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Foundations of Cardiometabolic Health Certification Course

Certified Cardiometabolic Health Professional (CCHP)

Heart Failure

Alanna A. Morris MD, MSc

Associate Professor of Medicine

Director of Heart Failure Research

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Definition, Epidemiology, and Pathophysiology of Heart Failure

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Heart Failure (HF):

High Morbidity, Mortality, and Costs

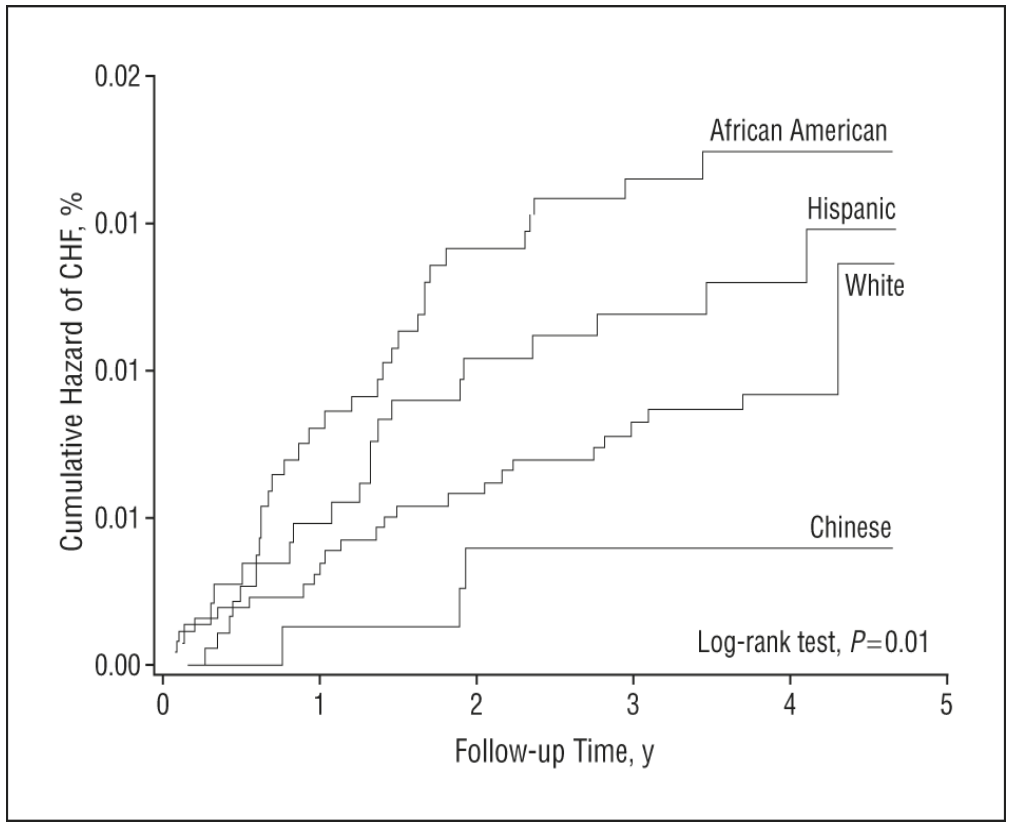
Prevalence	Incidence	Mortality	Hospital Discharges	Cost
~6,500,000	~1,000,000	42-50% at 5 years	994,000	$30.7 billion

- Major cost-driver of HF is high incidence of hospitalizations

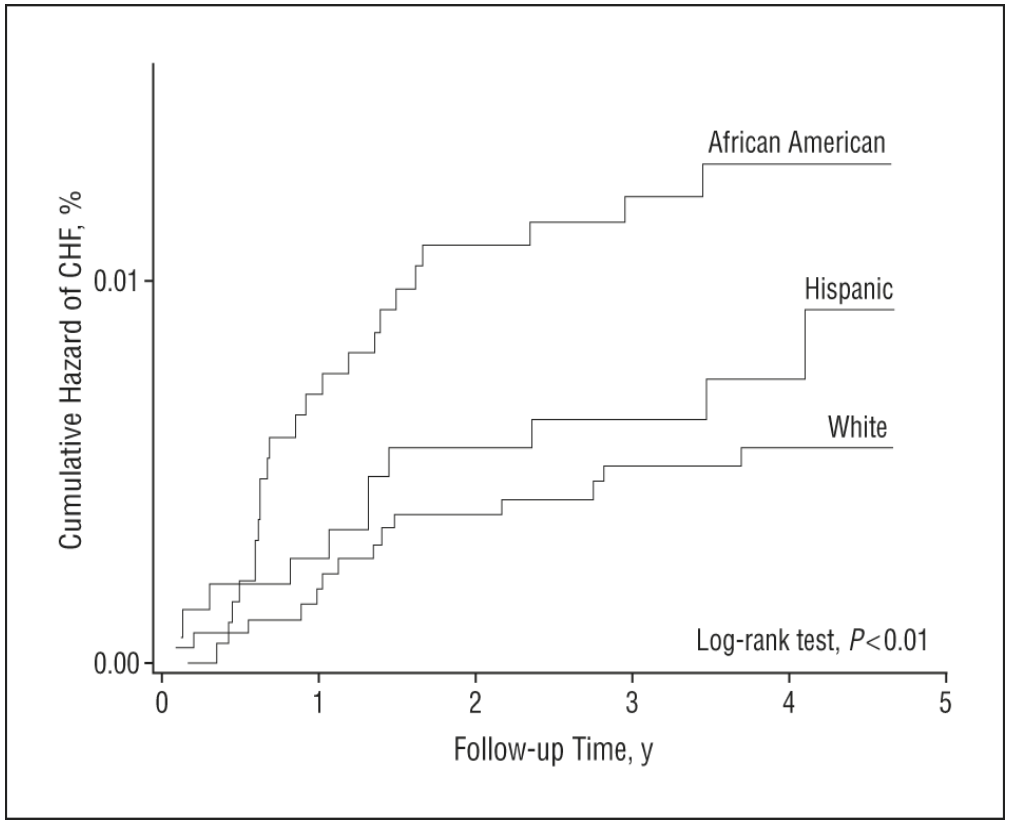
Virani et al. AHA *2021 Heart Dz and Stroke Statistics*

Incidence of HF Differs by Race and Ethnicity

Multi-Ethnic Study of Atherosclerosis (MESA) N=6814
Median follow-up 4.0 years



All Participants

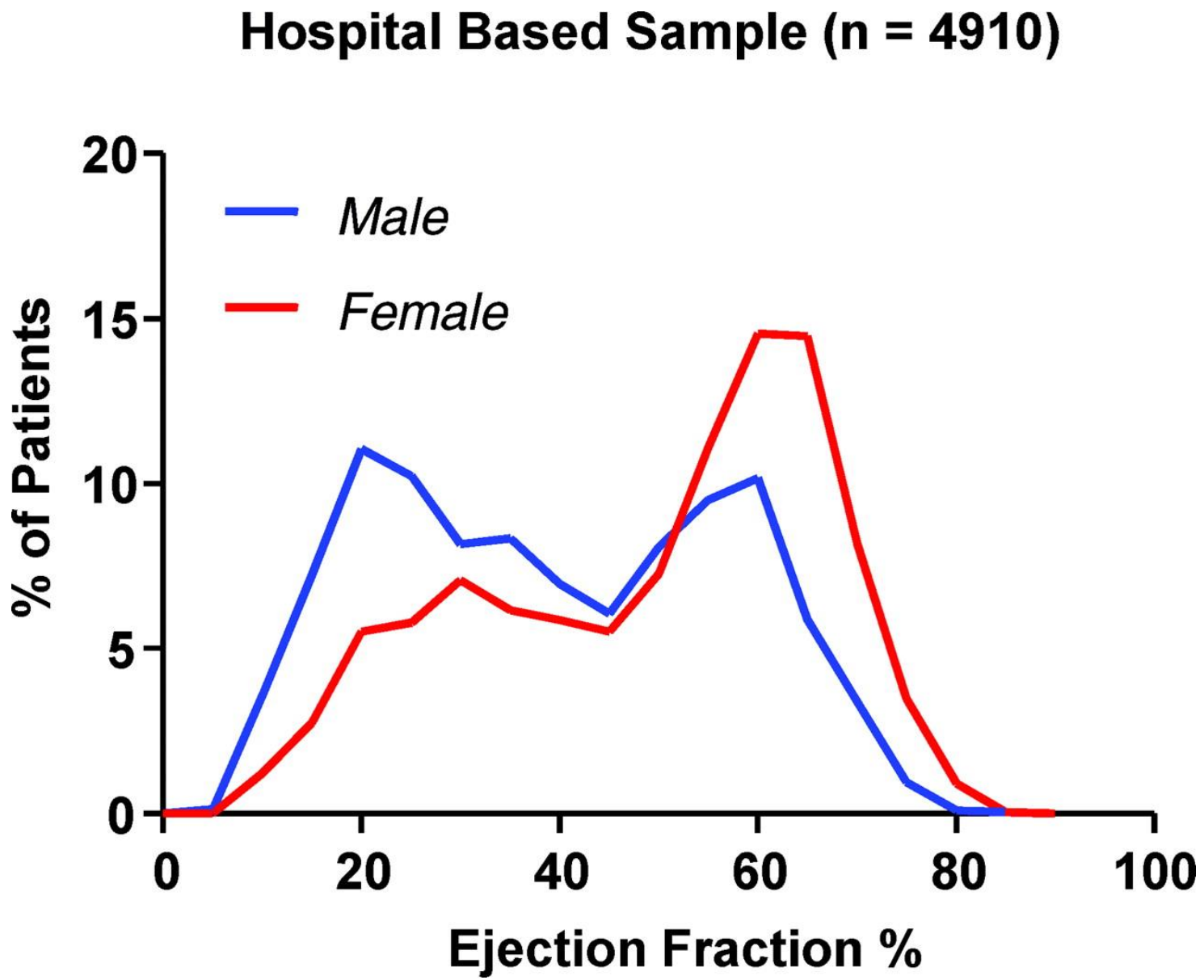


Participants without an Interim Myocardial Infarction

JAMA Network™

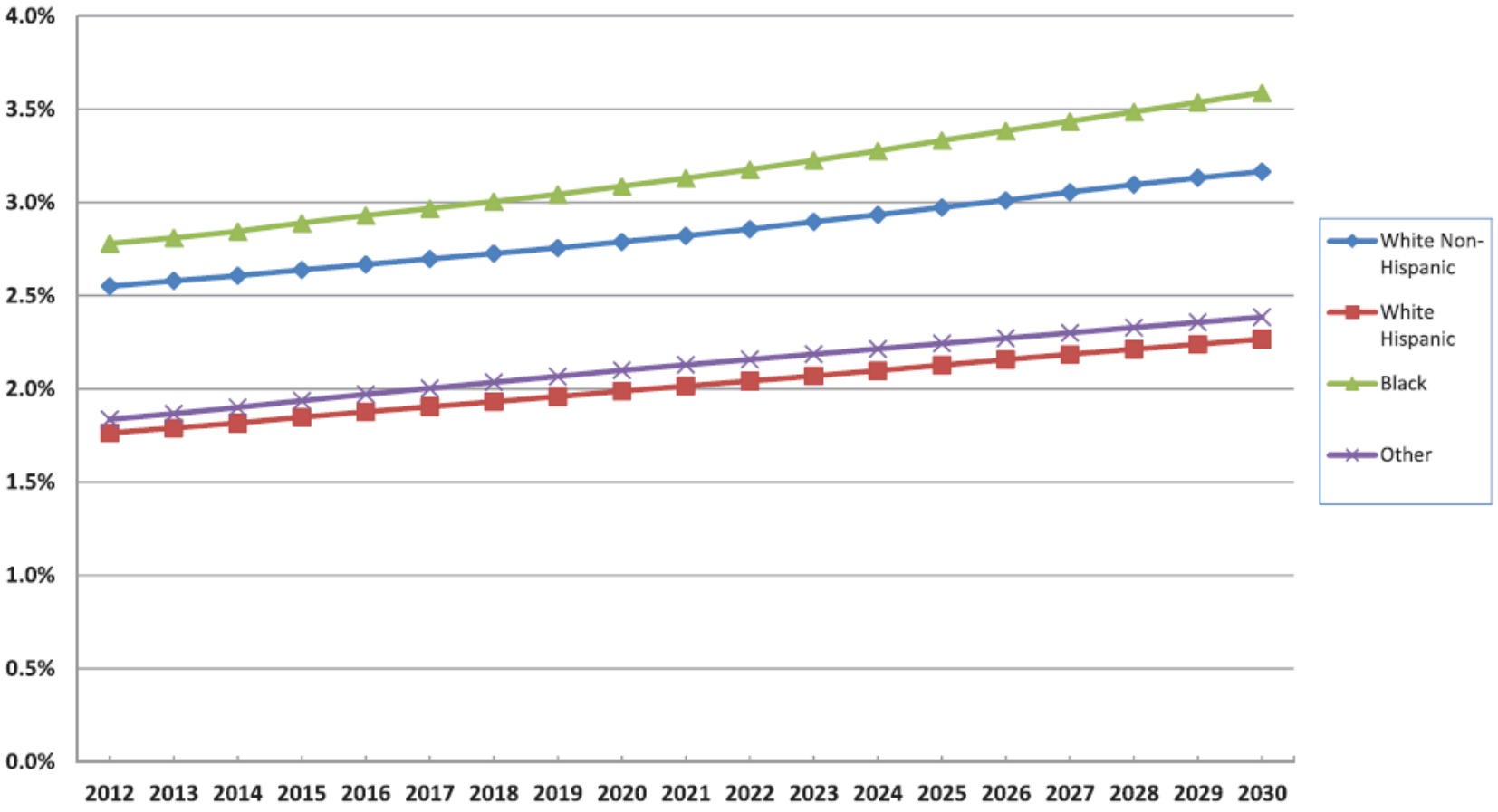
Bahrami et al. Arch Intern Med. 2008;168(19):2138-2145.

Incidence of HF Differs by Gender



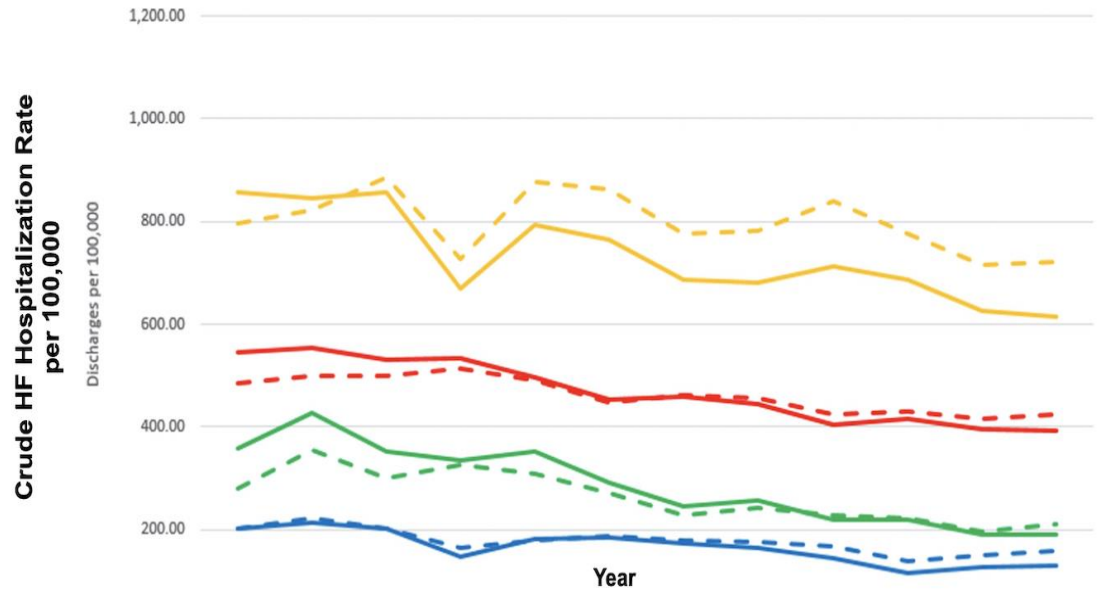
Borlaug and Redfield. Circulation. 2011

Prevalence of HF Differs by Race and Ethnicity

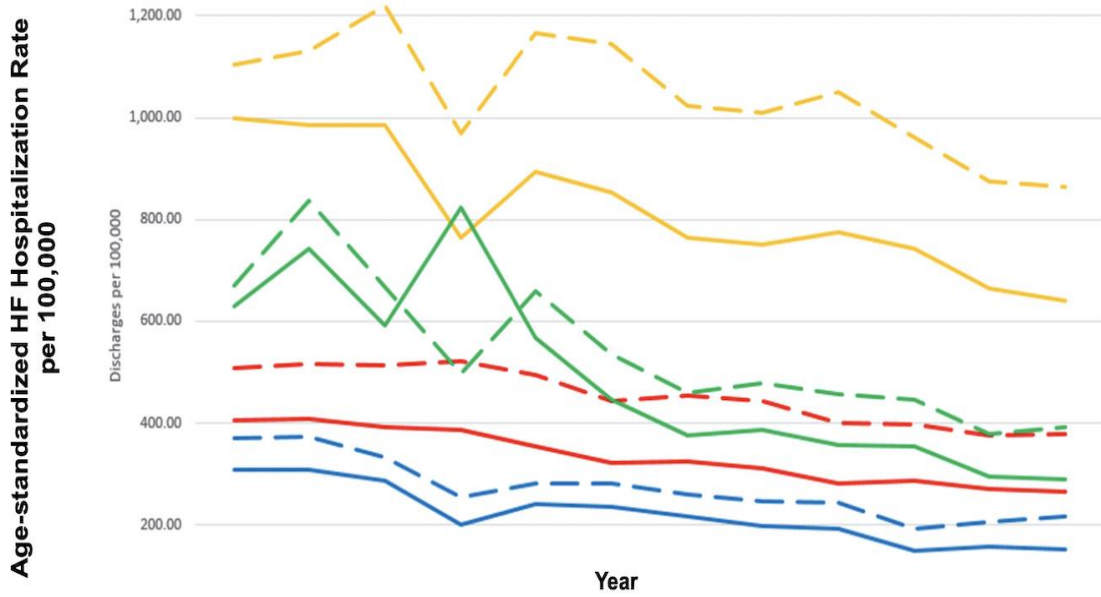


Heidenreich et al. Circulation HF 2013

Black Americans Have Higher Rates of HF-related Hospitalization



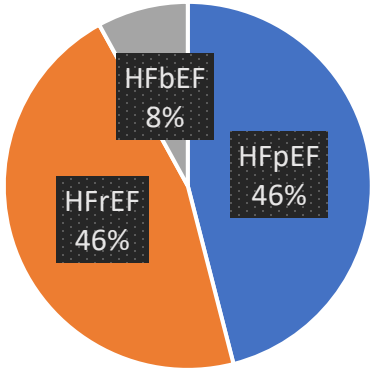
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White Male	484.40	499.16	499.60	513.97	491.34	446.48	460.38	457.01	423.87	428.42	414.35	423.54
White Female	546.00	553.67	531.73	533.53	494.81	453.33	459.81	443.83	403.86	416.16	395.54	391.83
Black Male	797.24	821.17	887.15	727.78	876.40	864.05	775.70	782.31	840.97	776.95	716.85	720.75
Black Female	856.07	846.02	856.63	669.81	792.10	764.69	687.77	682.26	711.92	686.39	625.05	613.75
Hispanic Male	281.03	354.75	300.06	325.56	307.95	270.22	228.34	241.53	227.58	221.71	197.32	210.23
Hispanic Female	359.01	427.52	350.93	334.17	352.22	290.18	244.46	257.66	220.19	219.04	190.49	190.93
Asian & PI Male	202.75	222.46	201.23	163.21	178.46	188.20	179.59	175.73	166.13	137.06	150.51	158.99
Asian & PI Female	202.09	212.04	200.84	148.03	181.45	184.74	173.51	163.81	145.40	116.34	127.49	128.95

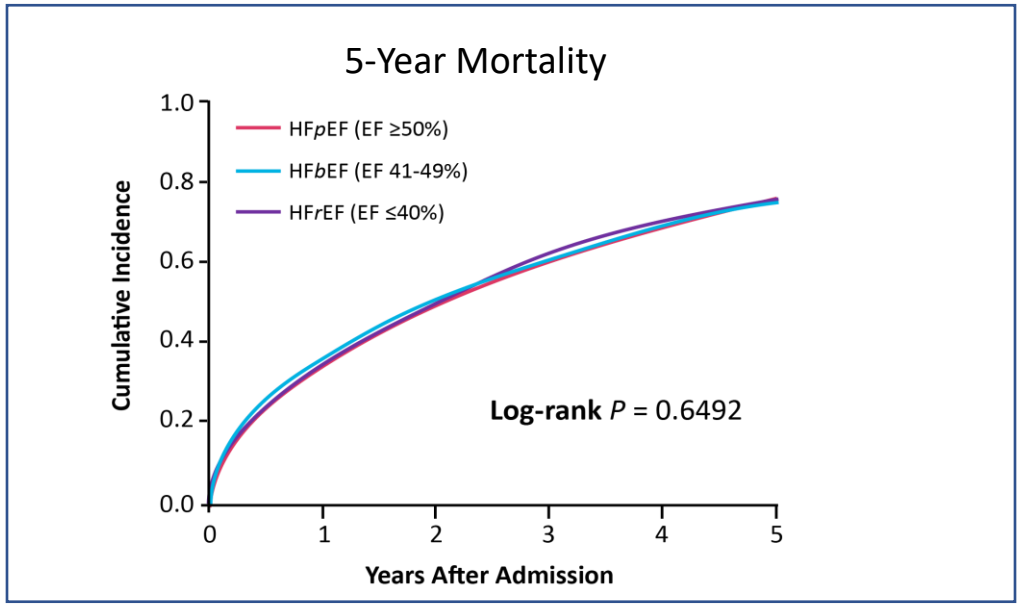


	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White Male	507.53	516.25	512.23	522.82	495.41	444.71	452.85	443.13	398.94	396.89	376.24	377.79
White Female	405.22	409.57	390.87	386.53	355.04	322.36	324.28	310.89	280.38	286.51	270.22	266.33
Black Male	1,104.07	1,131.19	1,221.23	968.52	1,164.84	1,144.04	1,021.79	1,010.83	1,050.09	960.94	875.29	863.45
Black Female	998.24	984.48	986.25	763.42	894.90	852.33	764.33	749.91	775.30	741.44	663.38	640.17
Hispanic Male	668.89	835.76	668.05	498.59	659.28	535.65	459.66	478.42	457.8	445.08	379.27	392.63
Hispanic Female	628.96	742.29	591.58	824.91	566.33	447.17	376.01	387.74	358.11	353.47	294.65	288.48
Asian & PI Male	371.14	373.78	333.58	253.94	282.08	282.87	259.17	246.22	242.99	192.63	206.82	215.53
Asian & PI Female	308.83	307.93	287.65	200.70	242.04	234.60	215.66	197.04	193.36	148.30	156.84	152.19

Ziaeian et al. Circ Cardiovasc Qual Outcomes. 2017;10

5-Year Outcomes of Elderly Patients Hospitalized with Heart Failure





Outcomes – 5-Year Event Rates (%)					
	Mortality	Readmission	CV Readmission	HF Readmission	Mortality/ Readmission
HFrEF	75.3	82.2	63.9	48.5	96.4
HFbEF	75.7	85.7	63.3	45.2	97.2
HFpEF	75.7	84.0	58.9	40.5	97.3

HFrEF: heart failure with reduced ejection fraction; HFbEF: heart failure with borderline ejection fraction; HFpEF: heart failure with preserved ejection fraction

Shah et al. J Am Coll Cardiol. 2017;70(20):2476-86.

Universal Definition of Heart Failure

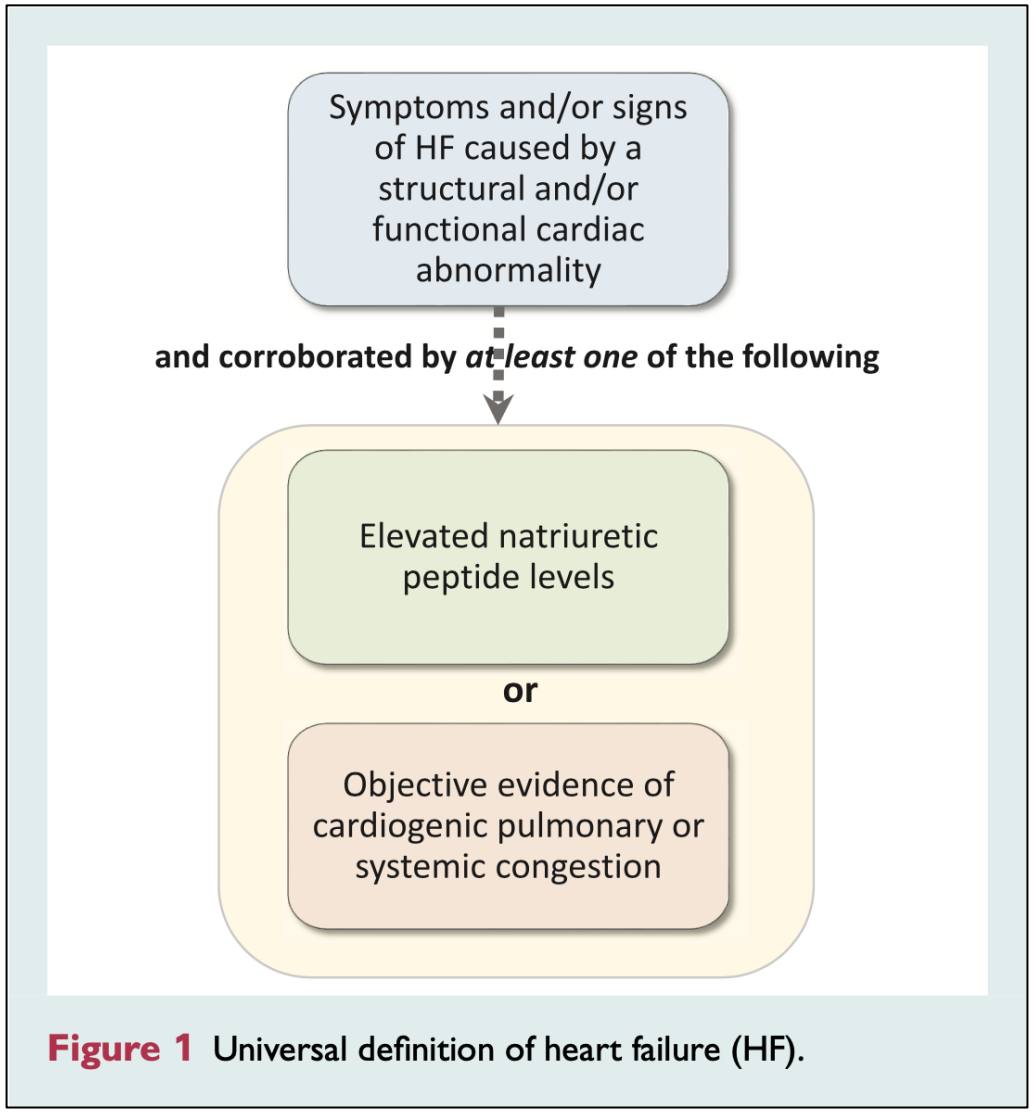


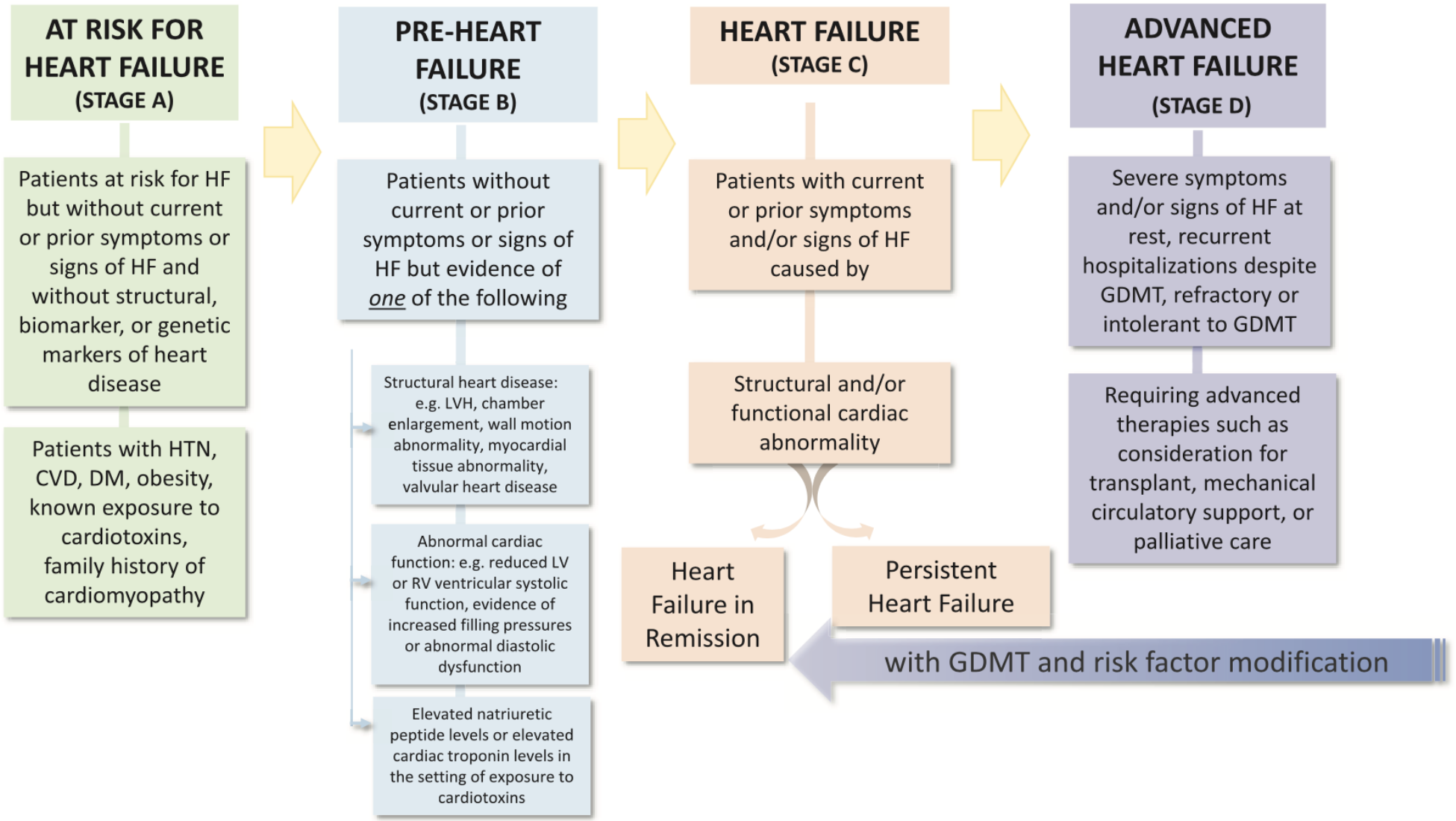
Figure 1 Universal definition of heart failure (HF).

Table 7 Natriuretic peptide levels supporting definition of heart failure

	Ambulatory	Hospitalized/ decompensated
BNP pg/ml	≥35	≥ 100
NT-proBNP pg/ml	≥ 125	≥ 300

Bozkurt et al. J Card Fail 2021

Universal Definition of Heart Failure: Stages



Bozkurt et al. J Card Fail 2021

Classifications of HF According to Ejection Fraction (EF)

Normal:

- LVEF >55%

HF with reduced EF (HFrEF):

- HF with LVEF ≤40%

HF with mildly reduced EF (HFmrEF):

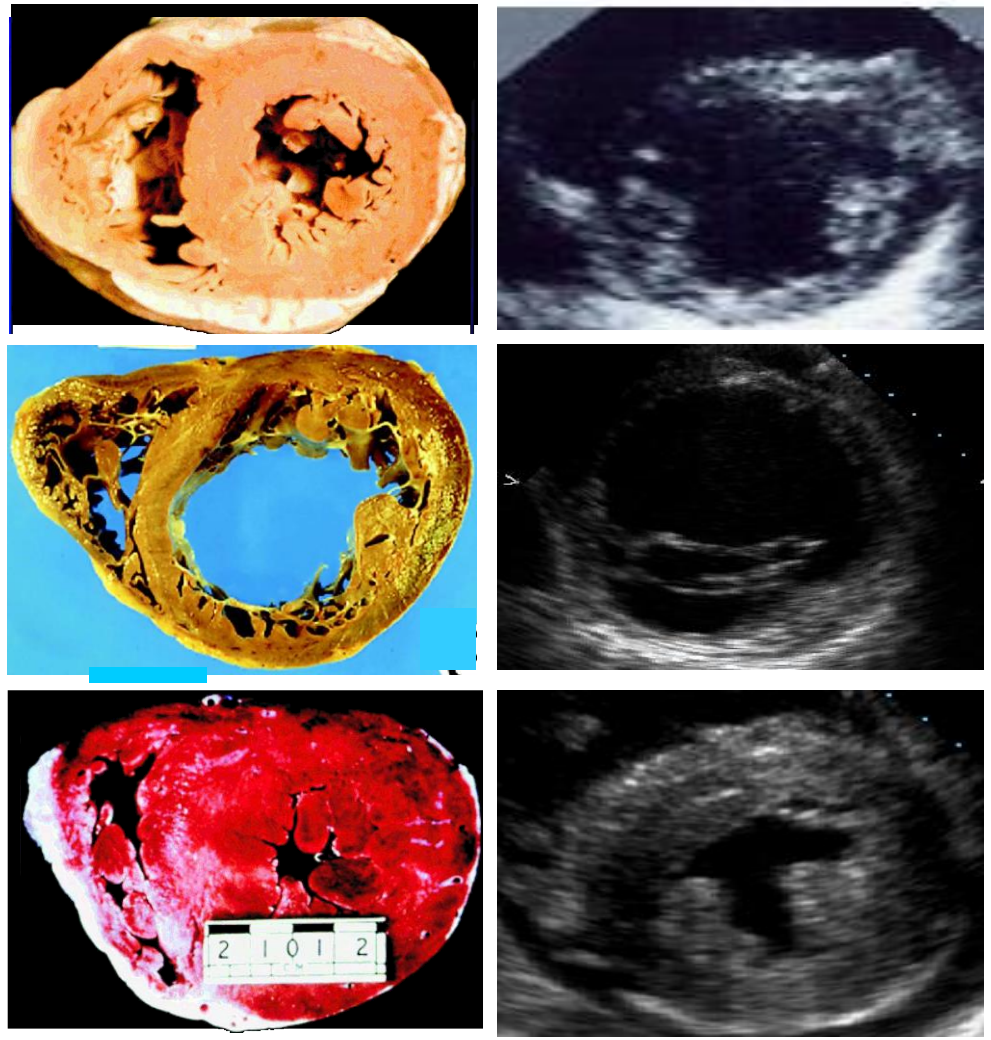
- HF with LVEF 41–49%

HF with preserved EF (HFpEF):

- HF with LVEF ≥50%

HF with improved EF (HFimpEF):

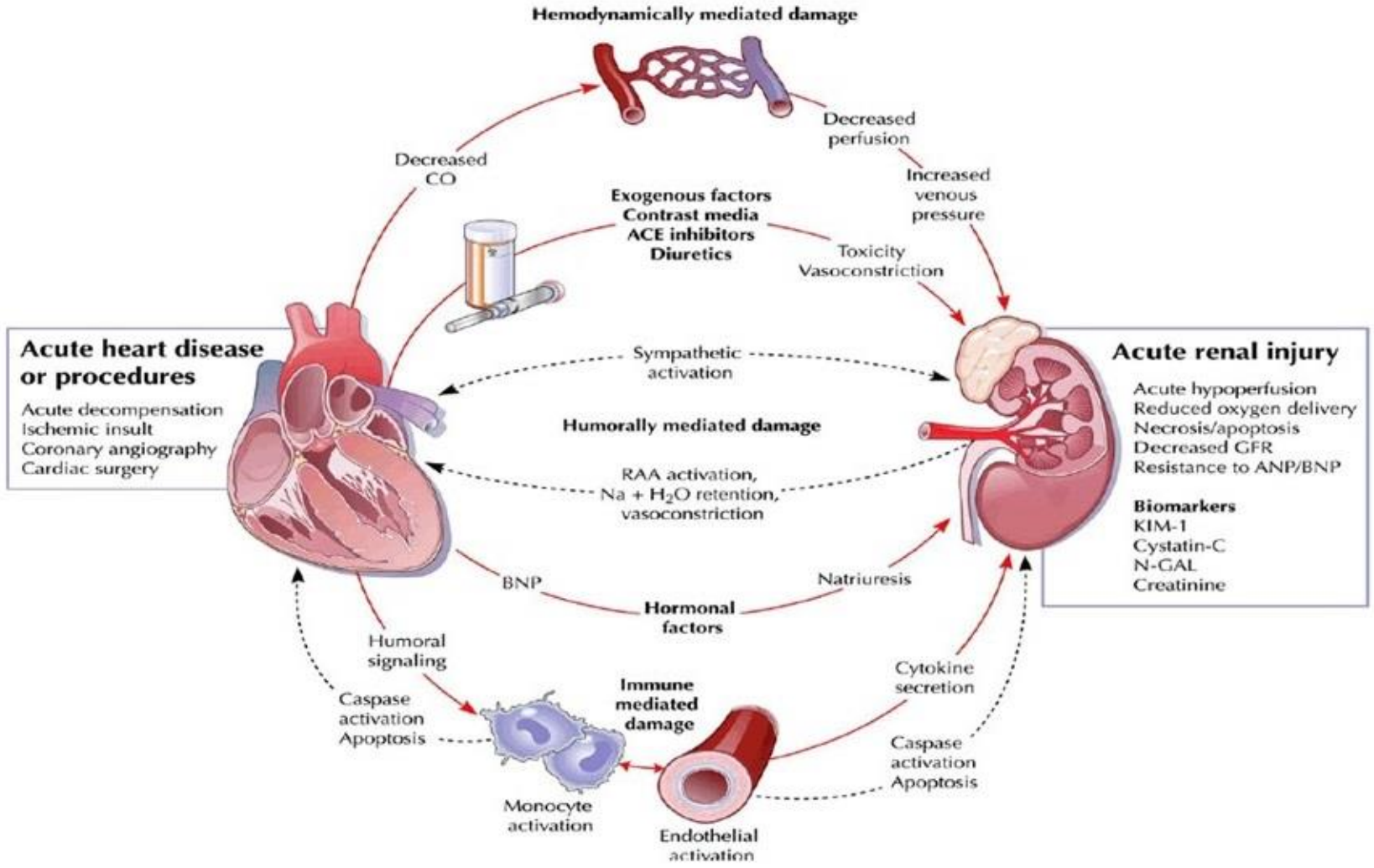
- HF with a baseline LVEF ≤40%, a ≥10 point increase from baseline LVEF, and a second measurement of LVEF >40%



Bozkurt et al. J Card Fail 2021

Image Source: Jessup M, Brozena SA. New Engl J Med. 2003;348:2007-2018:

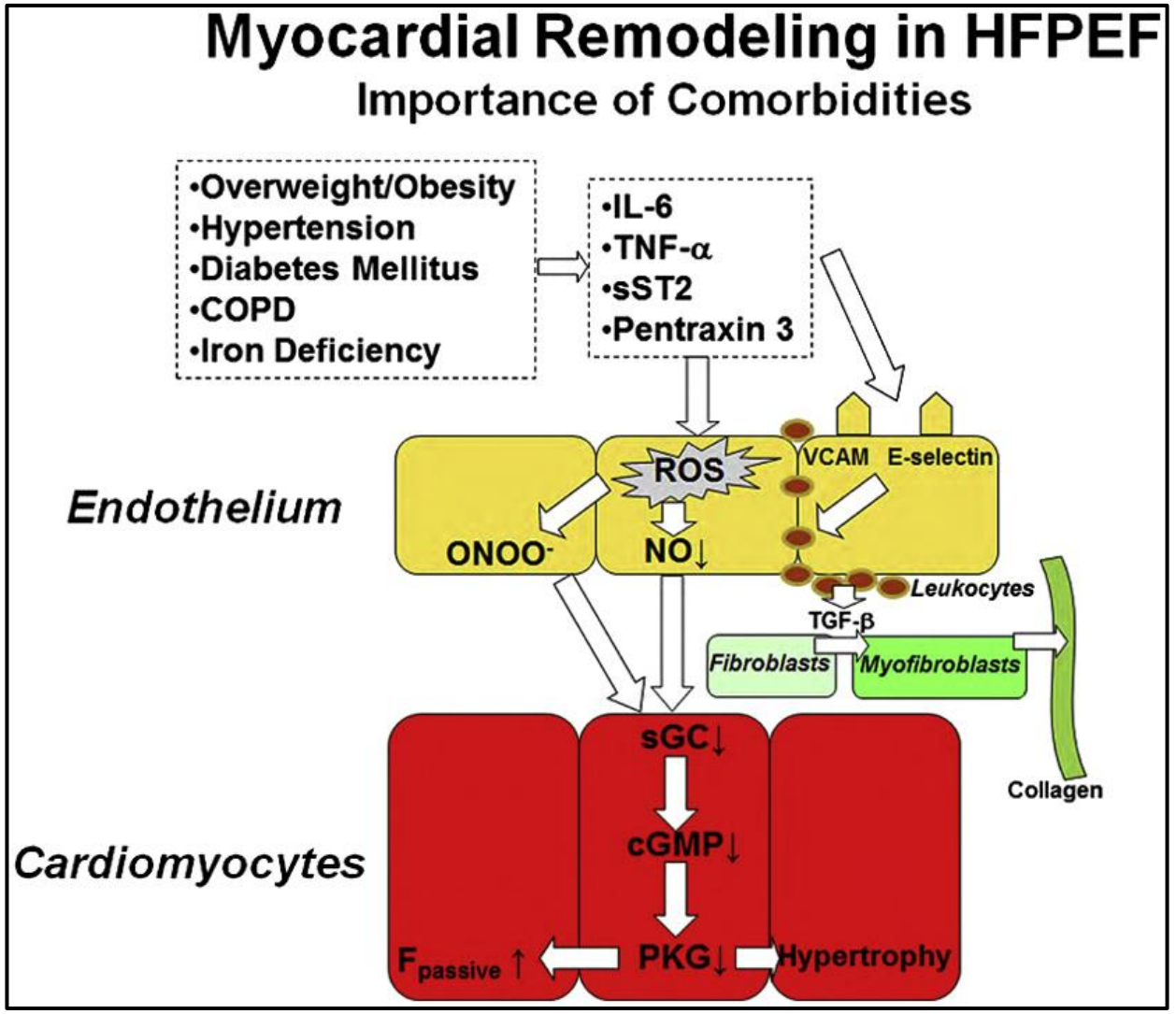
Pathophysiology of HFrEF



Capote et al. Pathophysiology of Heart Failure. In: Jagadeesh G., Balakumar P., Maung-U K. (eds) Pathophysiology and Pharmacotherapy of Cardiovascular Disease 2015

Pathophysiology of HFpEF:

Comorbidities Drive Myocardial Dysfunction through Inflammation

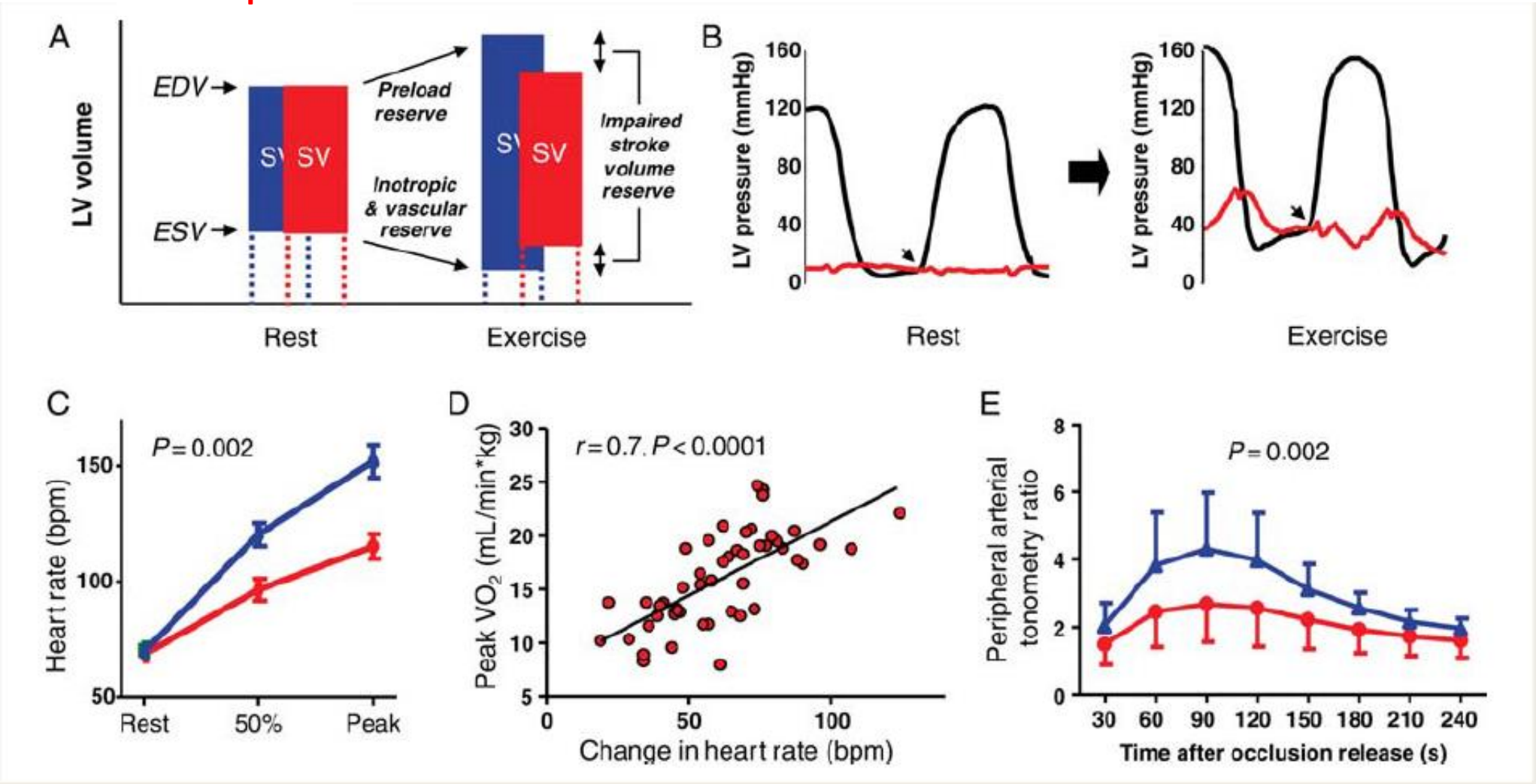


Paulus & Tschope. JACC 2013

Pathophysiology of HFpEF

Blue=controls

Red=HFpEF



Borlaug and Paulus Eur Ht J 2011

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HF & Cardiometabolic Risk connections

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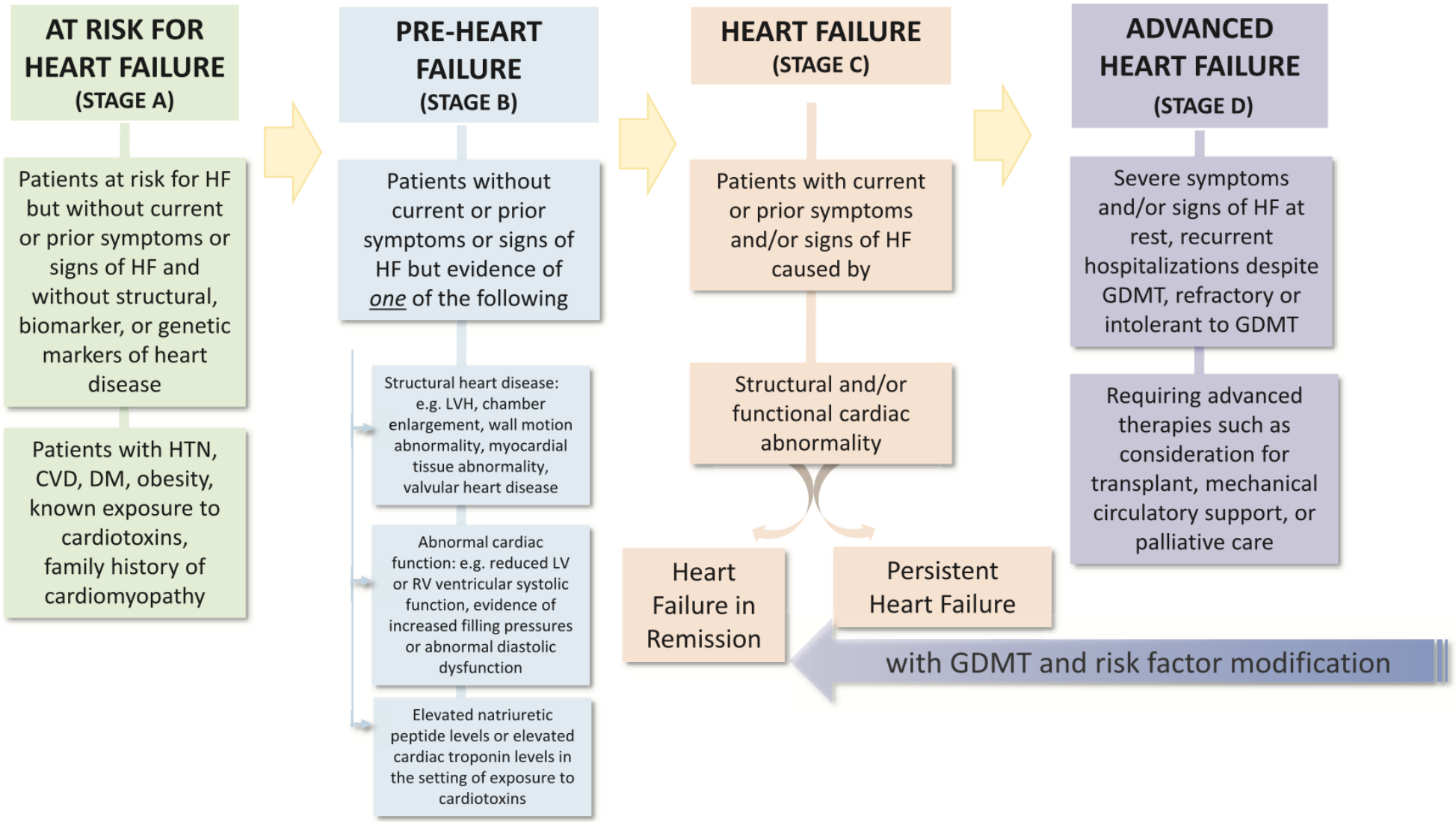
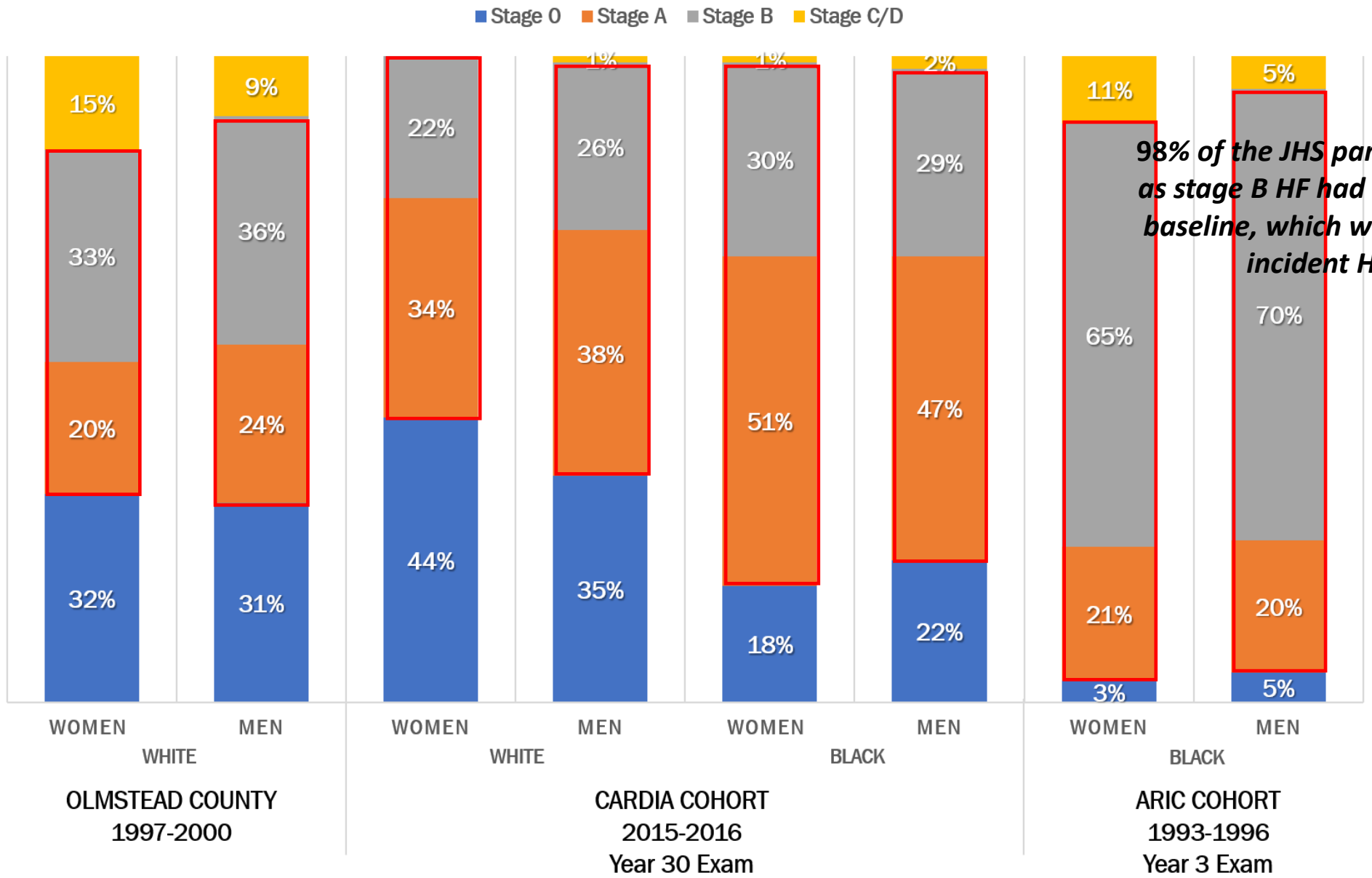
Universal Definition of Heart Failure: Stages



Bozkurt et al. J Card Fail 2021

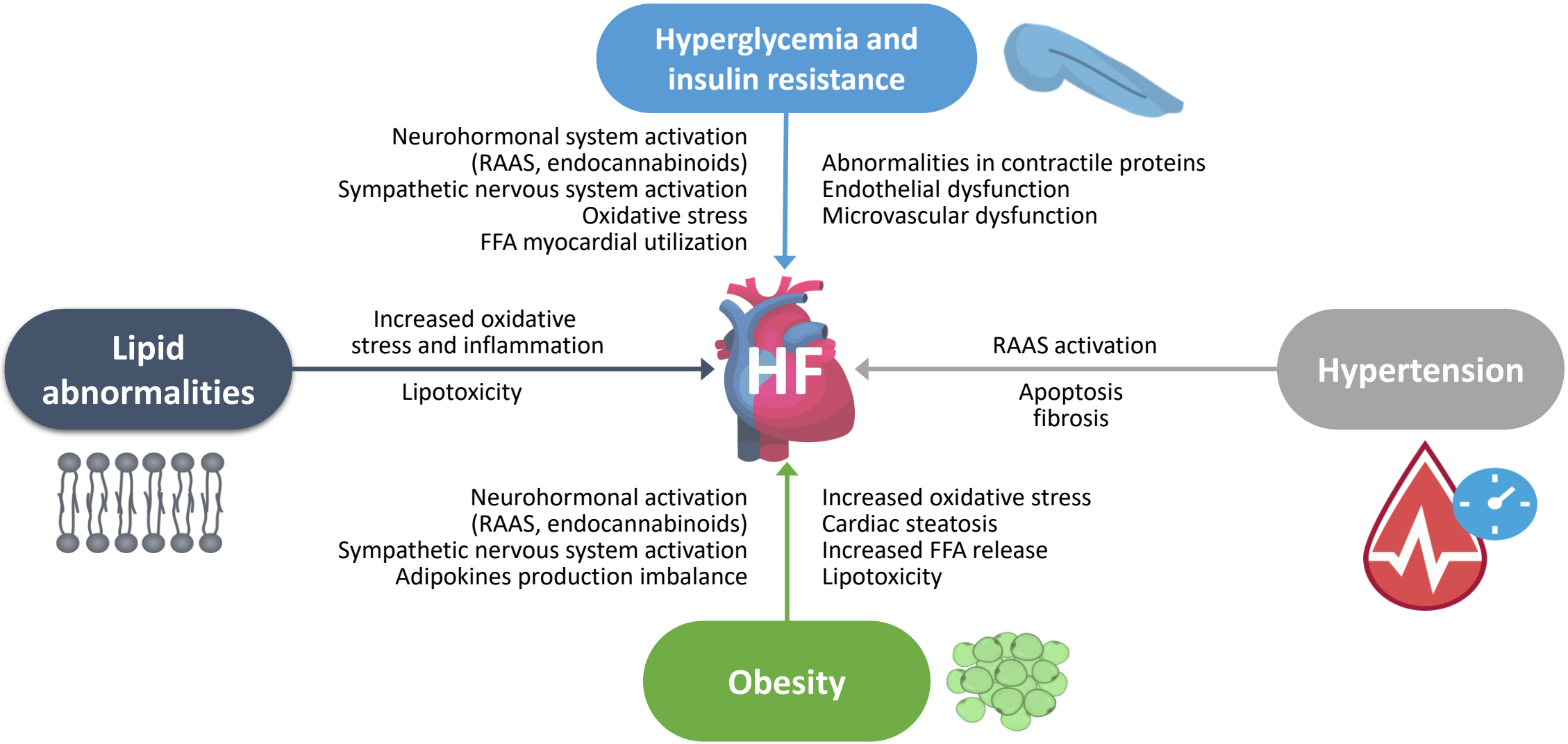
Comparison of HF Stages Across Community Cohorts



98% of the JHS participants classified as stage B HF had evidence of LVH at baseline, which was a risk factor for incident HF and CVD

Okoh & Morris JAHA 2021

At Risk for HF (Stage A): Cardiometabolic Risk Factors



Perrone-Filardi et al. Eur Ht Journal. 2015;36:2630-2634.

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Screening and Diagnostic Approaches

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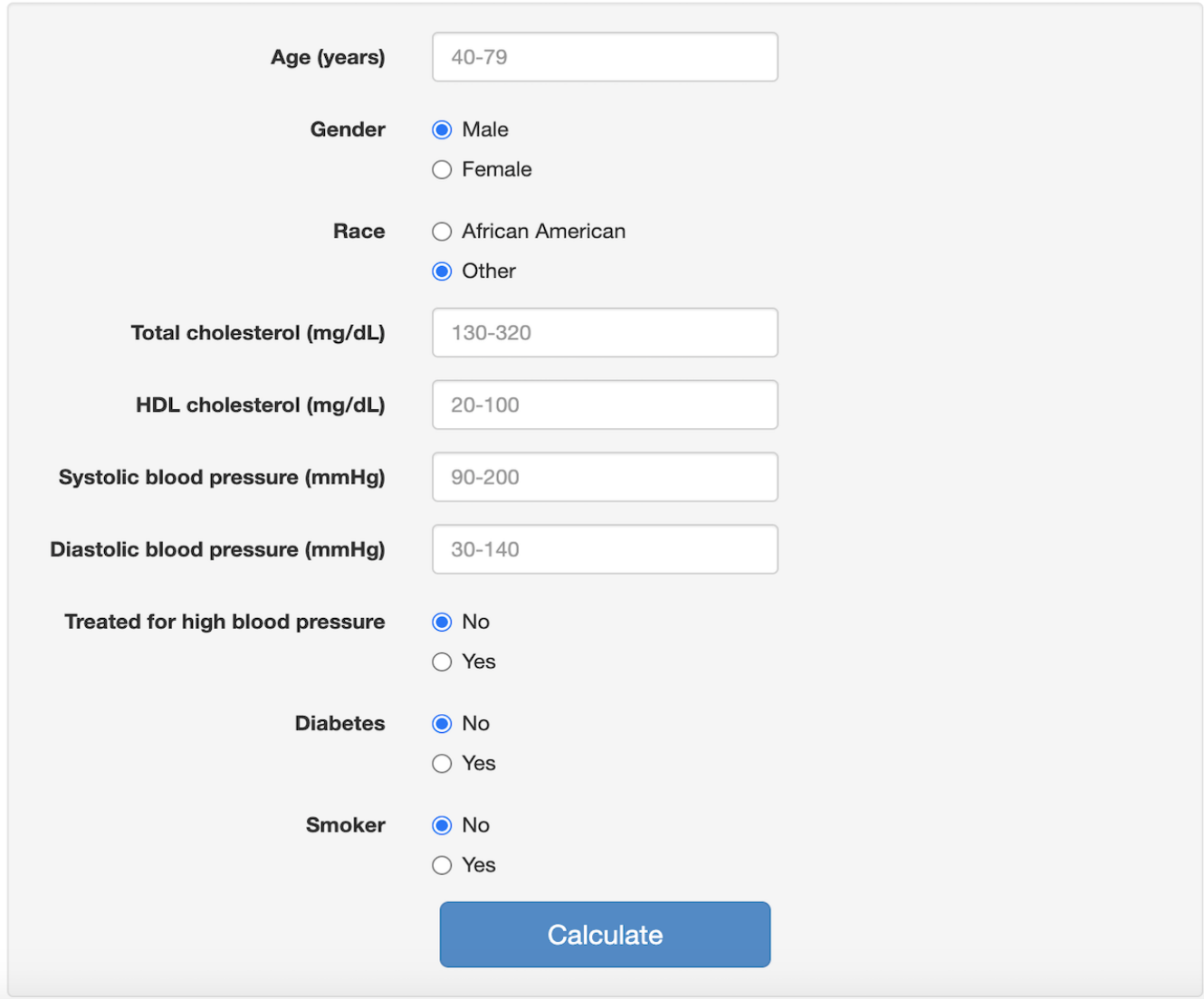
Risk Equations for Incident ASCVD



Calculate your 10-year risk of heart disease or stroke using the ASCVD algorithm published in 2013 ACC/AHA Guideline on the Assessment of Cardiovascular Risk.

This calculator assumes that you have not had a prior heart attack or stroke. If you have, generally it is recommended that you discuss with your doctor about starting aspirin and a statin. Furthermore, if you have an LDL-cholesterol (bad cholesterol) greater than 190, it is also generally recommended that you discuss with your doctor about starting aspirin and a statin.

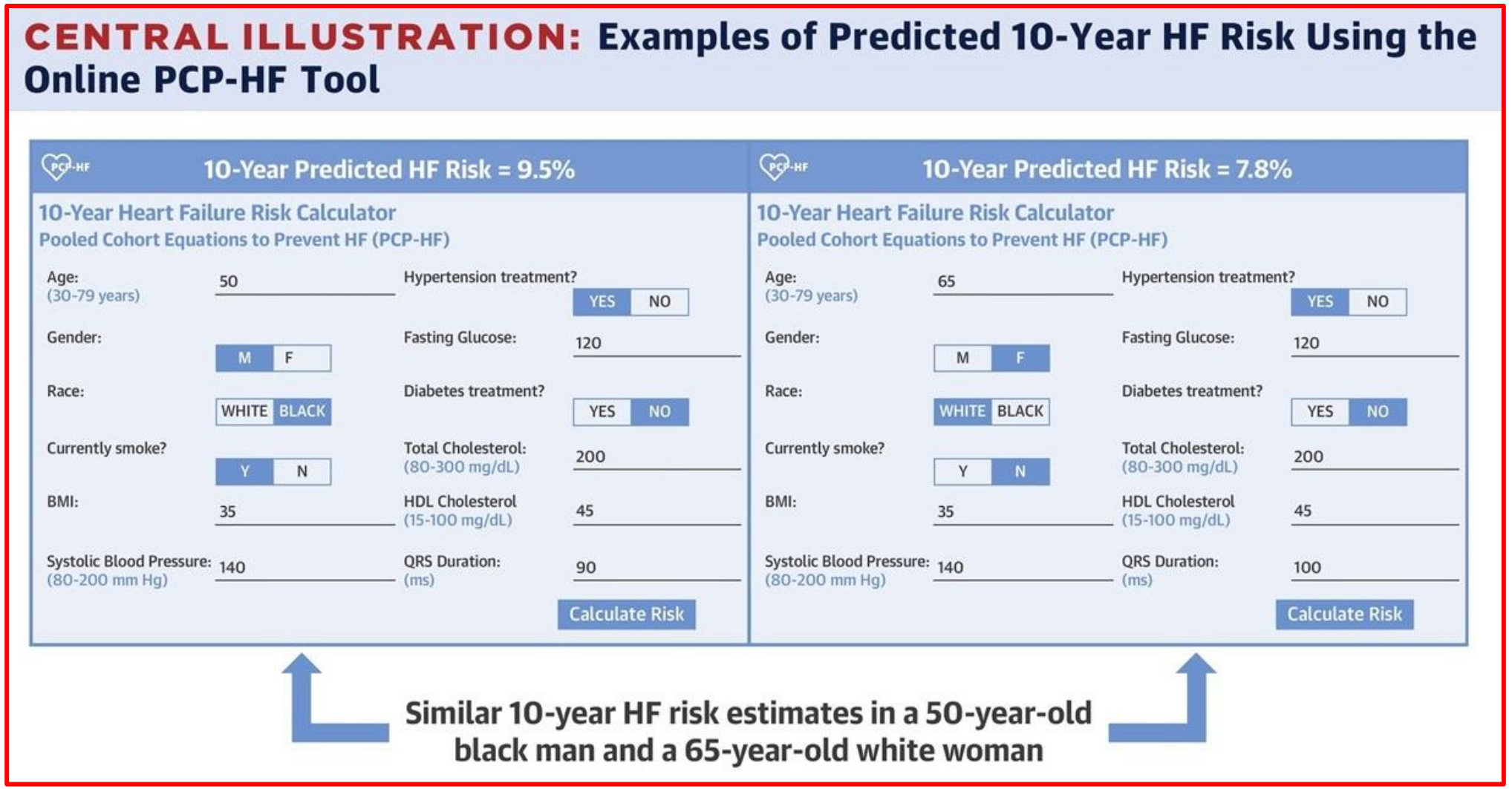
Unfortunately, there is insufficient data to reliably predict risk for those less than 40 years of age or greater than 79 years of age and for those with total cholesterol greater than 320.

UPDATE (11/21/17) -- The ACC/AHA has released their 2017 Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults. At a high level, the new guidelines redefine hypertension as blood pressure >130/80 and recommend starting anti-hypertensives based on ASCVD risk score of >10%. This will be a significant change from JNC-8. Please let us know if you would like us to incorporate the new guidelines into cvriskcalculator.com by completing this 1-question survey.

UPDATE (6/30/16) -- The calculator has been vetted against the final guidelines from the USPSTF for initiating aspirin therapy.

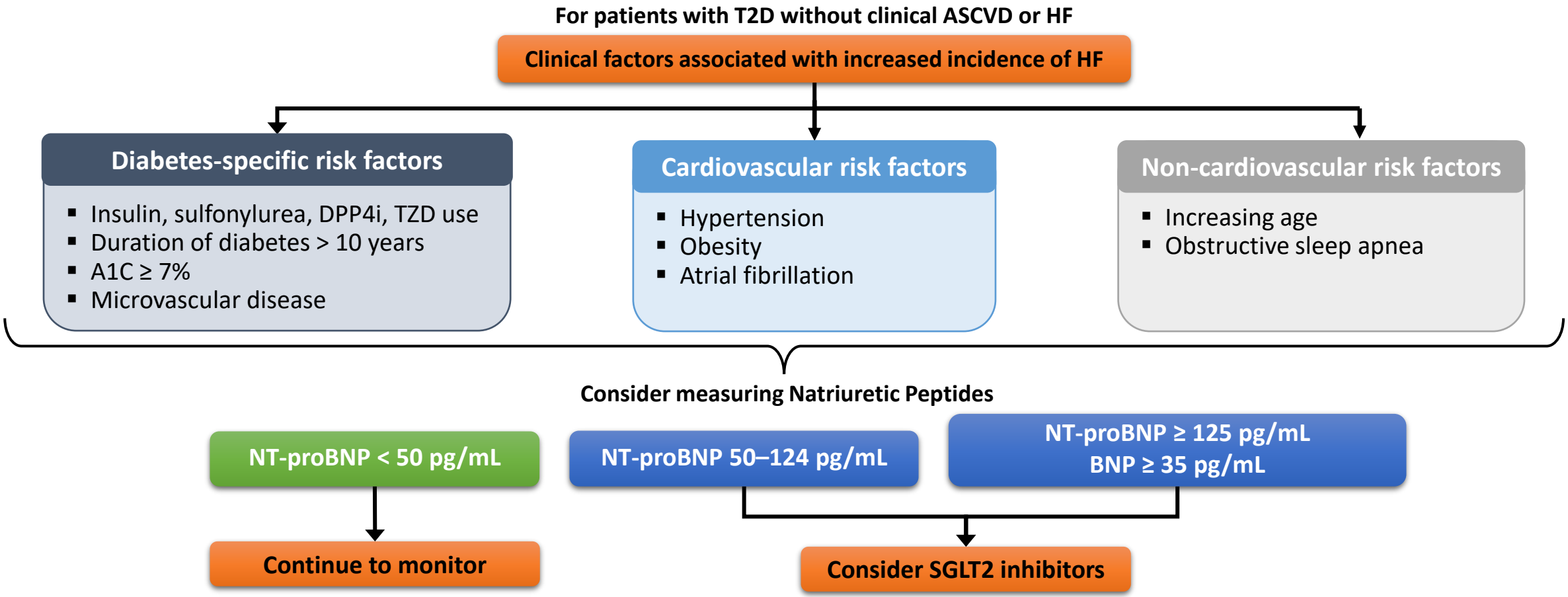
Goff et al. Circulation. 2014;129:S49–S73

Risk Equations for Incident HF



Khan et al. J Am Coll Cardiol 2019; 73:2388-2397

Predictors of HF in T2D: A Practical Approach to Prevention



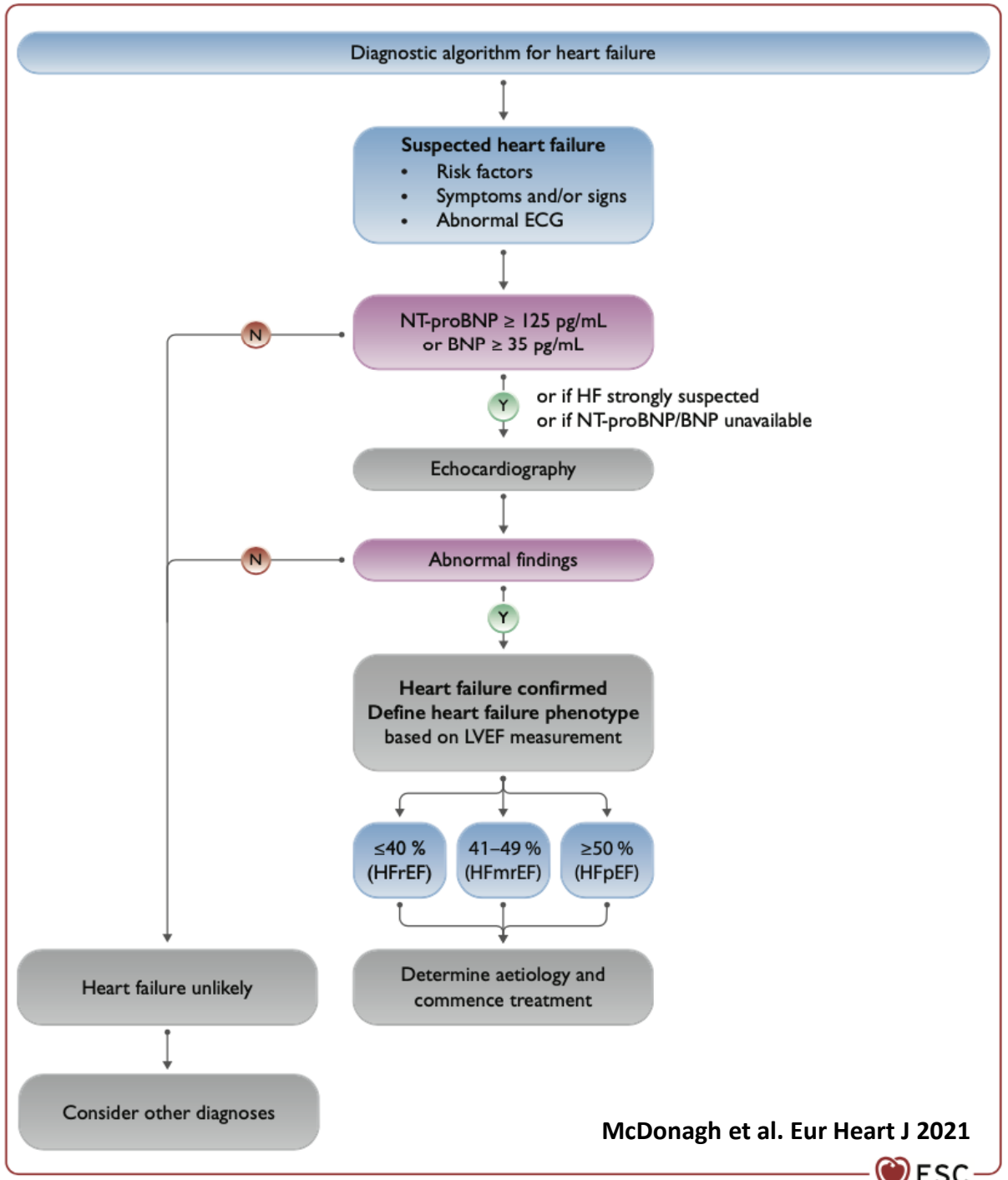
Using NT-proBNP in combination with clinical risk factors may help identify patients with T2D who may benefit from SGLT2 inhibitor

ASCVD, atherosclerotic cardiovascular disease; DPP4i, dipeptidyl peptidase 4 inhibitor; A1C, glycated haemoglobin A_{1c}; NT-proBNP, N-terminal pro-B-type natriuretic peptide; SGLT2, sodium-glucose cotransporter 2; TZD, thiazolidinedione.

Verma et al. *Curr Opin Cardiol.* 2019;34:578-83.

Diagnosis of HF

- **History**
  - Traditional risk factors, dietary habits, new medications (including OTC and holistic/alternative therapies), substance use
  - 3-generation family history
  - Recent hospitalizations or ED visits



McDonagh et al. Eur Heart J 2021

ESC

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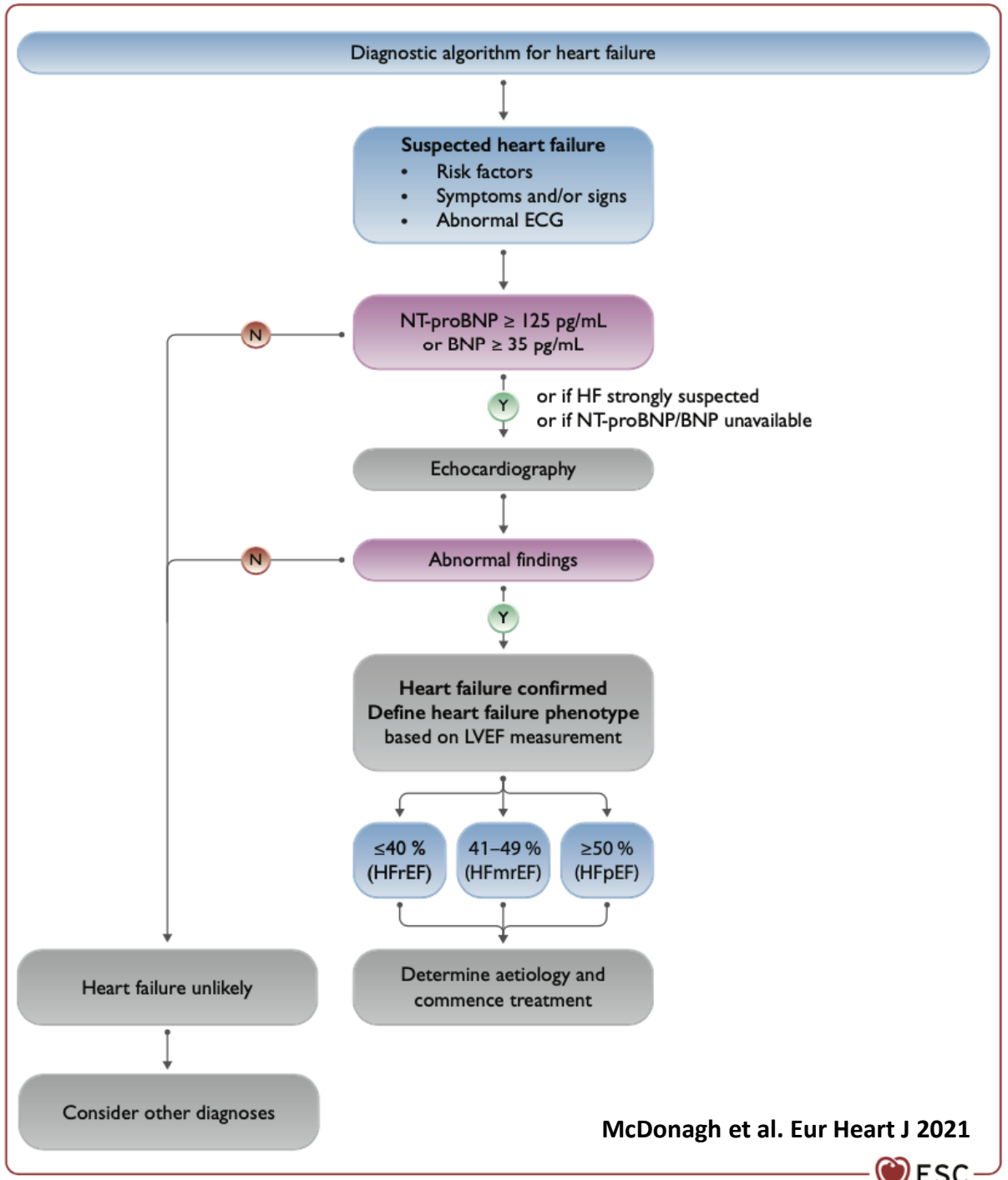
- **Physical – Symptoms and Signs**
  - Dyspnea, orthopnea, paroxysmal nocturnal dyspnea
  - Fatigue/exercise intolerance
  - Weight gain, peripheral edema, abdominal distention
  - Early satiety



McDonagh et al. Eur Heart J 2021

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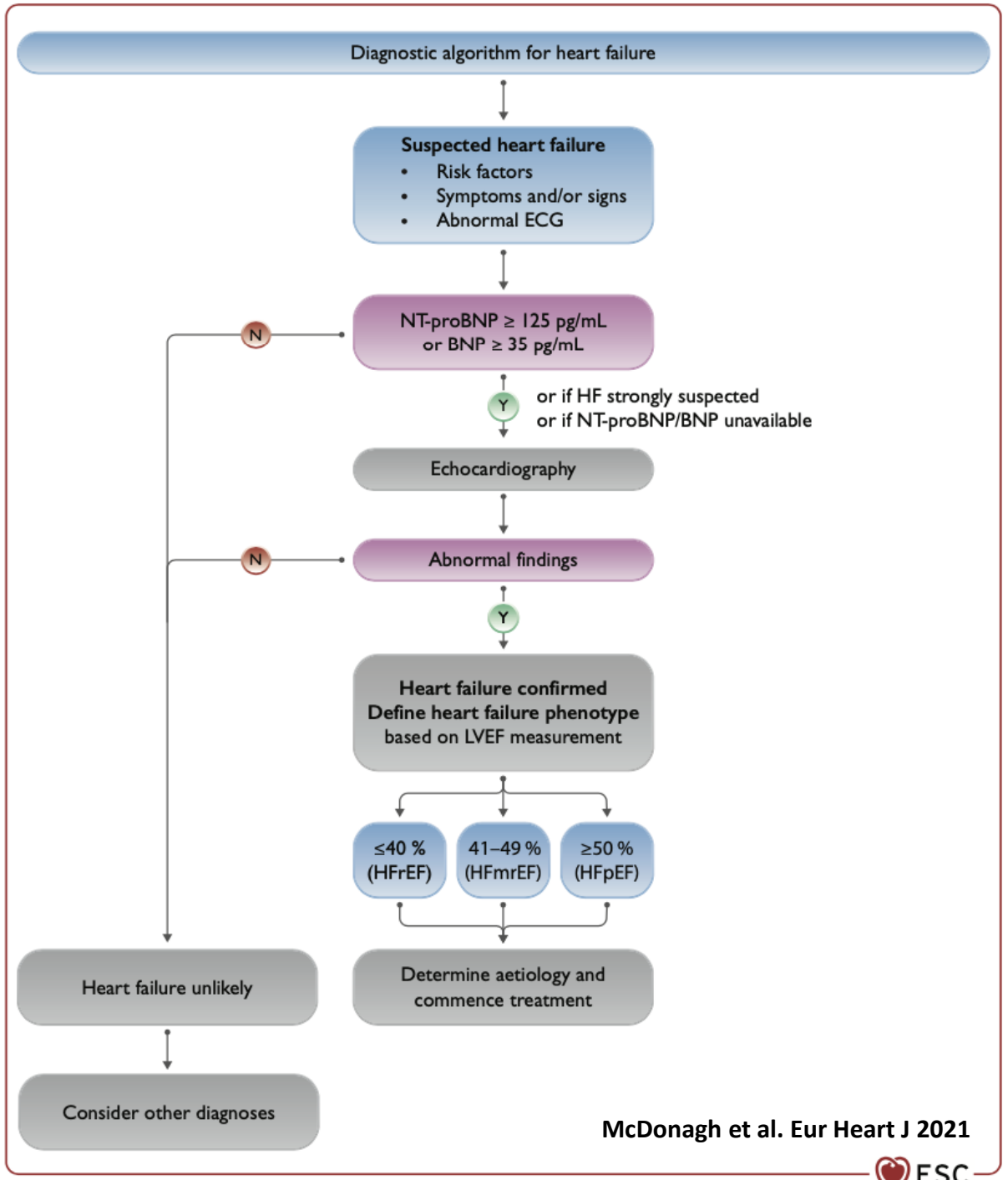
  - Early satiety
- **Diagnostic Tests**
  - 12-lead ECG
  - Labs: CBC, urinalysis, basic metabolic panel, fasting lipid profile, liver function tests, and thyroid-stimulating hormone (Class IC)
  - Biomarkers
    - Natriuretic peptides (BNP and NT-proBNP)
    - Other biomarkers (troponins) as applicable



McDonagh et al. Eur Heart J 2021

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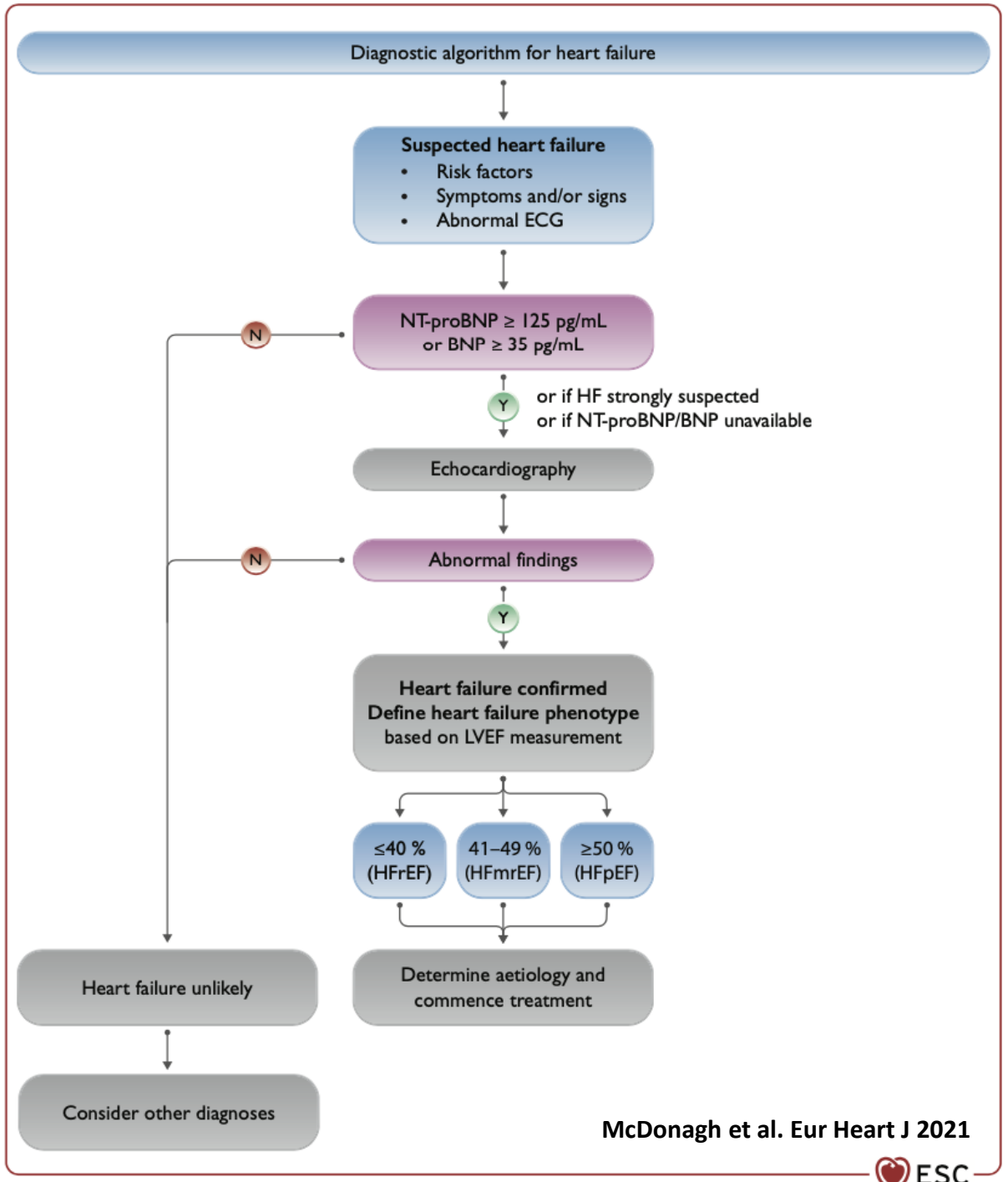
  - Biomarkers
    - Natriuretic peptides (BNP and NT-proBNP)
    - Other biomarkers (troponins) as applicable
- **Other tests (etiology)**
  - Cardiac catheterization
  - Genetic testing
  - Advanced Imaging: cardiac MRI, Technetium pyrophosphate (^{99m}Tc-PYP) scintigraphy, etc)



Evaluation and Diagnosis of HFpEF

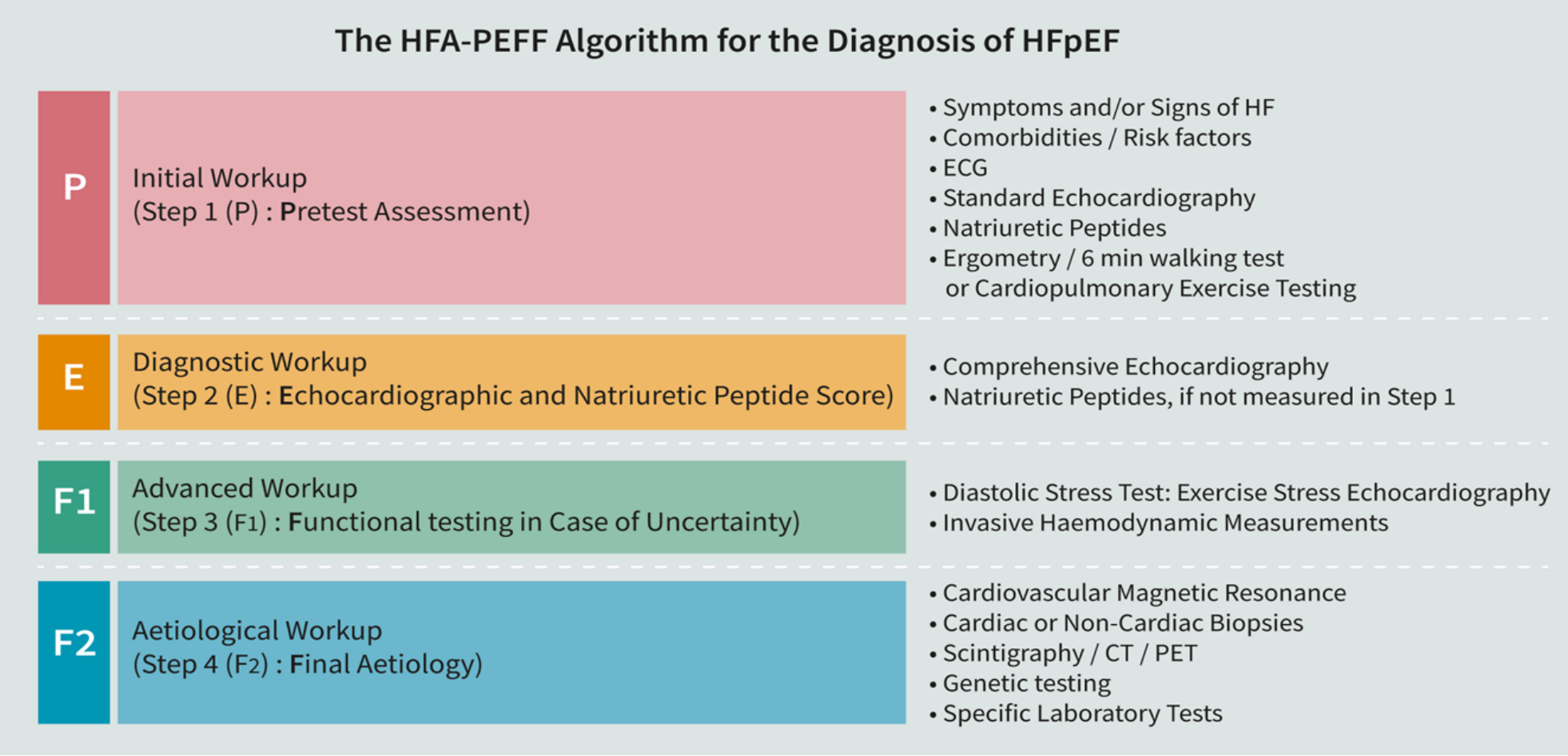
- HFpEF diagnosis may be more challenging to diagnose than HFrEF since:
  - Laboratory parameters (e.g., BNP, E/e' ratio, ECG data) normal in some cases
- Two scoring systems (H2FPEF, HFA-PEFF)
  - Available to evaluate HFpEF based on:
    - Clinical characteristics + Diagnostic data
      (↑ Sensitivity to detect HFpEF)

H_2FPEF Scoring System

	Clinical Variable	Values	Points
H_2	Heavy	BMI > 30 kg/m^2	2
	Hypertensive	Two or more antihypertensive medications	1
F	Atrial Fibrillation	Paroxysmal or Persistent	3
P	Pulmonary Hypertension	Doppler echocardiographic estimated pulmonary artery systolic pressure > 35 mmHg	1
E	Elder	Age > 60 years	1
F	Filling Pressure	Doppler Echocardiographic E/e' > 9	1
H_2FPEF score (≥ 6 or greater = ≥ 90% of HFpEF probability)			**Total (0-9)**

Reddy et al. Circulation 2018

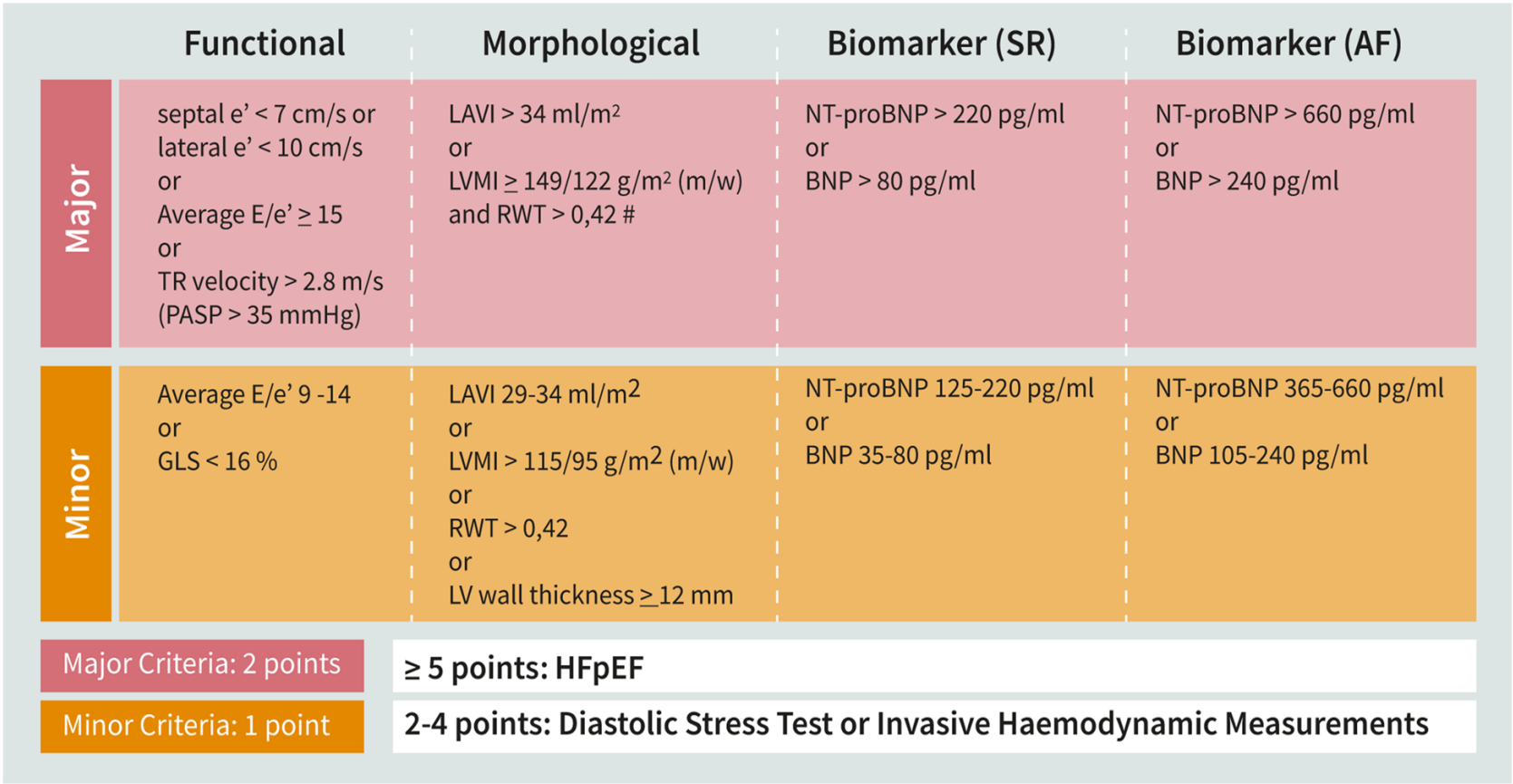
Heart Failure Association Algorithm (HFA–PEFF)



CT, computed tomography; **PET**, positron emission tomography

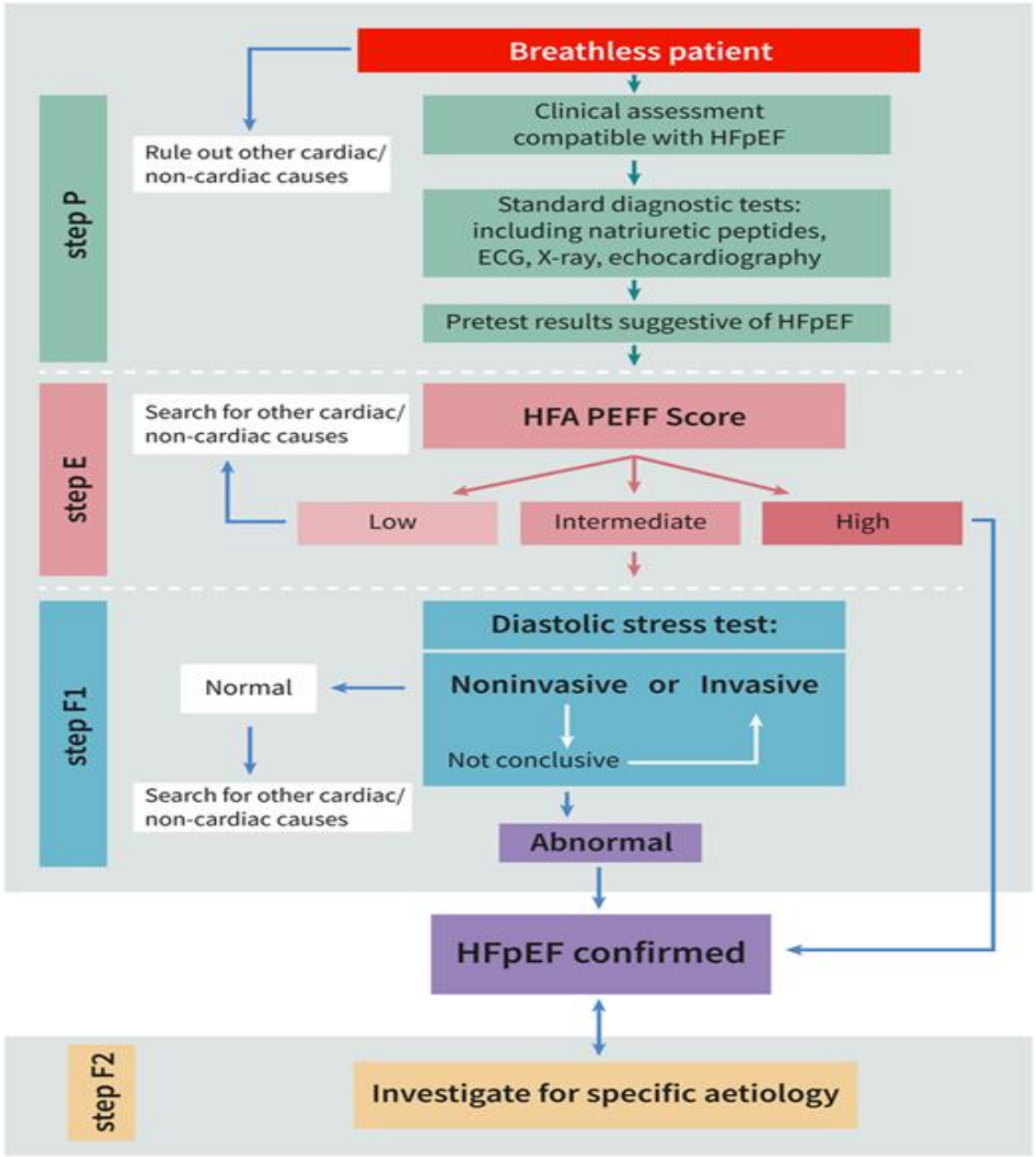
Pieske et al. Eur Heart J 2019

Heart Failure Association Algorithm (HFA–PEFF)



AF: atrial fibrillation, **BNP**: B-type natriuretic peptide, **GLS**: global longitudinal strain, **LAVI**: left atrial volume index, **LV**: left ventricle, **LVMI**: left ventricular mass index, **NT-proBNP**: N-terminal pro b-type natriuretic peptide, **PASP**: pulmonary artery systolic pressure, **RWT**: relative wall thickness, **SR**: sinus rhythm, **TR**: tricuspid regurgitation

Pieske et al. Eur Heart J 2019



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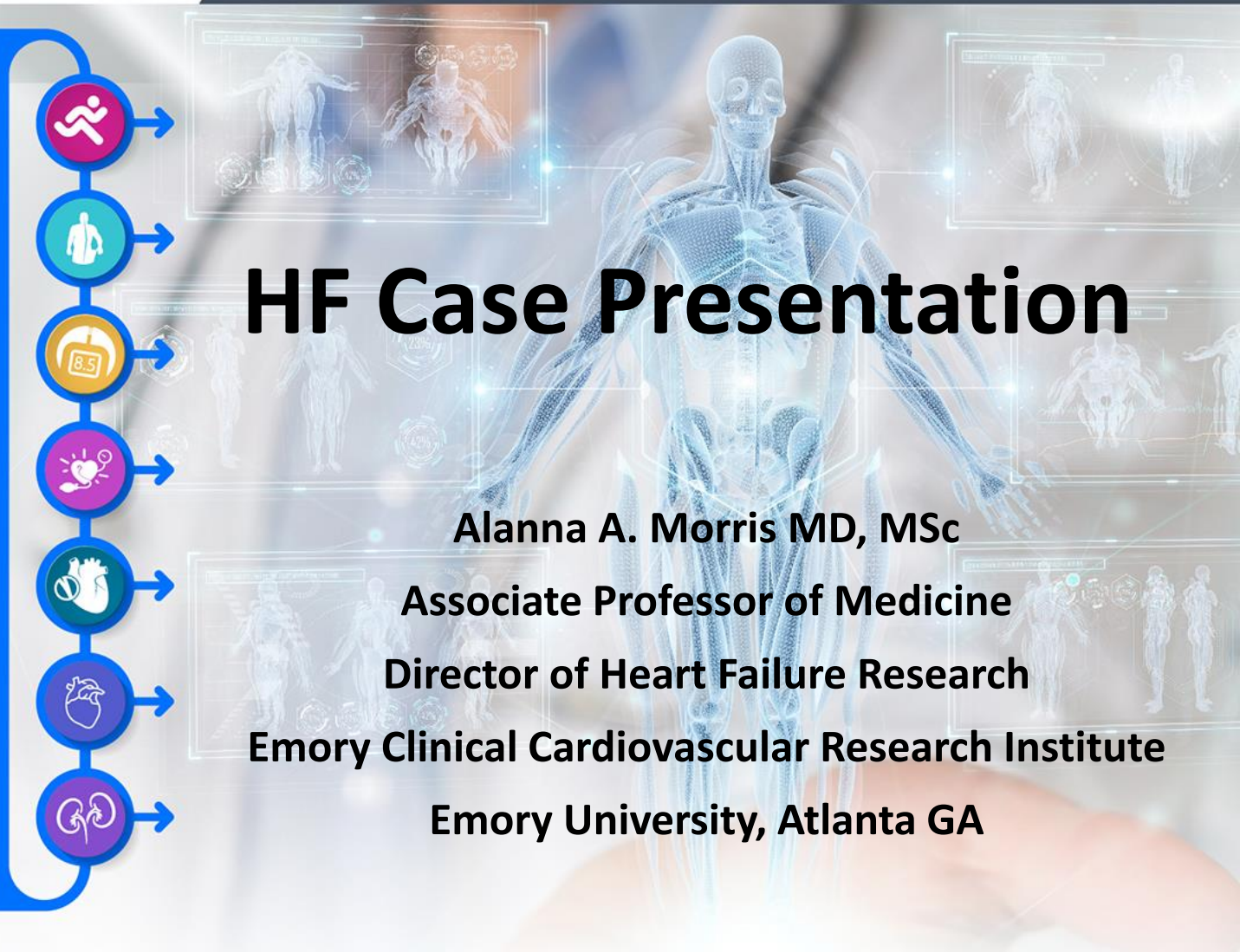

HF Case Presentation

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Director of Heart Failure Research

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Case #1: Pt AM

- AM is a 48F with a history of hypertension, pre-DM, class II obesity
- Her EKG shows some LVH
- Current medications: lisinopril 20 mg daily
- On exam: BP 142/85, HR 70 bpm, BMI 38 kg/m^2

Case #1: Pt AM

- AM is a 48F with a history of hypertension, pre-DM, class II obesity
- Her EKG shows some LVH
- Current medications: lisinopril 20 mg daily
- On exam: BP 142/85, HR 70 bpm, BMI 38 kg/m^2
- You order an echo – grade I diastolic dysfunction, LV posterior wall diameter 1.2 cm (+mild LVH)
- Labs – NT pro-BNP 100 pg/mL, eGFR 65 $ml/min/1.73\ m^2$
- She reports compliance with all of her medications, and attends all of her scheduled office visits

Case #1: Pt AM

- How would you optimize her medical management?
  - A. Increase lisinopril to 40 mg qd
  - B. Increase lisinopril to 40 mg qd and add semaglutide 2.4 mg qd
  - C. Add empagliflozin 10 mg qd
  - D. Add isosorbide mononitrate 30 mg qd

Case #1: Pt AM

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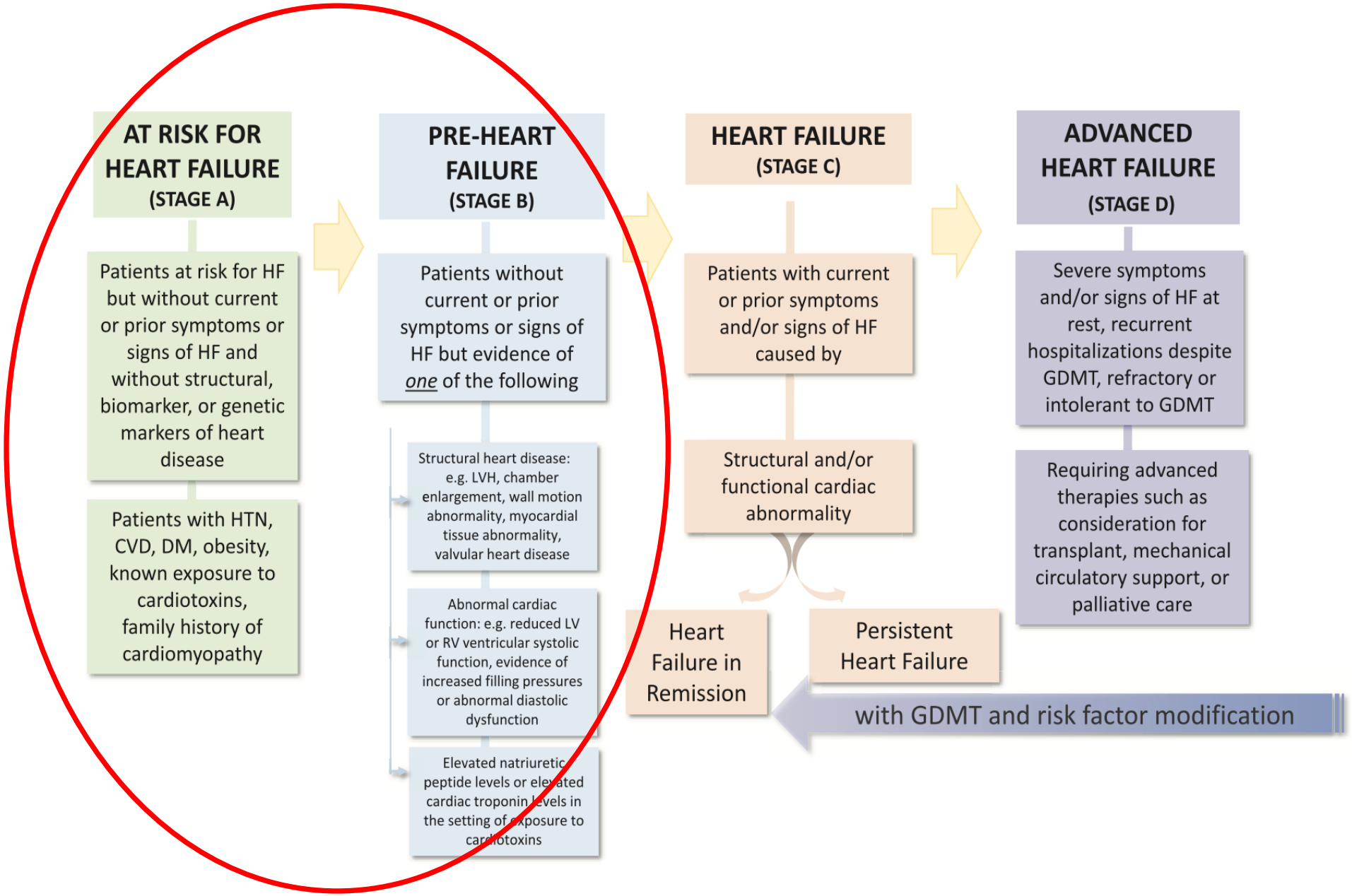
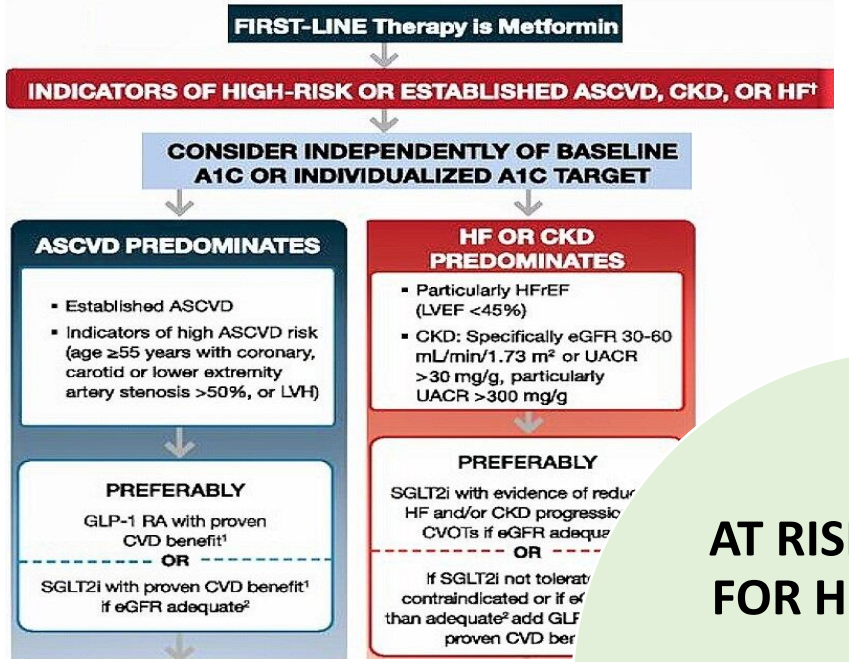
  - C. Add empagliflozin 10 mg qd
  - D. Add isosorbide mononitrate 30 mg qd

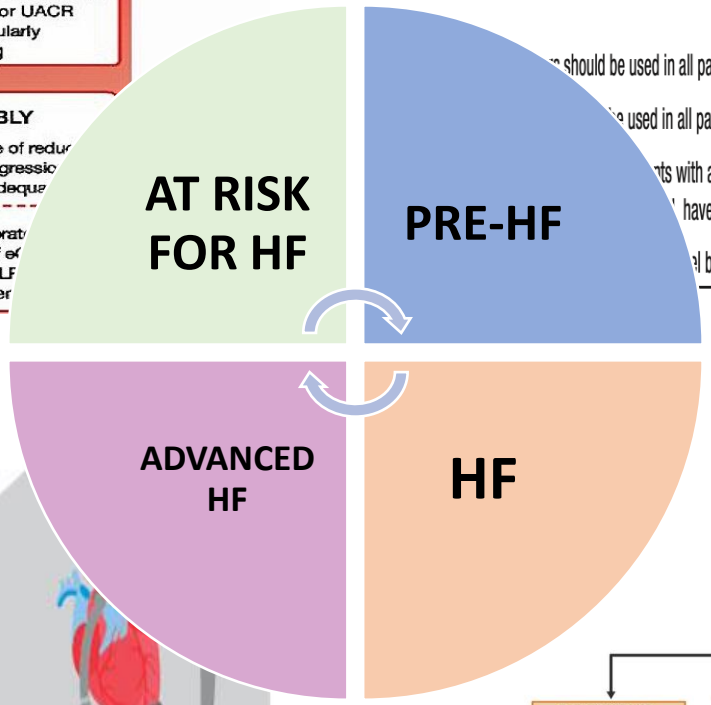


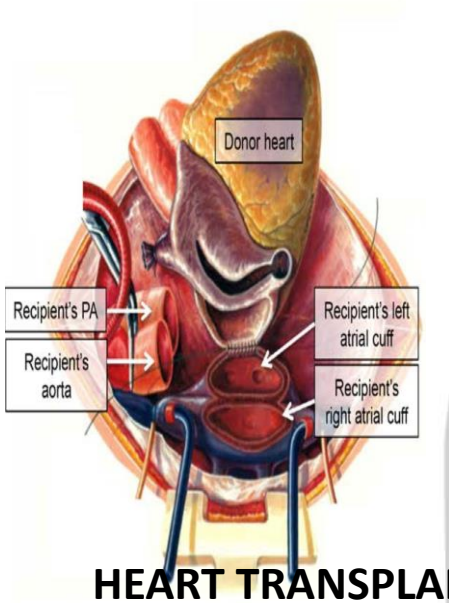
Bozkurt et al. EJHF 2021

Treatment Landscape for HF

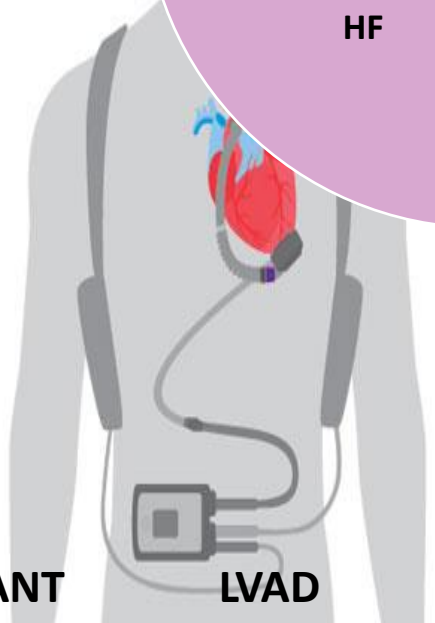


Recommendations	COR	LOE
In patients with a history of MI and reduced EF, ACE inhibitors or ARBs should be used to prevent HF	I	A
In patients with MI and reduced EF, evidence-based beta blockers should be used to prevent HF	I	B
In patients with MI, statins should be used to prevent HF	I	A
Blood pressure should be controlled to prevent symptomatic HF	I	A
…should be used in all patients with a reduced EF to prevent HF	I	A
…used in all patients with a reduced EF to prevent HF	I	C
…ts with asymptomatic ischemic cardiomyopathy …have an LVEF ≤30%, and on GDMT	IIa	B
…l blockers may be harmful in patients with low LVEF	III: Harm	C

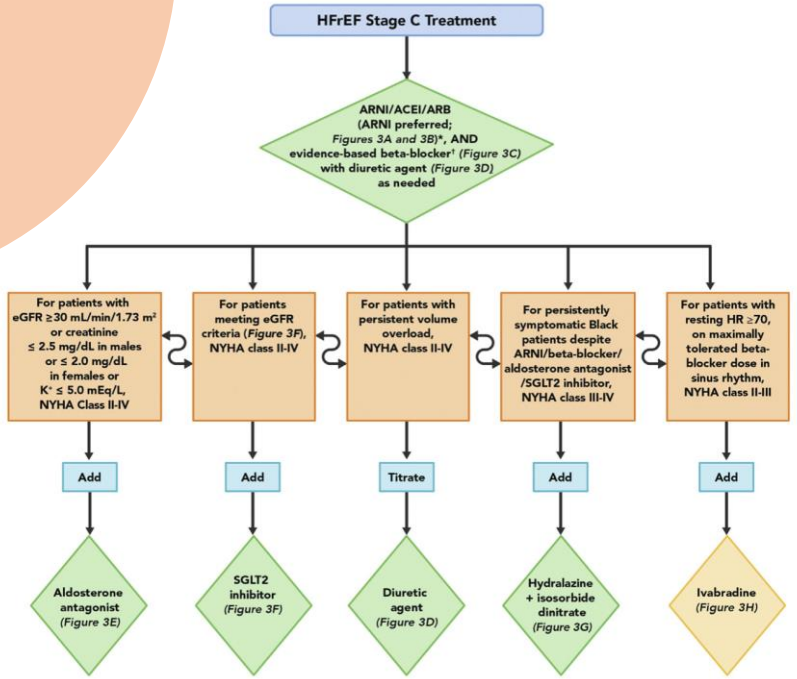




HEART TRANSPLANT

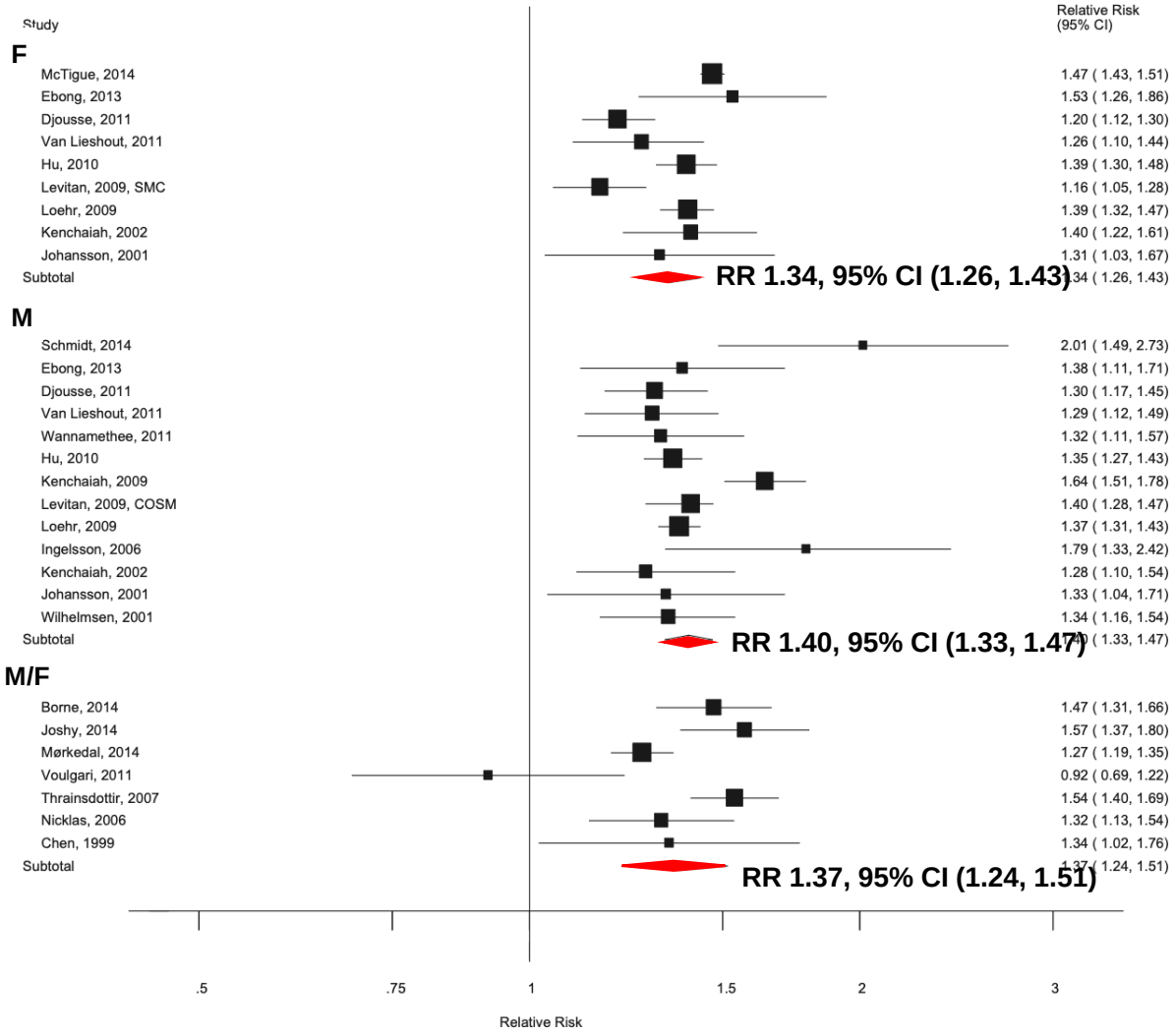


LVAD



Obesity Increases the Risk for HF

BMI and heart failure incidence by sex, dose-response analysis, per 5 units

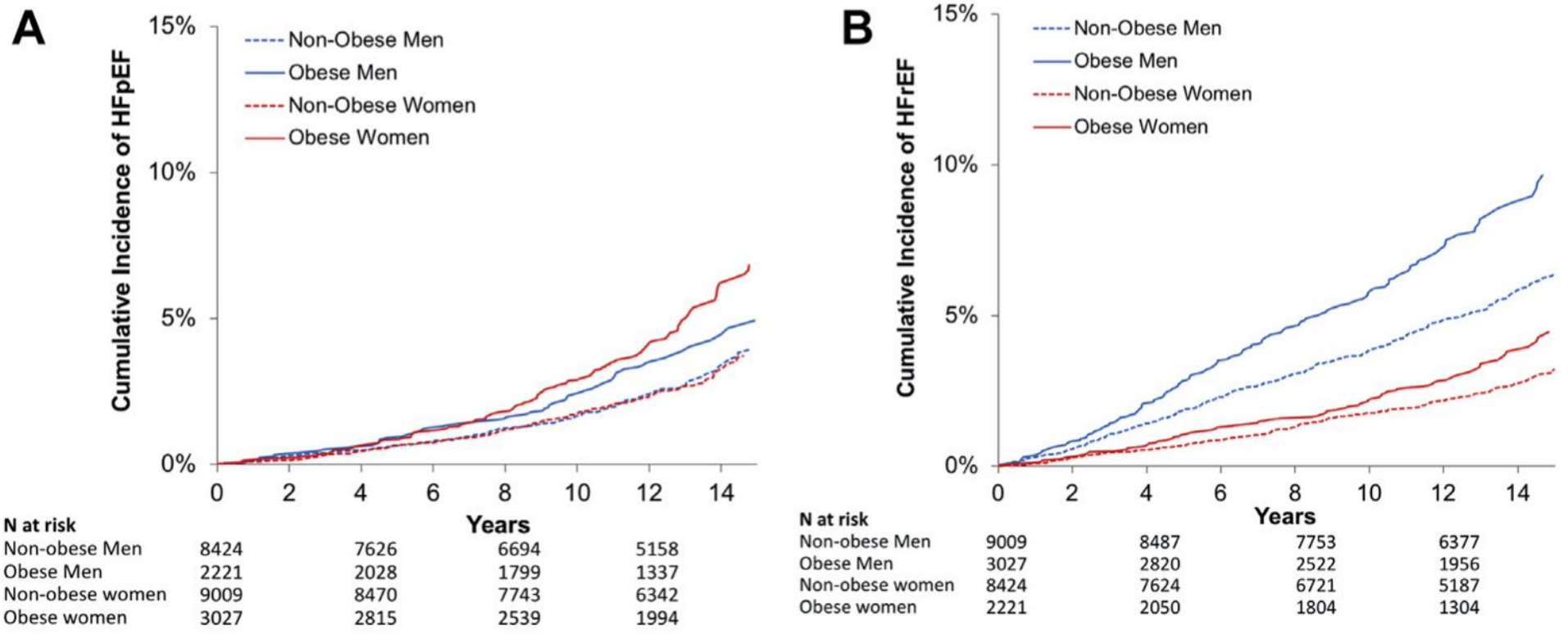


Aune et al. Circulation 2016

Relation of HF Subtypes among Obese and Non-Obese

N=22,681 participants from 4 community-based cohorts in the US
(23% from CHS, 15% from FHS, 29% from MESA, and 32% from PREVEND

FIGURE 1 Cumulative Incidence of HF Subtypes Among Obese and Nonobese Men and Women



Savji et al. JACC: HF 2018

Obesity Harbors a Greater risk for HFpEF in Women From Race-Ethnic Minority Groups

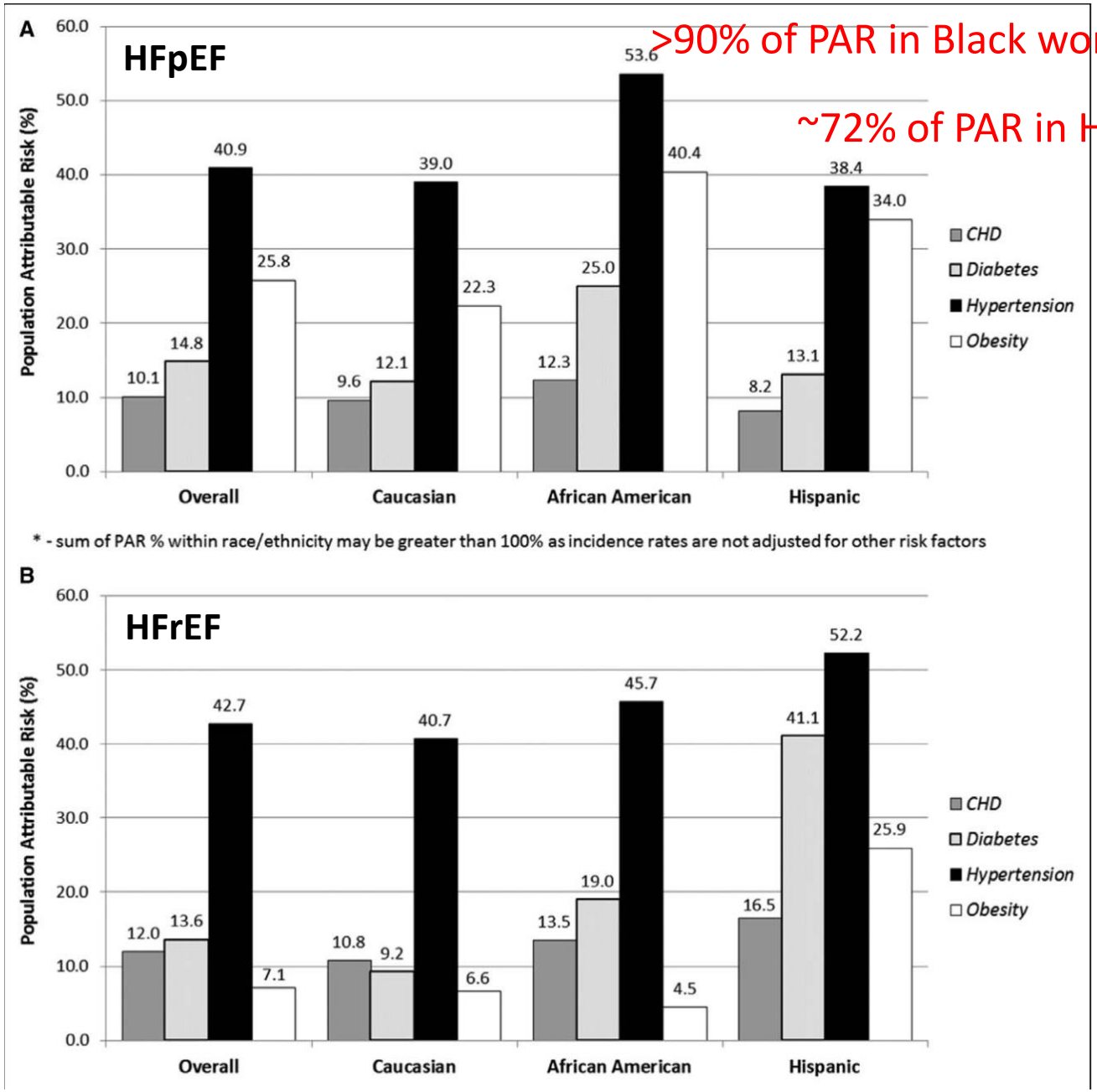
N= 42170 postmenopausal women mean follow-up 13.2 yrs incident hospitalized HF

Risk factor	HFpEF HR (95% CI)* Total	HFrEF HR (95% CI) Total	HFpEF HR (95% CI) white	HFrEF HR (95% CI) White	HFpEF HR (95% CI) African American	HFrEF HR (95% CI) African American	HFpEF HR (95% CI) Hispanic	HFrEF HR (95% CI) Hispanic
Age (ref=50–59 y)	†	‡	†	‡	§			
60–69	2.46 (1.95–3.10)	1.48 (1.11–1.97)	2.82 (2.05–3.87)	1.97 (1.30–2.97)	2.03 (1.40–2.94)	1.16 (0.75–1.81)	2.74 (1.25–6.04)	0.93 (0.34–2.57)
70–69	5.22 (4.05–6.73)	2.76 (2.01–3.79)	6.24 (4.49–8.67)	3.80 (2.48–5.84)	4.03 (2.61–6.21)	1.74 (1.01–3.01)	2.46 (0.75–8.02)	2.08 (0.62–6.98)
BMI (ref=BMI <25 kg/m^2)	†		†		†		‖	
25–<30	1.11 (0.88–1.40)	0.91 (0.68–1.21)	1.00 (0.78–1.29)	0.87 (0.62–1.21)	3.57 (1.40–9.08)	1.10 (0.60–2.03)	1.39 (0.43–4.43)	1.10 (0.21–5.65)
30–<35	1.35 (1.06–1.72)	1.00 (0.74–1.36)	1.08 (0.81 1.43)	1.12 (0.79–1.60)	6.27 (2.49–15.77)	0.81 (0.41–1.59)	0.90 (0.23–3.44)	1.75 (0.32–9.66)
≥35	2.36 (1.84–3.03)	0.87 (0.61–1.24)	2.10 (1.57–2.80)	0.69 (0.43–1.11)	7.50 (2.96–18.98)	1.09 (0.56–2.13)	4.29 (1.24–14.90)	3.09 (0.48–19.80)
Physical activity (ref=<1.25 MET h/wk)								
1.25–<6.25	0.91 (0.75–1.11)	0.92 (0.70–1.20)	0.94 (0.74–1.20)	0.95 (0.68–1.34)	0.77 (0.52–1.13)	0.81 (0.49–1.33)	1.62 (0.53–4.12)	1.08 (0.30–3.88)
6.25–<15.3	0.81 (0.66–1.00)	0.72 (0.54–0.96)	0.83 (0.65–1.07)	0.72 (0.50–1.03)	0.73 (0.48–1.11)	0.75 (0.44–1.27)	0.87 (0.29–2.60)	0.45 (0.08–2.47)
≥15.3	0.74 (0.59–0.93)	0.74 (0.54–1.00)	0.75 (0.57–0.98)	0.77 (0.53–1.12)	0.65 (0.41–1.03)	0.59 (0.32–1.09)	1.32 (0.46–3.82)	1.34 (0.30–6.08)

Eaton et al. Circ Heart Fail 2016

>90% of PAR in Black women due to HTN and obesity

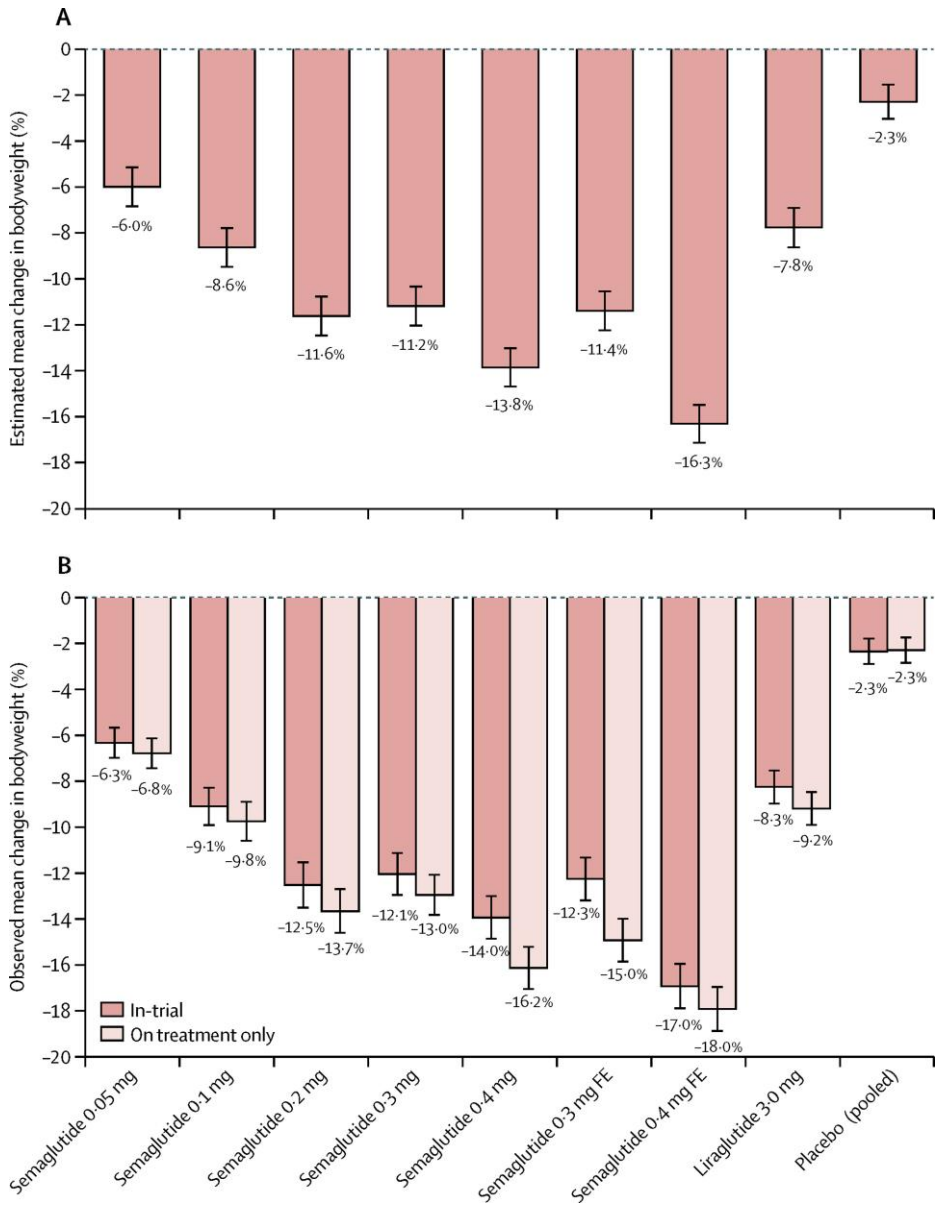
~72% of PAR in Hispanic women due to HTN and obesity



- N= 42170 postmenopausal women
- mean follow-up 13.2 yrs
- incident hospitalized HFpEF and HFrEF

Eaton et al. Circ Heart Fail 2016

Opportunities for Prevention – Obesity



O'Neil et al. Lancet 2018

Conclusions

- Patients ***at risk for HF (Stage A)*** or with ***pre-HF (stage B)*** constitute the largest group
  - Patients *at risk* should be treated with medical therapy that can prevent HF
  - *Pre-HF* patients, such as asymptomatic patients with elevated natriuretic peptide levels, may require referral to a cardiologist for further diagnostic and treatment strategies to prevent progression of HF

- Patients with ***HF (Stage C)*** can receive a timely diagnosis using a combination of elevated natriuretic peptide levels, or recognition of evidence of systemic or pulmonary congestion/elevated filling pressures