.
- They have left ventricular ejection fraction of 35% or less.
- They are receiving optimal pharmacological therapy.

Implantable cardioverter defibrillator

- For secondary prevention, that is, for patients who present, in the absence of a treatable cause, with one of the following:
  - having survived a cardiac arrest due to either ventricular tachycardia (VT) or ventricular fibrillation
  - spontaneous sustained VT causing syncope or significant haemodynamic compromise
  - sustained VT without syncope or cardiac arrest, and who have an associated reduction in ejection fraction (LVEF of less than 35%) (no worse than class III of the New York Heart Association functional classification of heart failure).
- For primary prevention of arrhythmias, that is, for patients who have:
  - a history of previous (more than 4 weeks) myocardial infarction and:
    either
    - ◊ left ventricular dysfunction with an LVEF of less than 35% (no worse than class III of the New York Heart Association functional classification of heart failure), **and**
    - ◊ non-sustained VT on Holter (24-hour electrocardiogram) monitoring, **and**
    - ◊ inducible VT on electrophysiological testing

    or
    - ◊ left ventricular dysfunction with an LVEF of less than 30% (no worse than class III of the New York Heart Association functional classification of heart failure) **and**
    - ◊ QRS duration of equal to or more than 120 milliseconds
  - a familial cardiac condition with a high risk of sudden death, including long QT syndrome, hypertrophic cardiomyopathy, Brugada syndrome or arrhythmogenic right ventricular dysplasia, or have undergone surgical repair of congenital heart disease.

Further information

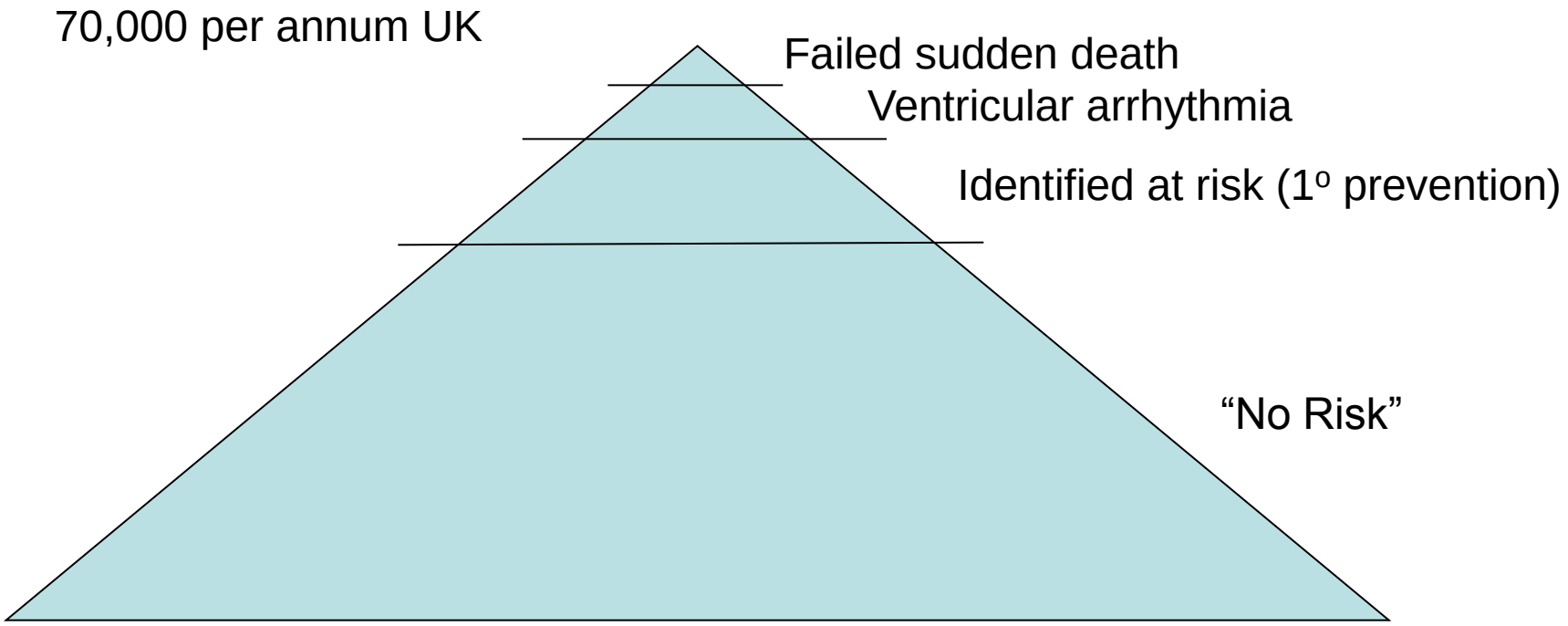
- The guidance on CRT is from NICE technology appraisal guidance 120, available from www.nice.org.uk/TA120
- The guidance on ICDs is from NICE technology appraisal guidance 95, available from www.nice.org.uk/TA095

Clinical Applicability of Genetic Testing

- Presymptomatic diagnosis
  - Pivotal when SCD may be first manifestation of disease
- Confirmatory diagnosis in borderline cases
  - Important when clinical diagnosis challenging
- Identification of silent carriers
  - Allows cascade screening and targetted clinical evaluation
- May influence risk stratification
  - LQT subtype affects response to β-blockers; Troponin T in HCM
- May influence therapy/lifestyle
- ? Role in reproductive counselling

- Technical feasibility/ cost-effectiveness
  - Pick-up rate of genotyping (60% in HCM; ≤10% in DCM; 30-40% in arrhythmogenic cardiomyopathy; 50-70% in AD LQTS)

- Sudden Cardiac Death
  - Scale of the problem



Most recent NICE guidance on ICD – 2006

Secondary Prevention

'Secondary prevention', that is, for patients who present, in the absence of a treatable cause, with one of the following:

- having survived a cardiac arrest due to either ventricular tachycardia (VT) or ventricular fibrillation (VF)
- spontaneous sustained VT causing syncope or significant haemodynamic compromise
- sustained VT without syncope or cardiac arrest, and who have an associated reduction in ejection fraction (LVEF of less than 35%) (no worse than class III of the New York Heart Association functional classification of heart failure).

Most recent NICE guidance on ICD – 2006

Primary Prevention

'Primary prevention', that is, for patients who have:

- a history of previous (more than 4 weeks) myocardial infarction (MI) and:
  either
  - left ventricular dysfunction with an LVEF of less than 35% (no worse than class III of the New York Heart Association functional classification of heart failure), **and**
  - non-sustained VT on Holter (24-hour electrocardiogram [ECG]) monitoring, **and**
  - inducible VT on electrophysiological (EP) testing

  or
  - left ventricular dysfunction with an LVEF of less than 30% (no worse than class III of the New York Heart Association functional classification of heart failure) **and**
  - QRS duration of equal to or more than 120 milliseconds

- a familial cardiac condition with a high risk of sudden death, including long QT syndrome, hypertrophic cardiomyopathy, Brugada syndrome or arrhythmogenic right ventricular dysplasia (ARVD), or have undergone surgical repair of congenital heart disease.

European Society of Cardiology 2012

Recommendations for the use of CRT where the evidence is uncertain—patients with symptomatic HF (NYHA functional class II–IV) and a persistently reduced EF despite optimal pharmacological therapy and in AF or with a conventional pacing indication

Recommendations	Class[a]	Level[b]	Ref[c]
Patients in permanent AF			
CRT-P/CRT-D may be considered in patients in NYHA functional class III or ambulatory class IV with a QRS duration ≥120 ms and an EF ≤35%, who are expected to survive with good functional status for >1 year, to reduce the risk of HF worsening if:			
• The patient requires pacing because of an intrinsically slow ventricular rate	IIb	C	–
• The patient is pacemaker dependent as a result of AV nodal ablation	IIb	C	–
• The patient's ventricular rate is ≤60 b.p.m. at rest and ≤90 b.p.m. on exercise.	IIb	C	–
Patients with an indication for conventional pacing and no other indication for CRT			
In patients who are expected to survive with good functional status for >1 year:			
• CRT should be considered in those in NYHA functional class III or IV with an EF ≤35%, irrespective of QRS duration, to reduce the risk of worsening of HF	IIa	C	–
• CRT may be considered in those in NYHA functional class II with an EF ≤35%, irrespective of QRS duration, to reduce the risk of worsening of HF.	IIb	C	–

Most recent NICE guidance on CRT – 2006!

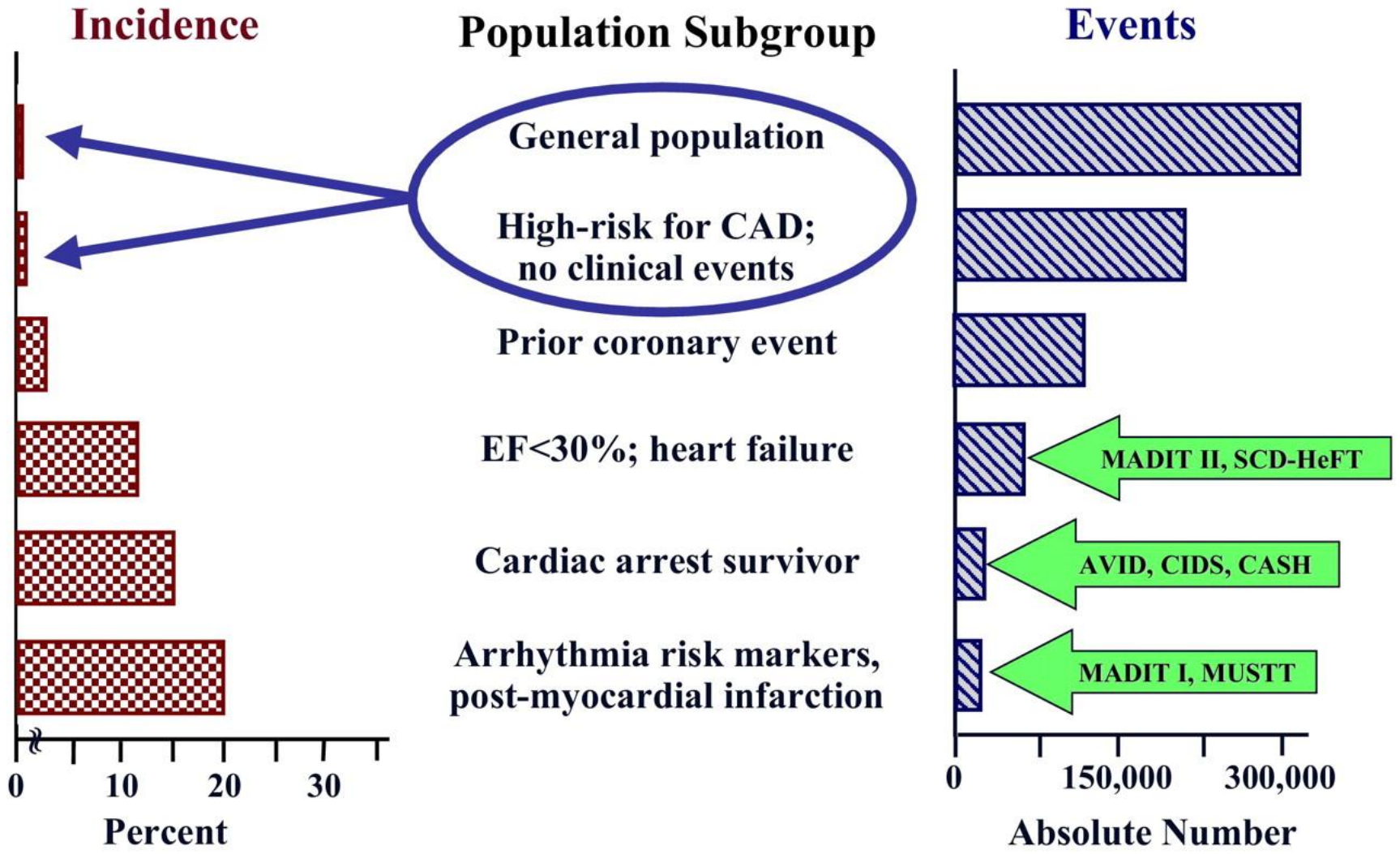
Cardiac resynchronisation therapy with a pacing device (CRT-P) is recommended as a treatment option for people with heart failure who fulfil all the following criteria.

- They are currently experiencing or have recently experienced New York Heart Association (NYHA) class III–IV symptoms.
- They are in sinus rhythm:
  - **either** with a QRS duration of 150 ms or longer estimated by standard electrocardiogram (ECG)
  - **or** with a QRS duration of 120–149 ms estimated by ECG **and** mechanical dyssynchrony that is confirmed by echocardiography.
- They have a left ventricular ejection fraction of 35% or less.
- They are receiving optimal pharmacological therapy.

Cardiac resynchronisation therapy with a defibrillator device (CRT-D) may be considered for people who fulfil the criteria for implantation of a CRT-P device in section 1.1 and who also separately fulfil the criteria for the use of an ICD device as recommended in NICE technology appraisal guidance 95.

Still NO guidance on non-ischaemic dilated cardiomyopathy!

The low risk – high number dilemma



Estimates of Incidence and Total Annual Population Burden for General Adult Population and Increasingly High-Risk Subgroups

Distribution of Clinical Status of Victims at Time of SCD