Recognizing and Treating Heart Failure

Scott Blois, MD and Liana Quinn, PA
Boulder Heart, 720-443-0163

Boulder Community Health

Who are your speakers today?

Boulder Community Health

- Scott Blois, 56 years old
- Born in North California
- Undergraduate college: UCLA (1984-1988)
- Medical School: Baylor College of Medicine, Houston, TX (1989-1993)
- Residency and Cardiology Training: University of Colorado Health Sciences Center, Denver (1993-2000)
- Cardiology practice Austin, TX. Head of Heart Failure clinic with 700 patients (2000-2015)
- Joined Boulder Heart August of 2015 (12 cardiologist group) to run HF program Sept 2015
- Boulder Heart HF clinic cares for more than 700 patients seeing us with emphasis on co-management with patients, lots of HF teaching and education & state-of-the-art medications and devices if needed.

Who are your speakers today?

Boulder Community Health

- Liana Quinn, 31 years old
- Born in Suffern , NY
- Undergraduate: Siena College, graduated 2013
- Graduate: SUNY Upstate Medical University, graduated 2018
- Lived and worked near Saratoga Springs, NY for the start of career in general cardiology
- Moved to Colorado February 2021, started with Boulder Heart December 2021
- Work alongside Dr. Blois and the other providers at Boulder Heart to provide quality care and educate patients with heart failure and many other cardiac conditions.

Outline of Talk/Objectives

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1. Understand definition of Heart Failure (HF)
2. Understand growing prevalence of HF and economic costs to USA
3. Learn signs and symptoms of HF
4. Learn some of leading causes of HF
5. Learn tests to work up and diagnose suspected HF patients
6. Briefly hear about some of principle treatments of HF (medications, pacemakers, defibrillators)
7. Learn how CHF specialty clinic works and lifestyle risk factor modifications
8. Questions

Definition of Heart Failure (HF)

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"… specific term used to define the clinical syndrome which ensues when the heart is unable to pump enough blood to supply the metabolic needs of the body."

- Bristow, Braunwald's Heart Disease textbook, 2000

Four Chambers of Heart: Importance of Left Ventricle in HF

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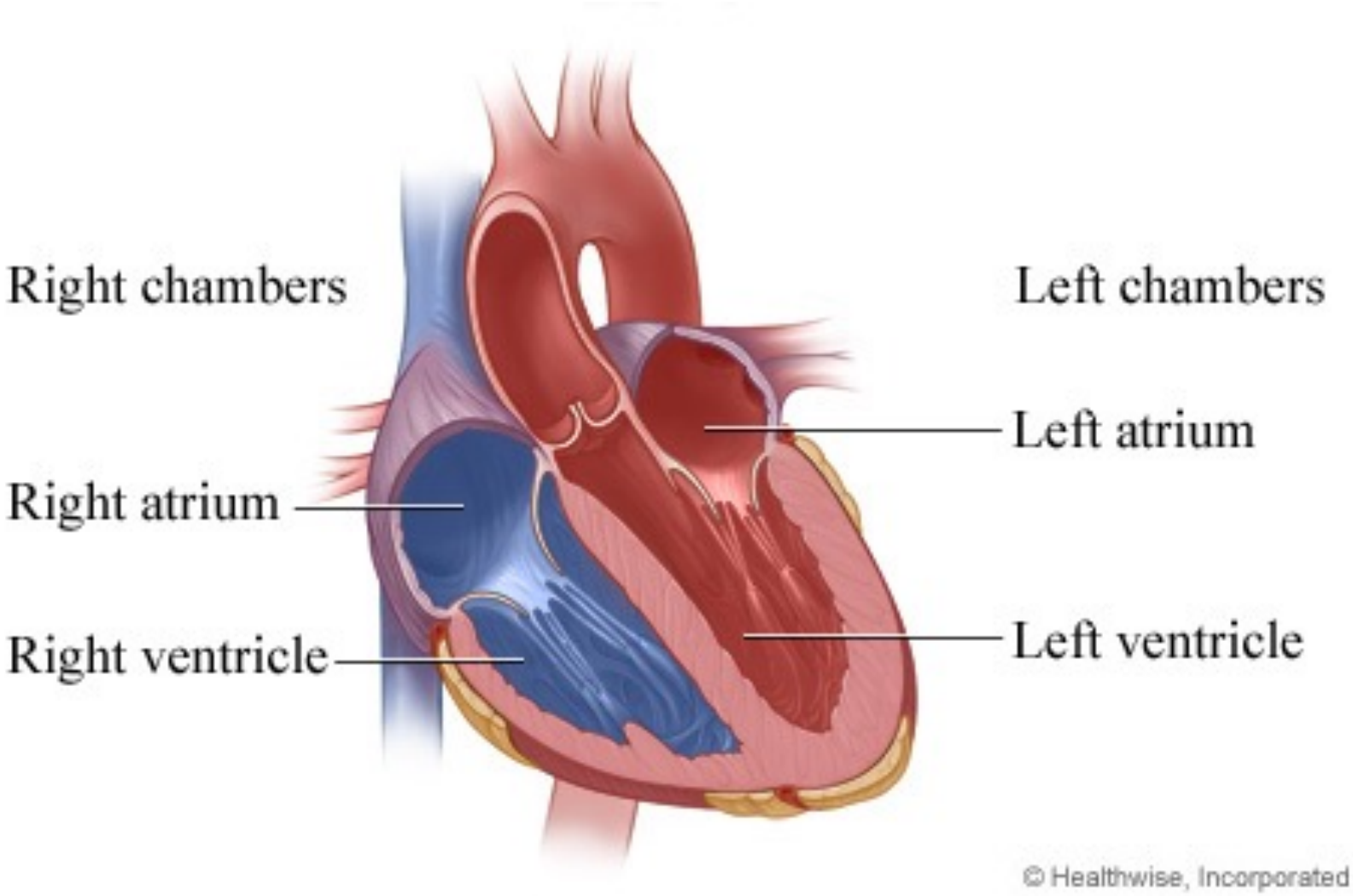

Heart Failure-Epidemiology

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- 1:5 people will develop HF during their lifetime.
- 5 million cases of symptomatic HF patients (estimated 5-6 million people with asymptomatic heart failure/heart weakening).
- 550,000 new cases of HF/ year in USA.
- 287,000 deaths from HF/year in USA.

Heart Failure: Economic Costs

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- 1998: total HF costs $20 billion.
- 2014: total HF costs $32 billion.
- Estimated 2030: total HF costs $72 billion.
- Most costly heart disease in USA (more than heart attacks, bypass surgeries or heart stents).
- Average length of stay (LOS) for HF hospitalization 5 days. Average cost $30-40 thousand/hospitalization.

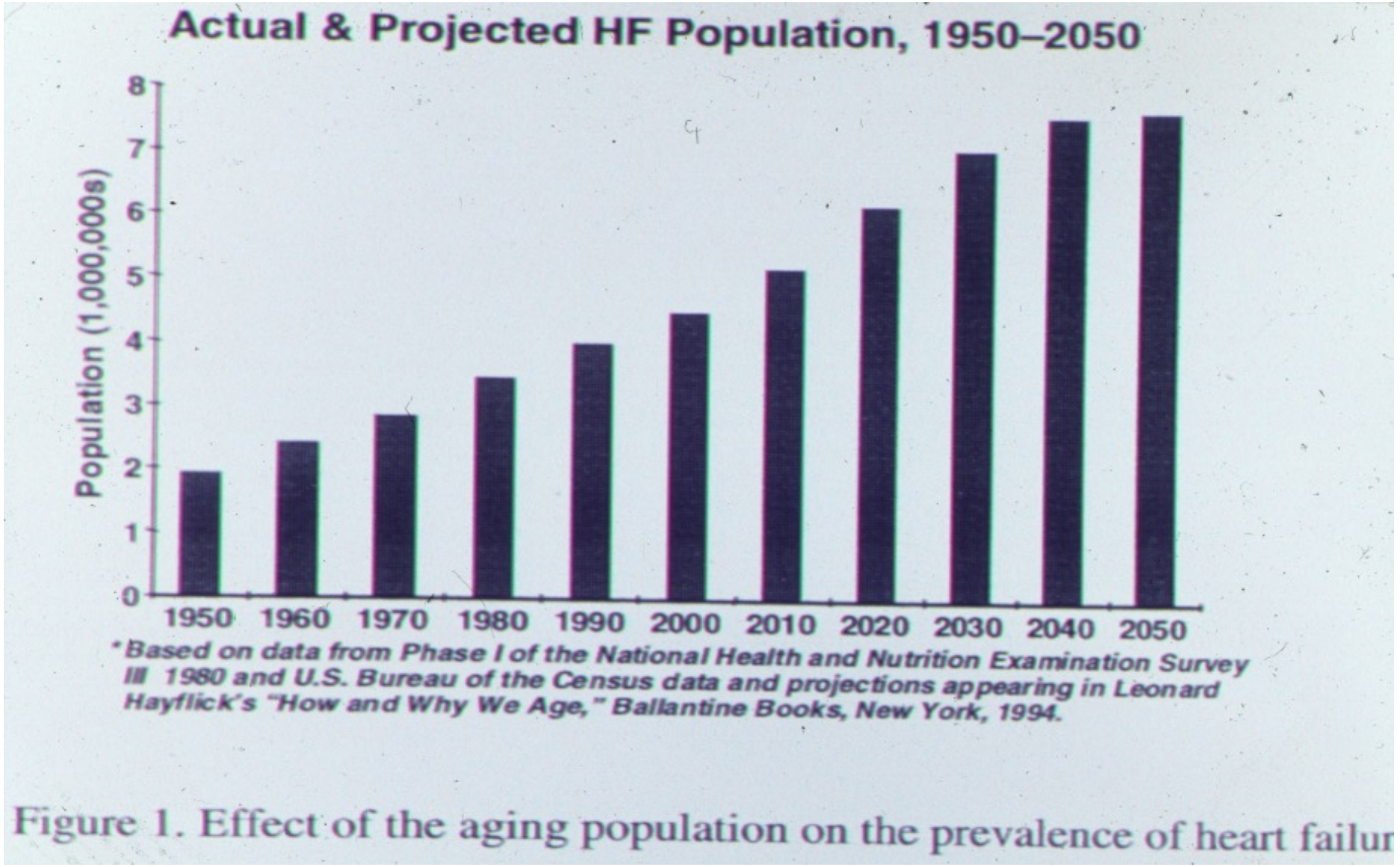

Figure 1. Effect of the aging population on the prevalence of heart failur

What Are The Symptoms of Heart Failure?

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Think **FACES**...

- **F**atigue
- **A**ctivities limited
- **C**hest congestion
- **E**dema or ankle swelling
- **S**hortness of breath

Signs/Symptoms of HF

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Commonly mistaken diagnoses that eventually are found to be Heart Failure:

- Asthma
- Pneumonia
- Upper respiratory infection
- Depression and tiredness in the elderly

    - Very important to diagnose HF early as this has a better treatment response and better prognosis.

Leading Causes of HF in USA

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- **Coronary Artery Disease (CAD), post heart attack**
- **HTN (Uncontrolled High Blood Pressure)**
- **Idiopathic (Double Hit Theory)**
  - ? Viral Exposure + Genetic Predisposition
- Valvular
- Alcoholic

Conditions That Preclude CHF

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Table 1. Known Causes of Dilated Cardiomyopathy.

Toxins

Ethanol*
Chemotherapeutic agents (doxorubicin, bleomycin)
Cobalt*
Antiretroviral agents (zidovudine,* didanosine,* zalcitabine*)
Phenothiazines*
Carbon monoxide*
Lead*
Cocaine*
Mercury*

Metabolic abnormalities

Nutritional deficiencies (thiamine,* selenium,* carnitine*)
Endocrinologic disorders (hypothyroidism,* acromegaly,* thyrotoxicosis,* Cushing's disease, pheochromocytoma,* diabetes mellitus)
Electrolyte disturbances (hypocalcemia,* hypophosphatemia*)

Inflammatory or infectious causes

Infectious
Viral (coxsackie virus, cytomegalovirus,* human immunodeficiency virus)
Rickettsial
Bacterial (diphtheria*)
Mycobacterial
Fungal
Parasitic (toxoplasmosis,* trichinosis, Chagas' disease)
Noninfectious
Collagen vascular disorders (scleroderma, lupus erythematosus, dermatomyositis)
Hypersensitivity myocarditis*
Sarcoidosis*
Peripartum dysfunction*

Neuromuscular causes

Duchenne's muscular dystrophy
Facioscapulohumeral muscular dystrophy
Erb's limb-girdle dystrophy
Myotonic dystrophy
Friedreich's ataxia

Familial cardiomyopathies

NEJM 1994

Tests to order in suspected HF pt

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- Electrocardiogram (ECG): often abnormal with hypertrophy of heart, evidence of previous heart attacks or slowed diseased electrical system.
- Labs to look for anemia, kidney, liver and thyroid function.
- Chest x-ray to look for enlarged heart or water in lung fields.
- Echocardiogram (most important test).
- Brain Naturietic Peptide Level (Blood test).

Diagnostic Testing: ECHO

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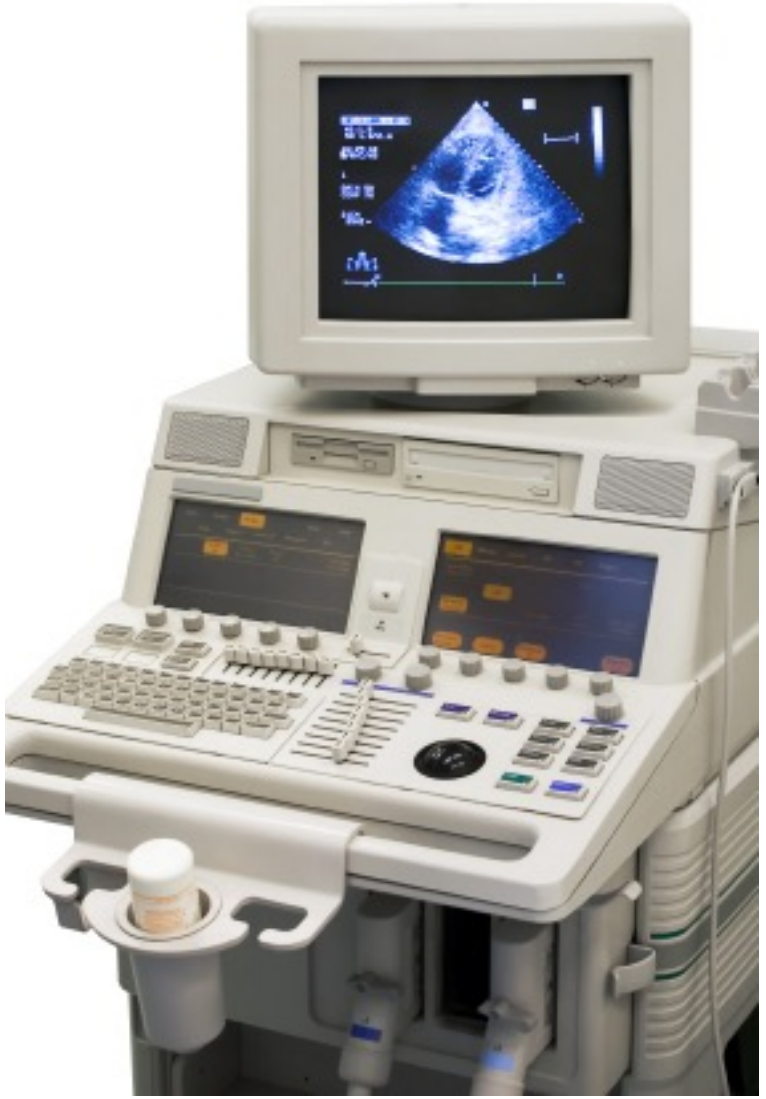

Diagnosing HF

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Lab test – "BNP" – brain natriuretic peptide

- Protein made in heart.
- Elevated if heart dilated and weakened and congested.
- Abnormal if >400pg/ml.
- NT-pro BNP: slightly different assay. Abnormal if >450.
- Good Sensitivity (90%), Very specific (98% negative predictive value).
- Other diseases see BNP elevated: Pulmonary issues like COPD, acute pneumonia, acute or subacute blood clots in lungs (PE), chronic kidney insufficiency, age >85 y/o, pulmonary hypertension.

Other heart tests maybe later to better define and make specific diagnosis:

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- Heart catheterization "Coronary angiogram": evaluate cholesterol blockages of heart arteries and take pressure readings in heart. Usually done thru artery and veins in wrist or groin.
- MRI of heart
- Stress test (Treadmill or Chemical stress)
- Labs
- Genetic testing

Two Types of Heart Failure

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- Diastolic HF: the muscle function of heart is relatively normal but problems with relaxation. LVEF/Ejection fraction is normal >50%.
- Systolic HF: heart muscle is weakened and LVEF/Ejection fraction <40%.

- Mixed HF: EF 41-49%.

Diastolic HF

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- Common etiologies: longstanding hypertension, atrial fibrillation, infiltrating process, e.g., amyloidosis, coronary artery disease, natural aging with heart getting stiffer and more fibrotic.
- In past no clear medicine class work but new positive data with SLGTs inhibitors, ARNI agents and mineral corticoid antagonists.
- Treat underlying cause as best we can.
- >50% of HF in older population (>70 y/o) this type of HF.

Causes of Diastolic HF

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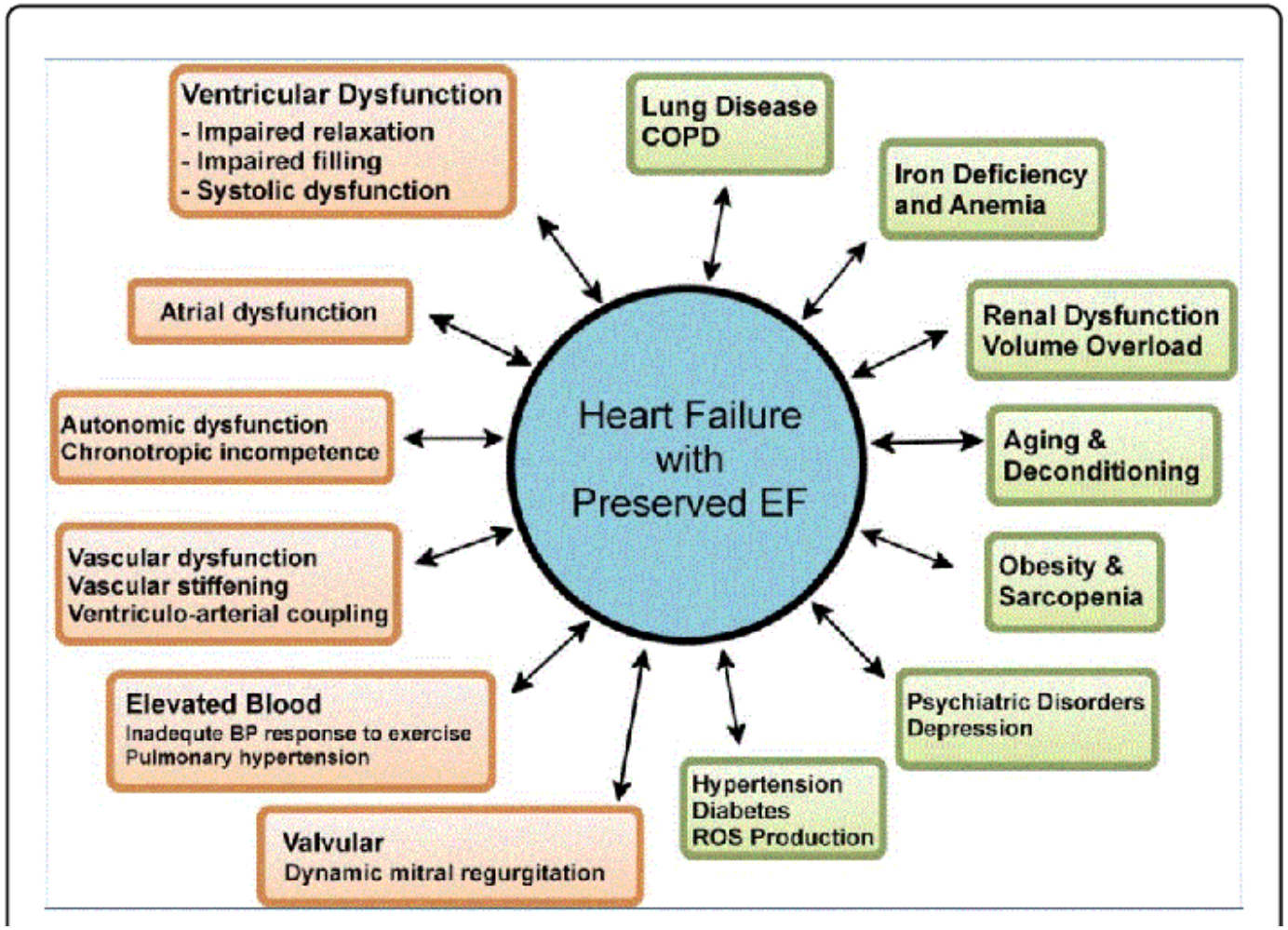

Goel, Sunny et al. "Treatment Modalities for Heart Failure with Preserved Ejection Fraction (HFpEF) - Current State of Evidence and Future Perspective." *Journal of Clinical and Experimental Cardiology* 2015 (2015): 0-0.

New York Heart Association Functional Classification

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I	No limitations No symptoms with ordinary activities
II	Slight limitation Symptoms with ordinary activities
III	Marked limitations Symptoms with less than ordinary activities
IV	Symptoms of heart failure at rest

New Approach to the Classification of Heart Failure

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	Stage	Patient Description
A	High risk for developing heart failure (HF)	▪ Hypertension ▪ CAD ▪ Diabetes mellitus ▪ Family history of cardiomyopathy
B	Asymptomatic HF	▪ Previous MI ▪ LV systolic dysfunction ▪ Asymptomatic valvular disease
C	Symptomatic HF	▪ Known structural heart disease ▪ Shortness of breath and fatigue ▪ Reduced exercise tolerance
D	Refractory end-stage HF	▪ Marked symptoms at rest despite maximal medical therapy (eg, those who are recurrently hospitalized or cannot be safely discharged from the hospital without specialized interventions)

Carvedilol is indicated for use in patients with mild to severe chronic HF and in patients with HTN.

Hunt SA et al. *J Am Coll Cardiol.* 2001;38:2101–2113.

Table 7. Clinical Stages of Chronic Heart Failure (CHF) Associated with Systolic Dysfunction. Based on Symptoms and CHF Hospitalization Requirement

Stage	Description	NYHA Class	Annualized mortality, %*	Hospitalizations/ Year
A (Asymptomatic-mild)	Asymptomatic or only minimal symptoms, rare hospitalizations	I-II	2-5	<0.25
B (Mild-moderate)	Mild-moderate symptoms, infrequent hospitalizations	II-III	5-15	0.25-0.75
C (Advanced)	Moderate-severe symptoms, frequent hospitalizations	III-IV	15-25	.75-2
D (Severe)	Persistent severe symptoms, frequent prolonged or continuous hospitalizations	IV	>25	>2

Risk of HF and COVID-19

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- Patients with chronic HF are at risk of worse outcome if get COVID infection.
- In general, 1% mortality if get COVID and have no medical issues.
- Patients with chronic HF who have gotten COVID infection, 10% mortality in registries.

That's the Bad News….
Now the Good News!!!

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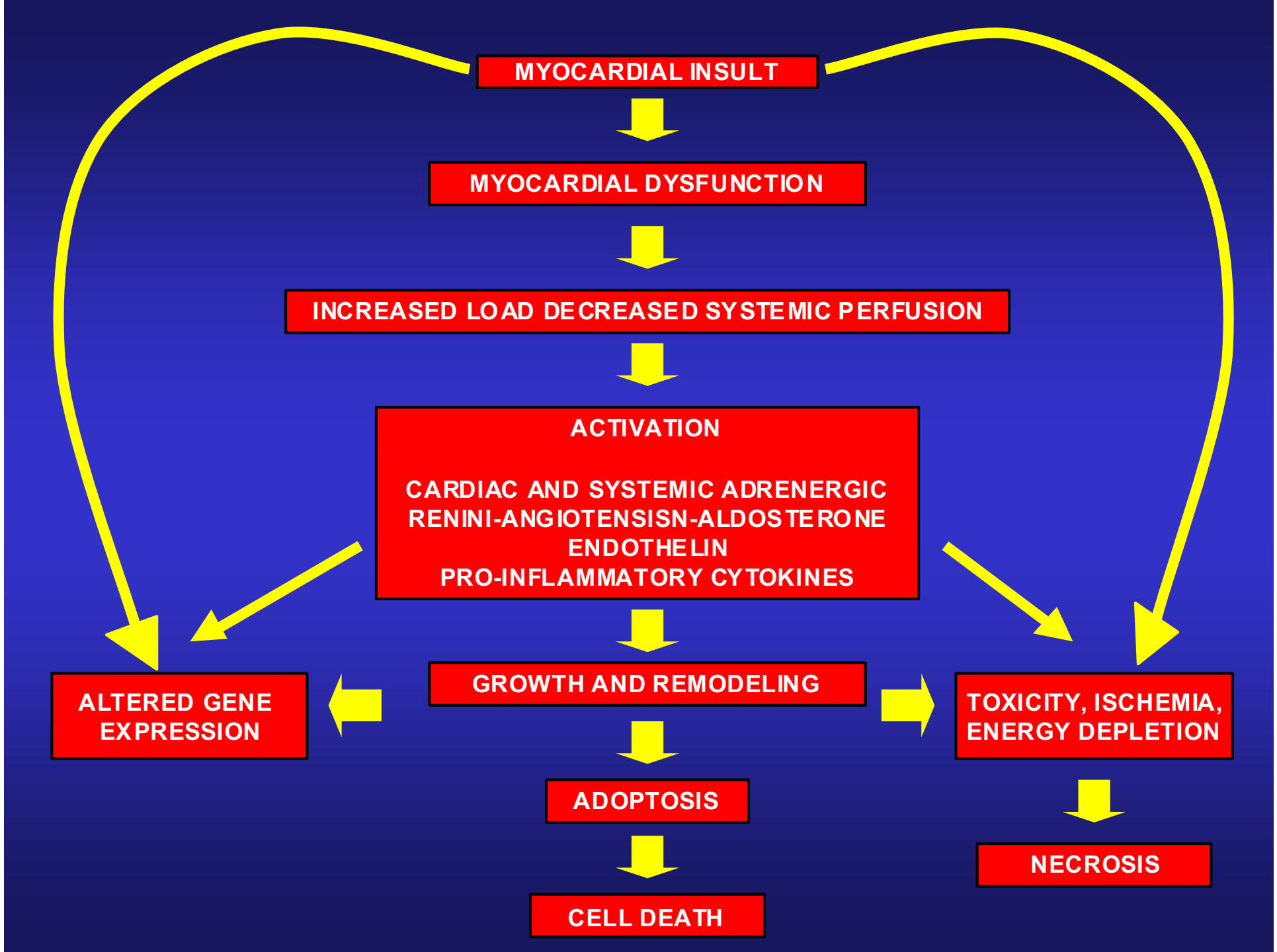
- Before 1990, if developed HF could treat with diuretics (Lasix), Digoxin and Morphine to get rid of congestion and swelling but couldn't get the heart stronger unless got heart transplant. Many studies <1990, five-year survival with HF comparable to metastatic breast and lung cancers.

- In 1990s, research started to show when one has HF, the body turns on 3-4 hormones (in heart, kidneys, adrenal gland, other organs) to make struggling heart work harder. Those hormones in long run are bad and toxic to heart. Treatment/ medications designed to block those hormone surges.


MYOCARDIAL INSULT
MYOCARDIAL DYSFUNCTION
INCREASED LOAD DECREASED SYSTEMIC PERFUSION
ACTIVATION
CARDIAC AND SYSTEMIC ADRENERGIC
RENINI-ANGIOTENSISN-ALDOSTERONE
ENDOTHELIN
PRO-INFLAMMATORY CYTOKINES
ALTERED GENE EXPRESSION
GROWTH AND REMODELING
TOXICITY, ISCHEMIA, ENERGY DEPLETION
ADOPTOSIS
NECROSIS
CELL DEATH

Glossary of Class of HF Medicines to Abbreviations We'll Use

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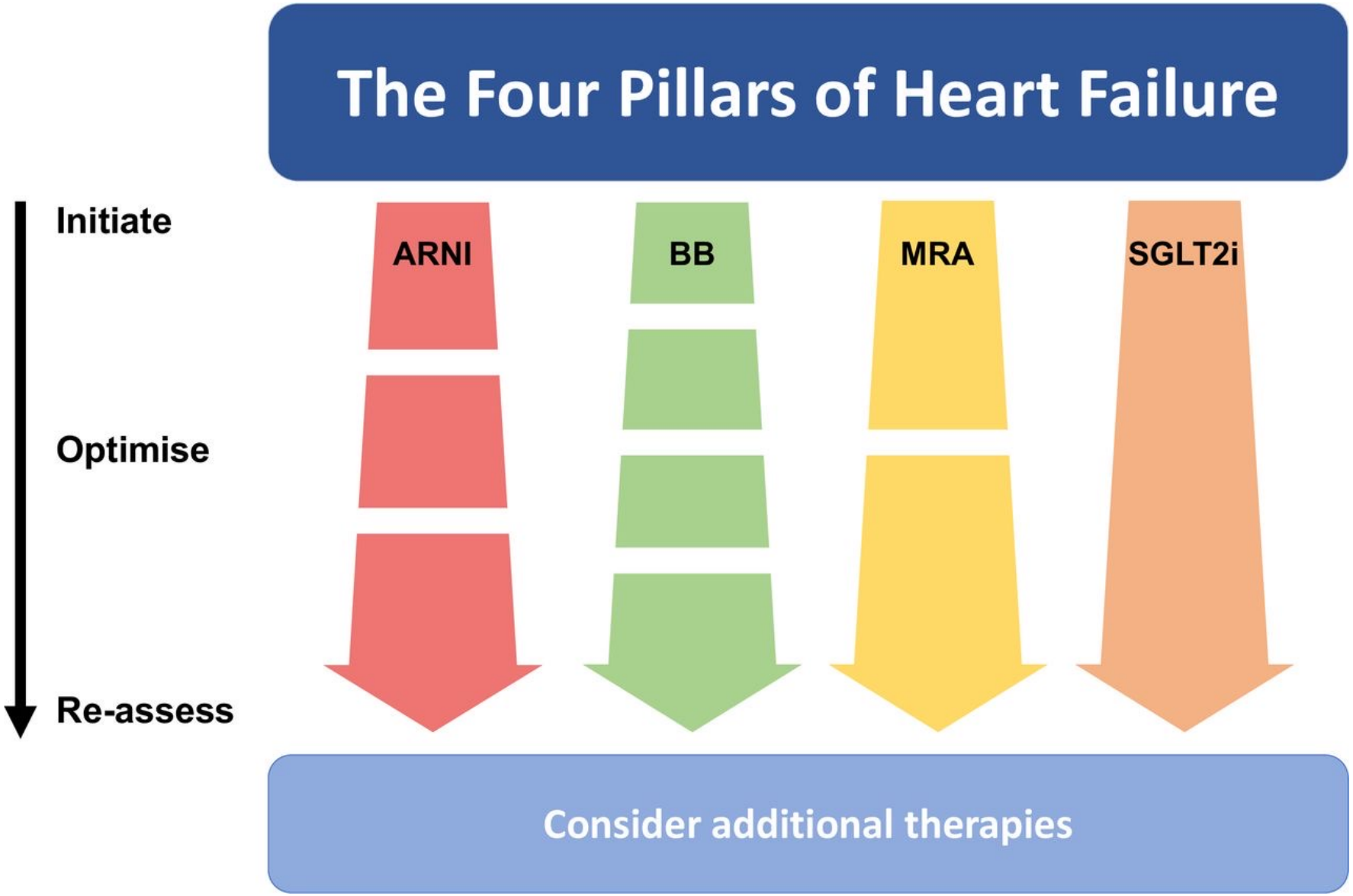
- **BB**: beta blocker meds. Blocks a beta receptor on heart cells, decrease Adrenalin levels…. (Toprol XL, Coreg and Bystolic).
- **SGLT2i**: medications that block a SGLT2 receptor in kidneys and used both to treat diabetes but also HF patients with/without diabetes. (e.g., Jardiance).
- **ARNI**: angiotensin receptor blocker agents. (e.g., Entresto). Also cousin of ACE inhibitors and ARB agents.
- **MRA**: mineralocorticoid antagonists, block detrimental hormone surge. (e.g., Spironolactone).



Straw S, McGinlay M, Witte KK
Four pillars of heart failure: contemporary pharmacological therapy for heart failure with reduced ejection fraction
Open Heart 2021;**8:**e001585. doi: 10.1136/openhrt-2021-001585

Benefits of Evidence Therapies in Patients with Systolic HF

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Evidence-Based Therapy	Relative Risk Reduction in All-Cause Mortality in Pivotal RCTs, %	NNT to Prevent All-Cause Mortality Over Time*
ACEi or ARB	17	22 over 42 mo
ARNi†	16	36 over 27 mo
Beta blocker	34	28 over 12 mo
Mineralocorticoid receptor antagonist	30	9 over 24 mo
SGLT2i	17	43 over 18 mo
Hydralazine or nitrate‡	43	25 over 10 mo
CRT	36	12 over 24 mo
ICD	23	14 over 60 mo

ACEi indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; ARNi, angiotensin receptor neprilysin inhibitor; CRT, cardiac resynchronization therapy; ICD, implantable cardioverter-defibrillator; SGLT2i, sodium-glucose cotransporter-2 inhibitor; and NNT, number needed to treat.

*Median duration follow-up in the respective clinical trial.
†Benefit of ARNi therapy incremental to that achieved with ACEi therapy. For the other medications shown, the benefits are based on comparisons to placebo control.
‡Benefit of hydralazine-nitrate therapy was limited to African American patients in this trial.

Table from: The 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure, slide 92.

What are the Medications used for Heart Failure?

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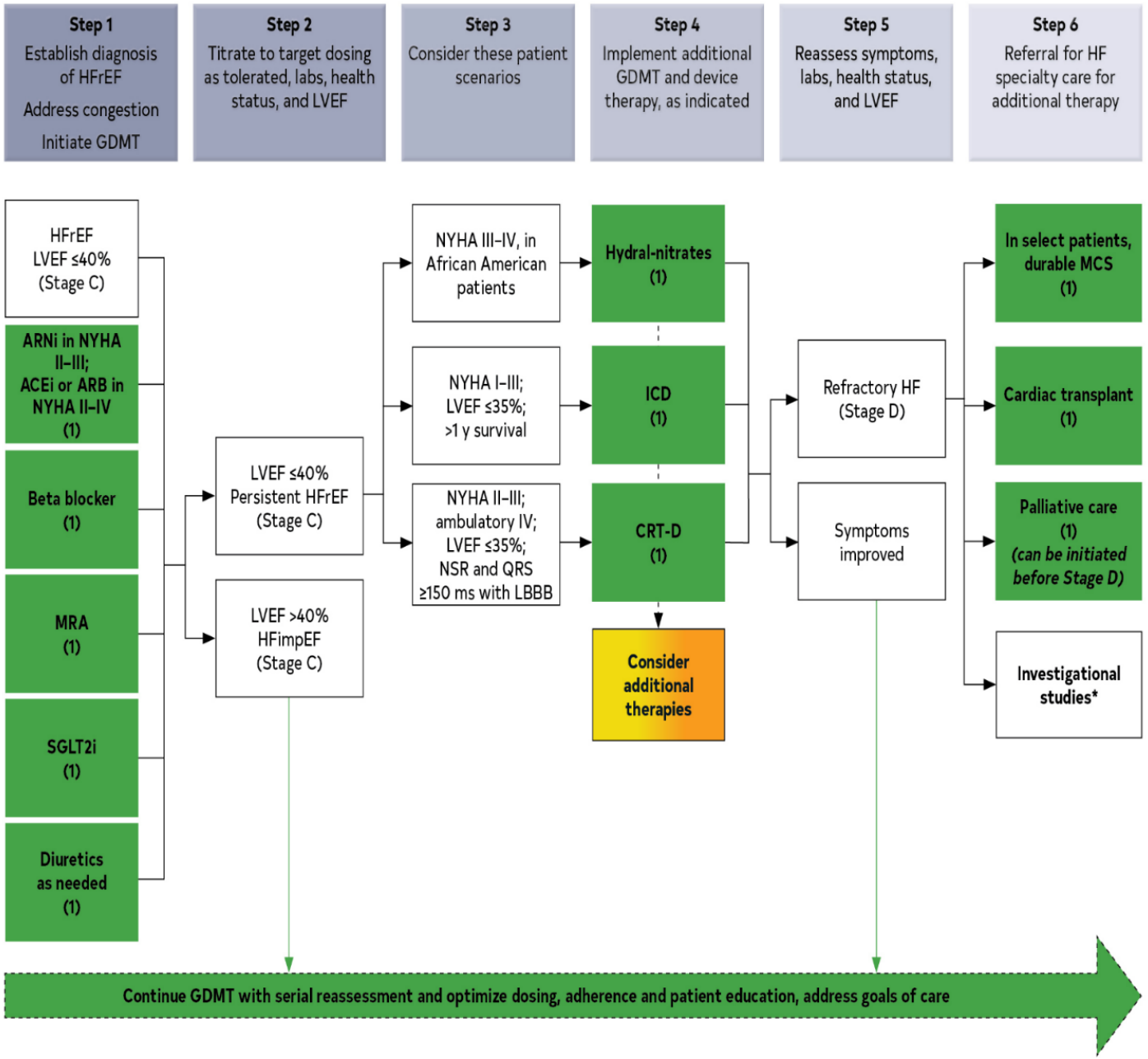
Experts recommend:

- Beta blockers - block high adrenalin levels in body. Can slow disease progression and make heart get stronger. (e.g., Carvidilol "Coreg" or Metoprolol "Toprol").
- ACE inhibitors or ARBs - block renin-angiotension hormone surge from kidneys and adrenal glands. Can slow disease progression and make heart get stronger. Increases blood flow. (e.g., Lisinopril, Monopril, Avapro, Diovan).
- Aldosterone blockers - block effects of highly elevated aldosterone hormone which causes heart to fibrosis, retain salt and water, weaken heart. Mild diuretic. (e.g., Spironolactone "Aldactone", "Inspra").
- SGLT2 inhibitors: probably about 4-6 mechanisms help heart cell work better besides it's glucose lowering (diabetes) mechanism.

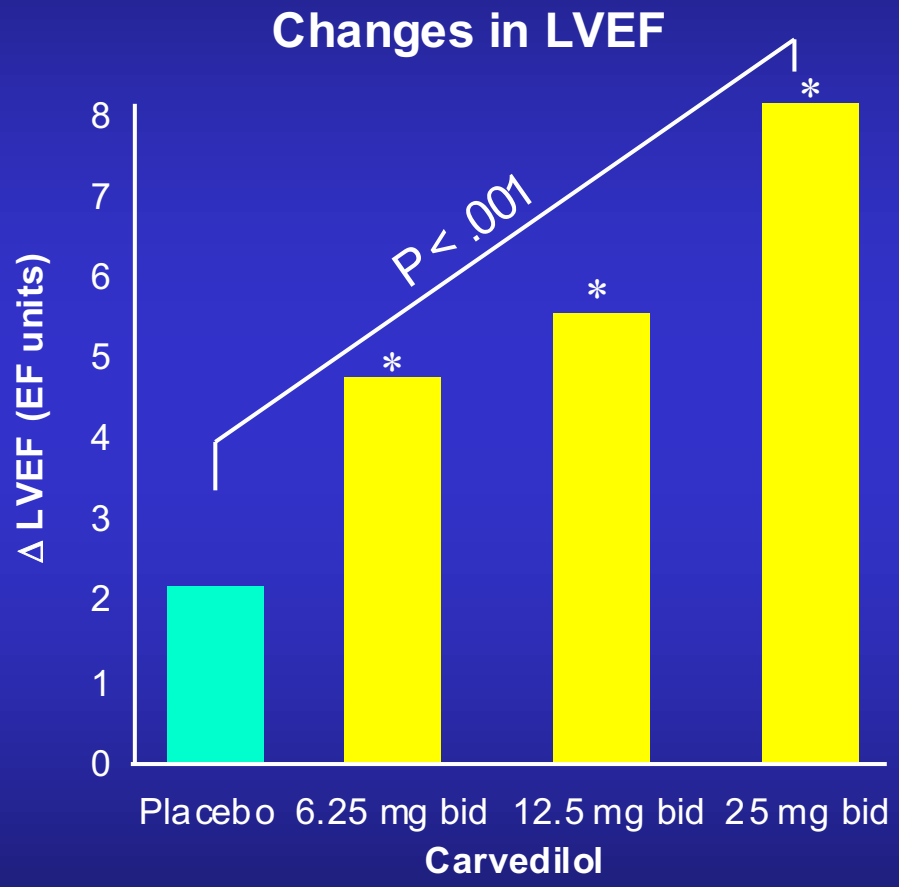
Treatment of Systolic CHF

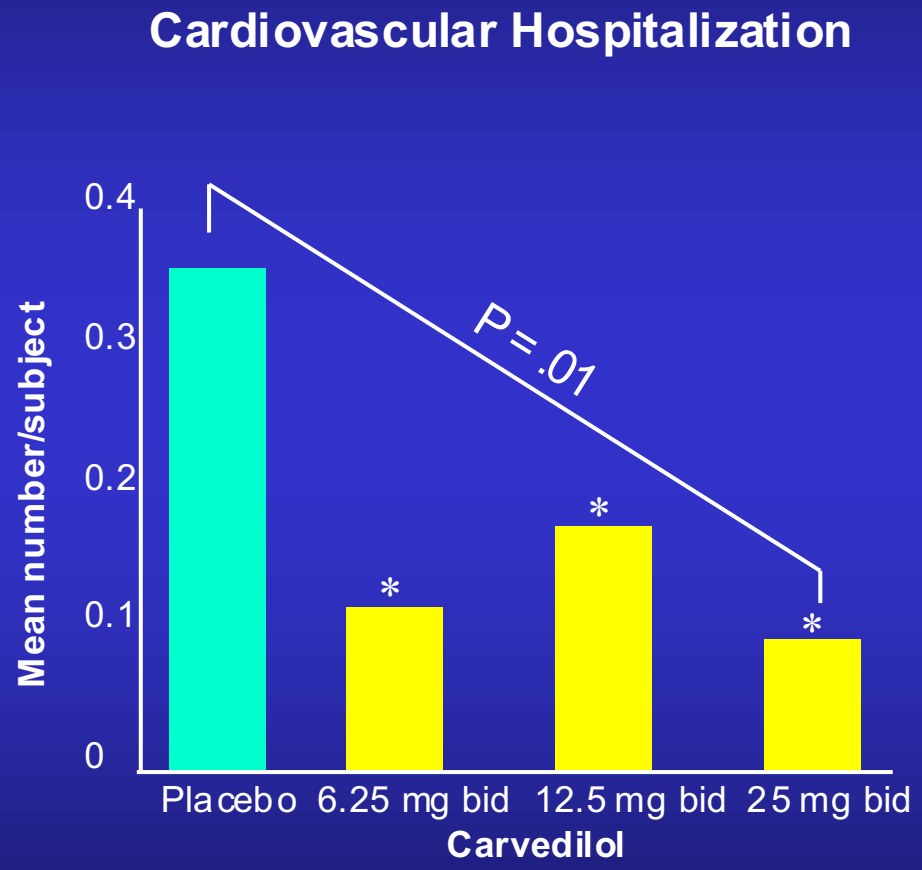


Treatment recommendations for patients with HFrEF are displayed. Step 1 medications may be started simultaneously at initial (low) doses recommended for HFrEF. Alternatively, these medications may be started sequentially, with sequence guided by clinical or other factors, without need to achieve target dosing before initiating next medication. Medication doses should be increased to target as tolerated.

Figure from from: The 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure, slide 79.

Carvedilol Dose-Response Trial (MOCHA)
Effect on Ejection Fraction and Morbidity





Patients receiving diuretics, ACE inhibitors, ± digoxin follow-up duration 6 months; placebo n=84), carvedilol (n=261). Adapted from Bristow, et al,1996.

**P < 0.5 vs placebo*

ACEI and ARBs and COVID infection

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- Initially some concern about taking ace inhibitor or Angiotensin receptor blocker meds used in HF and treatment of hypertension might increase risk of getting COVID infection.
- SARS-CoV2, which causes COVID-19, binds to ACE2 receptor and gains entry into host cells. ACEI and ARBs upregulate ACE2 receptor expression. Hypothesized initially that taking these meds lead to more severe infections and adverse outcomes.
- Have found this is not true and stopping your ACEI or ARB if have chronic HF can be very dangerous.

Medications Used in Heart Failure (II)

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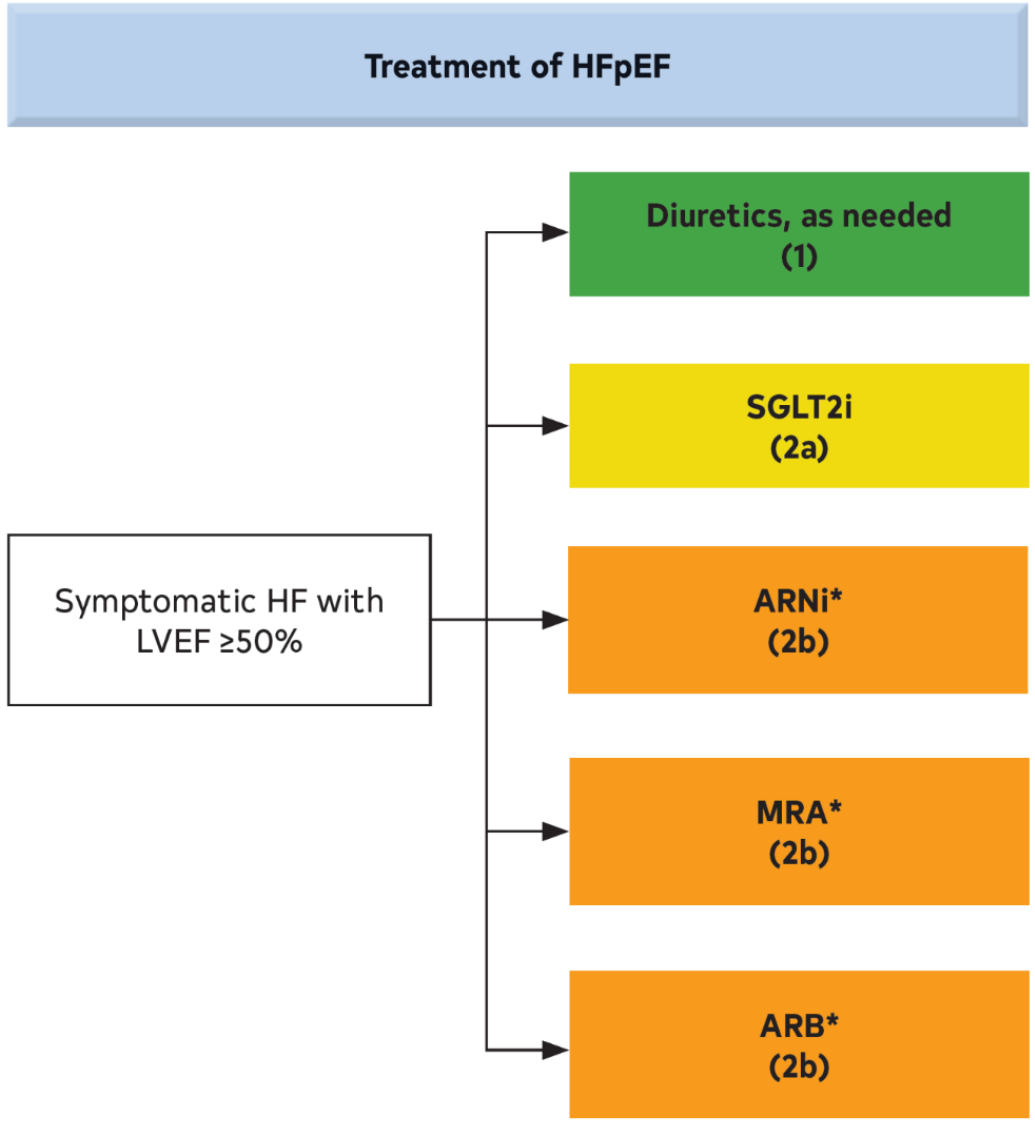
- Diuretics: helps urinate out water and salt. Controls symptoms of congestion (shortness of breath or swelling in legs). Examples: Furosemide “Lasix”, Torsemide “Demadex”, HCTZ.
- Digoxin (used less frequently now unless have AFIB too): weakly helps heart beat stronger.
- Hydralazine/isordil: especially help in African Americans with HF.

Treatment of Diastolic HF



Medication recommendations for HFpEF are displayed.

*Greater benefit in patients with LVEF closer to 50%.

ARB indicates angiotensin receptor blocker; ARNi, angiotensin receptor-neprilysin inhibitor; HF, heart failure; HFpEF, heart failure with preserved ejection fraction; LVEF, left ventricular ejection fraction; MRA, mineralocorticoid receptor antagonist; and SGLT2i, sodium-glucose cotransporter 2 inhibitor.

Figure from from: The 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure, slide 113.

Supplements in HF

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- Overall not found to be very helpful.
- Omega-3 free fatty acids helpful. Helps prevent further heart attacks and dementia.
- Coenzyme Q-10… If on statin.
- Multivitamin daily helpful.
- Iron if anemic.
- Rest of supplements not much if any benefit and overall trying to avoid polypharmacy and drug-drug reactions.

Treatments – Pacemakers and Defibrillators

- Regular Pacemakers – if slow, diseased electrical system in heart.
- Biventricular Pacemakers – If long “QRS” on EKG.
- Defibrillators – If LVEF <35% despite treatments at risk for serious, life-threatening heart arrhythmias. Recommendations are for defibrillators that can shock heart out of dangerous ventricular arrhythmia, if it occurs.

Advanced Therapies for HF: Mechanical Ventricular Assist Devices (VADS)

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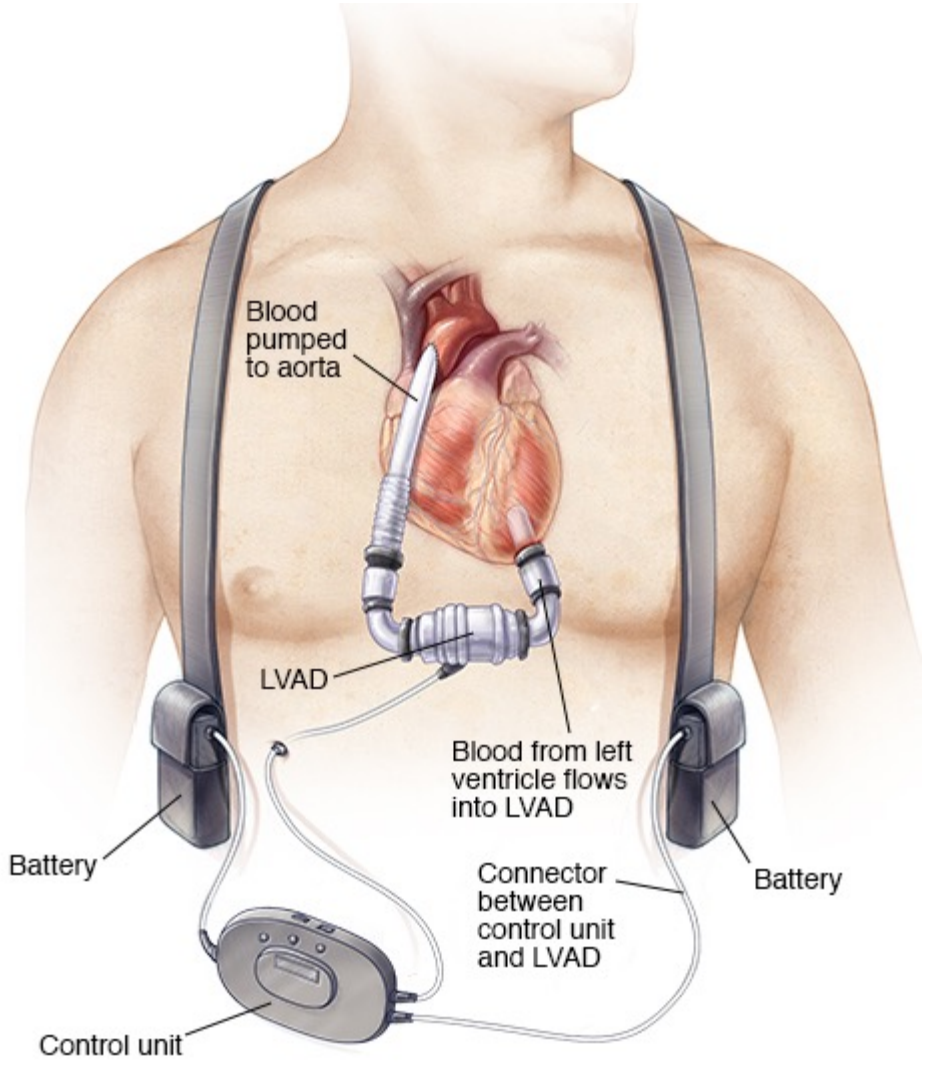

History of Transplant Medicine

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- 1947: first human cadaveric kidney transplant done in USA (Boston).
- 1963: first liver transplant in USA (Denver).
- 1966: first pancreatic transplant done.
- **1967: first heart transplant done by Christian Barnard in South Africa on December 3. Patient survives 18 days**.
- **1968: first heart transplant in USA by Norman Shumway at Stanford on January 6. Patient survives two weeks**.

History of Transplant Medicine

Boulder Community Health

- 1970: first heart-lung transplant.
- 1981: Cyclosporin discovered from mold in soil by German pharmacy company. Tested and approved for immunosuppression use in organ transplant recipients. Mortality and morbidity decreases dramatically. Heart transplant becomes more widespread thereafter.
- **Now: 3,000-4,000 heart transplant recipients/year in USA**.

Mortality

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- 20,000 living cardiac transplant recipients currently in US.

Years Since Surgery	Survival
• 1 year	85-90%
• 5 years	65%
• 9 years	50%
• 17 years	25%

Risk Factor/ Disease Modification for HF Patients

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- Patient Education on:
  - BP control (SBP 95-120. DBP <80)
  - fluid and salt restrictions (less than 2-4 grams Na/day)
  - pathophysiology of CHF and importance of hormones to help understand why polypharmacy needed. Helps with med compliance.
- Avoidance of NSAIDs
- Minimizing alcohol consumption
- Surveillance for cardiac ischemia
- Anticoagulation to reduce chance of TIA/ CVAs
- Sudden Death Prevention (holters, defibrillators)
- Prevention of Significant Anemia
- Immunizations
- Obesity/ Weight loss
- CHF Specialty Clinic referral options

Risk Factor Modification: Flu/immunizations

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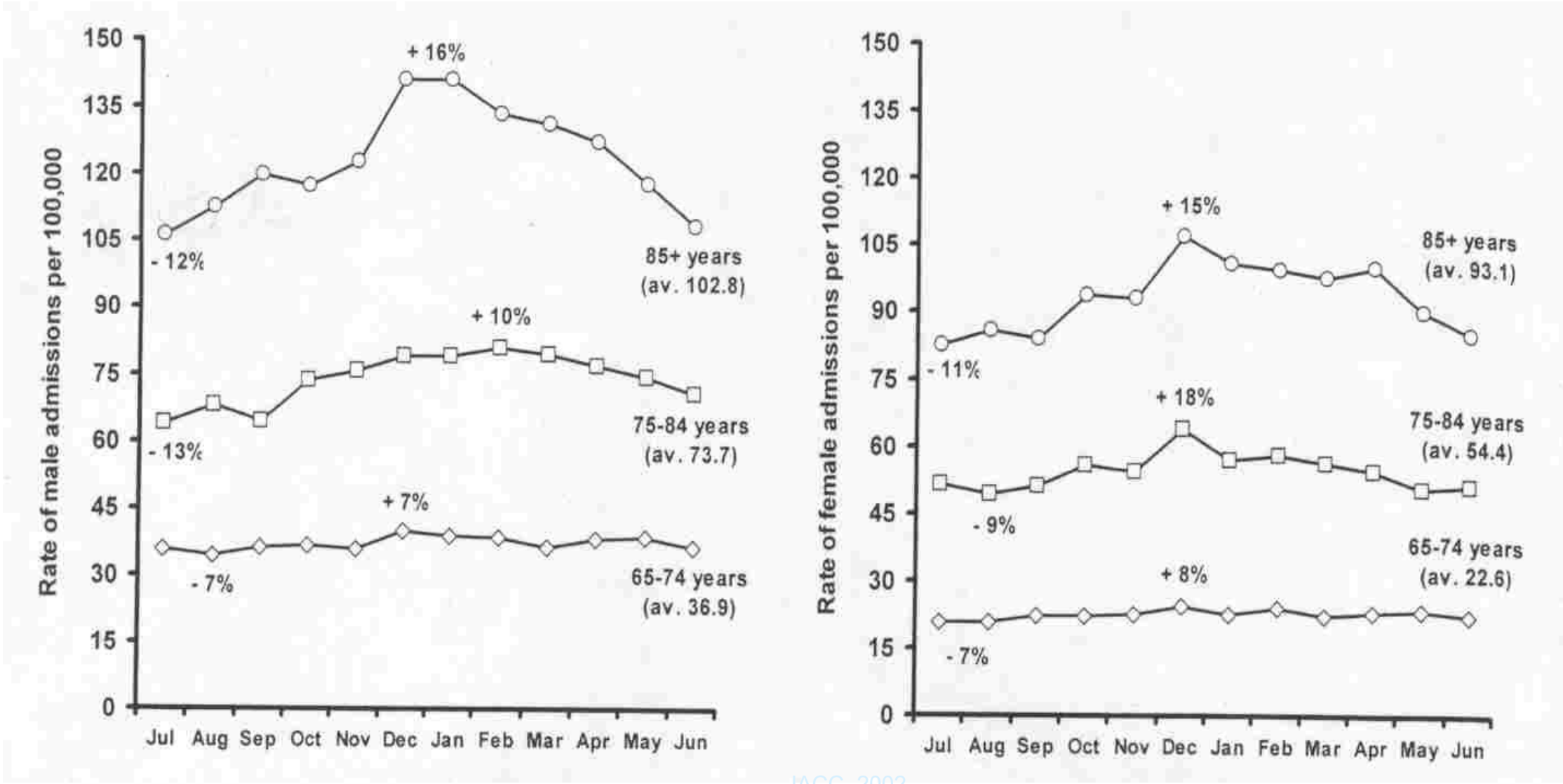
- "Heart Failure in a Cold Climate: Seasonal Variations in HF-related Morbidity and Mortality," JACC 2002.
  - Scotland 1990 to 1996
  - Elderly pts (>75y/o), **15-18% higher admission and mortality rate in winter months**.
  - Author's conclusions:
    - Higher morbidity and mortality of HF pts attributable to concurrent respiratory illnesses.
    - Extra vigilance of HF pts advised in winter.
    - **Immunize against pneumococcus and influenza.**

Modification of Risk Factors: Seasonal Variation in Heart Failure Hospitalizations and Deaths



JACC, 2002.

Risk Factor Modification: Obesity

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- Update of Framingham study, NEJM 2002
  - Body Mass Index (BMI)
    - 18.5 to 24.9 normal
    - 25.0 to 29.9 overweight
    - >30.0 obese
  - **Obesity linked to heart enlarging, HF and diabetes.**
  - **Men: 5% increase risk of developing HF per 1% increase in BMI.**
  - **Women: 7% increase risk of developing HF per 1% increase in BMI.**

Risk Factor Modification: NSAIDs

Boulder Community Health

- "Association of NSAIDs with First Occurrence of HF and with Relapsing HF," Arch Int Med 2002.
  - 7,277 pts followed in Rotterdam with HF.
  - **People with HF who used NSAIDs on a regular daily basis had 10-fold risk of dying than if not using NSAIDS regularly**.
  - Conclusions: 1) NSAIDs reduce renal perfusion; 2) impair adequacy of renal prostaglandin production. Renal prostaglandins crucial role in compensating renal hemodynamics in pts with LV systolic dysfunction; 3) increase serum creatinine levels.

Salt and Water Restrictions in Heart Failure

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- Weakened heart has a difficult time pumping water and salt thru heart out to kidneys to urinate out of body.
- Many of deleterious hormones activated in HF cause water and salt/sodium retention.
- HF patient should limit total fluid intake per day to <64 oz (6-8 glasses total fluid).
- HF patient should limit to sodium intake to <1,800 mg per day.

Smoking and Alcohol in Heart Failure

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- Need to stop smoking completely. If continue smoking, poor prognosis even if on right HF medications and treatments. Heart is already weaken and continued cigarette/nicotine can cause constriction of blood vessels, new heart attacks and sticky blood that make HF patient at risk for stroke.
- Alcohol >two glasses per day turns into toxin to heart. Cut back heavy alcohol use or heart will not get better.

Exercise in Heart Failure

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- Usually it is safe and important to exercise if have heart failure.
- Studies show MODERATE exercise 3-4x/week for 30 minutes each session has survival benefit in HF.
- Out-patient cardiac rehab is now covered by Medicare for patients with chronic heart failure.

Understanding Need for Polypharmacy in Treating Heart Failure

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- Many deleterious hormones turned on in HF (at least 3-4 hormone systems known already and more being discovered).
- No magic bullet pill that will cure HF.
- Usually need to take 4-7 meds to best treat HF. Luckily most of these are all now generic ($4-10/month/medication).
- Need to learn to compulsively monitor daily weight with scale at home and diary.

Risk Factor Modification: CHF Referral Centers

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Getting your care at a designated CHF clinic has many good outcomes:

- Get on best HF meds and at right doses.
- Many studies show better survival and less chance of getting hospitalized for HF decompensation if get care at designated HF center like Boulder Heart.
- More cost effective. Less expenses for both patient and healthcare system.
- More understanding of their disease process with more time for communication and explaining HF and answering questions.
- More accessibility to telephone RNs and answering questions.
- Outcomes at Boulder Foothills Hospital for treating HF and survival one of best in state of Colorado and better than national norms.

Future Breakthroughs

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- Genomic Testing – sample of blood to see that genes you have and what medications will work best for you. Are you a better responder to Toprol XL or Coreg?
- Stem Cell Replacement in Heart – via surgical injection into injured part of heart or via blood transfusion.
- Gene Replacement – to grow new muscle cells in heart.
- Mechanical Hearts – continue to be smaller and less morbidity and last longer without clots in pump or pump parts wearing out.

Summary (I)

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- Heart Failure (HF) is when the heart is not strong enough to pump blood to keep up with metabolic needs of body.
- HF is most common and expensive cardiac condition in USA. 1:5 people will develop HF in their lifetime.
- Symptoms are many and vague. Shortness of breath, swelling body and fatigue most common.
- Echocardiogram (echo) is most important test to evaluate and confirm HF.

Summary (II)

Boulder Community Health

- HF is not an irreversible disease usually. Since early 1990s, many medicines and pacemakers have been developed that can make HF a chronic, tolerable disease with potential for the heart muscle to regenerate and get stronger.
- Early detection of HF is important and portends to best chance of recovery and good overall prognosis.
- If one has HF, many lifestyle modifications are necessary to do well (moderate exercise, salt and water restrictions, adherence to complex polypharmacy regime, stop smoking, keep up with vaccinations, etc.)
- HF clinics like the one we have at Boulder Heart are best at treating HF and usually have the best survival rates.

Thank You!

Boulder Community Health

Questions?

Recognizing and Treating Heart Failure

Scott Blois, MD and Liana Quinn, PA
Boulder Heart, 720-443-0163

Boulder Community Health