Approach to Congestive Heart Failure
A Case Based Approach

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Disclosures

- None

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Objectives

- Case based
- Congestive heart failure types
- Lifestyle modifications
- Medical therapy
- Implantable cardiac devices

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Case 1

- Mrs. J is a 94F presents to hospital with 4 day history of shortness of breath and leg edema.
- PMHx: Hypertension. DM2.
- No prior cardiac history

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Case 1

- On examination:
  - BP 168/78 mmHg, HR 72 bpm, O2 sat 92% on R/A
  - JVP elevated
  - Normal heart sounds. Bilateral lung crackes.
  - Moderate leg edema.
- 12 Lead EKG
  - Normal sinus rhythm.
- Bedside Echocardiogram
  - Normal LV/RV size and function. No significant valvular abnormalities.

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Case 1

- Labs:
- Hb 105, WBC 11, PLT 150
- Creatinine 110, Na/K= normal.
- NT pro-BNP elevated at 2000.
- Troponin – normal.
- CXR: Increased vascular redistribution
- Diagnosis:
  - Congestive heart failure with PRESERVED LV function.

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Congestive Heart Failure Subtypes

- Congestive Heart Failure with Preserved LV function (HFPeF)
  - LVEF>50%
- Congestive Heart Failure with mid-range EF (HFmEF)
  - LVEF 41-49%
- Congestive Heart Failure with REDUCED LV systolic function (HFReF)
  - LVEF <40%

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Case 1

- Patient was treated with iv Furosemide until euvolemic
- Patient discharged home on maintenance diuretics
  - Furosemide 40mg po daily
  - Spironolactone 12.5 mg daily.
  - Empagliflozin 10mg daily

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HFPeF

- Medical Treatment:
  - Loop diuretics (ie. Furosemide)
  - MRA inhibitors (ie. Spironolactone)
  - SGLT2 inhibitors

Medications reduce hospitalizations, but do not reduce mortality.

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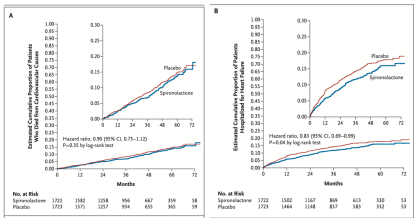
Medical therapy for HFPeF

Spironolactone
TOPCAT Study
NEJM 2014



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Medical therapy for HFPeF

- Empagliflozin

EMPEROR-Preserved NEJM 2021

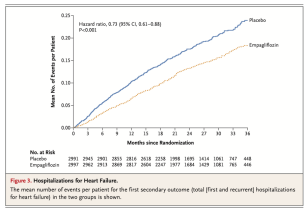

Figure 3. Hospitalizations for Heart Failure.
The mean number of events per patient for the first secondary outcome (total [first and recurrent] hospitalizations for heart failure) in the two groups is shown.

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Lifestyle modifications for CHF

- Diet
  - Well balanced diet, consider careful weight loss
- Salt
  - Avoid salt rich foods
  - < 2,000mg daily. (even less if hypertensive)
- Fluids
  - <1.5-2L daily
- Alcohol
  - Limit as much as possible. (<1 beverage daily)
- Avoid
  - NSAIDS

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Lifestyle modifications for CHF

- Exercise
  - Daily activities
  - Walking
  - Avoid over-exertion
  - Increase amount of activity slowly
  - Symptom limited
  - Consider referral to cardiac rehab.

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Lifestyle modifications for CHF

- Self Monitoring
  - Report the following to primary care or Cardiology
    - Change in breathing pattern. (SOB, Orthopnea, PND)
    - Worsening fatigue
    - Weight gain (1 Kg in 2-3 days)
    - Edema- increase
    - Side effects from medications
    - Irregular pulse, abnormal vital signs

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Case 2

- 62M with history of HTN, DM2 presents to ER with 4 days of worsening shortness of breath, leg edema, lightheadedness
- In ER, BP 105/74mmHg, HR 162 bpm, O2 Sat 92% on 2L O2
- JVP elevated to angle of jaw, Mild early peaking systolic murmur at the base
- Bilateral leg edema

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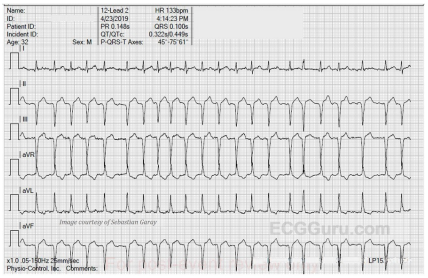
Case 2



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Case 2

- 12 lead EKG: Atrial fibrillation with rapid ventricular response
- 2D Echocardiogram:
  - Global hypokinesis. SEVERE LV systolic function. LVEF 25-30%.
  - Mild aortic stenosis.
- Coronary angiography: Normal coronaries

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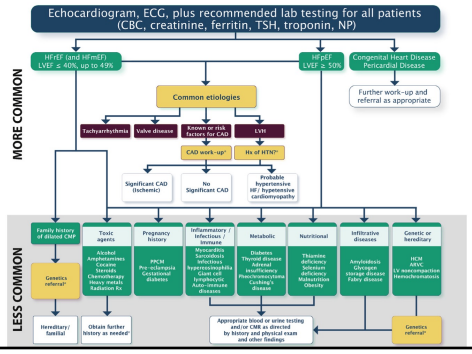

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Case 2

- Patient was successfully cardioverted back to sinus rhythm
- Discharged home on Bisoprolol 5mg daily, Apixaban 5mg bid

- 3 months later....
  - Patient remains in sinus rhythm.
  - Repeat Echocardiogram: Normal LV systolic function!

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Case 3

- 72M with history of MI 2021- PCI to LAD/RCA. HTN. DM2
- Meds: ASA 81mg daily, Ramipril 5mg OD, Atorvastatin 20mg
- Presents with symptoms suggestive of CHF.
- On examination
  - BP 145/70 mmHg, HR 94 bpm, O2 96% RA
  - JVP elevated. Normal heart sounds.
  - Mild leg edema

- EKG: Sinus rhythm. Septal infarct pattern

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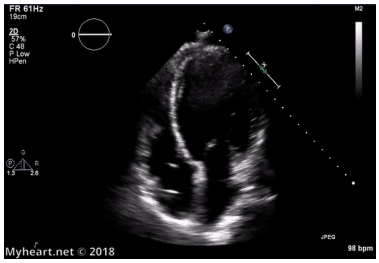
Case 3

- Echocardiogram:
- Severe LV systolic dysfunction.

LVEF 25%



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Case 3

- Patient started on Furosemide for diuresis, and then initiated GDMT= Guideline Directed Medical Therapy

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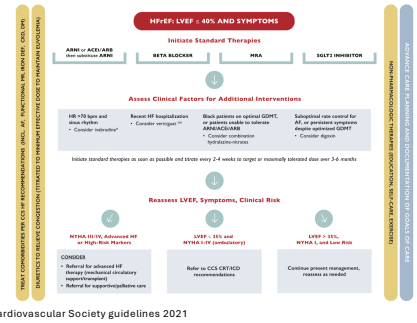

Canadian Cardiovascular Society guidelines 2021

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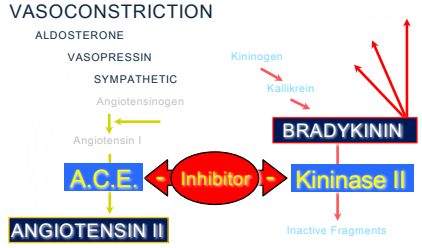

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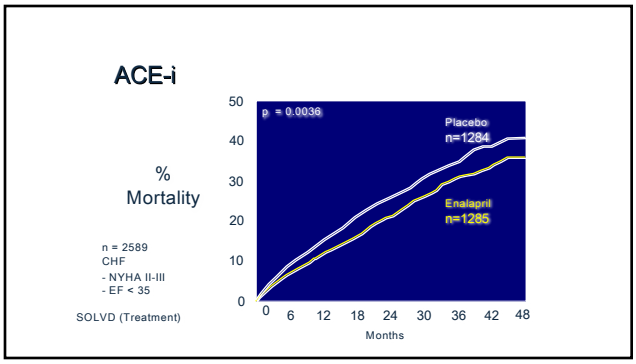

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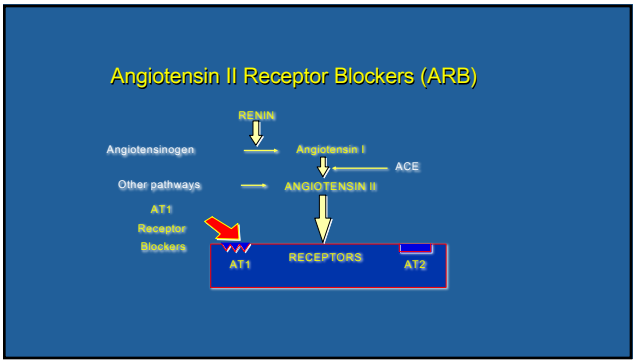

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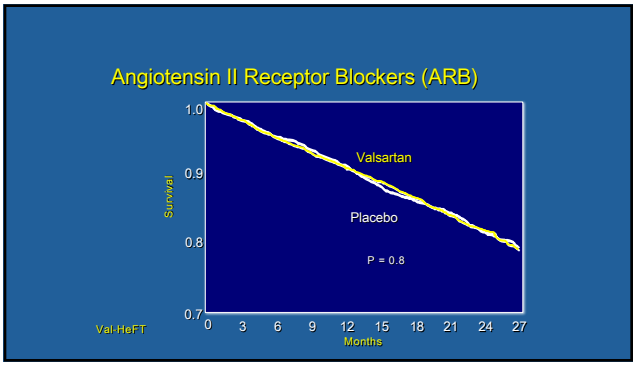

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ß-Adrenergic Blockers Mechanism of action

- Decreased Neurohormonal activation
- Decreased HR
- Antiischemic
- Antihypertensive
- Antiarrhythmic
- Antioxidant, Antiproliferative

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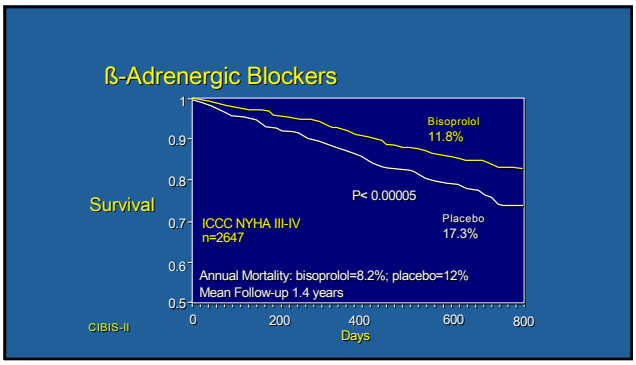

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Supplemental Table S3. Evidence-based heart failure medications and doses in the management of patients with heart failure with reduced ejection fraction

Drug	Start Dose	Target Dose
ACE Inhibitors		
Captopril	6.25-12.5 mg TID	25-50 mg TID
Enalapril	1.25-2.5 mg BID	10 mg BID
Lisinopril	2.5-5 mg OD	20-35 mg OD
Perindopril	2-4 mg OD	4-8 mg OD
Ramipril	1.25-2.5 mg BID	5 mg BID
Trandolapril	1-2 mg OD	4 mg OD
Beta-blockers		
Bisoprolol	1.25 mg OD	10 mg OD
Carvedilol	3.125 mg BID	25 mg BID*
Metoprolol CR/XL**	12.5-25 mg OD	200 mg OD
ARBs		
Candesartan	4 mg OD	32 mg OD
Valsartan	40 mg BID	160 mg BID
Aldosterone Antagonists		
Spironolactone	12.5 mg OD	50 mg OD
Eplerenone	25 mg OD	50 mg OD
Vasodilatators		
Hydralazine	37.5 mg TID	75 mg TID
Isorbide dinitrate	20 mg TID	40 mg TID

* 50 mg BID if weight is >85 kg

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Aldosterone Inhibitors

Spironolactone → ALDOSTERONE

Competitive antagonist of the aldosterone receptor (myocardium, arterial walls, kidney)

- Retention Na^+ → Edema
- Retention H_2O → Edema
- Excretion K^+ → Arrhythmias
- Excretion Mg^{2+} → Arrhythmias

Collagen deposition → Fibrosis
- myocardium
- vessels

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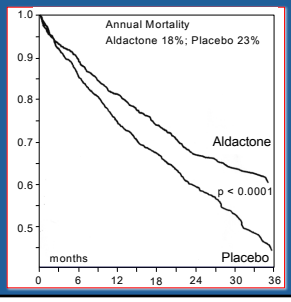
Spironolactone

Survival

N = 1663
NYHA III-IV
Mean follow-up 2 y

RALES



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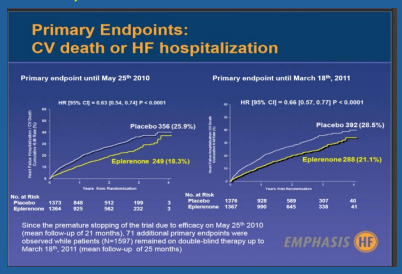
Eplerenone (INSPRA)



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Aldosterone Antagonists		
Spironolactone	12.5 mg OD	50 mg OD
Eplerenone	25 mg OD	50 mg OD
Vasodilatators		
Hydralazine	37.5 mg TID	75 mg TID
Isorbide dinitrate	20 mg TID	40 mg TID

* 50 mg BID if weight is >85 kg

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ENTRESTO

- PARADIGM-HF Trial
- LCZ696 =
  - Sacubutril (Neprilysin inhibitor) + Valsartan (ARB)
- 8442 patients NYHA 2-4, EF<40% randomized to LCZ696 vs. Enalapril 10mg bid.

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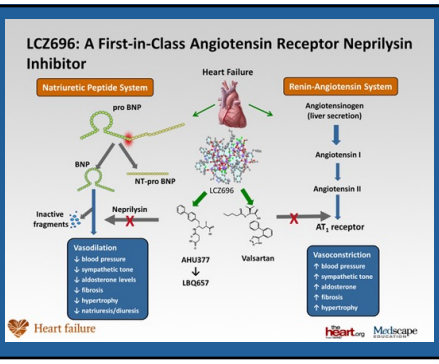

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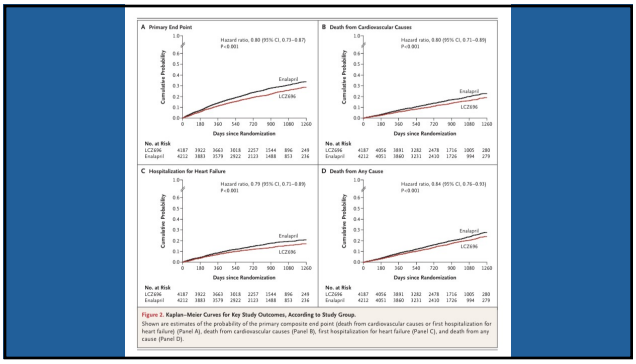

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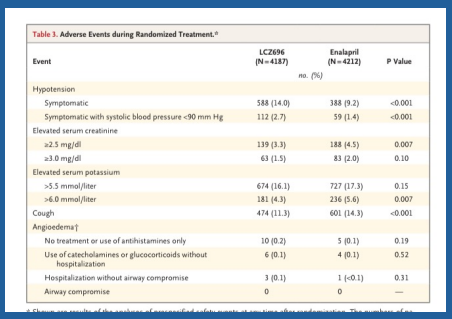

Table 3. Adverse Events during Randomized Treatment.*

Event	LCZ696 (N = 4187)	Enalapril (N = 4212)	P Value
	no. (%)		
Hypotension			
Symptomatic	588 (14.0)	388 (9.2)	<0.001
Symptomatic with systolic blood pressure <90 mm Hg	112 (2.7)	59 (1.4)	<0.001
Elevated serum creatinine			
≥2.5 mg/dl	139 (3.3)	188 (4.5)	0.007
≥3.0 mg/dl	63 (1.5)	83 (2.0)	0.10
Elevated serum potassium			
>5.5 mmol/liter	674 (16.1)	727 (17.3)	0.15
>6.0 mmol/liter	181 (4.3)	236 (5.6)	0.007
Cough	474 (11.3)	601 (14.3)	<0.001
Angioedema†			
No treatment or use of antihistamines only	10 (0.2)	5 (0.1)	0.19
Use of catecholamines or glucocorticoids without hospitalization	6 (0.1)	4 (0.1)	0.52
Hospitalization without airway compromise	3 (0.1)	1 (<0.1)	0.31
Airway compromise	0	0	—

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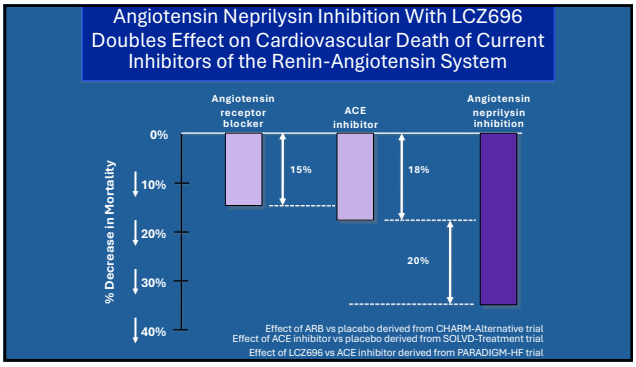

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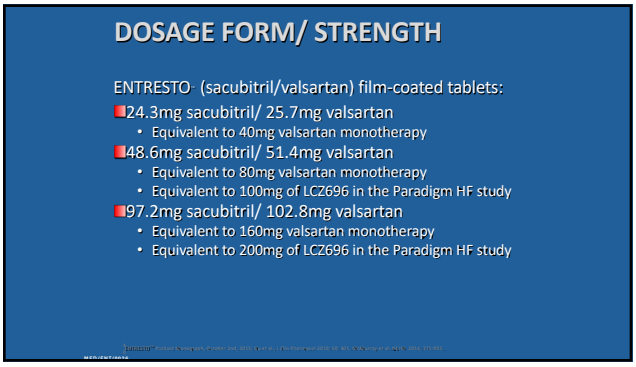

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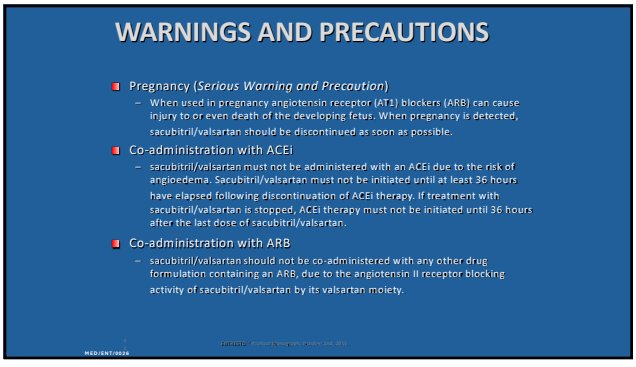

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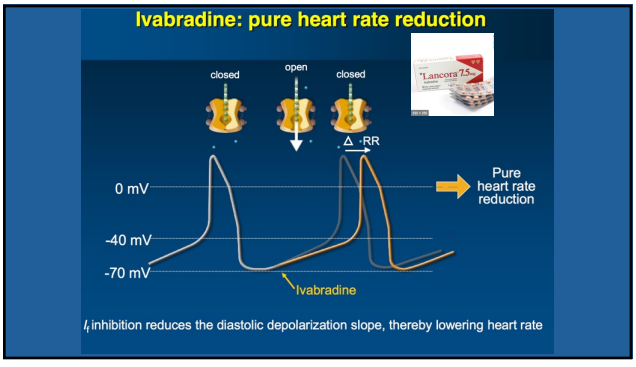

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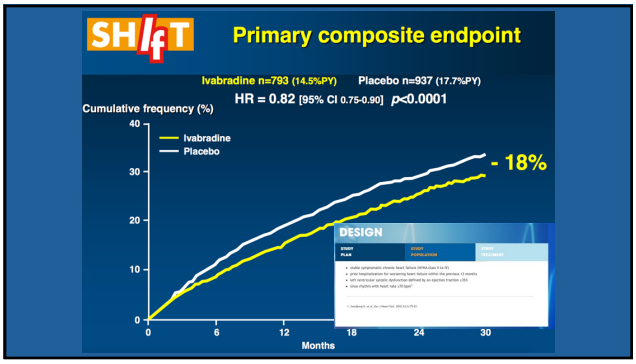

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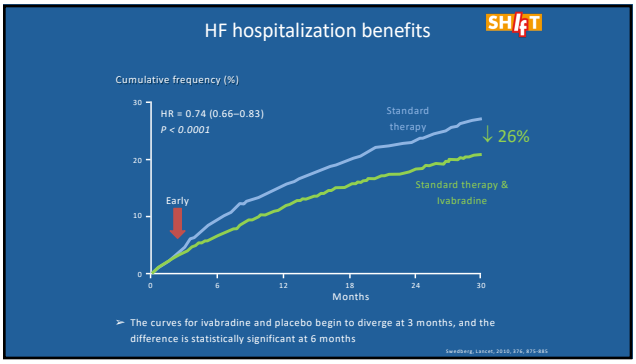

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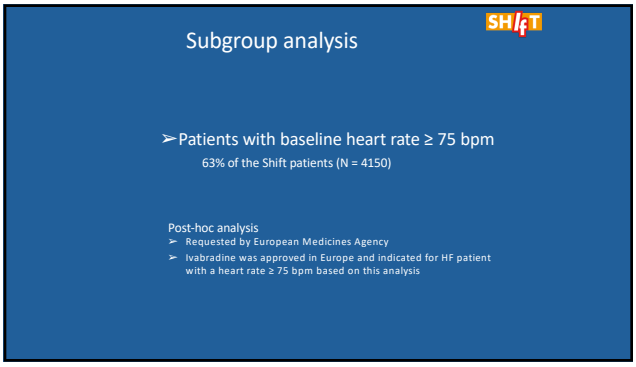

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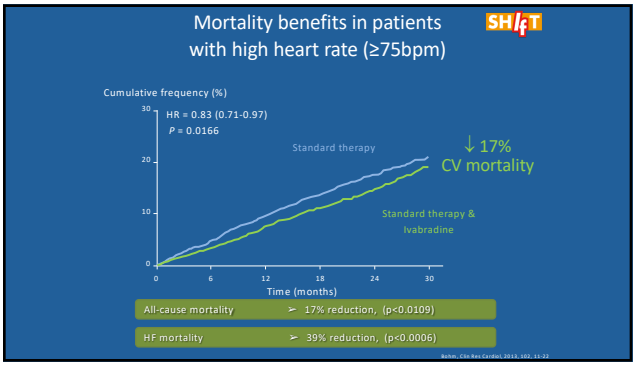

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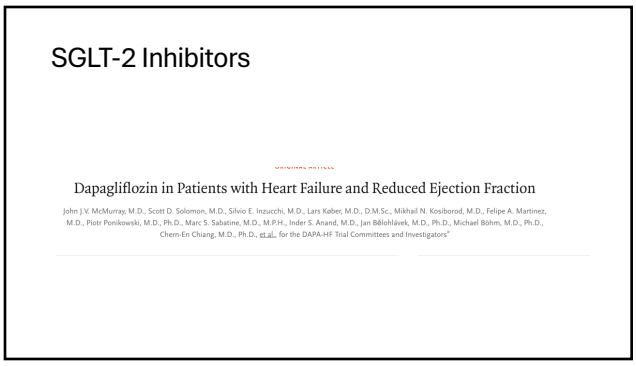

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DAPA-HF Trial

- 4744 patients with NYHA 2-4
- HFREF (LVEF <40%)
- Diabetes not necessary
- Randomized:
  - Dapagliflozin 10mg daily vs Placebo
- Primary outcome:
  - Composite: worsening HF/hospitalization or cardiovascular death

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Table 1. (Continued.)

Characteristic	Dapagliflozin (N=2373)	Placebo (N=2371)
Heart failure medication — no. (%)		
Diuretic	2216 (93.4)	2217 (93.5)
ACE inhibitor	1332 (56.1)	1329 (56.1)
ARB	675 (28.4)	632 (26.7)
Sacubitril–valsartan	250 (10.5)	258 (10.9)
Beta-blocker	2278 (96.0)	2280 (96.2)
Mineralocorticoid receptor antagonist	1696 (71.5)	1674 (70.6)
Digitalis	445 (18.8)	442 (18.6)
Glucose-lowering medication — no./total no. (%)**		
Biguanide	504/993 (50.8)	512/990 (51.7)
Sulfonylurea	228/993 (23.0)	210/990 (21.2)
DPP-4 inhibitor	161/993 (16.2)	149/990 (15.1)
GLP-1 receptor agonist	11/993 (1.1)	10/990 (1.0)
Insulin	274/993 (27.6)	266/990 (26.9)

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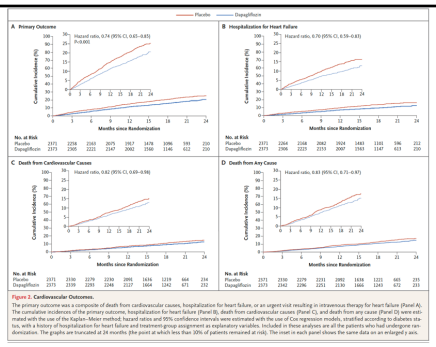

Figure 2. Cardiovascular Outcomes.

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ORIGINAL ARTICLE

Cardiovascular and Renal Outcomes with Empagliflozin in Heart Failure

Milton Packer, M.D., Stefan D. Anker, M.D., Ph.D., Javed Butler, M.D., Gerasimos Filippatos, M.D., Stuart J. Pocock, Ph.D., Peter Carson, M.D., James Januzzi, M.D., Subodh Verma, M.D., Ph.D., Hiroyuki Tsutsui, M.D., Martina Brueckmann, M.D., Waheed Jamal, M.D., Karen Kimura, Ph.D., et al., for the EMPEROR-Reduced Trial Investigators*

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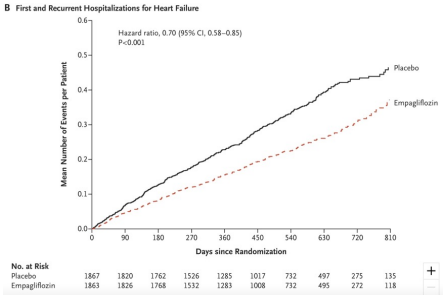

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VERICIGUAT

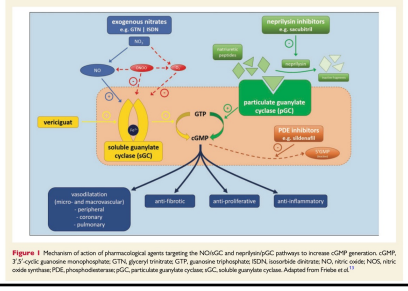

Figure 1. Mechanism of action of pharmacological agents targeting the NO/sGC and neprilysin/pGC pathways to increase cGMP generation. cGMP, 3′,5′-cyclic guanosine monophosphate; GTN, glyceryl trinitrate; GTP, guanosine triphosphate; ISDN, isosorbide dinitrate; NO, nitric oxide; NOS, nitric oxide synthase; PDE, phosphodiesterase; pGC, particulate guanylate cyclase; sGC, soluble guanylate cyclase. Adapted from Friebe et al.[1]

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Vericiguat in Patients with Heart Failure and Reduced Ejection Fraction

Paul W. Armstrong, M.D., Burkert Pieske, M.D., Kevin J. Anstrom, Ph.D., Justin Ezekowitz, M.B., B.Ch., Adrian F. Hernandez, M.D., M.H.S., Javed Butler, M.D., M.P.H., M.B.A., Carolyn S.P. Lam, M.B., B.S., Ph.D., Piotr Ponikowski, M.D., Adriaan A. Voors, M.D., Ph.D., Gang Jia, Ph.D., Steven E. McNulty, M.S., Mahesh J. Patel, M.D., Lothar Roessig, M.D., Joerg Koglin, M.D., Ph.D., and Christopher M. O'Connor, M.D., for the VICTORIA Study Group*

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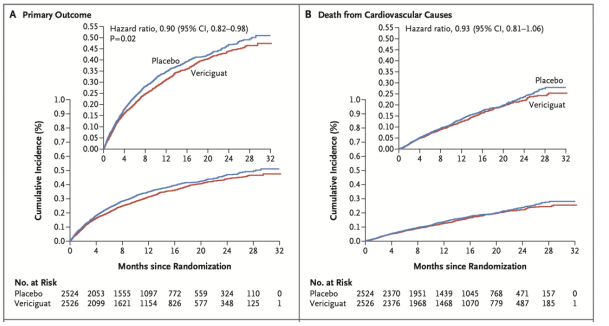

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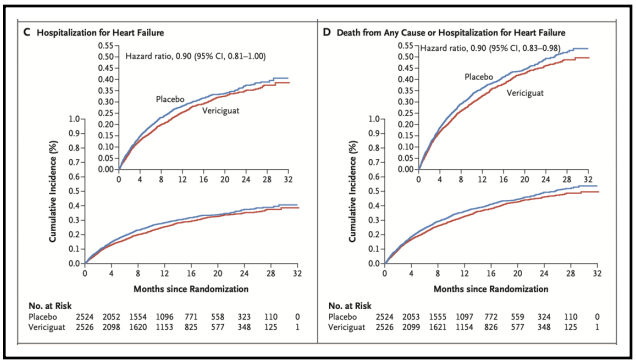

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DRUGS to AVOID in HFReF

- Calcium Channel blockers
- Class Ic anti-arrhythmic medications
- NSAIDS
- Cold/cough meds with ephedrine
- Thiazoladinediaones

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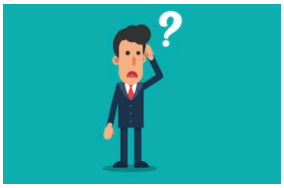

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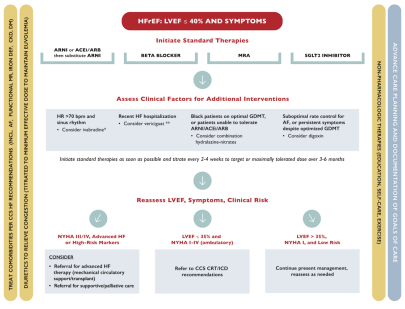

Canadian Cardiovascular Society guidelines 2021

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Case 3 - 3 months later

- Patient feeling a lot better.
- Meds:
  - Entresto 48 mg po BID. (Switched from Ramipril with 48h washout)
  - Bisoprolol 5mg po daily. (Feels fatigued on Bisoprolol)
  - Empaglifozin 10mg daily
  - Spironolactone 25mg po daily
  - ASA 81mg daily, Atorvastatin 20mg OD
- Vitals:
  - BP 95/60 mmHg. HR 82 bpm. (SINUS RHYTHM)
  - JVP not elevated. Normal heart sounds. No edema
- ?Further medication additions?

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Case 3 – 3 months later

- Patient started on Ivabradine 5mg po bid
- BP: 90/60 mmHg. HR 65 bpm.
- JVP not elevated. Normal heart sounds. No edema.
- Repeat ECHOcardiogram
  - LV systolic mildly improved. LVEF ~30%.

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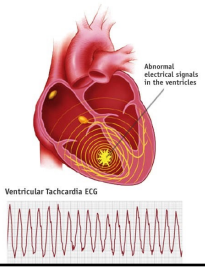
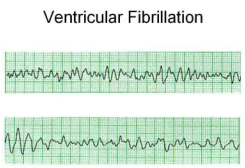
Long term sequelae of Severe LV systolic dysfunction





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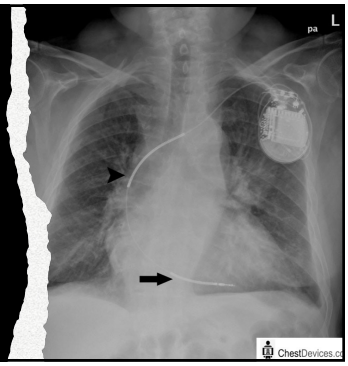
Implantable Cardiac Defibrillators



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Implantable Cardiac Defibrillators

- Indications:
  - PRIMARY prophylaxis
  - SECONDARY prophylaxis

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Primary Prophylaxis Indications

RECOMMENDATION

51. We recommend consideration of primary ICD therapy in patients with:
    i. Ischemic cardiomyopathy, NYHA class II-III, EF ≤ 35%, measured at least 1 month post MI, and at least 3 months post coronary revascularization procedure (Strong Recommendation; High-Quality Evidence); or
    ii. Ischemic cardiomyopathy, NYHA class I, and an EF ≤ 30% at least 1 month post MI, and at least 3 months post coronary revascularization procedure (Strong Recommendation; High-Quality Evidence); or
    iii. Nonischemic cardiomyopathy, NYHA class II-III, EF ≤ 35%, measured at least 3 months after titration and optimization of GDMT (Strong Recommendation; High-Quality Evidence).
52. We recommend against ICD implantation in patients with NYHA class IV symptoms who are not expected to improve with any further therapy and who are not candidates for cardiac transplantation or mechanical circulatory support (MCS) (Strong Recommendation; Moderate-Quality Evidence).

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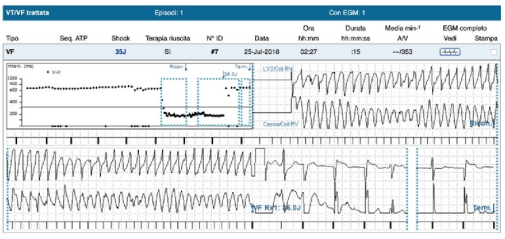
How an implantable cardiac defibrillator works



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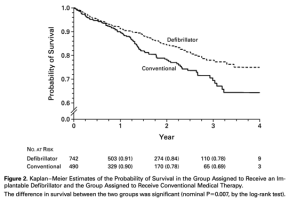
MADIT II- NEJM 2002

- 1232 patients ischemic cardiomyopathy. ICD vs Conventional therapy



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Case 4

- 48F admitted to hospital with congestive heart failure.
- Echocardiogram: Severe global hypokinesis, LVEF 25%.
- Coronary angiogram: Normal coronaries.

- Patient initiated on GDMT.
  - Entresto
  - Bisoprolol
  - Empagliflozin
  - Spironolactone

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Case 4

- 3 months later, patient remains stable, euvolemic
- NYHA 2.

- Repeat ECHOcardiogram:
  - LVEF 30%. No significant change
- Cardiac MRI:
  - LVEF 28%. No LGE.
- Diagnosis: Nonischemic cardiomyopathy

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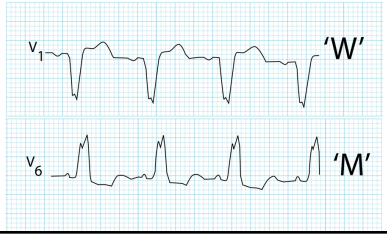
Case 4

- 12 Lead EKG: Sinus rhythm. LBBB.



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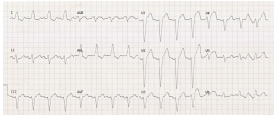
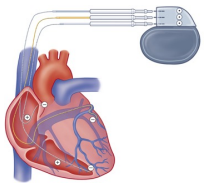
Cardiac Synchronization Therapy





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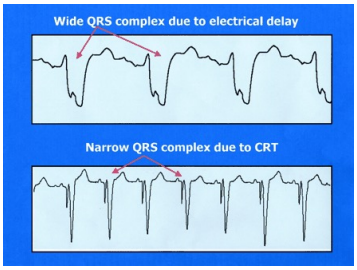
CRT leads to improved interventricular synchrony



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Cardiac Resynchronization Therapy

- Benefits:
  - Improved symptoms
  - Reduction of mortality
  - Improved cardiac output
  - Improvement of LVEF
  - ?Reduction of arrhythmia burden

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Cardiac Resynchronization Therapy

Benefit
- NYHA >1
- LBBB (wider the better)
- NYHA >1, EF<50% with AV block (BLOCK-HF trial)

No Benefit
- Narrow QRS (<120msec)
- RBBB
- Atrial fibrillation (unless AV nodal ablation)

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RECOMMENDATION

58. We recommend CRT for patients in sinus rhythm with NYHA class II, III, or ambulatory class IV HF despite optimal medical therapy, a LVEF ≤ 35%, and QRS duration ≥ 130 ms with left bundle branch block (LBBB) (Strong Recommendation; High-Quality Evidence).
59. We suggest that CRT may be considered for patients in sinus rhythm with NYHA class II, III, or ambulatory class IV HF despite optimal medical therapy, a LVEF ≤ 35%, and QRS duration ≥ 150 ms with non-LBBB (Weak Recommendation; Low-Quality Evidence).

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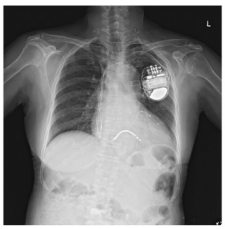
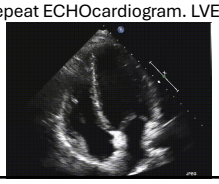
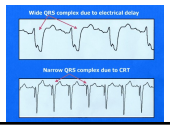
Case 4

- Patient had successful CRT-d implantation
- 3 months later, patient feeling well.

- Repeat ECHOcardiogram. LVEF 60%!







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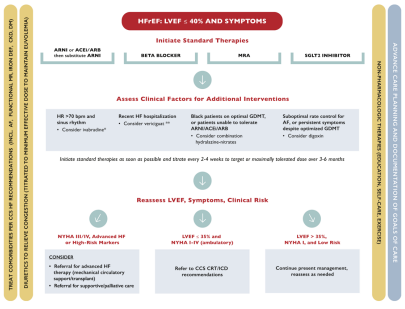

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The End

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