XI annual meeting on State of the Art in Advanced Heart Failure: Clinical Practice and Organizational Models

CRT and drug therapy, a synergistic relationship. How to implement it?

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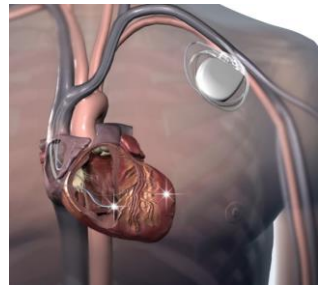
HFrEF Guidelines

ICD and CRT

HFrEF patients with EF < 35% despite optimal medical treatment

- **ICD**
- **CRT** if QRS > 130m (and even more if > 150ms)

Wearable ICD in patients with high risk for SCD as „Bridge to implantable Device - IIb, B



Management of patients with HFrEF

- ACE-I/ARNI[a]
- Beta-blocker
- MRA
- Dapagliflozin/Empagliflozin
- Loop diuretic for fluid retention (Class I)

LVEF ≤35% and QRS <130 ms and where appropriate	LVEF >35% or device therapy not indicated or inappropriate	SR and LVEF ≤35% and QRS ≥130 ms
ICD Non-ischaemic (Class IIa) Ischaemic (Class I)		**CRT-D[b]/-P** QRS 130-149 ms (Class IIa) QRS ≥150 ms (Class I)

If symptoms persist, consider therapies with Class II recommendations

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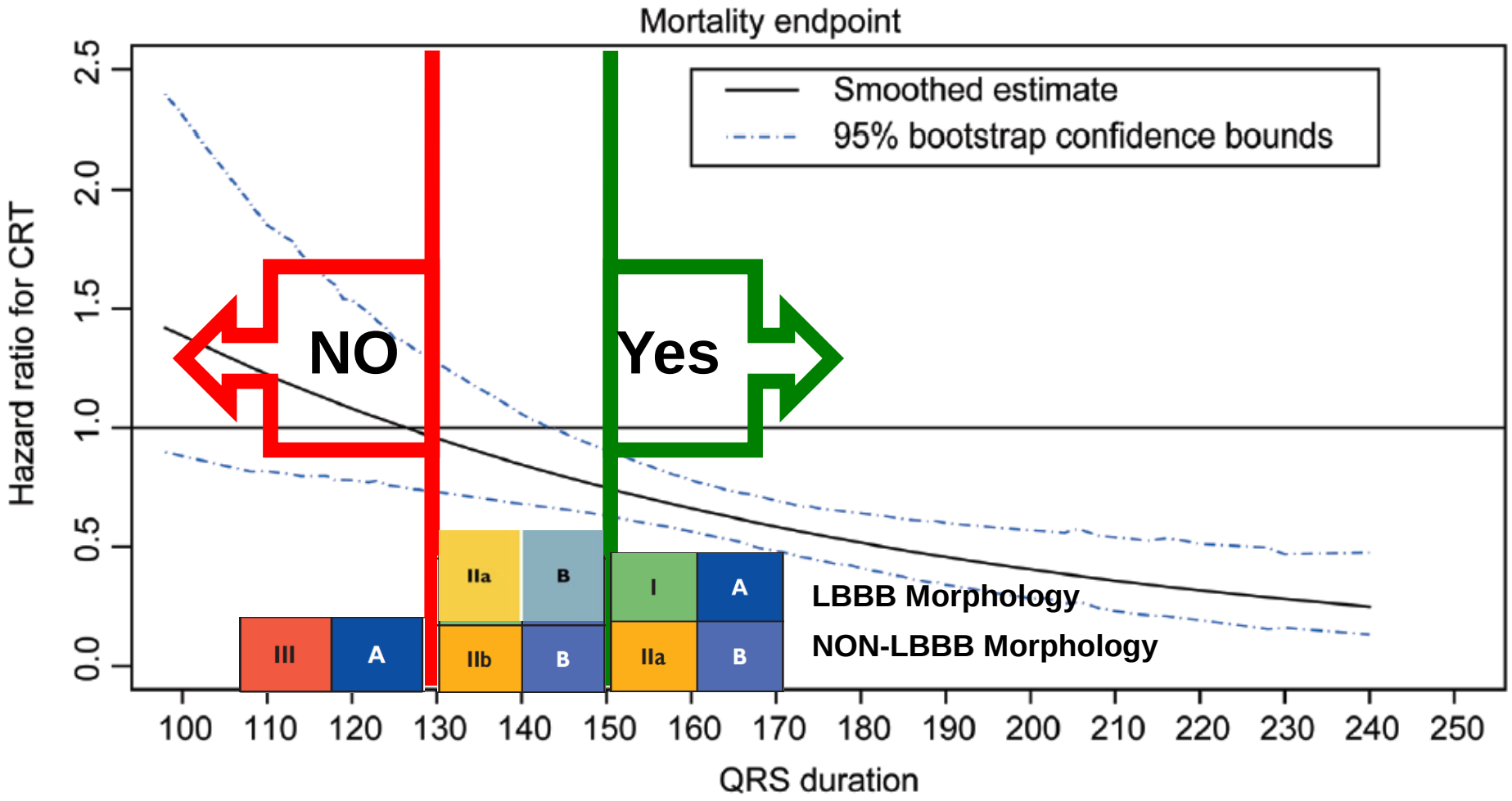
ESC

Indications for CRT (ESC-Guidelines 2016/2021)



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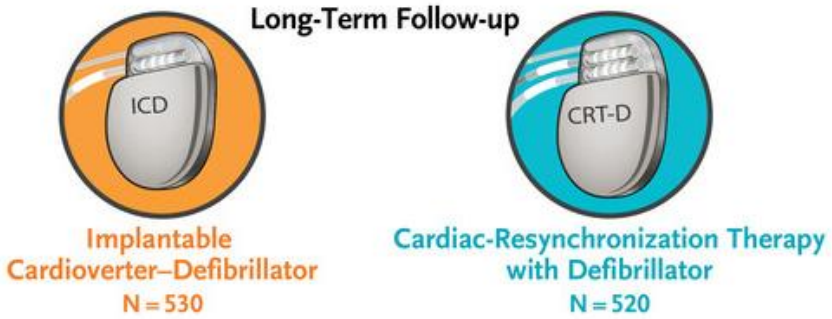
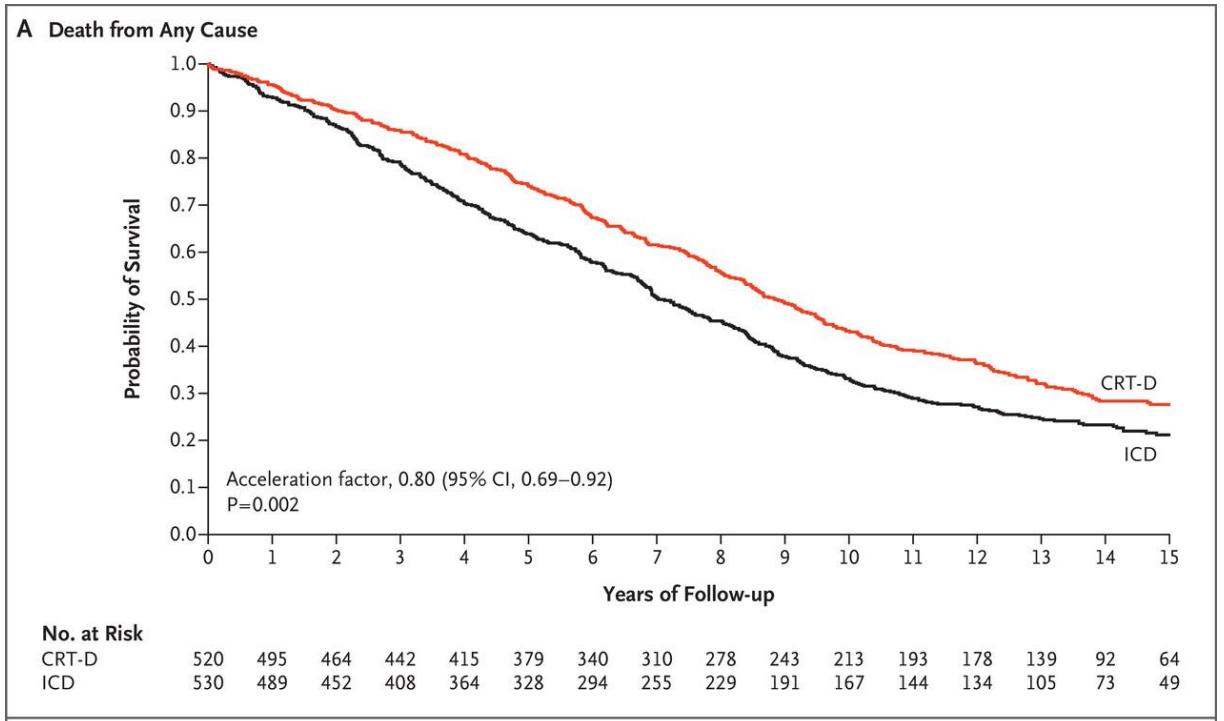
Cleland, Linde and Ruschitzka 2016

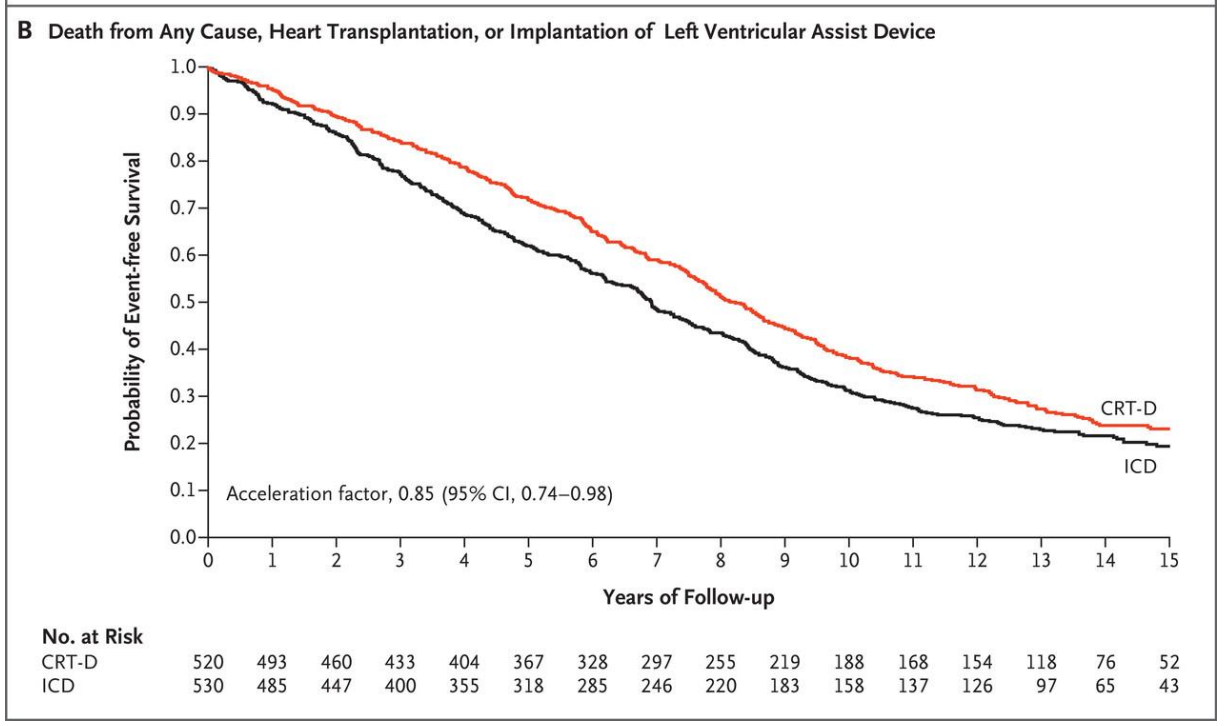
CRT: very efficient even in the long run

Long survival benefit of CRT-D (versus ICD) in HFrEF and widened QRS



FU to multicentre double-blind randomised controlled RAFT trial.
1798 patients, NYHA II-III EF <30%, QRS > 120ms
Median FU 7.7 years





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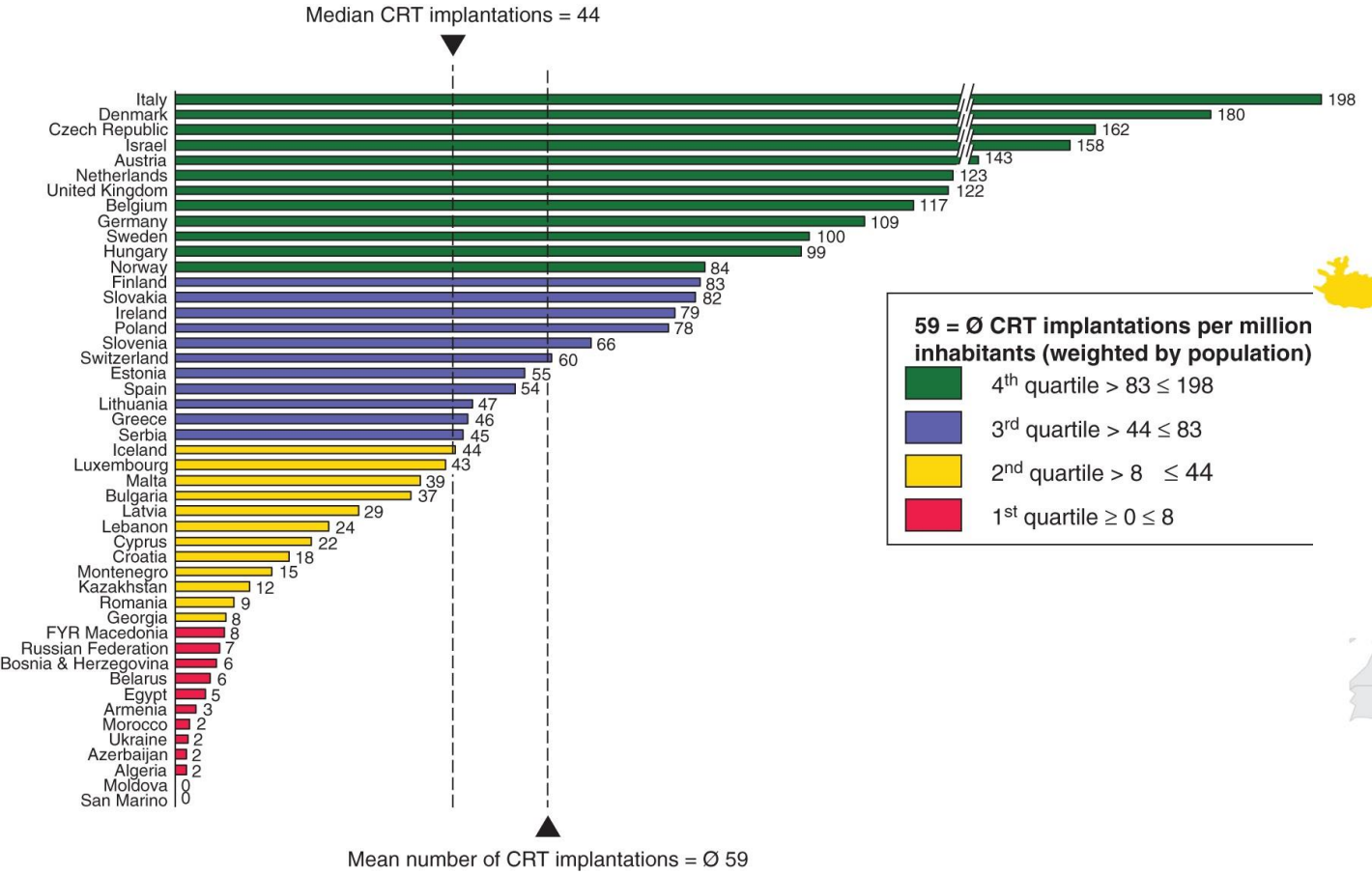
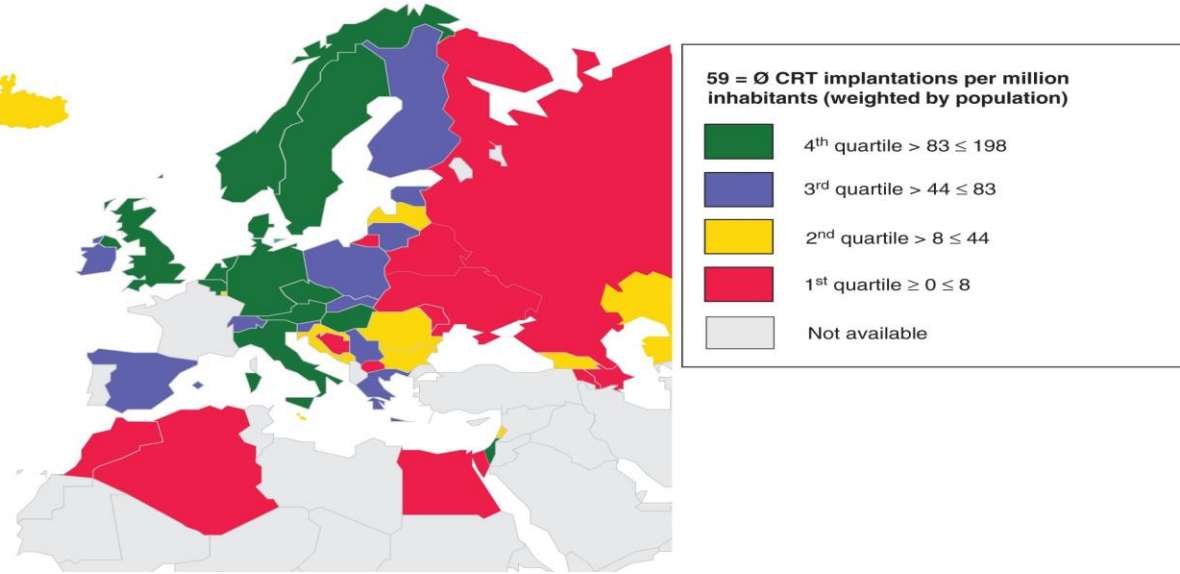
Sapp JL et al, NEJM 2024

HOWEVER: Only about one in three eligible patients actually receive a CRT device

Cardiac resyncronization therapy (CRT) device implantations per million inhabitants 2013





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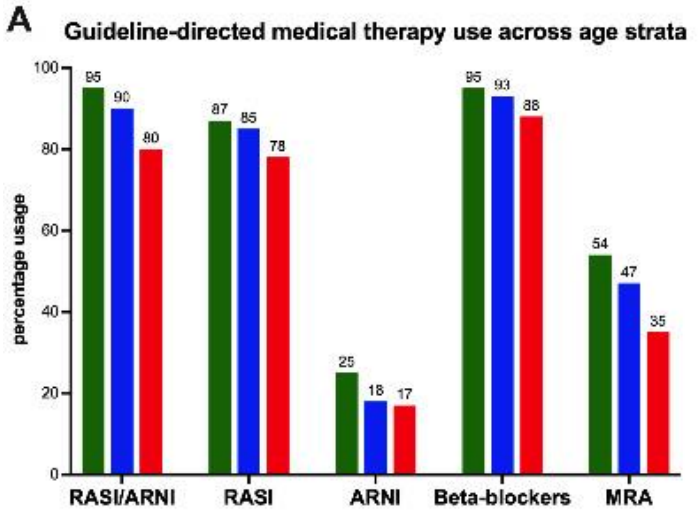
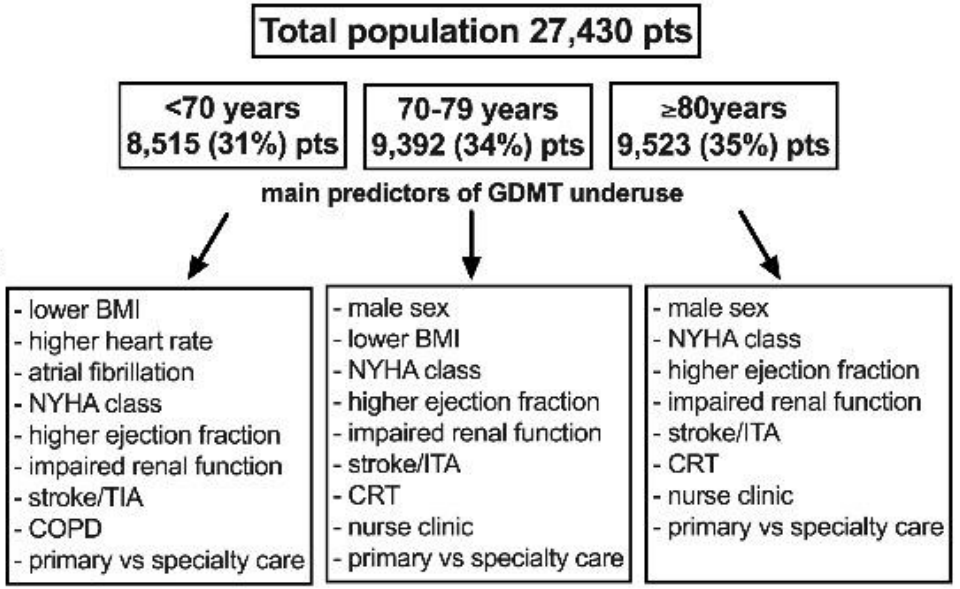
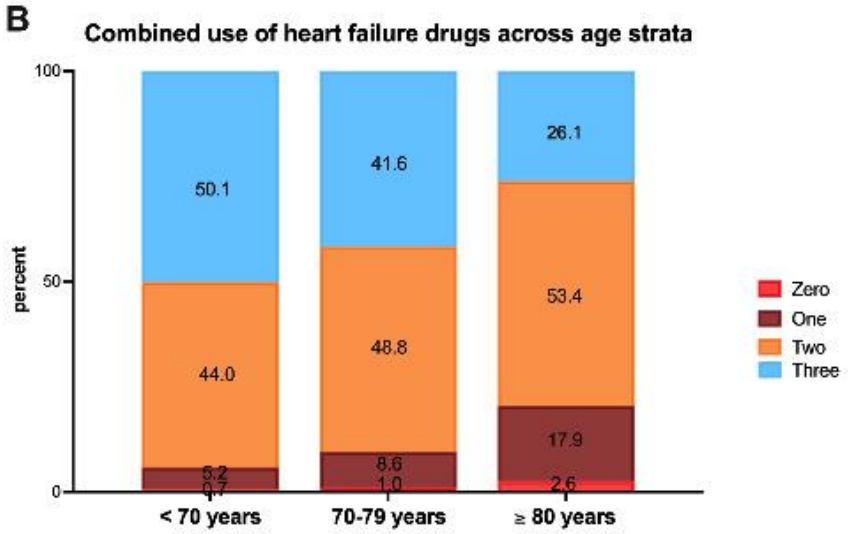
Raatikainen MJP et al, EP Europace 2015

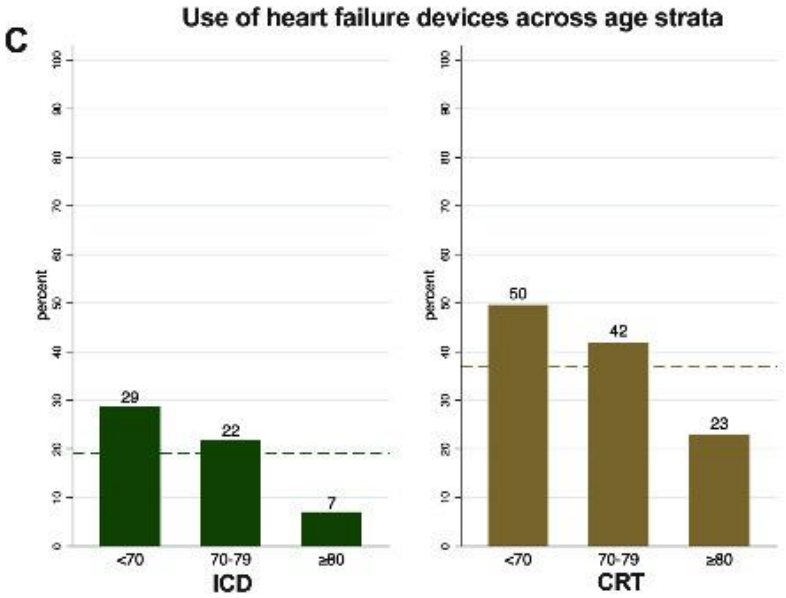
Implementation of GDMT in HFrEF accross different age strata – Swedish HF-Registry

Older patients reamin undertreated!









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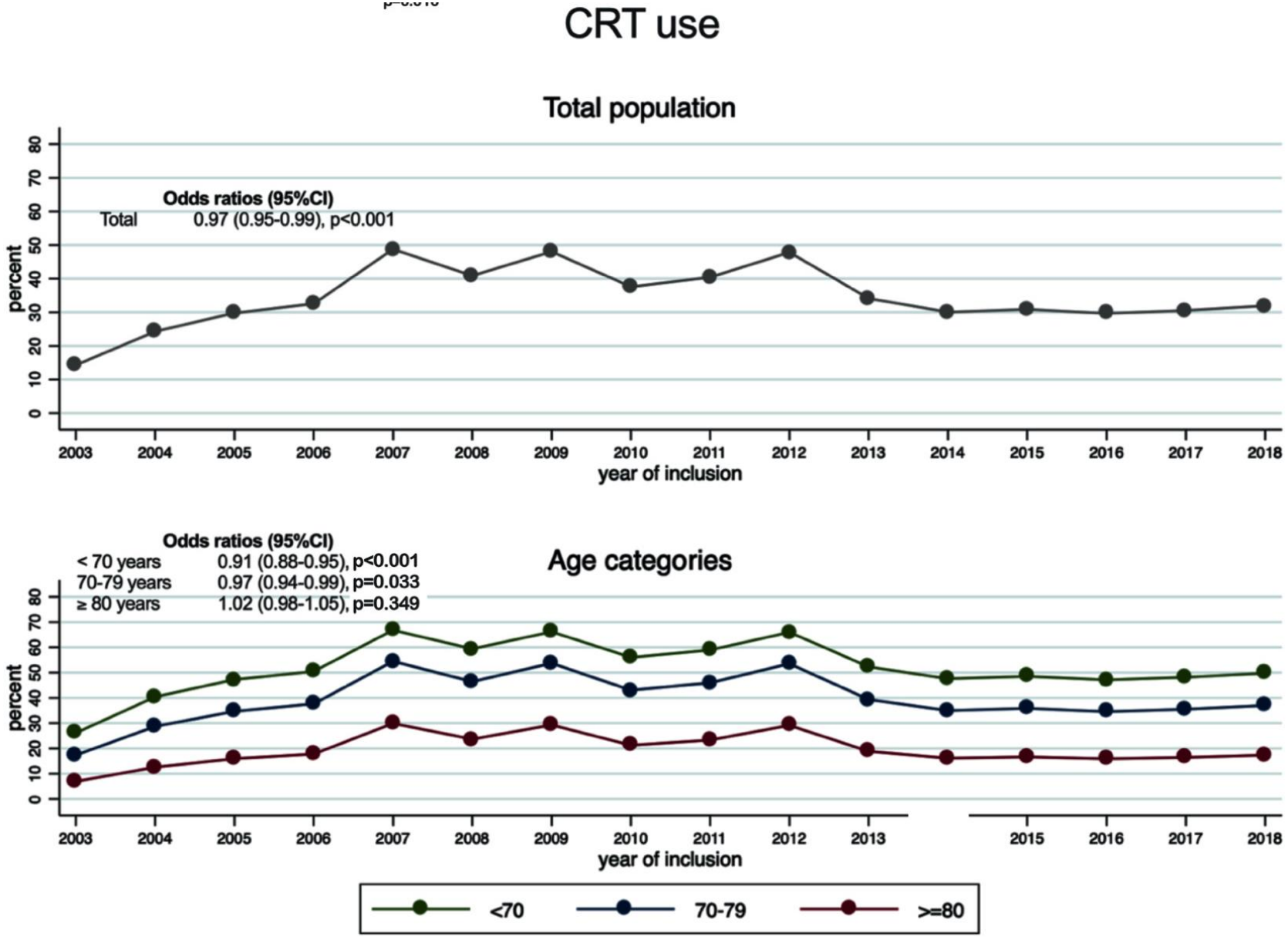
Stolfo D et al, EJHF 22

Temporal trends in the adjusted probability of HF device use in the

SwedeHF



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Stolfo D et al, EJHF 22

ESC European Society of Cardiology

European Journal of Heart Failure (2020) **22**, 2349–2369
doi:10.1002/ejhf.2046

POSITION PAPER

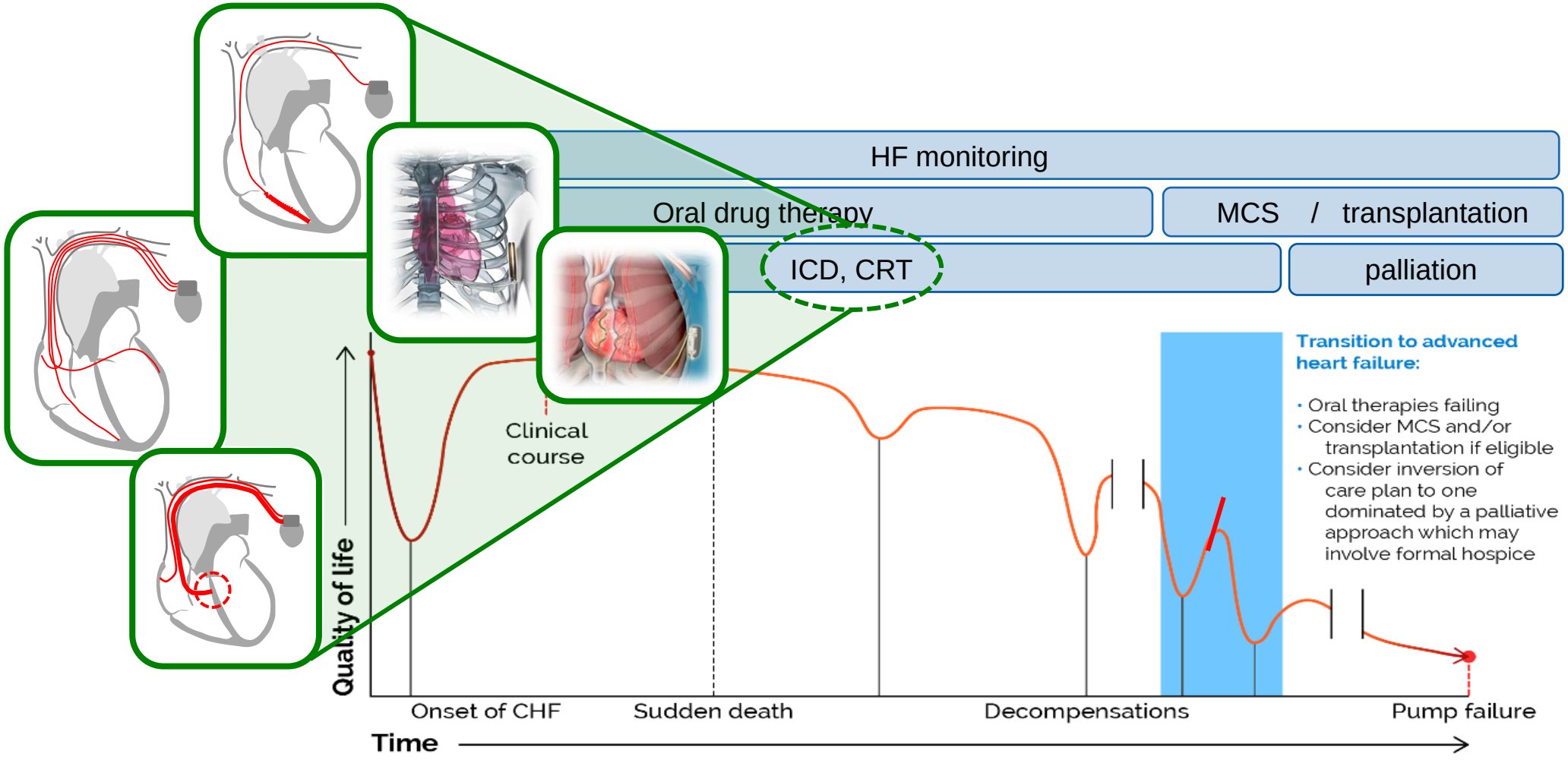
Optimized implementation of cardiac resynchronization therapy: a call for action for referral and optimization of care

A joint position statement from the Heart Failure Association (HFA), European Heart Rhythm Association (EHRA), and European Association of Cardiovascular Imaging (EACVI) of the European Society of Cardiology

Wilfried Mullens[1,2]*, Angelo Auricchio[3], Pieter Martens[1,2], Klaus Witte[4], Martin R. Cowie[5], Victoria Delgado[6], Kenneth Dickstein[7], Cecilia Linde[8], Kevin Vernooy[9,10], Francisco Leyva[11], Johann Bauersachs[12], Carsten W. Israel[13], Lars H. Lund[14], Erwan Donal[15], Giuseppe Boriani[16], Tiny Jaarsma[17,18], Antonio Berruezo[19], Vassil Traykov[20], Zaheer Yousef[21], Zbigniew Kalarus[22], Jens Cosedis Nielsen[23], Jan Steffel[24], Panos Vardas[25], Andrew Coats[26], Petar Seferovic[27], Thor Edvardsen[28], Hein Heidbuchel[29], Frank Ruschitzka[30], and Christophe Leclercq[15]

Why is CRT underused?

Devices in Heart Failure – Timing



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Slide courtesy from Winnik. Adapted from Allan et al., *Circulation,* 2012

Timing

Differences in long-term clinical outcomes

Delays from a first heart failure hospitalization (HFH) to CRT implantation were associated with progressively worse long-term clinical outcomes.

English database from 2010-2019

Leyva F et al, EP Europace 2023

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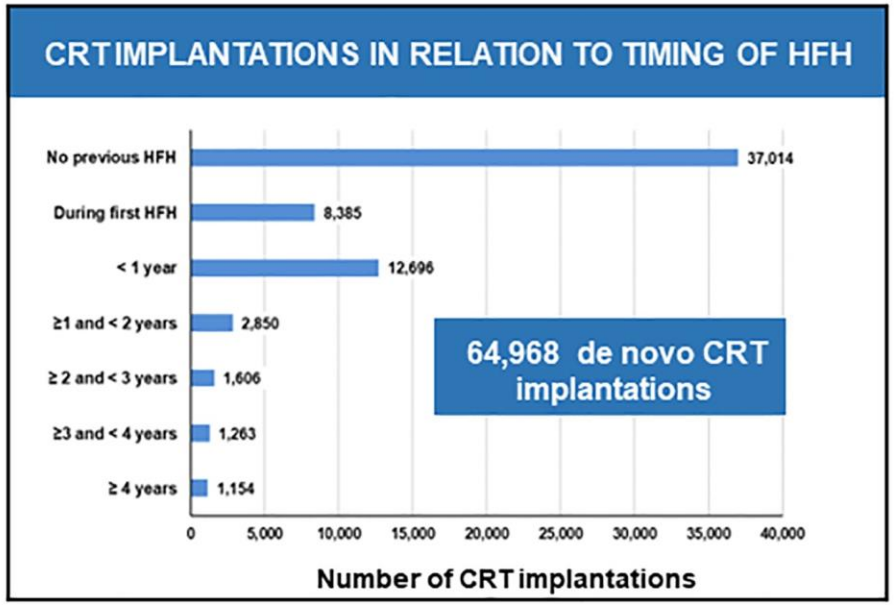
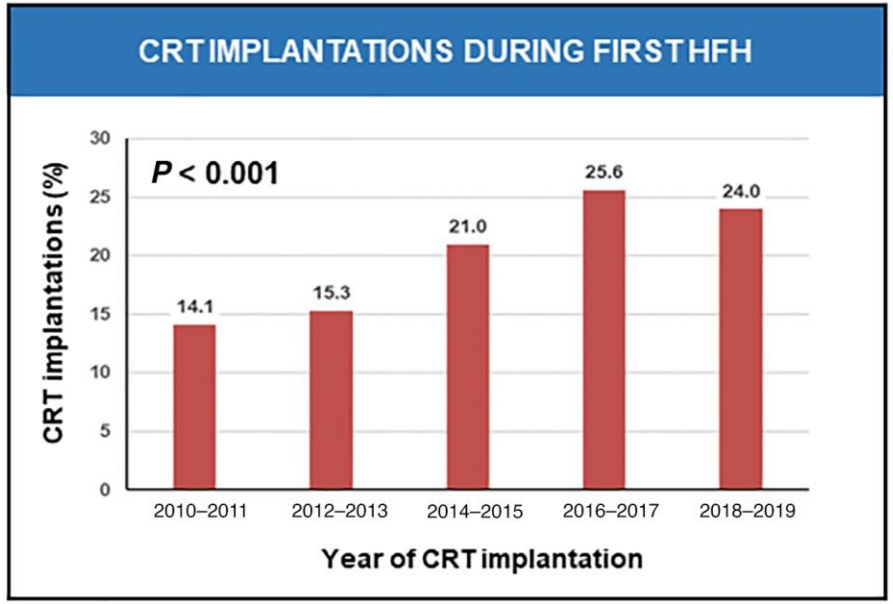
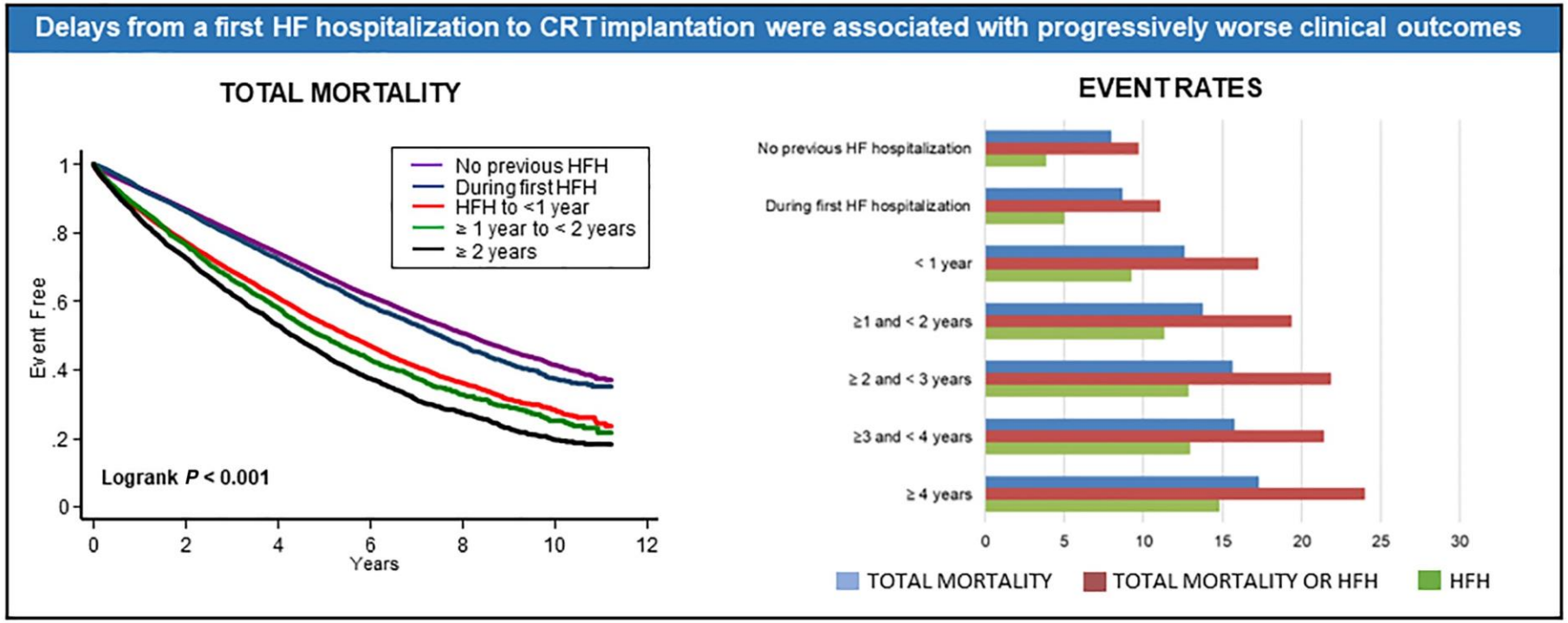




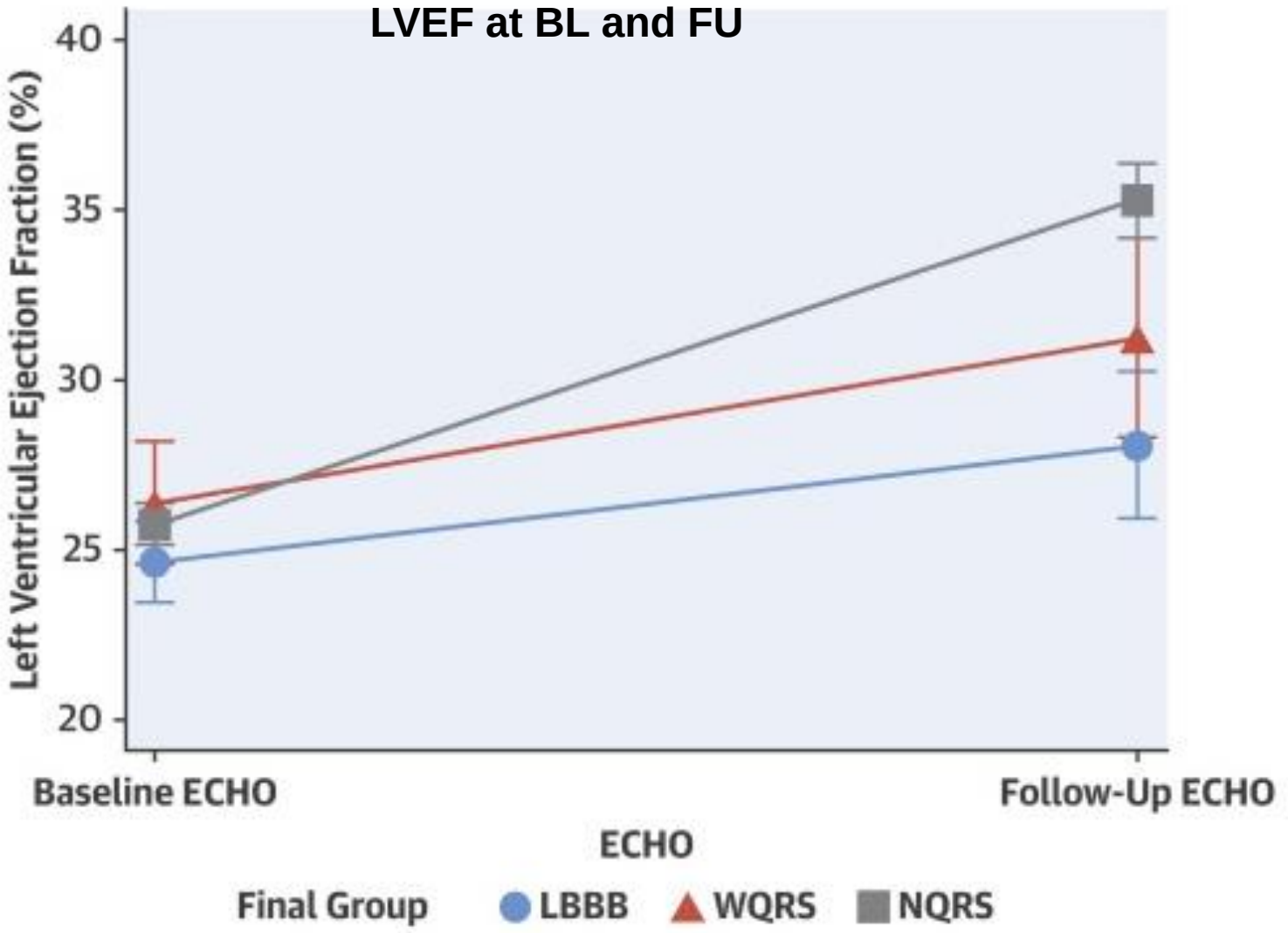


Less functional LV recovery in patients with LVEF ≤35% and LBBB than do those with a NQRS

Among patients with LBBB, the likelihood of large improvement in LVEF is modest, even when considering revascularization and use of GDMT.

Current guidelines that mandate 3 months of GDMT should be more flexible.

For some patients with LBBB, recovery of LVEF >35% is unlikely with medicines alone, and these patients may be better served with earlier implantation of CRT.



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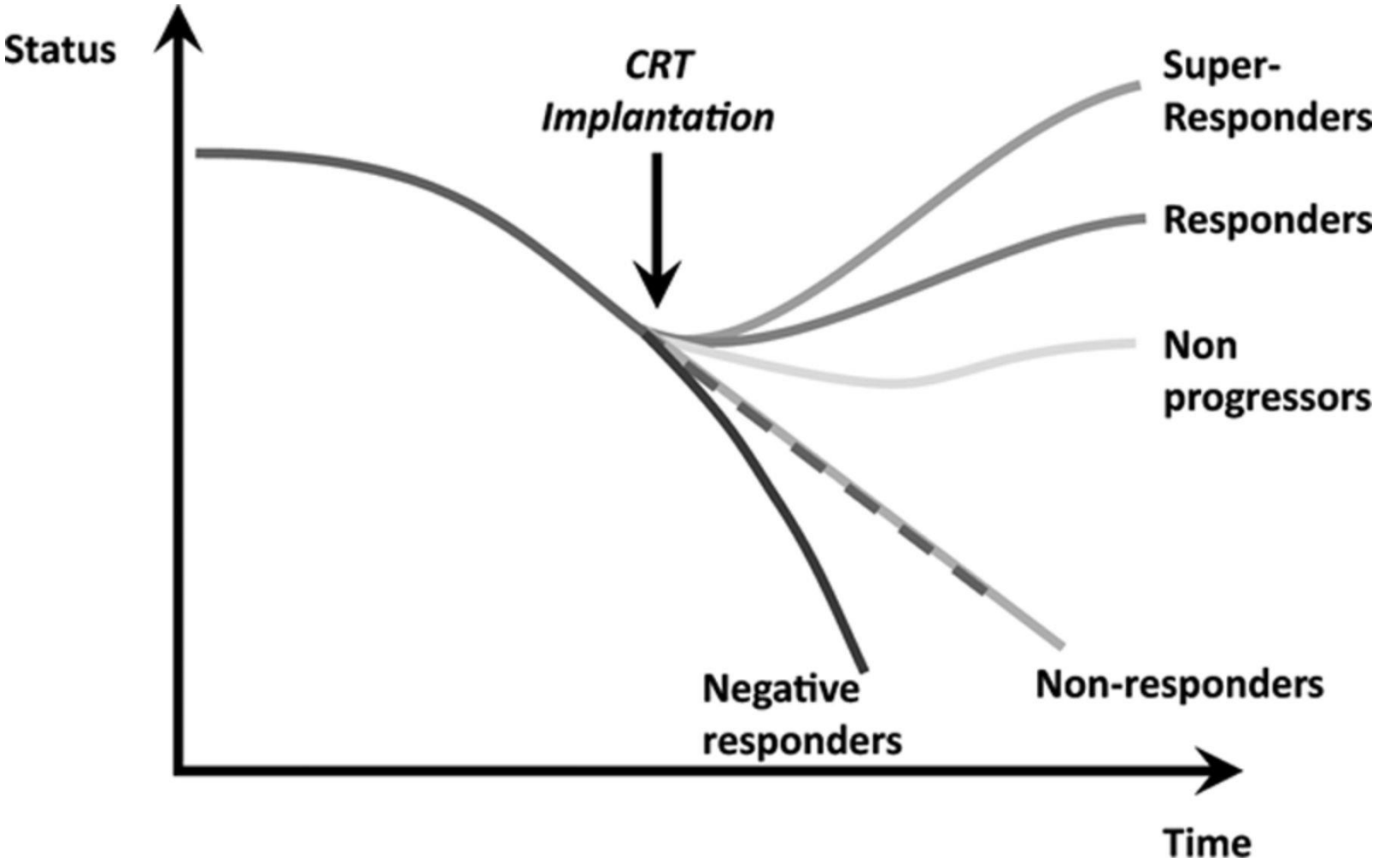
SZE E et al. JACC 2018

Universal definition of super response to CRT does not exist



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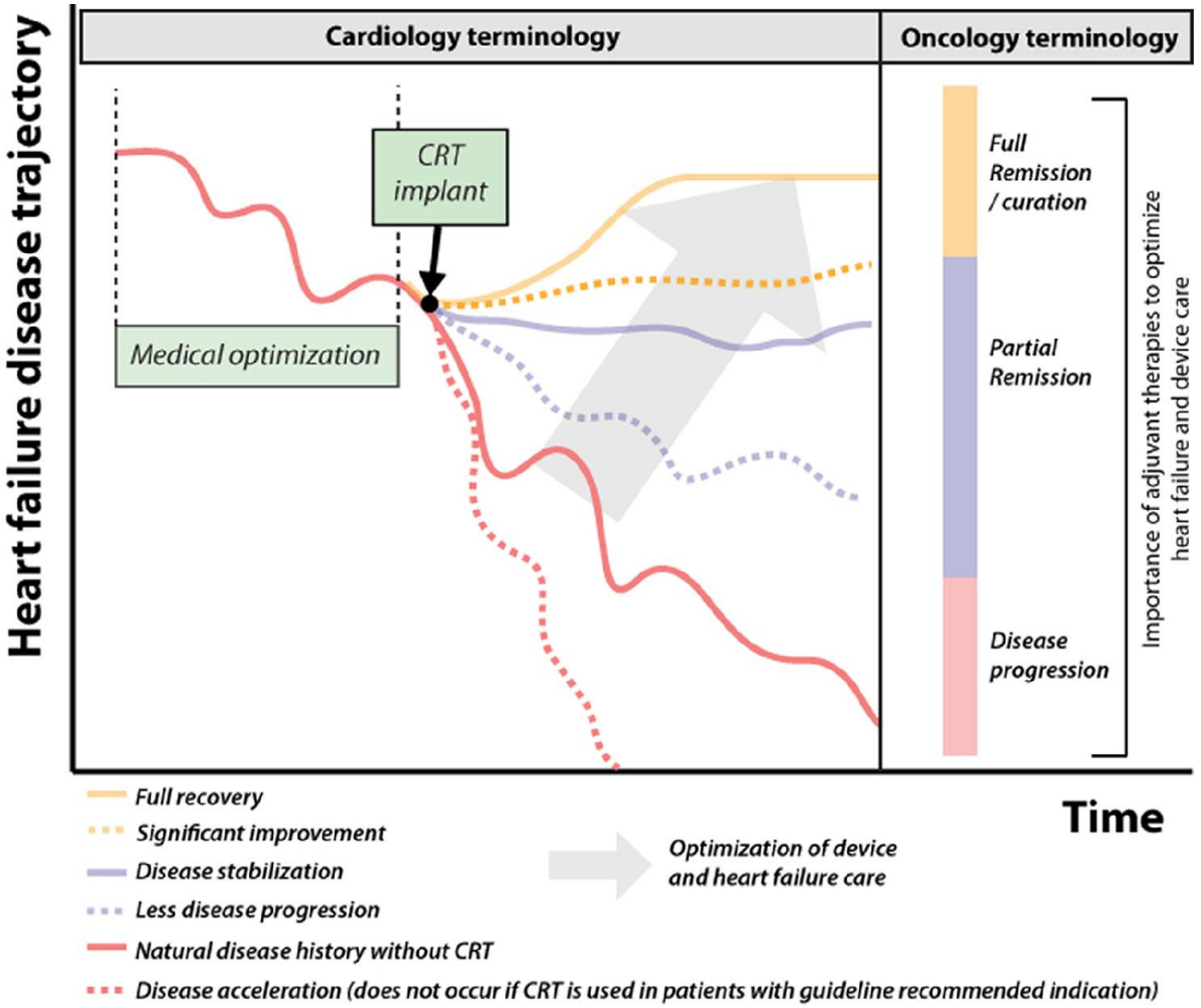
Steffel J, Ruschitzka F. Circulation 2014

Heart failure disease trajectory

Success of CRT must not be defined as the degree of reverse remodeling – but the grade of disease modification



Mullens W et al, EJHF 2020

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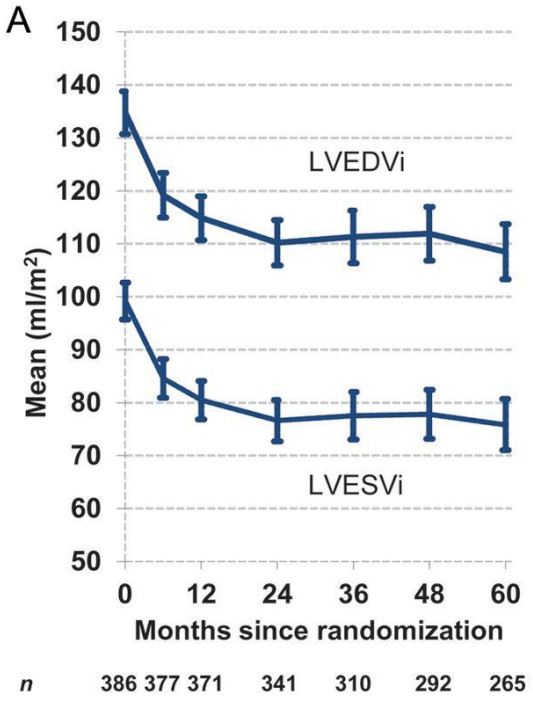
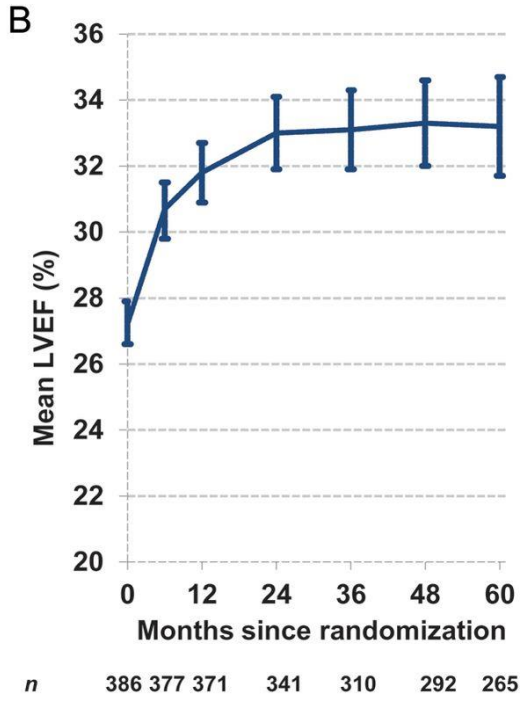
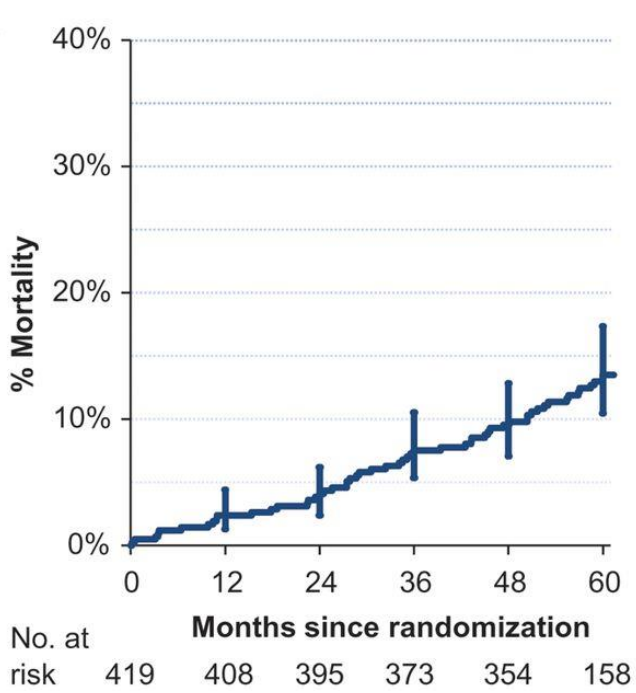
Even patients with “mild” HF seem to profit in the long term:

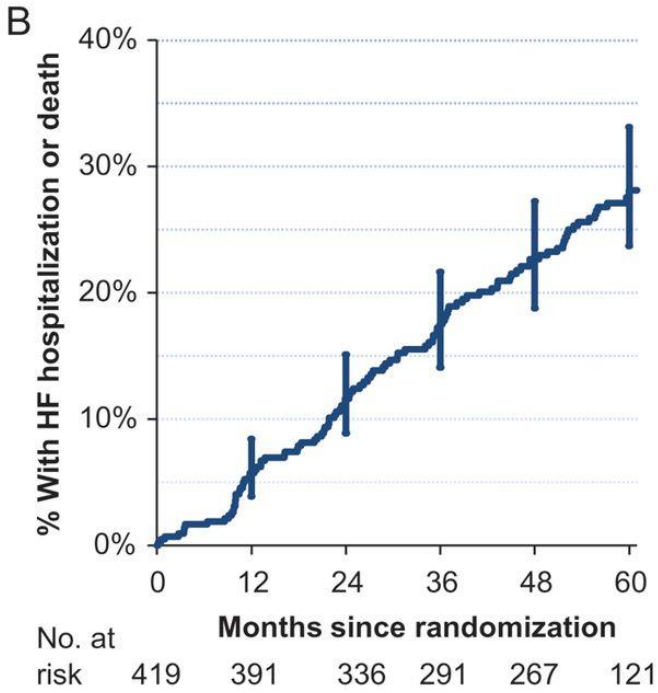
Pre-planned 5-year analysis from the REVERSE study (NYHA I and II EF < 40%)

CRT in addition to OMT with long-standing clinical benefits in “mild” HF









CRT in addition to optimal medical therapy produces long-standing clinical benefits

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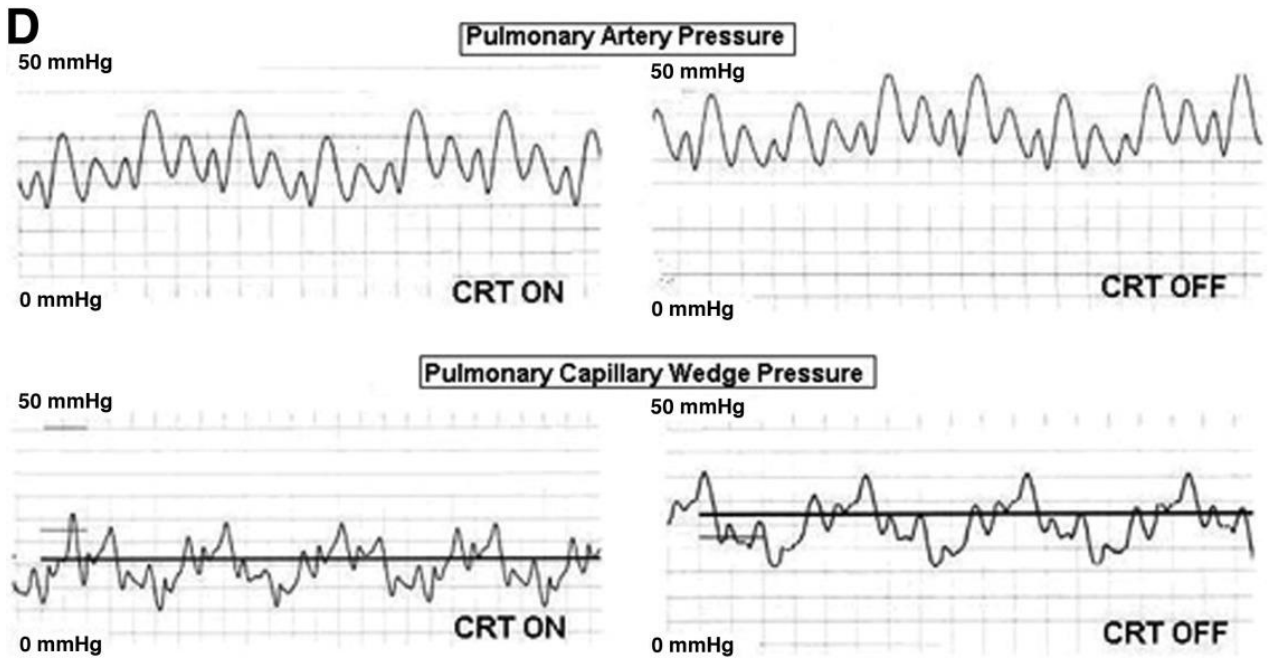
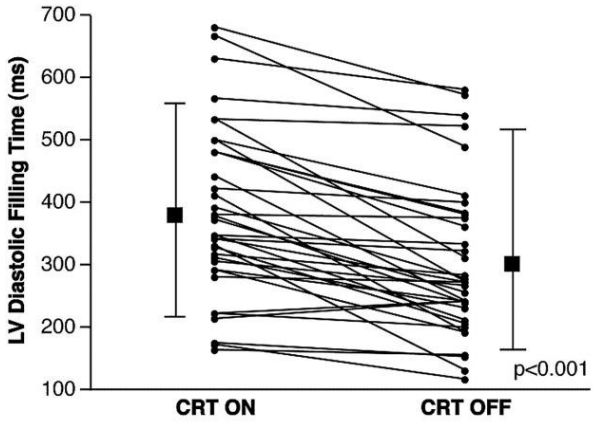
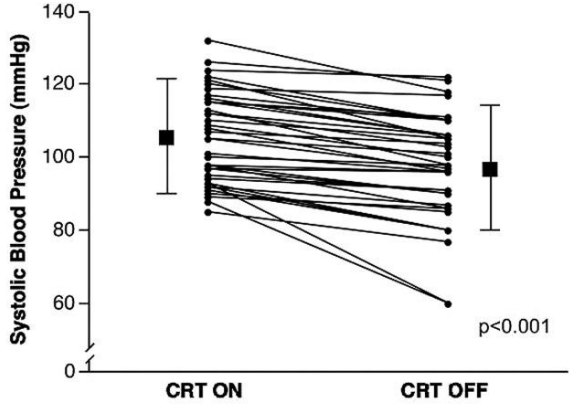
Linde C et al, EHJ 2013

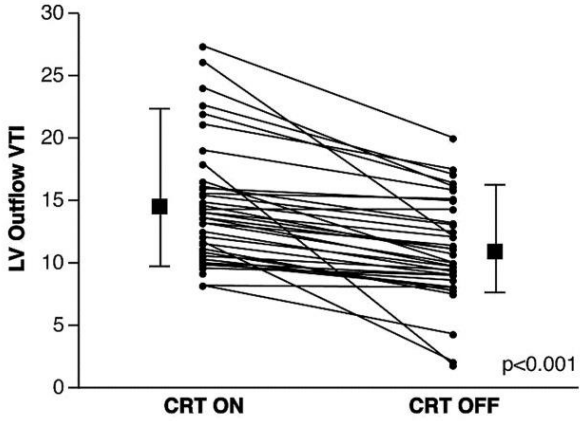
CRT in advanced heart failure?

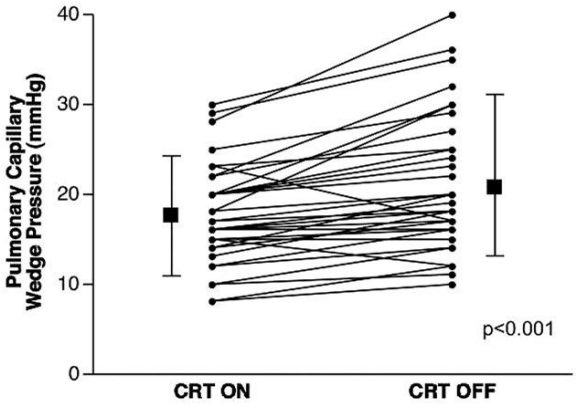
CRT provides persistent hemodynamic augmentation in the failing heart, despite adverse cardiac remodeling and decompensations

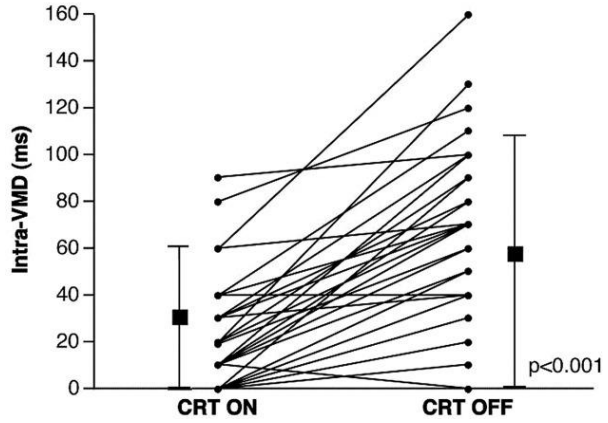


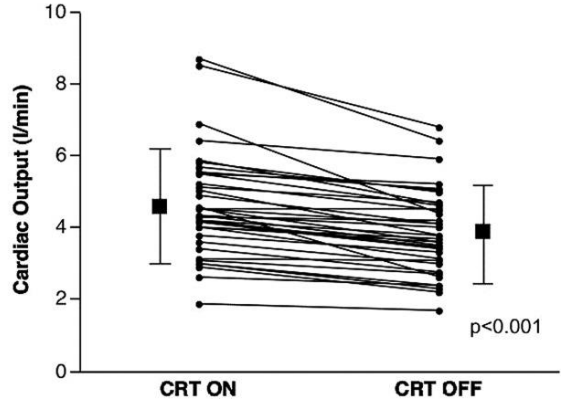












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Mullens et al, JACC 2009

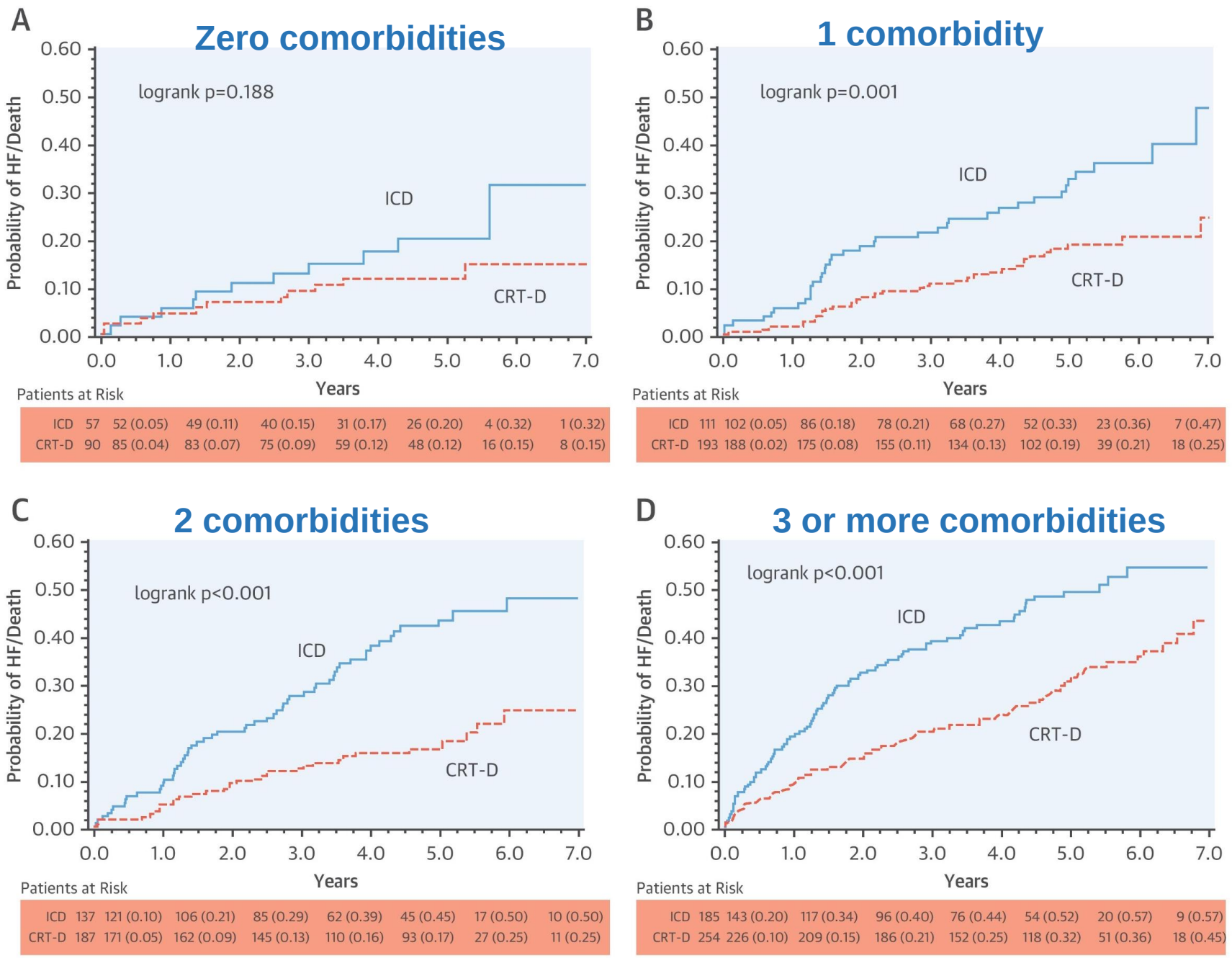
Barrier to referral and acceptance of implantation is the presence of comorbidities – However, CRT may be even more beneficial in comorbidities

Patients with comorbidities should not be denied CRT – relative risk reduction is same (MADIT-CRT)

Treatment Effect of CRT-D versus ICD in Comorbidity Groups

Comorbidities:
renal dysfunction, hypertension, diabetes, CAD, atrial arrhythmias, ventricular arrhythmias, smoking, cerebrovascular accident

Zeitler EP et al, JACC 2017



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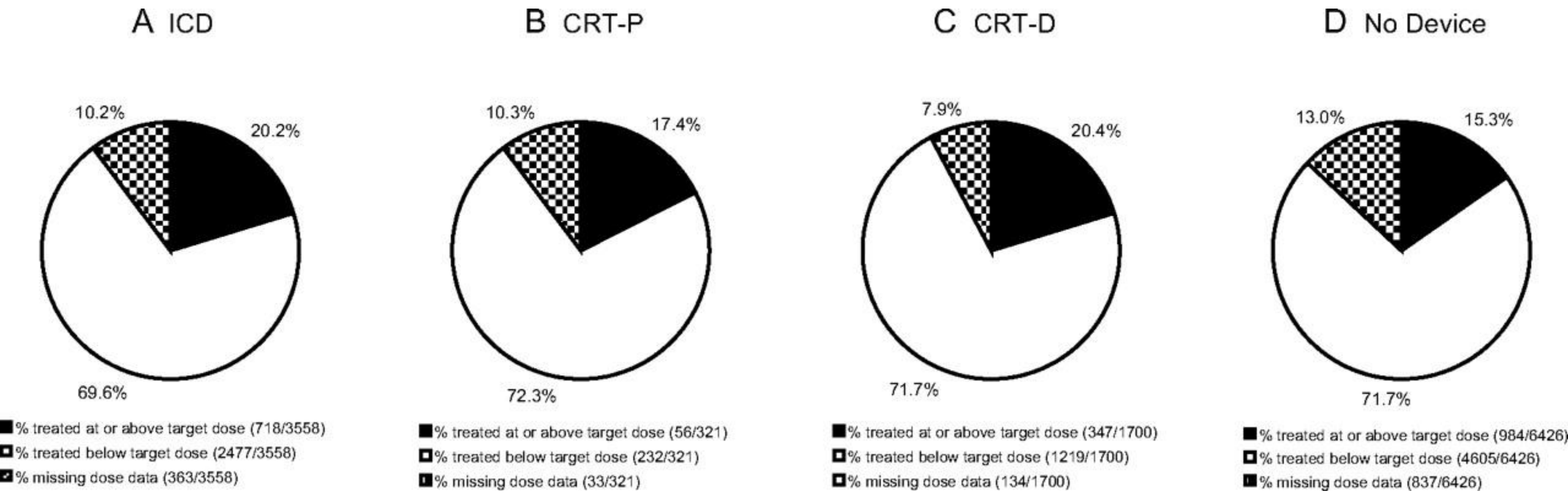
Implantation is not the end of care:

Drug titration and device optimization should be delivered by a multidisciplinary post-CRT team – the heart failure specialist should be in the lead

Rates for GDMT higher in patients with a CRT device – and - patients have higher probability to achieve recommended dose (IMPROVE-HF trial)



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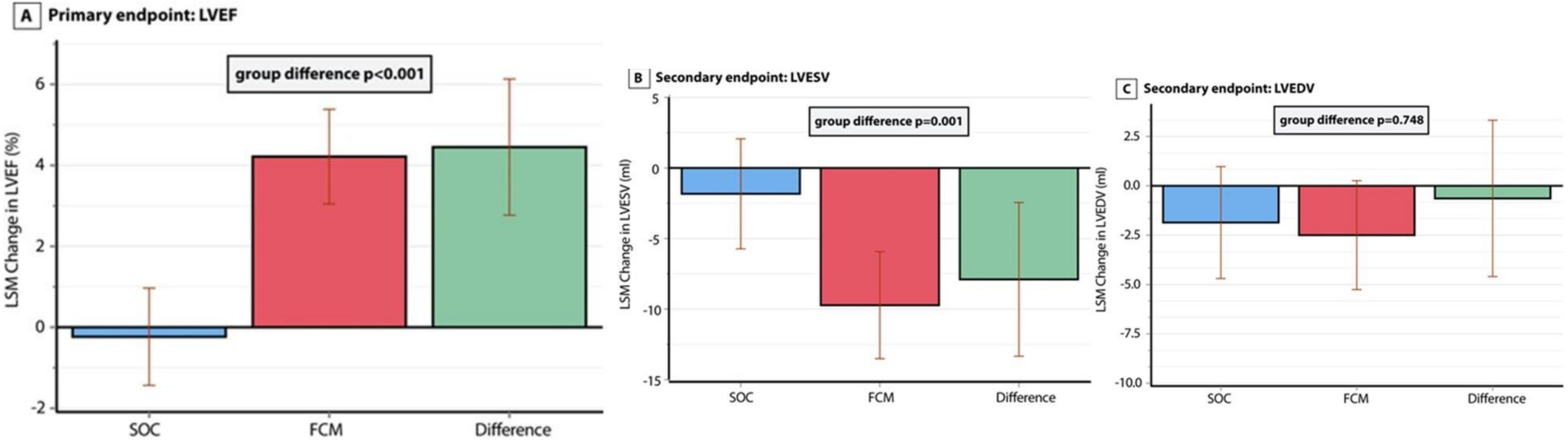
Heywood T et al, Circ HF 2010

Treatment with iv iron (ferric carboxymaltose) in HFrEF patients with iron deficiency and persistently reduced LVEF after CRT results in an improvement of cardiac function measured



Symptomatic HFrEF (n=75), iron deficiency, persistently reduced left ventricular ejection fraction (LVEF <45%) at least 6 months after cardiac resynchronization therapy (CRT) implant

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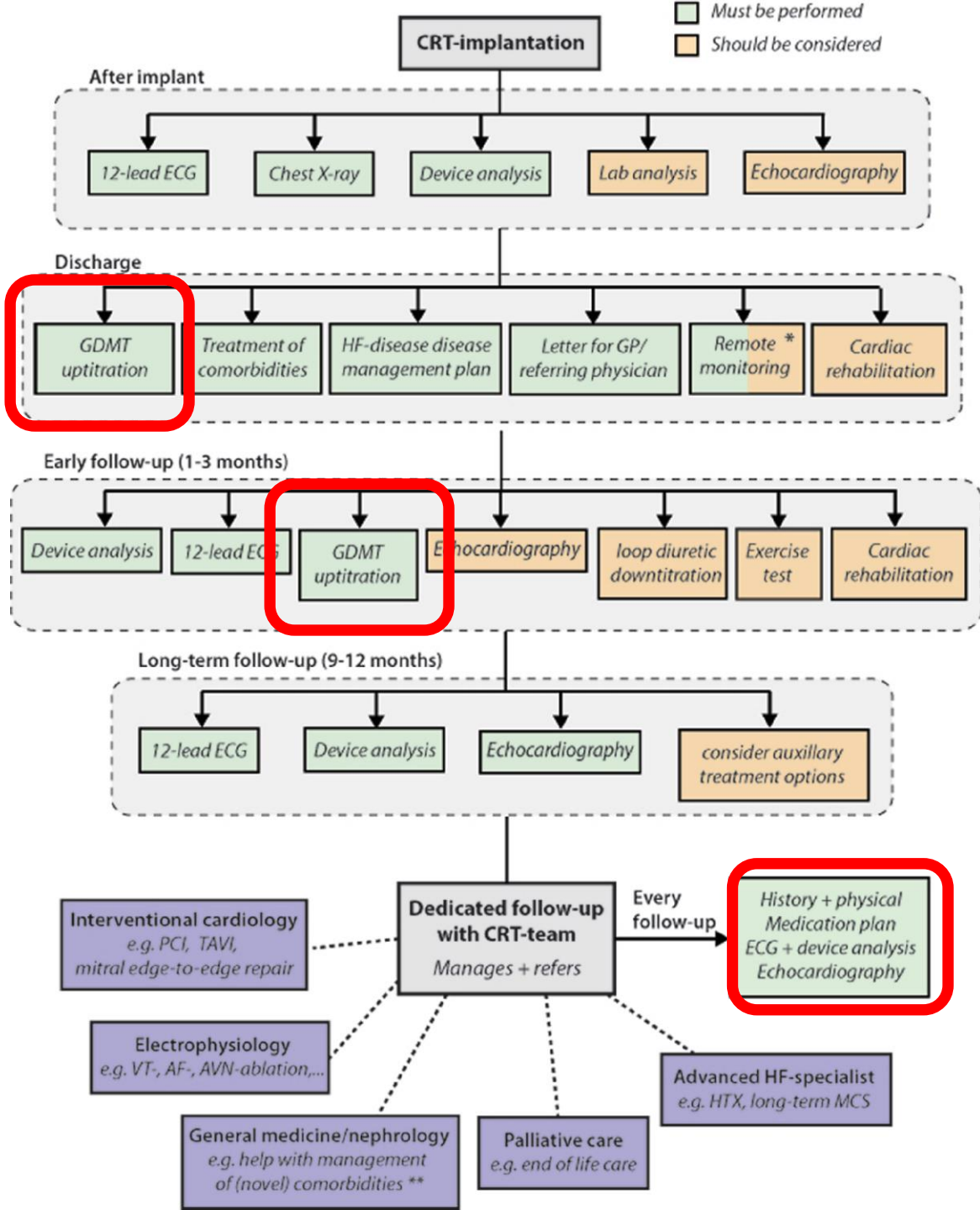
Martens P et al, EHJ 2021

Structured post-implant CRT care



Mullens W et al, EJHF 2020

Withdrawal of neurohumoral blockers in patients with normalized EF with CRT? STOP-CRT

Pilot trial of patients with normalized ejection fractions after CRT:

feasible to withdraw neurohumoral blockers in almost 2 of 3 subjects without observing changes in clinical condition, LV volume, and natriuretic peptides over a follow-up period of 2 years

Nijst P et al, JACC 2020

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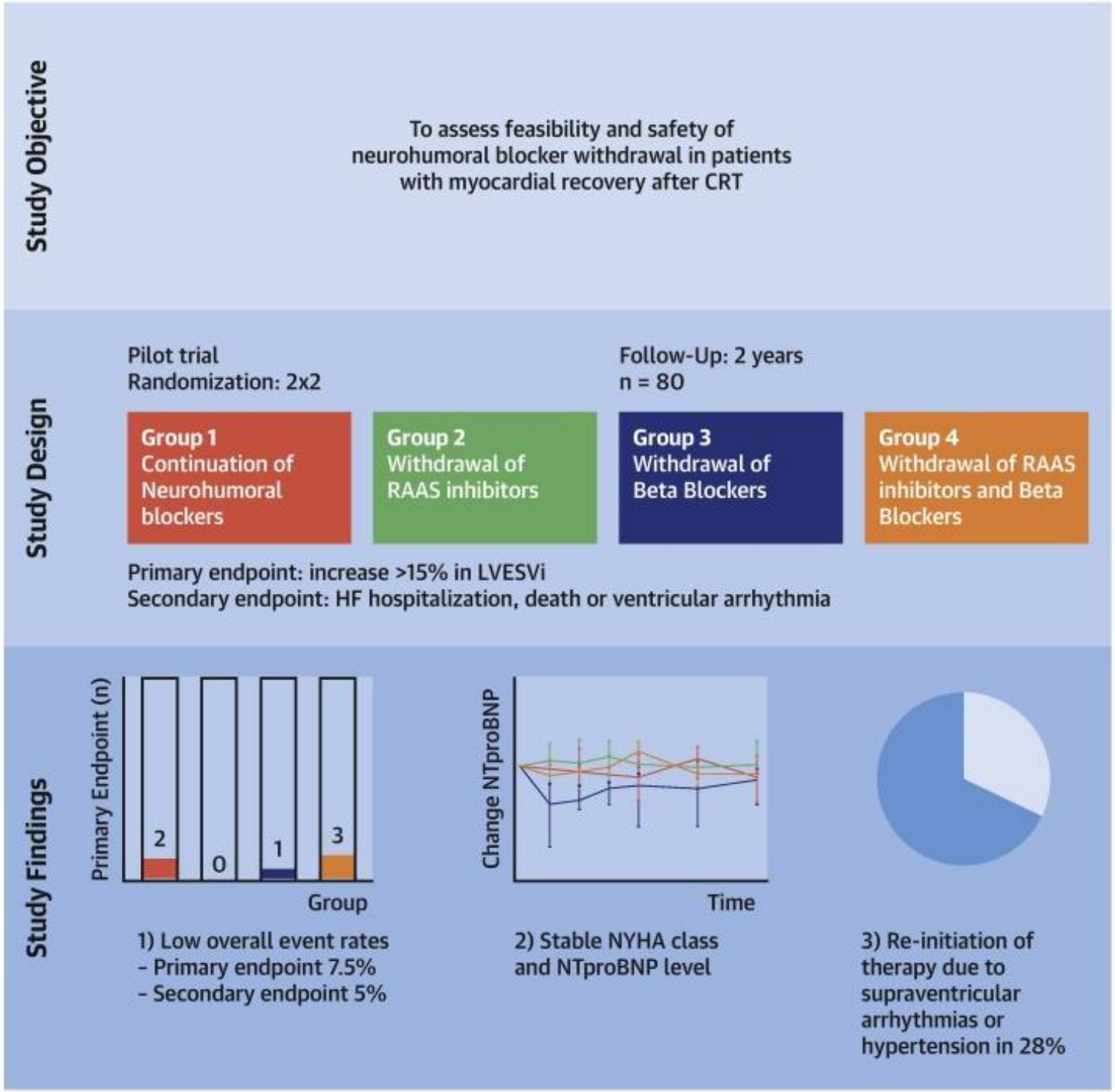

Strategies for better implementation
Summary of most important points

- **Increase awareness (even nowadays)**. Although evidence is robust (also in the long-term) and guidelines for implantation are straight forward, only about 1/3 of patients qualifying are receiving a CRT

- **Timing of implantation may be too late**. Only minority of patients in CRT trials were on OMT – and effects of these drugs on LVEF are less pronounced in LBBB. Furthermore, CRT helps to achieve OMT

- **CRT should be seen as a disease modifier** – concept of ”non-responder” is obsolete

- CRT: significant benefit in patients with **comorbidities**

- **Post-implant care** is essential – Up-titration of GDMT

- **CRT is a heart failure d**evice. Patient care should be in the hand of heart failure specialists

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Table 1 Myths and strategies for better implementation

Common myths of CRT	Explanation
Myths related to the pre-implant phase of CRT	
30% of patients do not respond to CRT	CRT response has been classified by arbitrary definitions: its effect in any one individual should be seen as continuous disease modification and whilst they may not feel 'better', they are highly likely to be 'better than without the device'.
Patients with an ischaemic aetiology of heart failure benefit less from CRT	On average, patients with an ischaemic aetiology of heart failure manifest less reverse remodelling but have an equal relative risk reduction after CRT for heart failure admission and death as the non-ischaemic group.
If the QRS is narrow, patients will never have an indication for CRT	In patients with HFrEF, remodelling of the left ventricle is accompanied by electrical remodelling such that QRS duration lengthens. Follow-up ECG is necessary. Consideration should be given to those with poor LVEF and a pacing indication that will lead to high proportion of RV pacing.
CRT is an expensive therapy	CRT is a cost-effective heart failure therapy.
Consideration of CRT should only occur after repeated (failed) attempts to achieve guideline-recommended doses of RAASi and beta-blockers	Only a minority of patients included in CRT trials were on optimal doses of RAASi and beta-blockers, and the effects of these drugs on LVEF improvement are far less pronounced in LBBB than in narrow QRS. CRT can help achieve guideline-recommended doses.
Patients with multiple comorbidities derive no benefit of CRT	Patients with comorbidities derive significant benefit from CRT, especially when the comorbidities are addressed. The need for CRT-D should be dealt with openly in this population.
All patients should receive CRT-D	The benefit of the ICD is determined by the risk of sudden cardiac death over the risk of non-sudden cardiac death. Those at highest risk of heart failure death derive no benefit from an ICD.
Physicians know when to refer patients for CRT	Most patients are only referred within cardiology. The non-cardiology medical and allied health community and patients need education to improve referral.
Echocardiography should be used as a technique to select patients that will not respond to CRT	Echocardiography is poor at determining 'need' or 'response' to CRT. Patients should not be denied CRT based upon echocardiography.
Access to CRT is not an issue as CRT implantation can be done by everyone who can implant a DDD pacemaker	CRT implant does have a higher risk, and does require more training than conventional DDD pacemakers. Efforts should be made to increase access.
Myths related to the post-implant phase of CRT	
Optimization of CRT is only needed in non-responders	Ideally, all CRT patients should receive regular review of their heart failure therapy, which should include a review of medical treatment (including drug doses) and device programming. Not only is heart failure a progressive disease, such that adjustments can be of benefit, but recent and future developments in medical therapy should be applied to this group as rapidly as possible.
Patients on CRT are on optimal medical therapy	Only a minority are on optimal dosages of GDMT at the moment of implant, more than 60% can be further up-titrated after CRT
Out of the box device programming suffices in most CRT patients	All CRT patients should receive regular (at least annual) device checks and might need optimization of device settings (brady/tachy) by physicians specifically trained in cardiac device programming and troubleshooting.
Remote monitoring is not useful	Comprehensive remote monitoring including device/lead integrity, % of biventricular pacing and arrhythmias in CRT patients has been demonstrated to improve clinical outcome in at least one randomized trial with tightly controlled review and action systems in place. Regular device checks (at least once per year) remain important in patients undergoing remote monitoring.

Mullens W et al, EJHF 2020

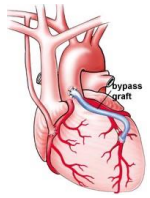
(R)evolution of heart failure treatment

Drugs, Devices, Interventions

Palliative Drugs | **Neurohormonal Drugs** | **Devices** | **ARNI** | **SGLT-2 Inhibitors**

Pre-1980 → 1980s → 1990s → 2000s → 2010s → 2015 → 2020

Digitalis
Diuretics



ACE-I

β-Blockers

ICDs

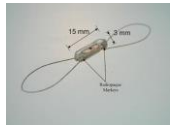
Transplantation

CABG

LVAD

CRT, CRT-D

MR-Antagonists



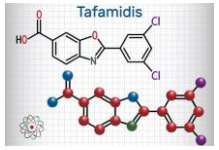
Sensing Devices

Ivabradine

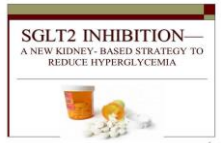
Iron

Mitraclip

ARNI



Tafamidis



SGLT-2 Inhibitors

Afib Ablation

Telemonitoring

VICTORIA

Vericiguat

USZ Universitäts Spital Zürich

Ruschitzka / Flammer

Thank you for your attention

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Strategies for better implementation

- See CRT as a disease modificator
- equal risk reduction in ischemic vs. non-ischemic HF
- Patient with narrow QRS may change to wide QRS – monitor
- CRT is cost-effective
- only minority of patients in CRT trials were on OMT – and effects of these drugs on LVEF are less pronounced in LBBB. CRT helps to achieve OMT
- patients with comorbidities: significant benefit

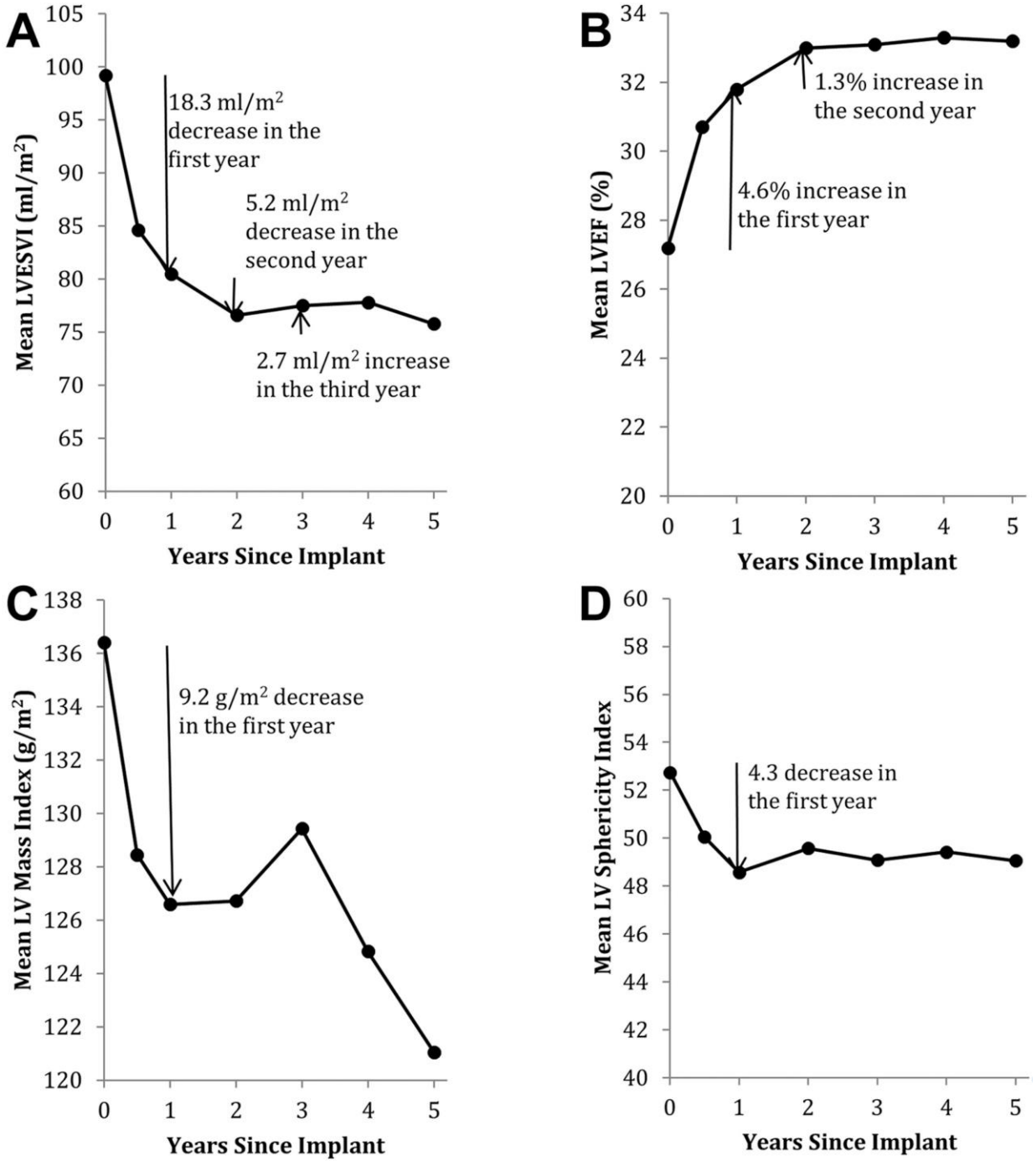
Common myths of CRT	Explanation
Myths related to the pre-implant phase of CRT	
30% of patients do not respond to CRT	CRT response has been classified by arbitrary definitions: its effect in any one individual should be seen as continuous disease modification and whilst they may not feel 'better', they are highly likely to be 'better than without the device'.
Patients with an ischaemic aetiology of heart failure benefit less from CRT	On average, patients with an ischaemic aetiology of heart failure manifest less reverse remodelling but have an equal relative risk reduction after CRT for heart failure admission and death as the non-ischaemic group.
If the QRS is narrow, patients will never have an indication for CRT	In patients with HFrEF, remodelling of the left ventricle is accompanied by electrical remodelling such that QRS duration lengthens. Follow-up ECG is necessary. Consideration should be given to those with poor LVEF and a pacing indication that will lead to high proportion of RV pacing.
CRT is an expensive therapy	CRT is a cost-effective heart failure therapy.
Consideration of CRT should only occur after repeated (failed) attempts to achieve guideline-recommended doses of RAASi and beta-blockers	Only a minority of patients included in CRT trials were on optimal doses of RAASi and beta-blockers, and the effects of these drugs on LVEF improvement are far less pronounced in LBBB than in narrow QRS. CRT can help achieve guideline-recommended doses.
Patients with multiple comorbidities derive no benefit of CRT	Patients with comorbidities derive significant benefit from CRT, especially when the comorbidities are addressed. The need for CRT-D should be dealt with openly in this population.
All patients should receive CRT-D	The benefit of the ICD is determined by the risk of sudden cardiac death over the risk of non-sudden cardiac death. Those at highest risk of heart failure death derive no benefit from an ICD.
Physicians know when to refer patients for CRT	Most patients are only referred within cardiology. The non-cardiology medical and allied health community and patients need education to improve referral.
Echocardiography should be used as a technique to select patients that will not respond to CRT	Echocardiography is poor at determining 'need' or 'response' to CRT. Patients should not be denied CRT based upon echocardiography.
Access to CRT is not an issue as CRT implantation can be done by everyone who can implant a DDD pacemaker	CRT implant does have a higher risk, and does require more training than conventional DDD pacemakers. Efforts should be made to increase access.

Mullens W et al, EJHF 2020

Greater penetration of the therapy

- Education of primary care and secondary care physicians, nurses and allied professionals
- Misconception of hampering referral is the definition of ‘response» – success of CRT must not be defined as the degree of reverse remodeling – but the grade of disease modification
- Stabilization must also be considered of success
- Best way to assess response: decrease in hospitalization, improvement in QoL and survival
- Important barrier to referral and acceptance of implantation: presence of comorbidities – CRT is beneficial in comorbidities
- Implantation is not the endo of the pathway: post CRT care to make the most of the opportunity and drug titration and device optimization should be delivered by a multidisciplinary post-CRT team

change in LV architecture in patients with mild HF with CRT is associated with structural and functional remodeling



St. John SM et al, JACC HF 2017

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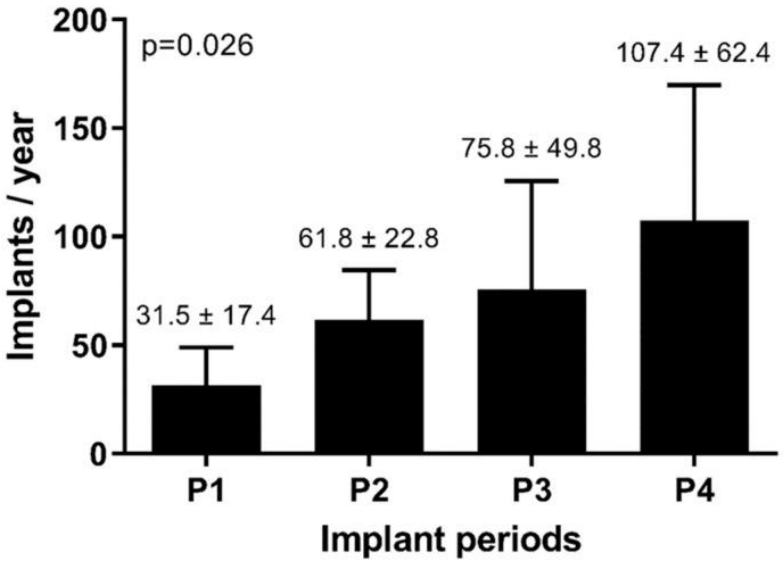
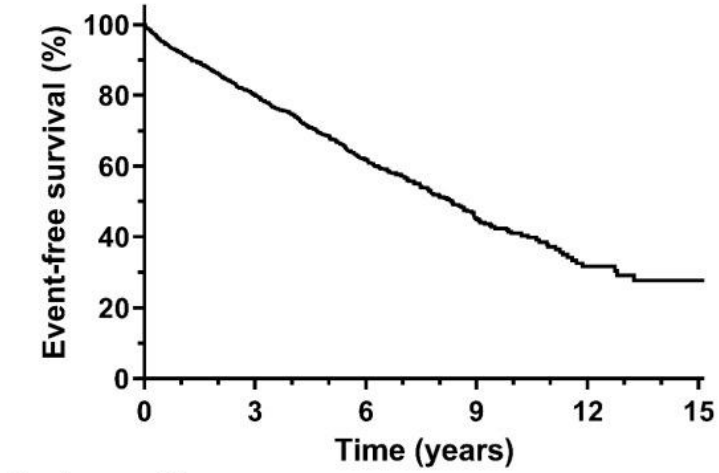
Evolution of CRT implantation in a Real-world registry of 2275 patients
Despite pharmaceutical and technological innovations, an adjusted regression analysis revealed stable overall survival over time

- first period (P1) from the start of the registry (30 November 2000) to the publication of the MADIT-CRT findings on 1 October 2009.
- Second period (P2) extended from the release of MADIT-CRT until the 2013 ESC pacing and CRT guidelines (25 June 2013).
- third period (P3) from the publication of the 2013 ESC guidelines to the publication of the 2016 ESC guidelines on 20 May 2016.
- The fourth, (P4) time span from the 2016 ESC guidelines to the last patient included on 31 December 2019

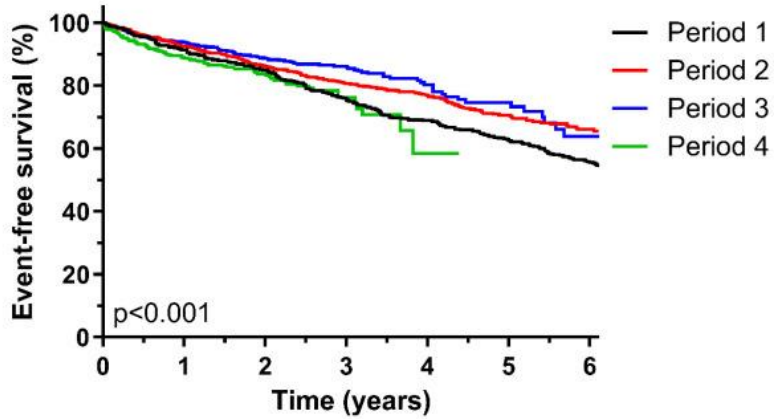


(a)



Numbers at risk

2275	1122	379	115	32	4	



Numbers at risk

Period 1	429	388	361	322	289	262	225
Period 2	692	631	586	505	362	249	132
Period 3	661	583	431	233	113	58	22
Period 4	493	347	195	62	6	0	0

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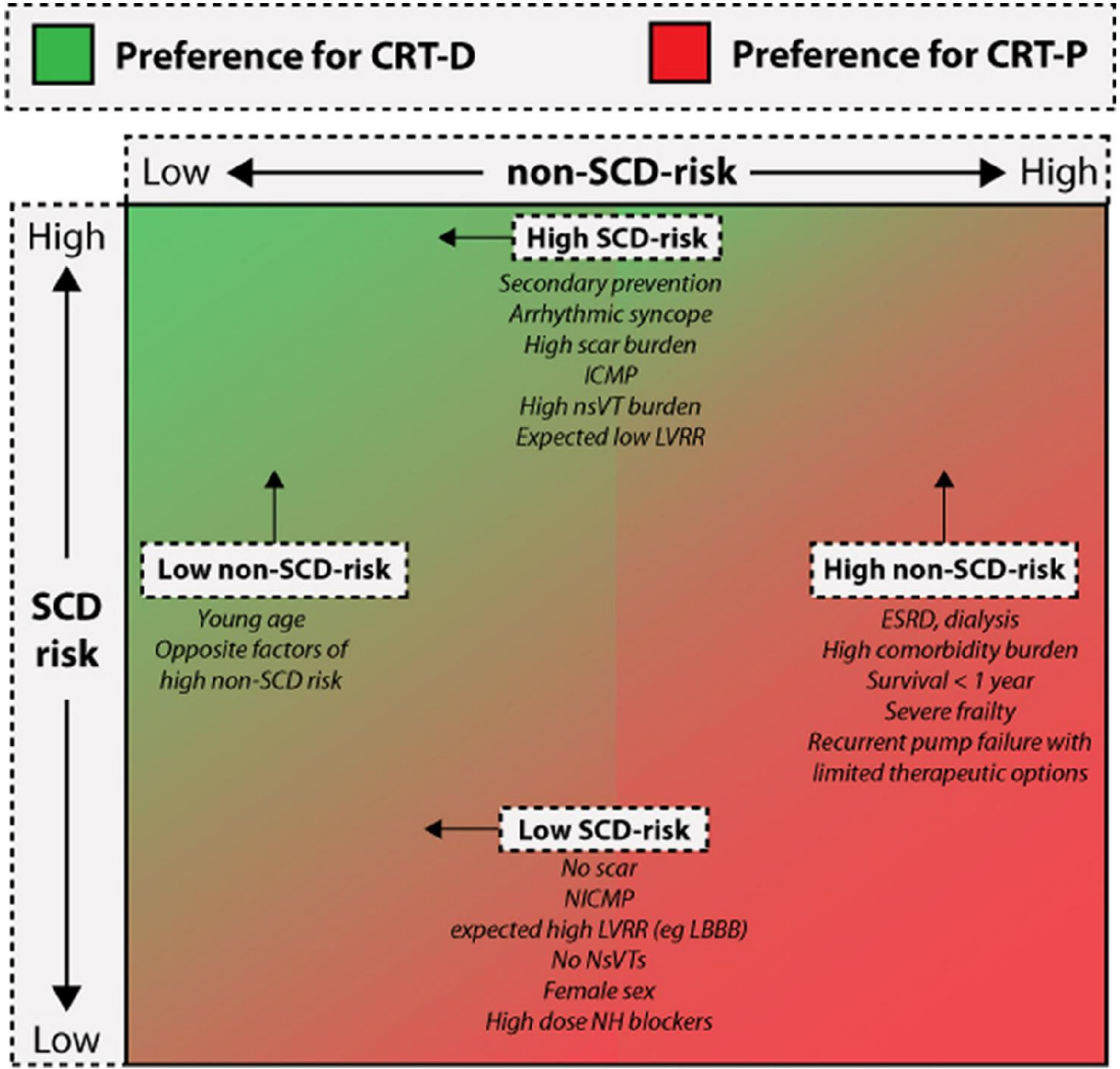
Bijnens J et al, J Clin med. 2024

Individualizing CRT-P vs. CRT-D



Mullens W et al, EJHF 2020

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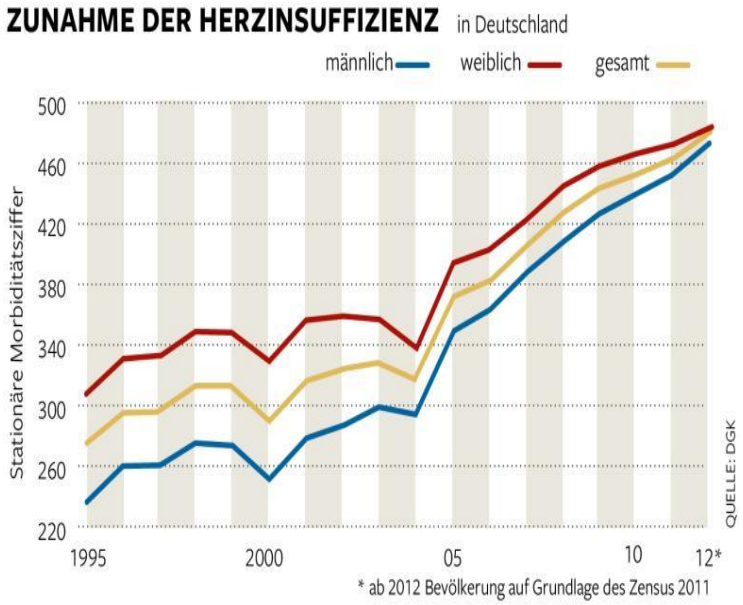
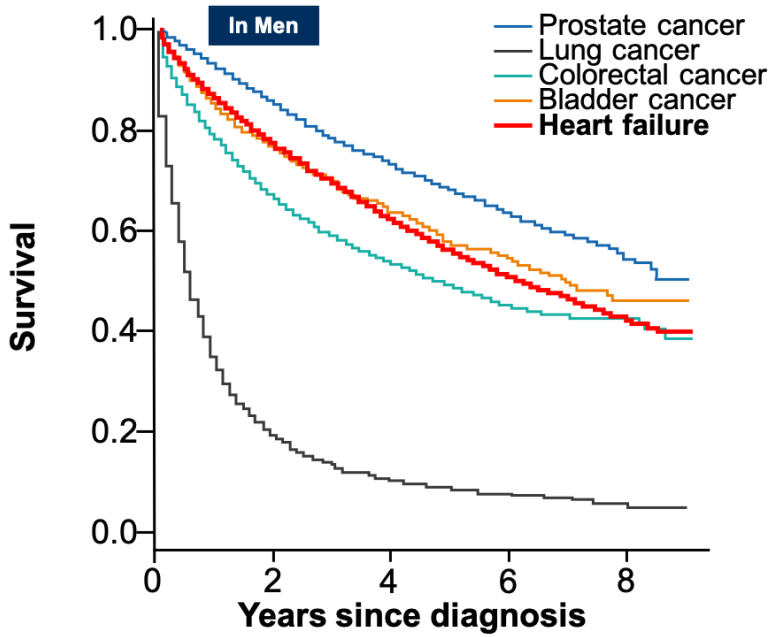
Herzinsuffizienz
die häufigste, tödlichste und teuerste aller Herzerkrankungen

Prävalenz Herzinsuffizienz nimmt zu. 3-4% in der CH, ca. 300‘000 Patienten



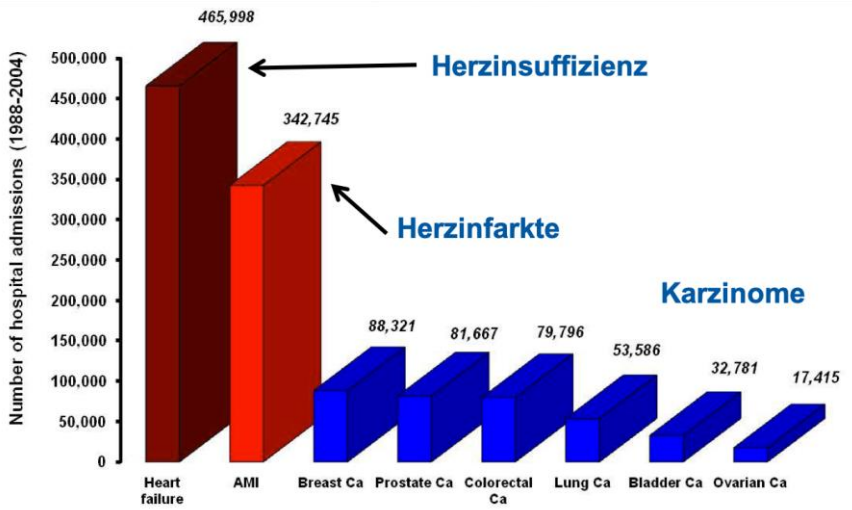
Statistisches Bundesamt

Prognose ist ähnlich wie bei häufigen Karzinomen



Mamas MA. et al. *EJHF* 2017

Führt zu mehr Hospitalisationen als Infarkte oder Tumore



Stewart, Ekman et al Circ CV Outcomes 2010

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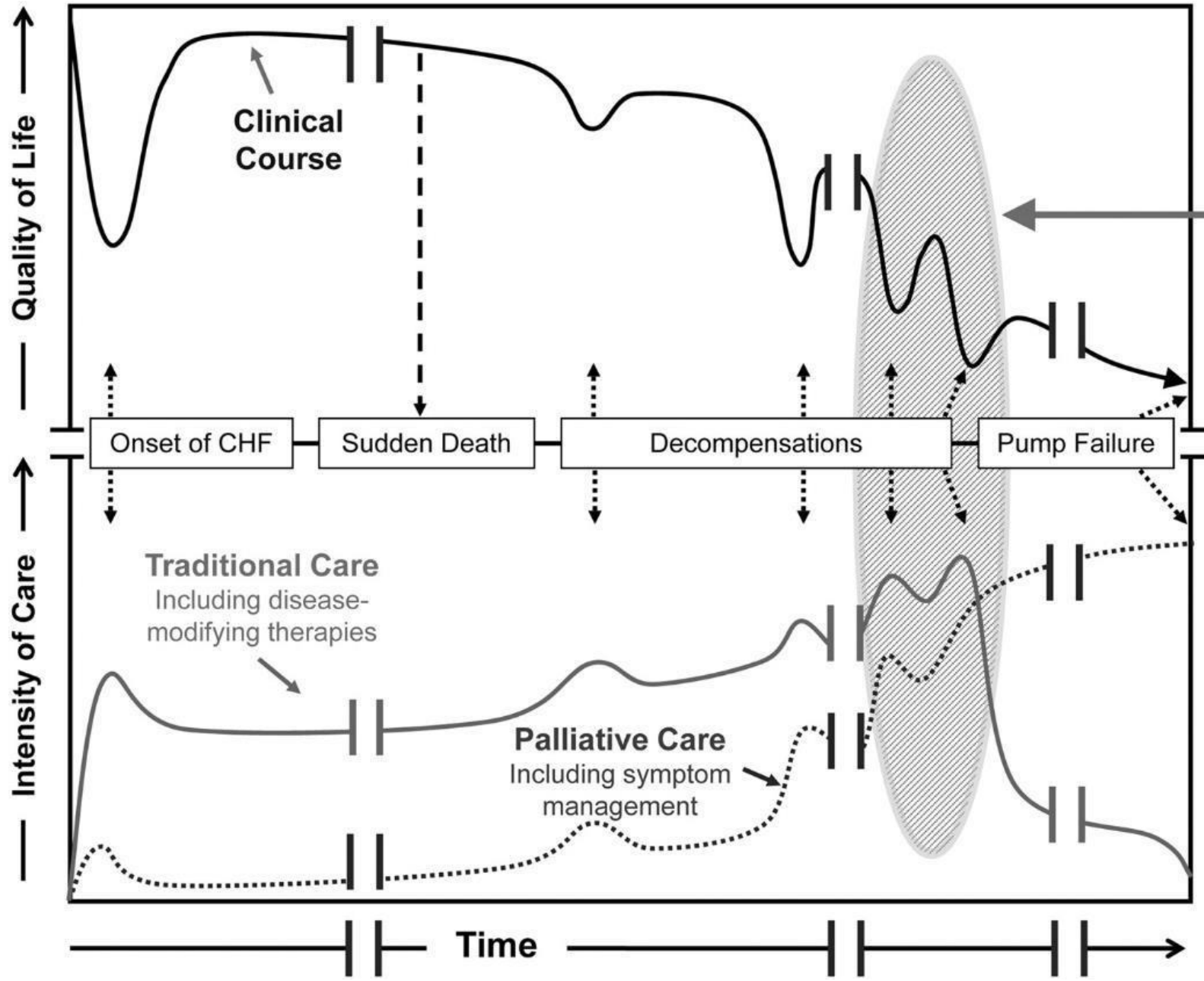
Heart Failure Natural History



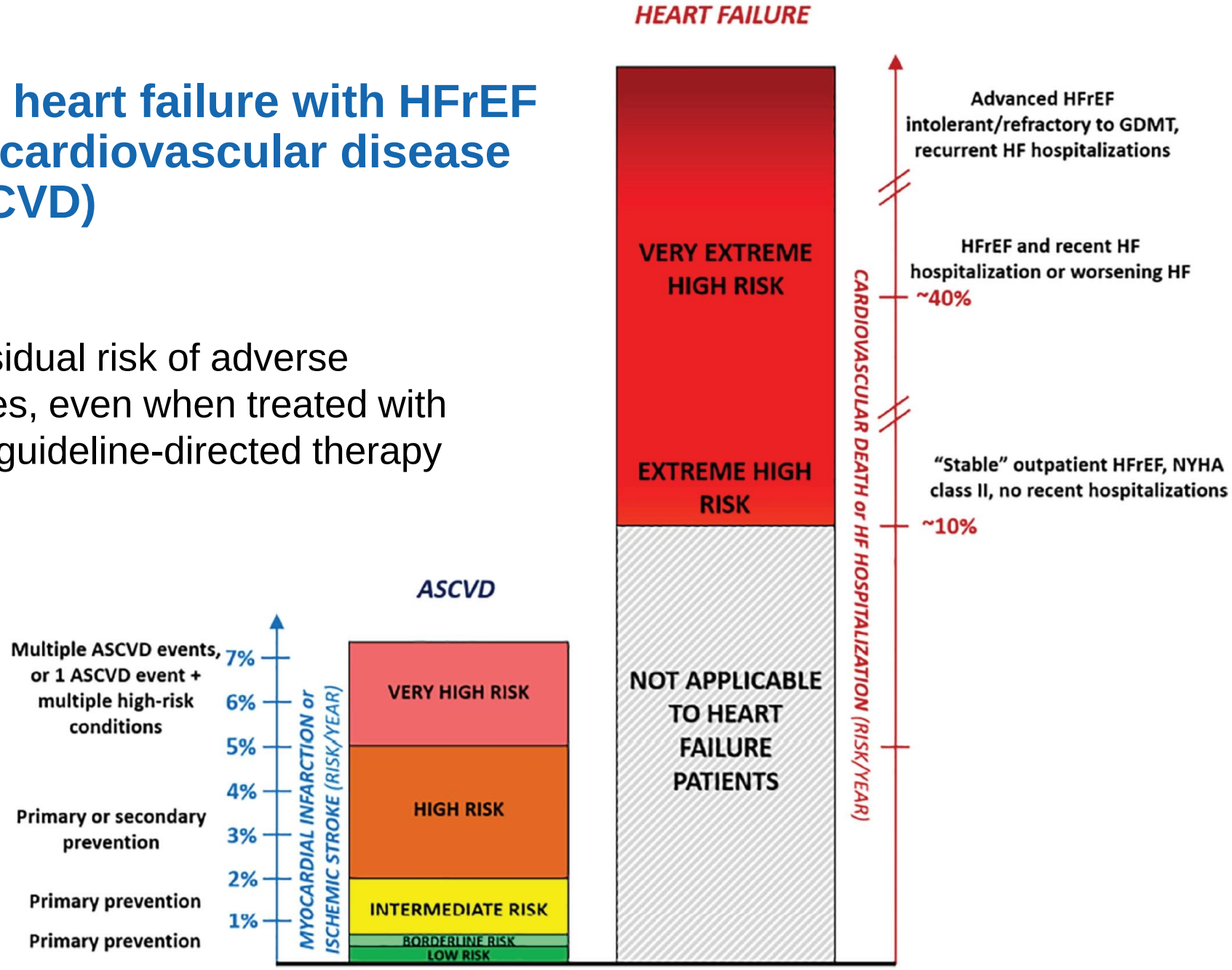
Transition to Advanced Heart Failure:

- Oral therapies failing
- A time for many major decisions
- Consider MCS and/or transplantation, if eligible
- Consider inversion of care plan to one dominated by a palliative approach, which may involve formal hospice

Allen et al. Circulation 2012

The risk associated with heart failure with HFrEF versus atherosclerotic cardiovascular disease (ASCVD)

High residual risk of adverse outcomes, even when treated with optimal guideline-directed therapy



Butler J et al. EHJF 22

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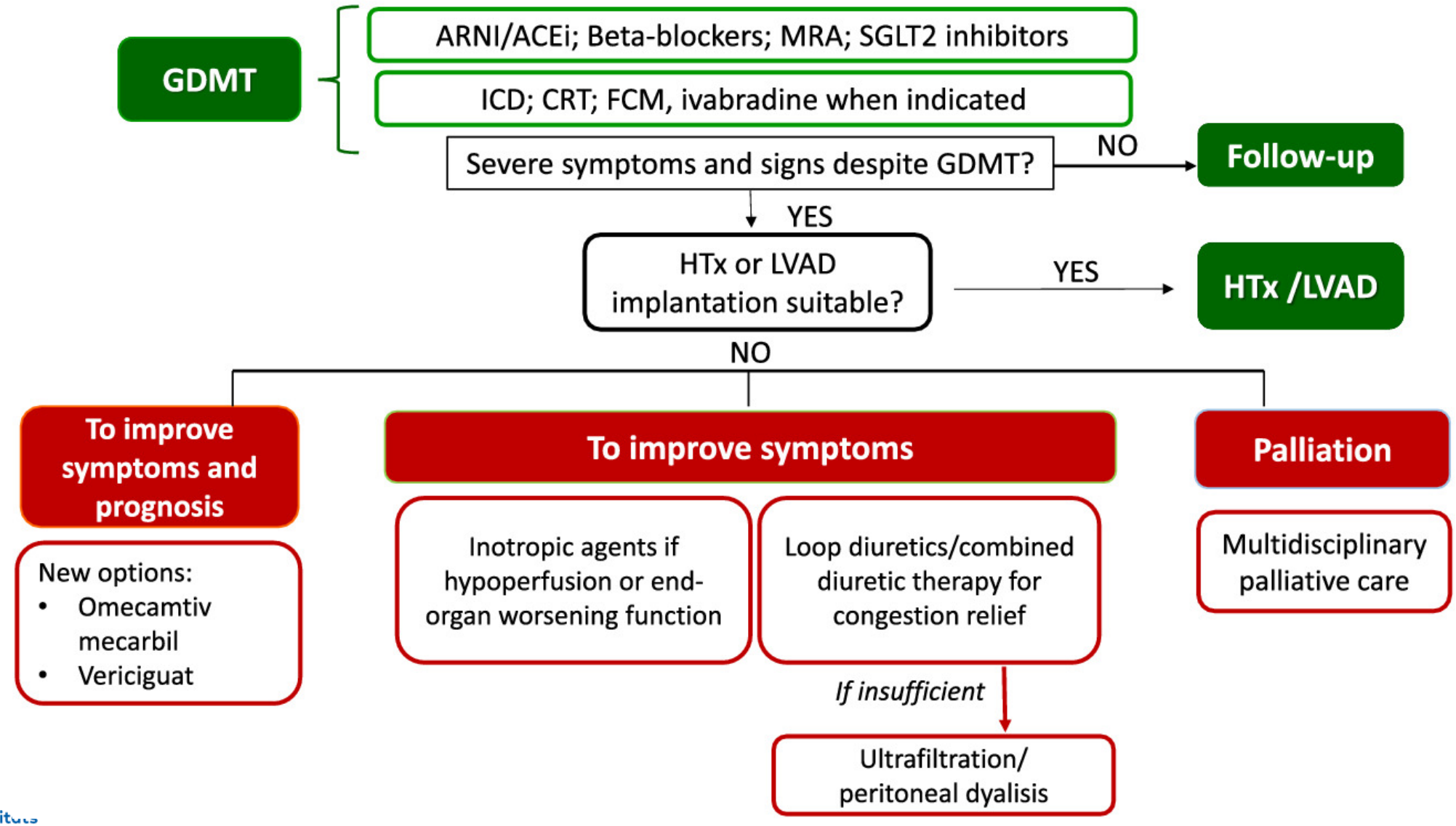
Management of advanced HFrEF patients



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Tomasoni D et al, ESC Heart Failure 2022

(R)evolution der Herzinsuffizienz-Behandlung

Medikamente, Devices und Interventionen

Palliative Drugs

Neurohormonal Drugs

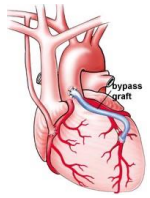
Devices

ARNI

SGLT-2 Inhibitors

Pre-1980 | 1980s | 1990s | 2000s | 2010s | 2015 | 2020

Digitalis
Diuretics



ACE-I

β-Blockers

Transplantation

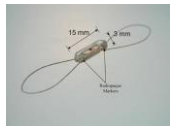
CABG

ICDs

LVAD

CRT, CRT-D

MR-Antagonists



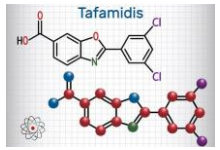
Sensing Devices

Ivabradine

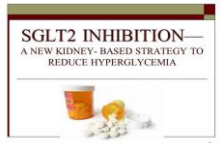
Iron

Mitraclip

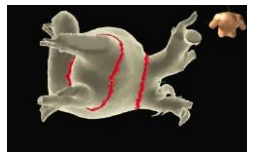
ARNI



Tafamidis



SGLT-2 Inhibitors



Afib Ablation

Telemonitoring

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Vericiguat

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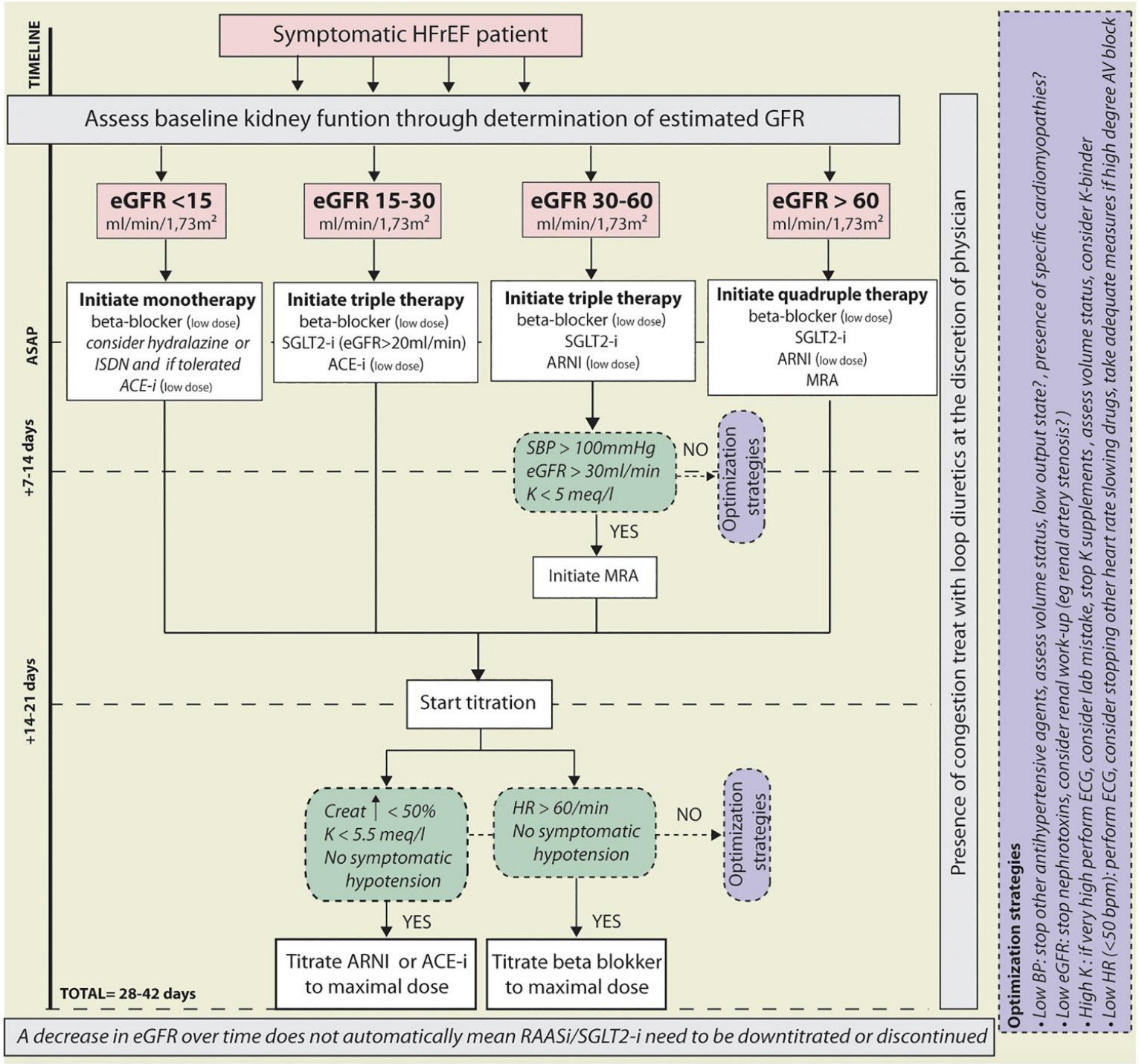
Titration of HFrEF medication according to GFR

Starkt

- if GFR>60: quadruple therpy
- if GFR 30-60: triple therapy (BB, SGLT2, ARNI), if BP good and GFR>30 add MRA in a 2. stepp
- if GFR 15-30: triple trerapy (BB, SGLTS, ACEI low dose)
- if GFR<15: monotherapy (BB)

Titration

- if creatine increases less then 50%, potassium <5.5 and no symptomatic hypotension: titrate ARNI or ACEI
- if HR >60% and no symptomatic hypotensin: titrate Beta-Blocker



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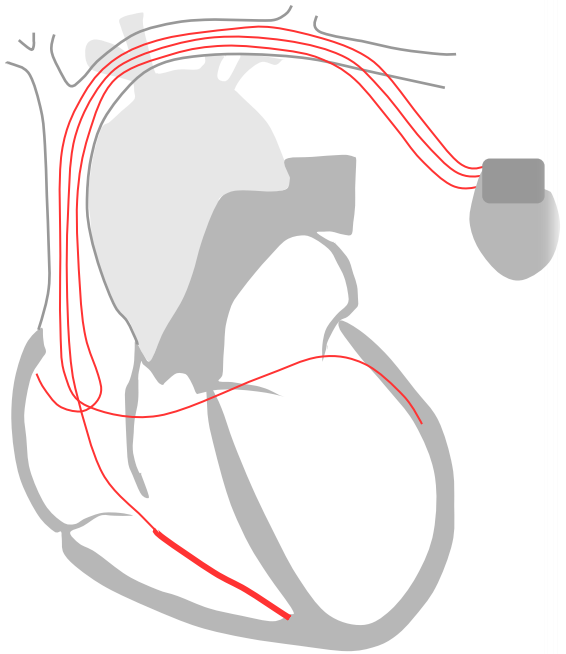
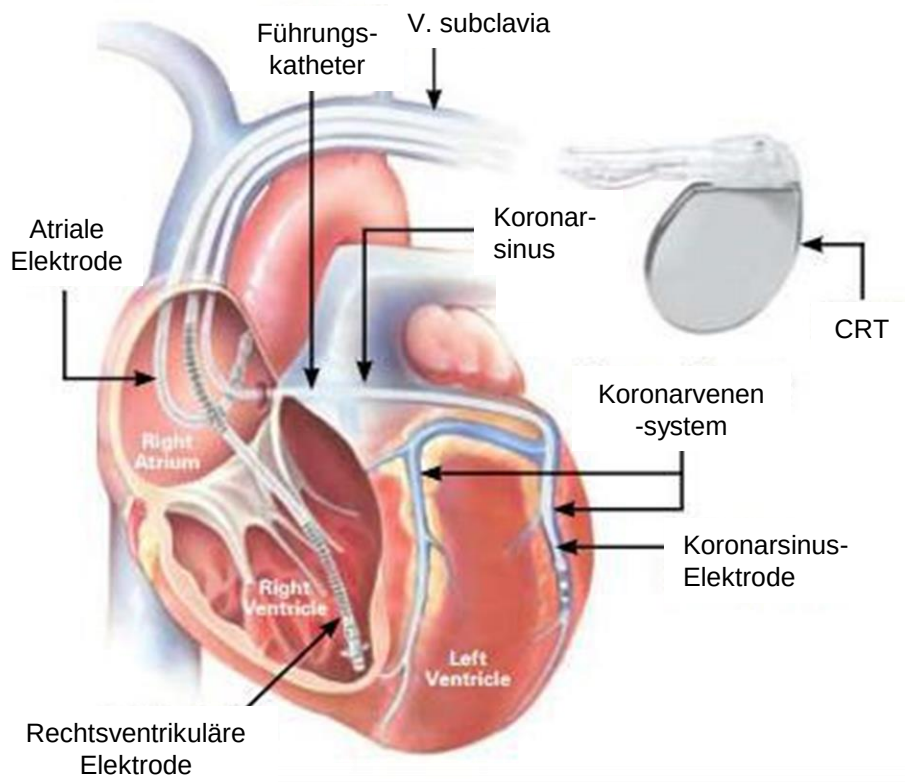
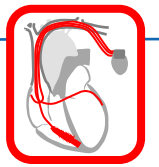
Mullens W et al, EJHF 2022

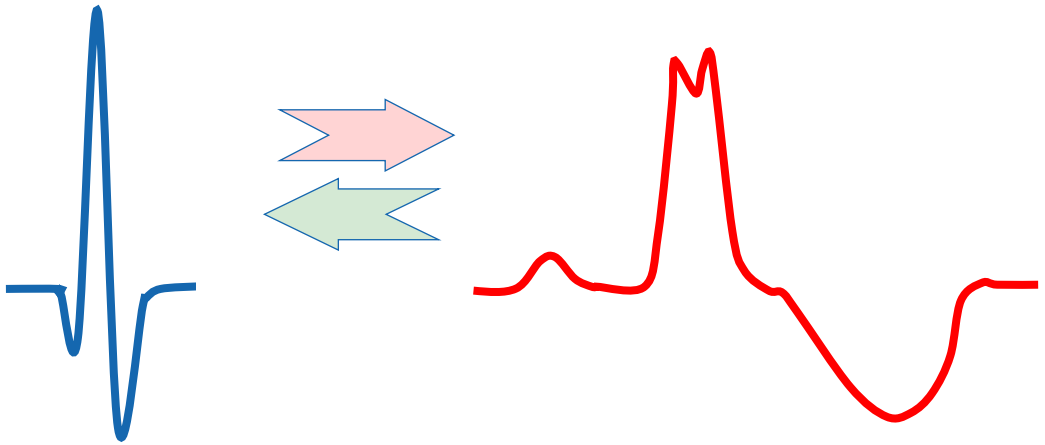
Cardiac Implantable Electronic Devices - CRT



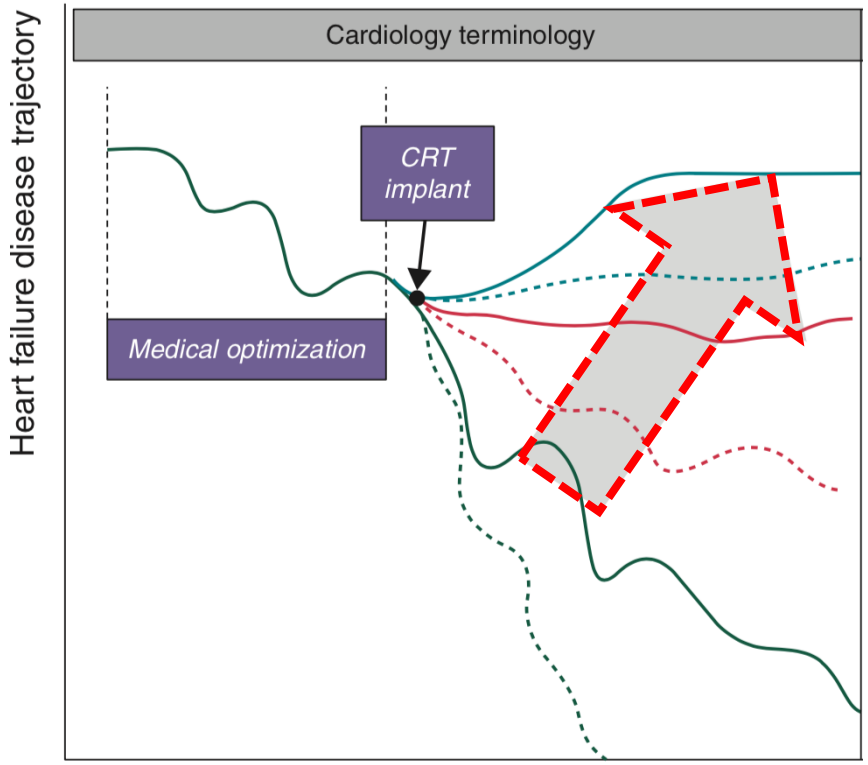


Cardiac Implantable Electronic Devices - CRT





Cardiac Implantable Electronic Devices - CRT



- *Full recovery*
- *Significant improvement*
- *Disease stabilization*
- *Less disease progression*
- *Natural disease history without CRT*

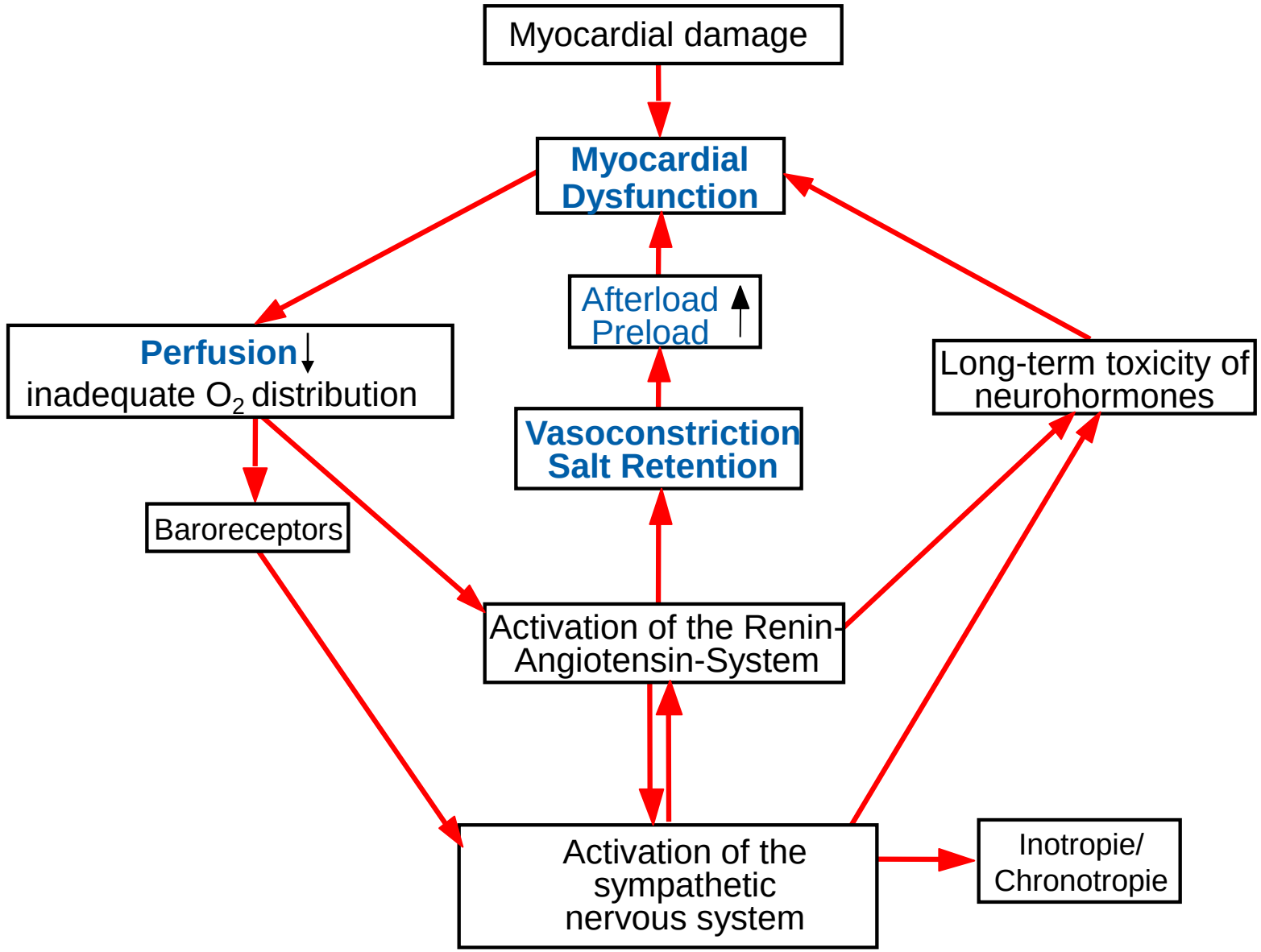
→ *Optimization of device and heart failure care*

Qualitative post-implant management can influence the disease course !

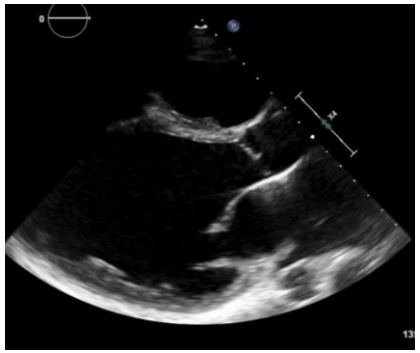
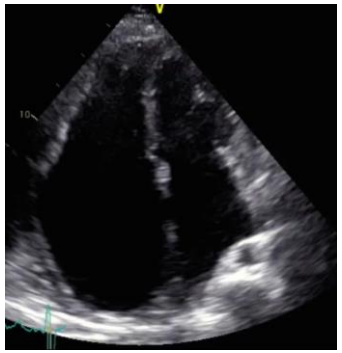
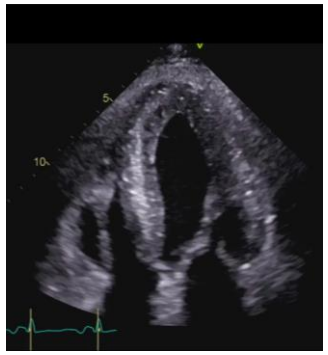
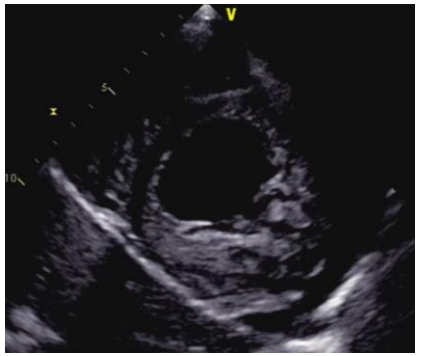
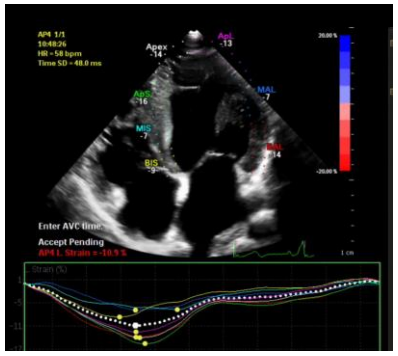
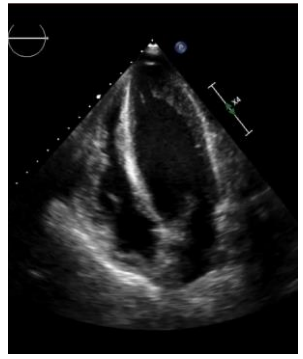
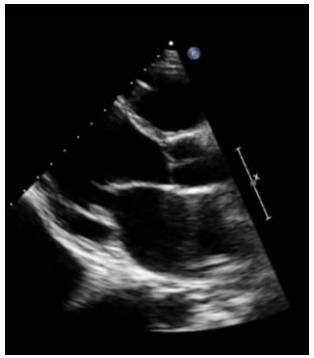
Neurohormonal mechanisms of heart failure (HFrEF)

Through the **failing power** of the heart, the body reacts as if blood loss happens:

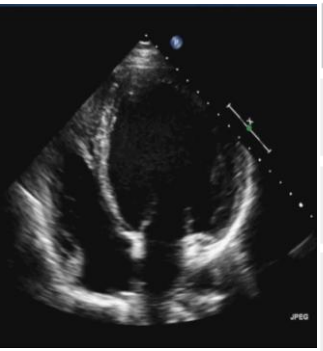
Volume retention occurs, although enough volume actually is there



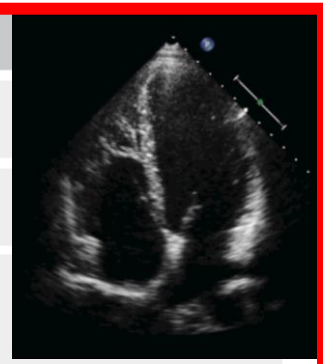
Herzinsuffizienz ist ein klinisches Syndrom, unabhängig von der Ätiologie

Behandlung basiert auf dem LVEF Phänotyp
HFmrEF - > «mildly reduced»

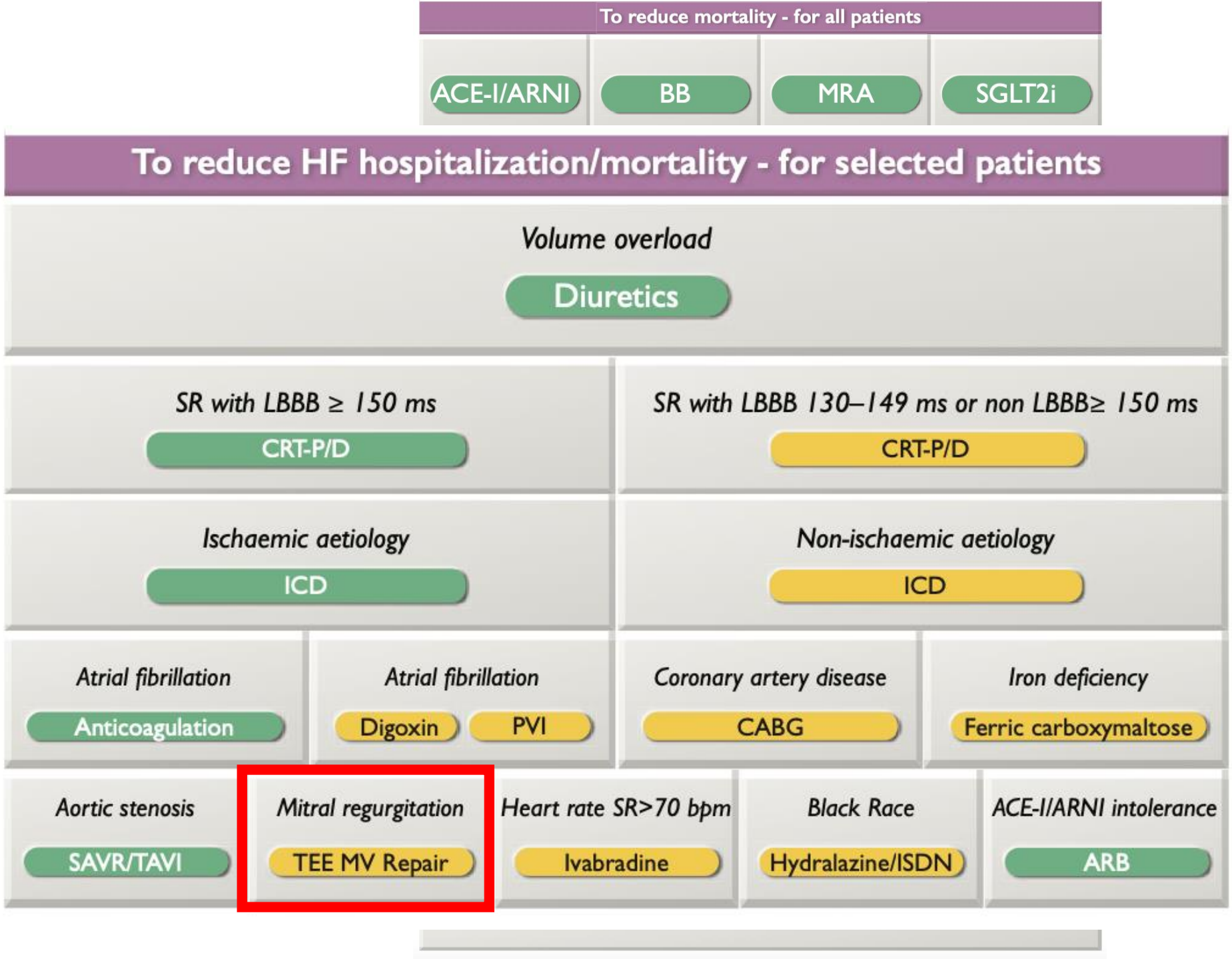


HFrEF	HFmrEF	HFpEF
Symptoms ± Signs[a]	Symptoms ± Signs[a]	Symptoms ± Signs[a]
LVEF ≤40%	LVEF 41–49%[b]	LVEF ≥50%
–	–	Objective evidence of cardiac structural and/or functional abnormalities consistent with the presence of LV diastolic dysfunction/raised LV filling pressures, including raised natriuretic peptides[c]



Algorithm for the treatment of HFrEF

„selected patients“



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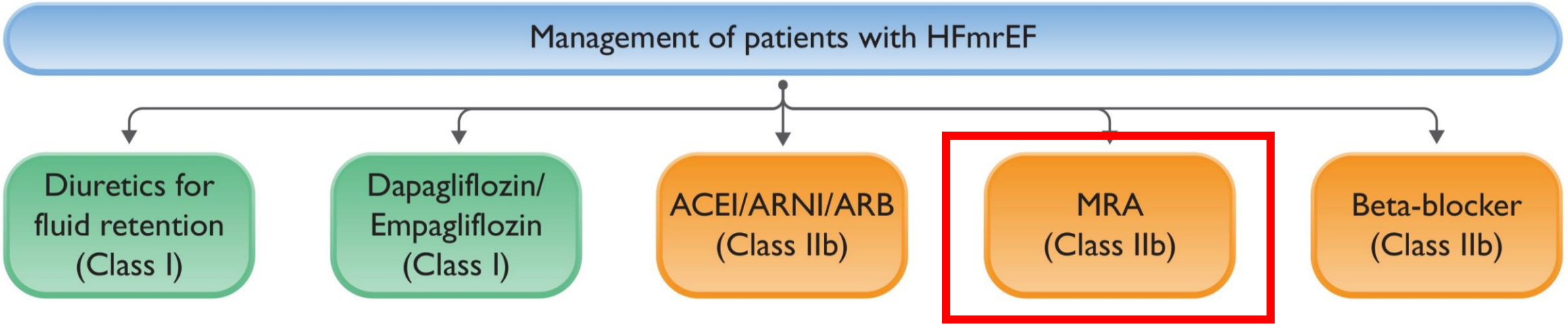
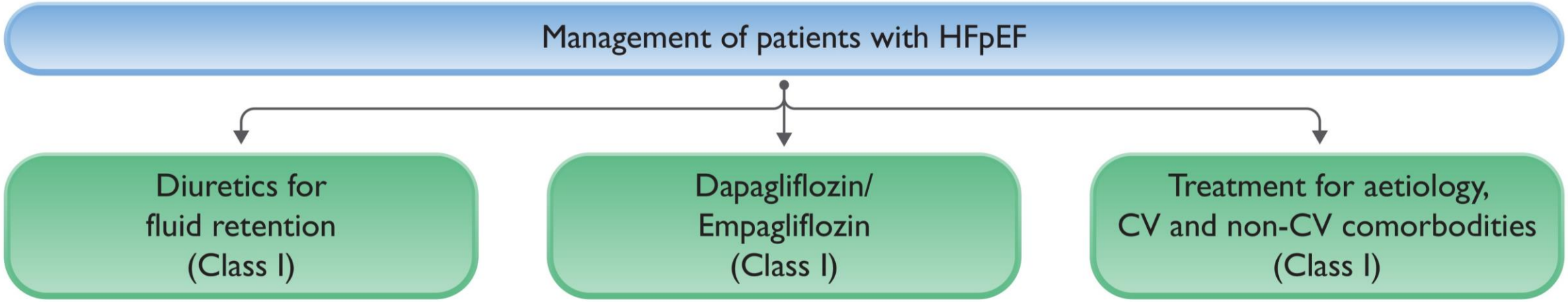
Treatment of HFmrEF – Update 2023



Treatment of HFpEF – Update 2023

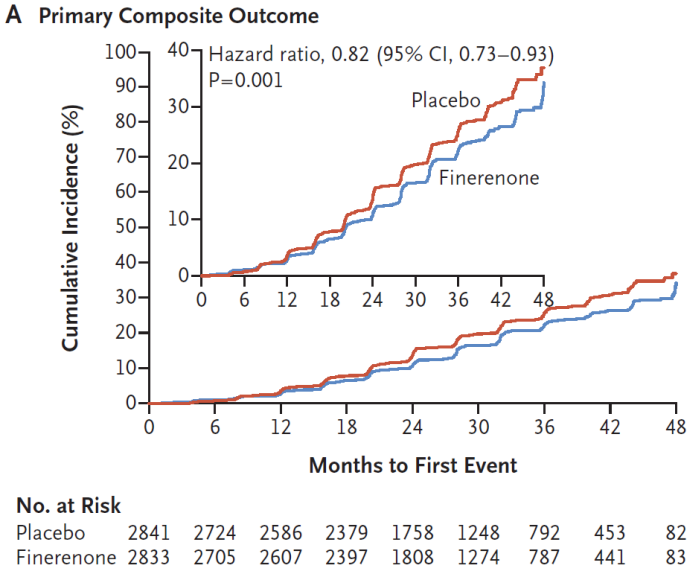


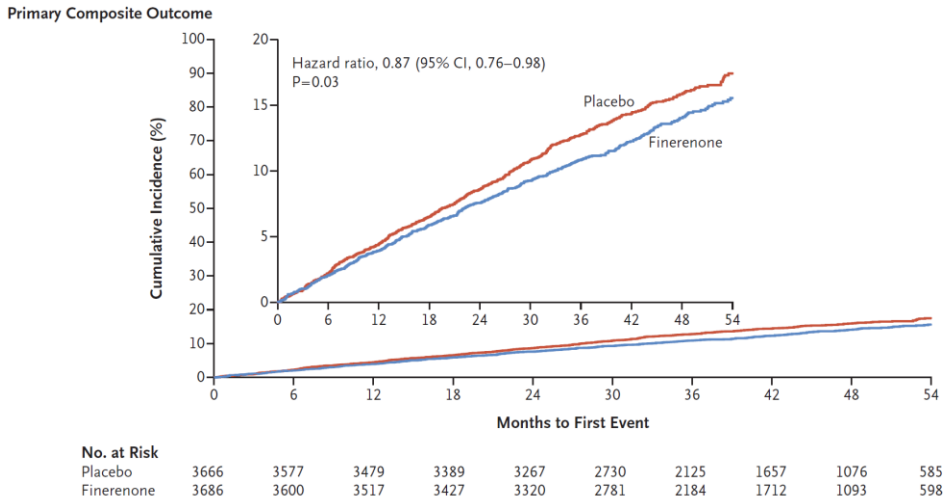
ESC focussed update 2023: Finerenone bei Diabetes und Niereninsuffizienz

Recommendations	Class[a]	Level[b]
In patients with T2DM and CKD,[c] finerenone is recommended to reduce the risk of HF hospitalization.[10,11,34,40]	I	A

FIDELIO-DKD and FIGARO-DKD

Finerenone verbessert die Prognose bei Niereninsuffizienz und DM2





Bakris et al. NEJM 2020

Pitt et al. NEJM 2021

Kerendia

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C: eGFR 25-60 mL/min/1.73 m2, urinary albumin-to-creatinine ratio 30-300 mg/g, and diabetic retinopathy, or an eGFR 25-75 mL/min/1.73 m2 and a urinary albumin-to-creatinine ratio 300-5000 mg/g, in FIDELIO-DKD;10 and an eGFR 25-90 mL/min/1.73 m2 and a urinary albumin-to-creatinine ratio 30 to <300 mg/g, or an eGFR >60 mL/min/1.73 m and a urinary albumin-to-creatinine ratio 300-5000 me/g, in FIGARO-DKD.

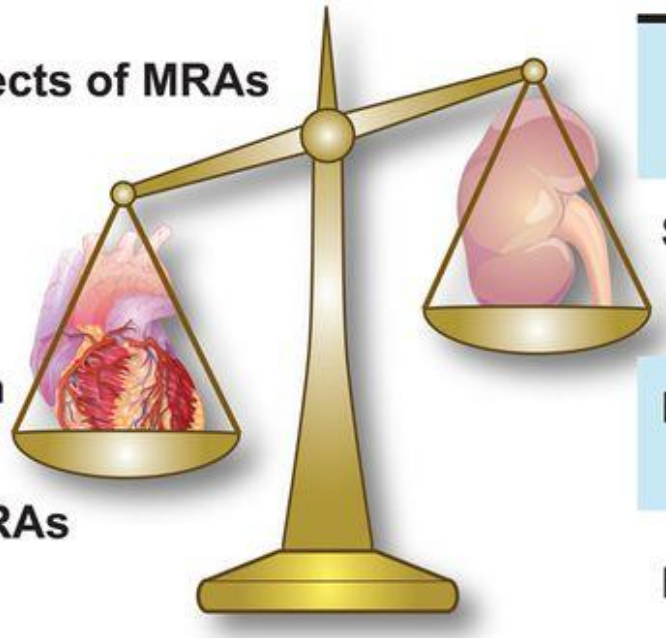
Finerenone: A non-steroidal MRA for HF and CKD

Desired cardiovascular effects of MRAs

↓Cardiovascular mortality
↓Heart failure hospitalizations
↓Arrhythmias
↓Fibrosis
↑Systolic and diastolic function

Adverse renal effects of MRAs

↑Hyperkalemia
↓Renal function



Finerenone?

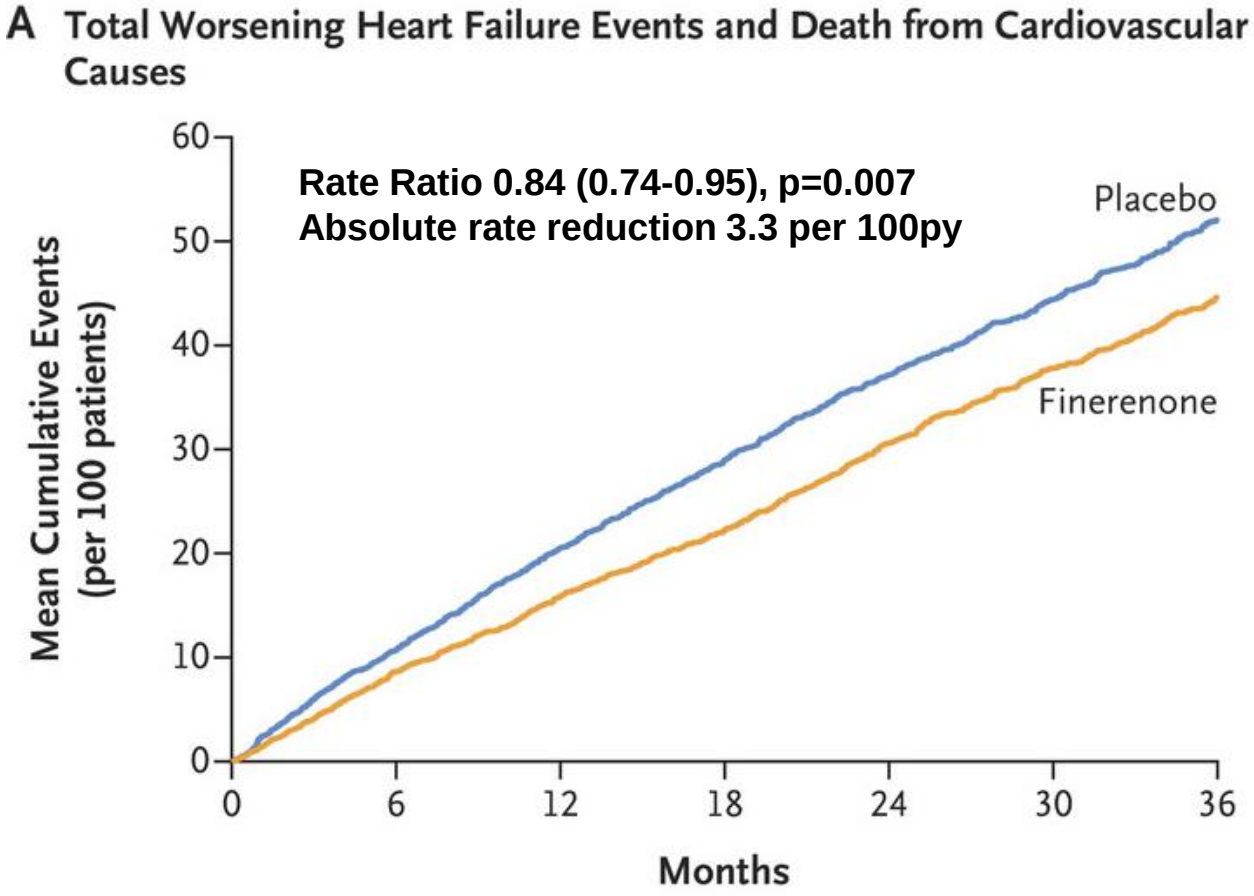
	Affinity to MR	Affinity to other SHR	Tissue distribution in heart vs. kidney
Spironolactone	High	Moderate	6-fold higher in kidney
Eplerenone	Moderate	Very low	3-fold higher in kidney
Finerenone	High	Very low	Balanced between heart and kidney

Nägele, Hernandez & Ruschitzka, Eur Heart J 2016

Highlight: FINEARTS-HF trial

Internationale, doppelblinde Studie in Patienten mit **HFmrEF und HFpEF (EF > 40%)**, 1:1 Finerenone 20-40mg oder Plazebo.

Endpunkt:
«Composite of total worsening heart failure events (event= first or recurrent unplanned Hosp or urgent visit for HF) and death from CV cause”



Charachteristics:
- 72J, 45% Frauen, vorherige HI-Hosp 60%
- BD 129mmHg, BMI 30, GFR 62ml/min, K 4.4mmol/l
- LVEF 52.5% (36%<50%), NTproBNP 1030ng/l, NYHA II-III
- 88% Hypertonie, 40% DM2, 38% VHF, 25% MI
- 85% BB, 36% ARB, 35% ACEI, 8% Sac/Val, 13% SGLT2, 87% Schleifendiuretika

Solomon SD et al, NEJM 2024

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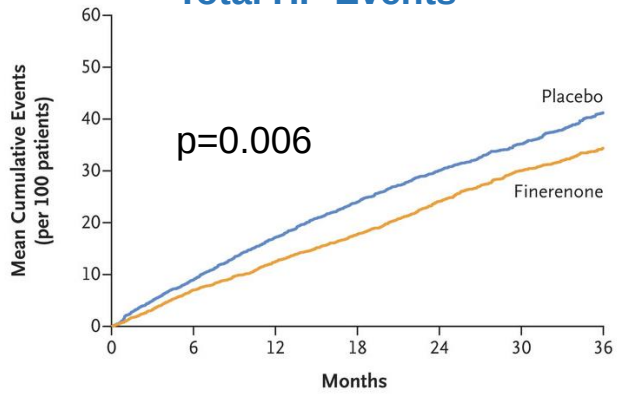
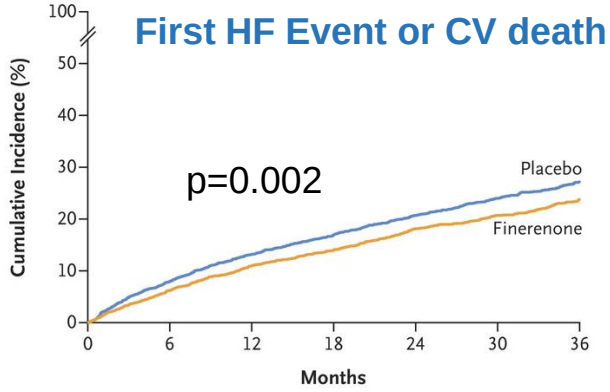
Total HF-Events

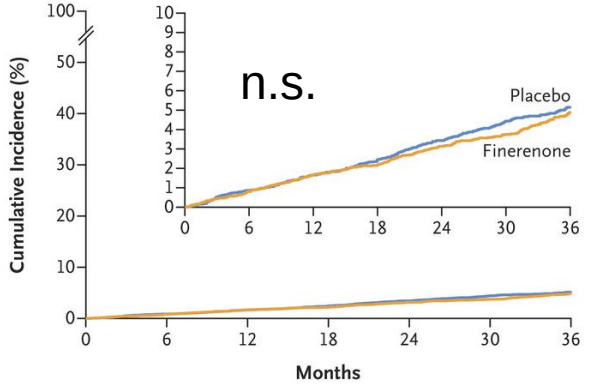


D First Worsening Heart Failure Event or Death from Cardiovascular Causes

First HF Event or CV death



CV death



Treatment for ALL HFrEF patients:

4 “pillars” to reduce Mortality for all patients with EF<40% (Class IA or B)

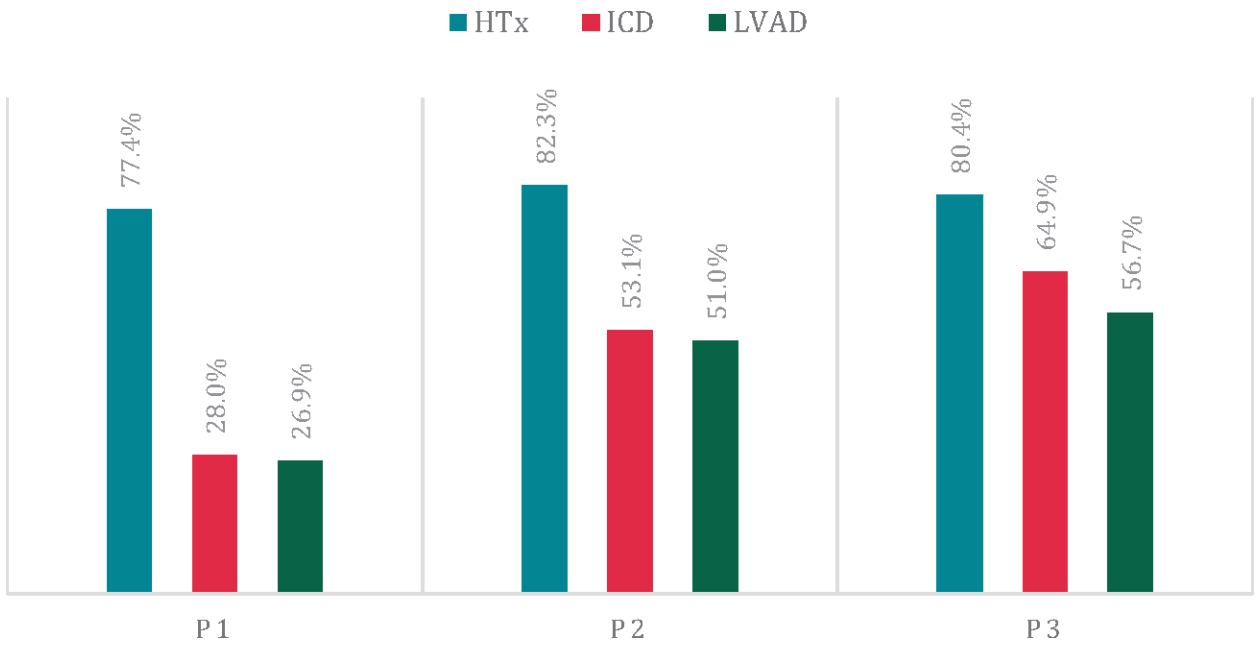
ACE-Inhibitor Sacubitril/Valsartan (ARB)

Beta-Blocker

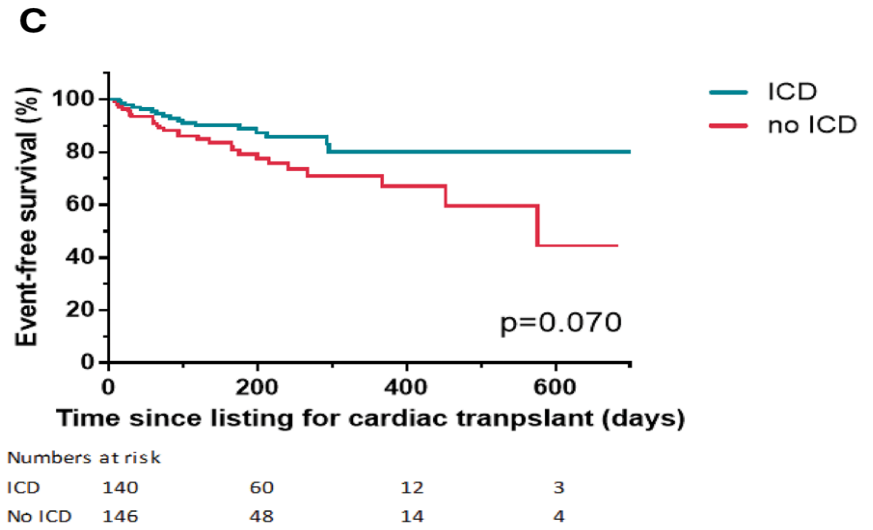
Mineralocorticoid Receptor Antagonist

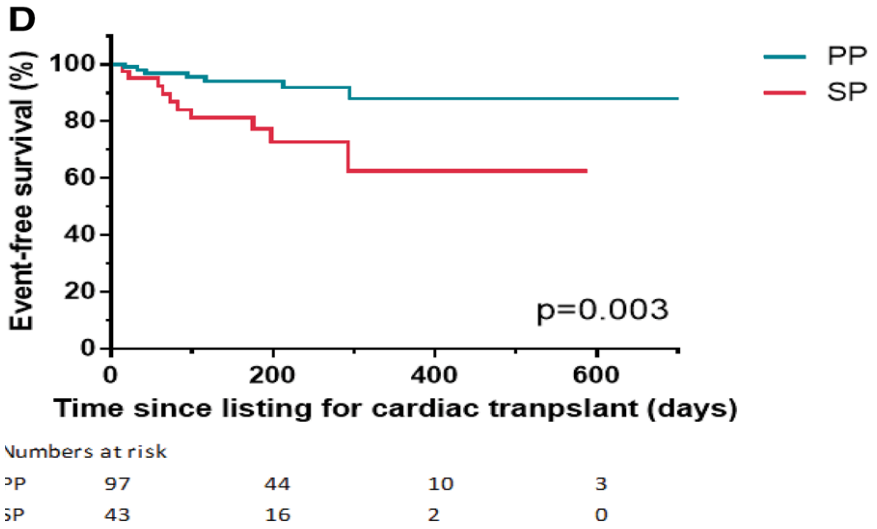
SGLT-2 Inhibitor

Device Therapy on the waiting list fo TPL increases over the last decades - use of ICD may improve survival



P1, period 1 (2002 until 2005); P2, period 2 (2006 until 2009); P3, period 3 (2010 until 2014)





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Vandenbark B et al, EP Europace, 2018,

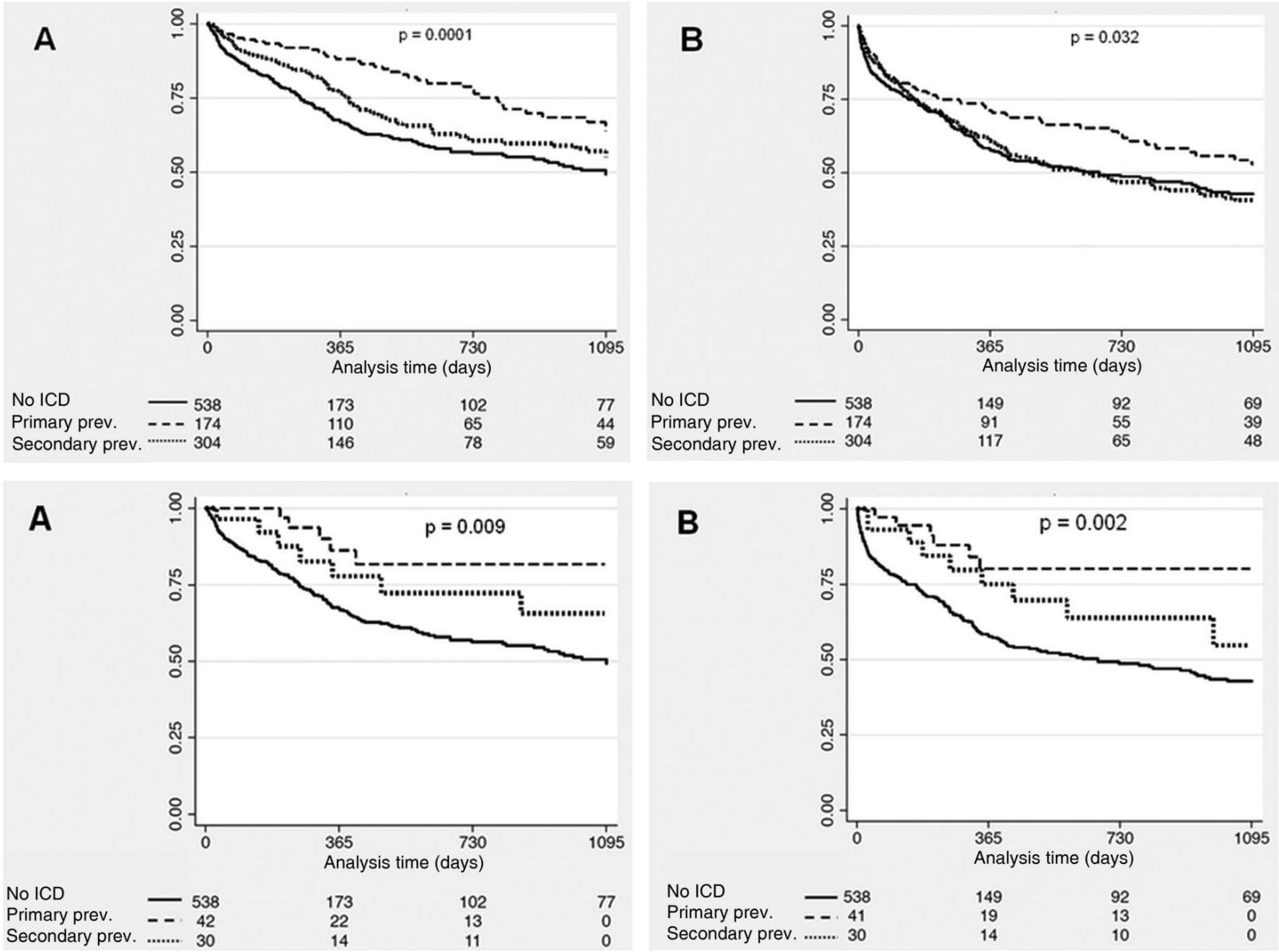
ICD implantation is associated with an immediate and sustained survival benefit for patients awaiting heart transplantation

Effect on all cause mortality (A) and death from any cause or need for assist devices (B)

1089 consecutive patients listed for HTPL in two tertiary heart transplant centers

Same if implanted while on the waiting list

Georg M Fröhlich et al. Heart 2013



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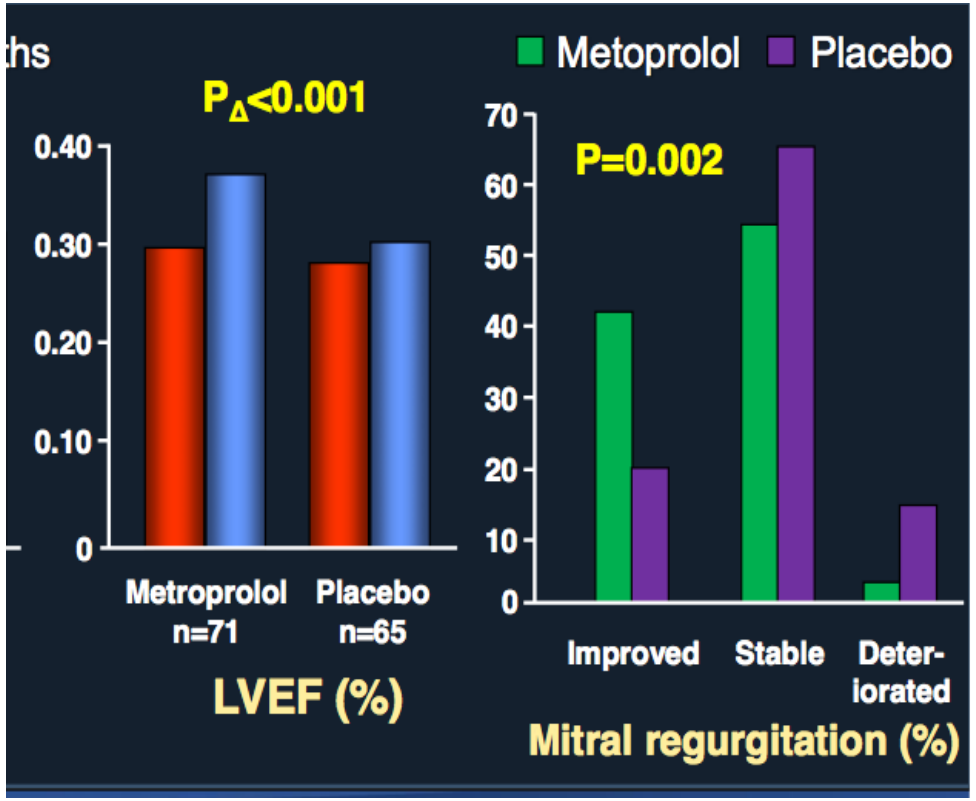
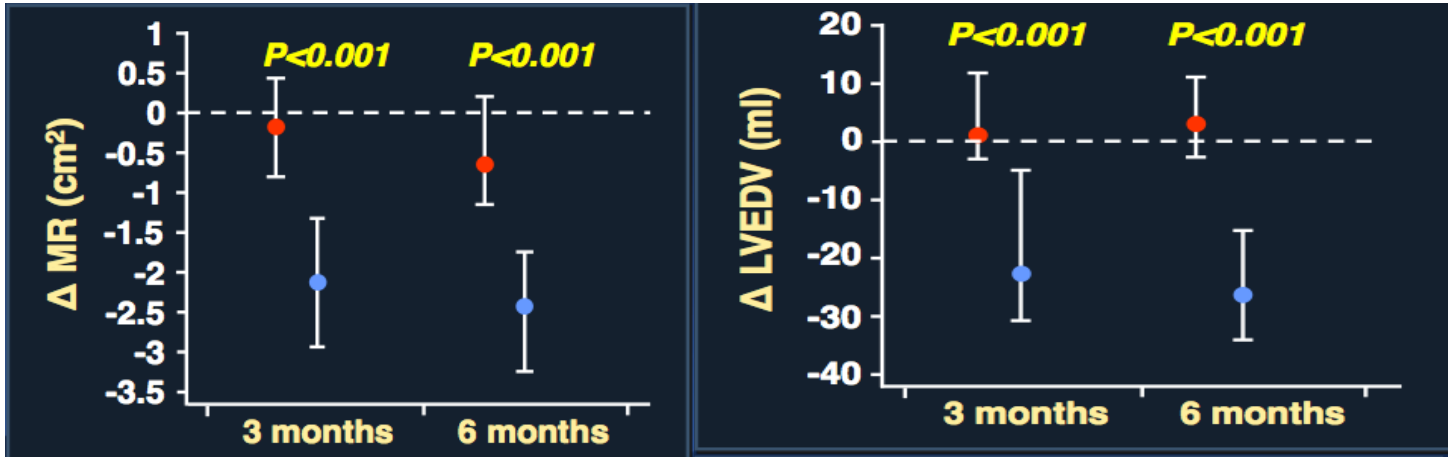
Medical therapy and CRT improve FMR (by reverse remodeling, reducing preload and afterload)

Reverse remodeling achieved by beta-blocker is associated with reduction in MR in selected patients after 6 months



Waagstein, EJHF, 2003

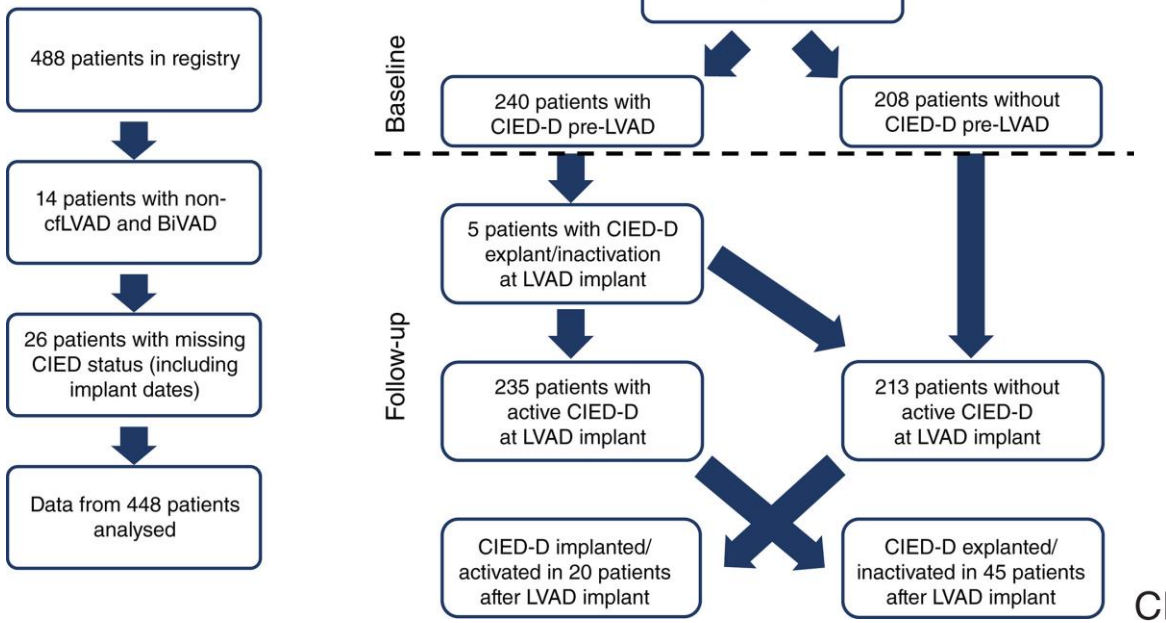
MIRACLE: CRT improves MR

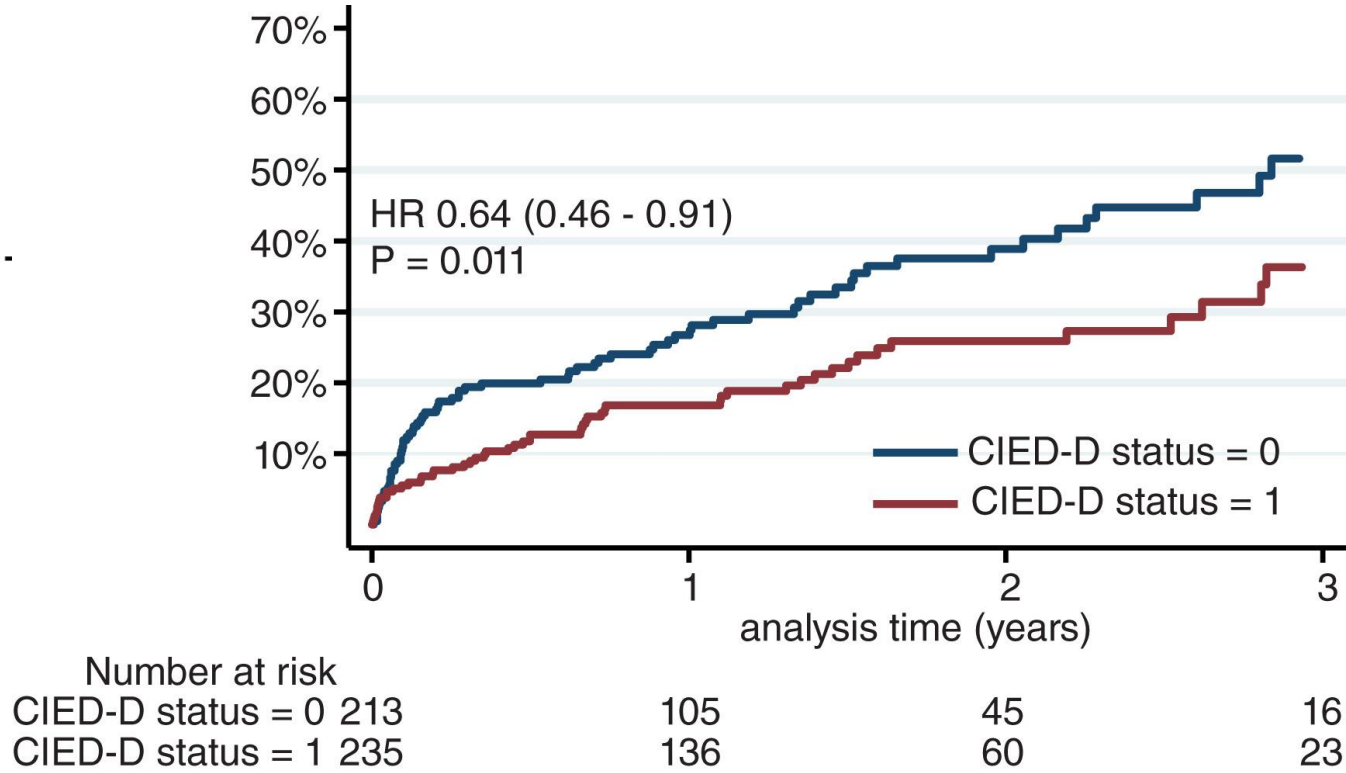


450 pts with LVEF < 35% and QRS>130 sec

John Sutton et al, Circulation 2007

Cardiac implantable electronic devices with a defibrillator component was associated wit significantly better survival during LVAD support (results from the PCHF-VAD registry)





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CIKES M et al, EJHF 2019

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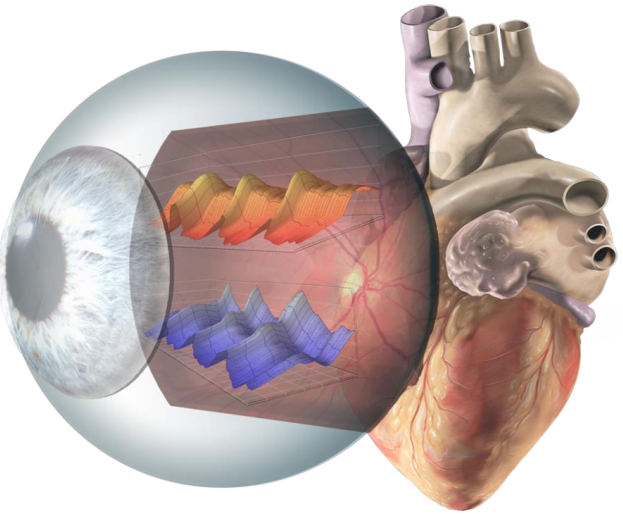

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Focus:

Vascular function, “Eye as a window to the heart”, Heart Failure, Volume regulation

Funding:

SNSF, Heart Foundation, USZ Foundation, FreeNovation, Industry