Management of acute decompensated heart failure and cardiogenic shock

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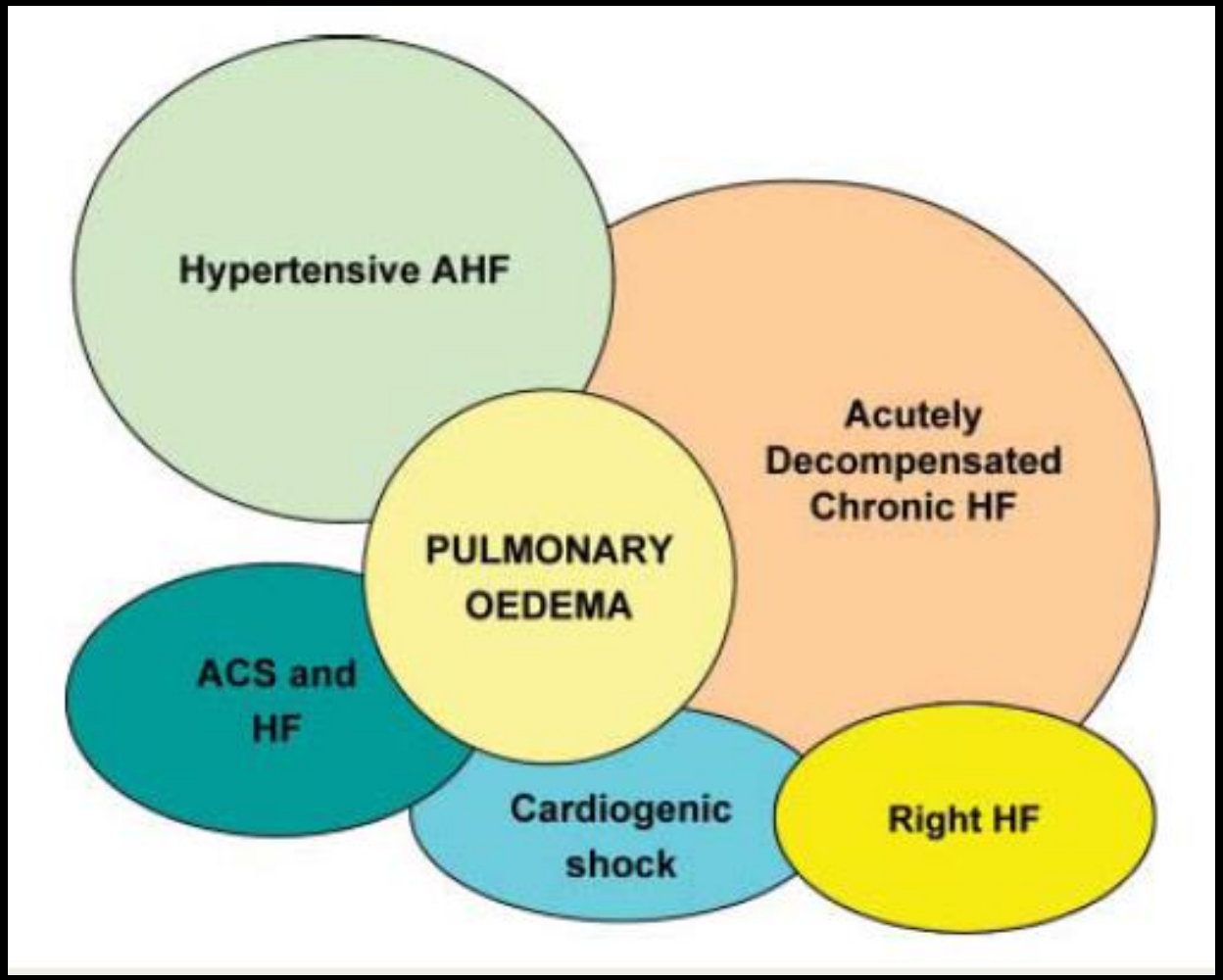
Acute heart failure: spectrum



Case

- 64 y/o M with Hx of non-ischemic DCM (LVEF=25-30%)
- Previously able to walk 1km, currently cannot walk more than 10 feet before developing dyspnea
- PND 3 times per night, 4 pillow orthopnea, increasing lower extremity edema, 4 Kg weight gain
- Exam: JVP=10cm, bibasilar rales, 2+ pitting edema, warm extremities, BP=115/78, P=82
- Creat=1.6 (baseline=1.2), hs-Tn- WNL
- Current Meds: carvedilol 12.5mg bid, enalapril 5mg bid, spironolactone 25 mg od, furosemide 40 mg od

Management

1. Does he have ADHF?
2. Should I admit him?
3. Treatments should be prescribed?
4. Any urgent/emergent management?

Management of AHF

Phase I: urgent/emergent

establish diagnosis, identify etiology and precipitating factor, stabilize

Phase II: hospital care

diuretics, RAAS blockage, beta blocker

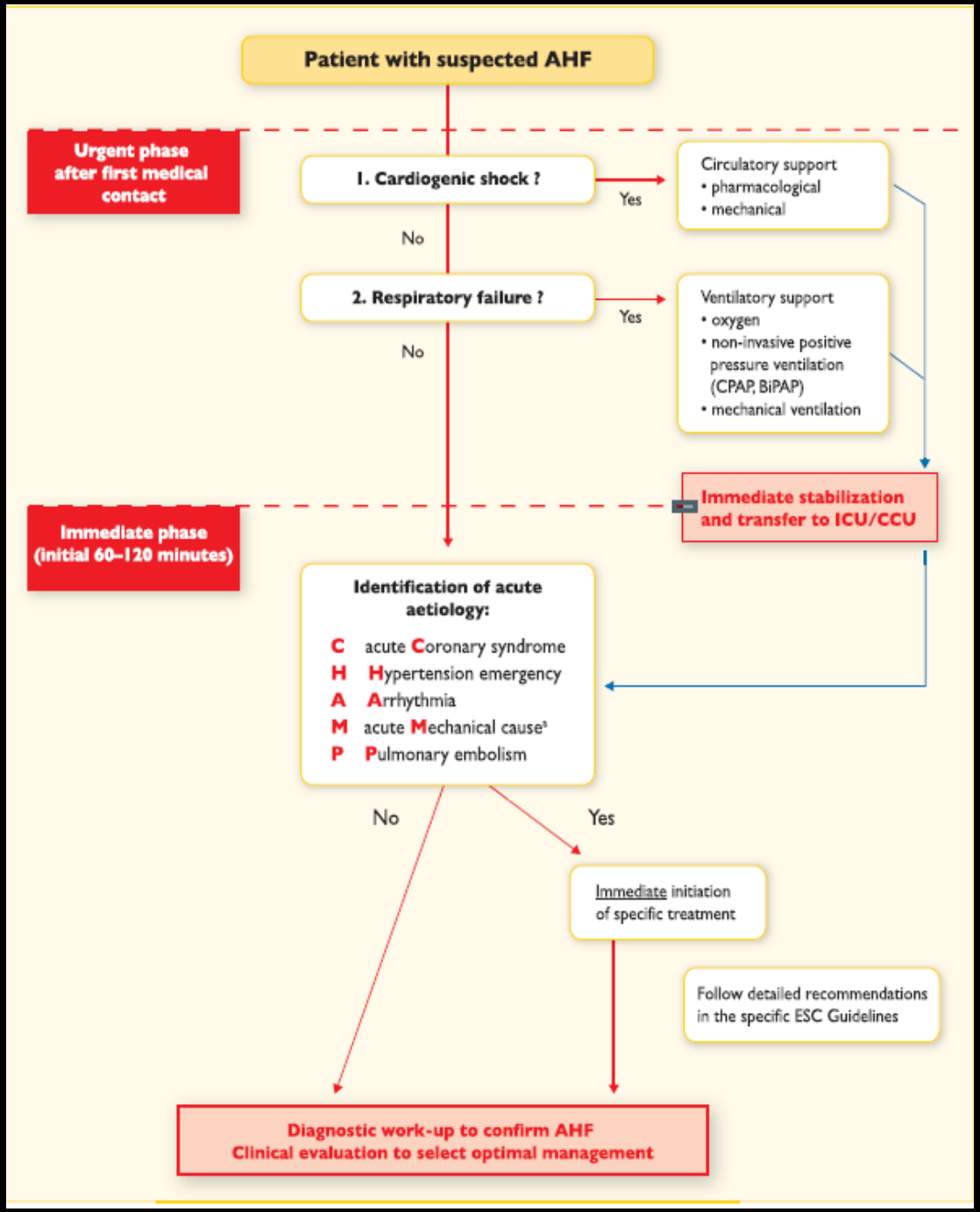
Phase III: pre discharge planning

Phase IV: post discharge management (early follow up)

AHF: Initial assessment

1. Does the patient have HF or is there an alternative cause for symptoms and signs (COPD, anemia, ARF, PE)?
2. If the patient does have HF, is there a precipitant and does it require immediate treatment or correction (arrhythmia or ACS)?
3. Is the patient's condition immediately life-threatening because of hypoxemia or hypotension leading to under-perfusion of the vital organs?

Initial management of a patient with acute heart failure



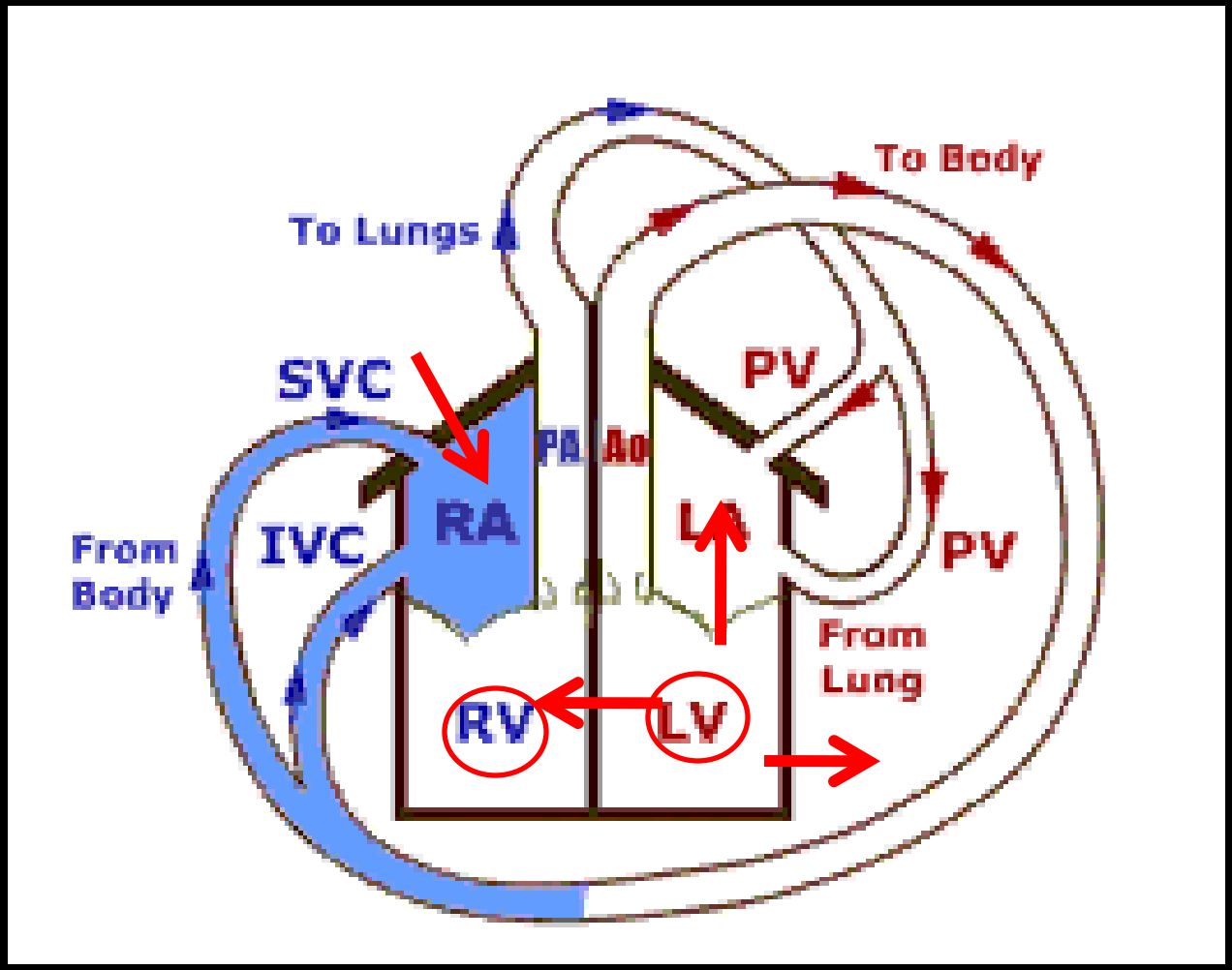
Low blood pressure

BP = CO x SVR

BP = (SV x HR) x SVR

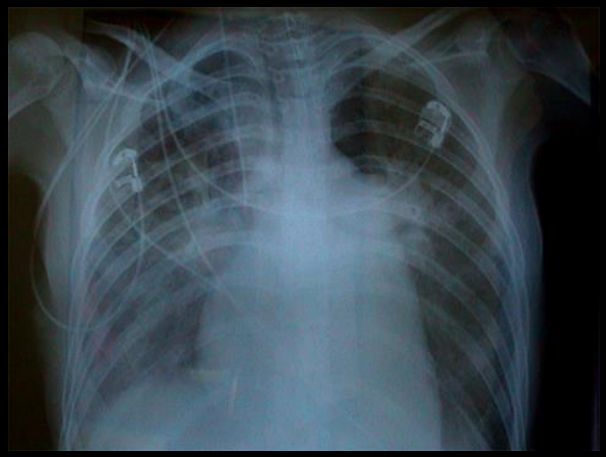
Stroke volume: ejection fraction
preload
after load

What causes low stroke volume?



Cardiogenic shock

- Evidence of hypoperfusion
  - Cold clammy skin feet/hand
  - Cloudy conscious
  - Oliguria
- Systolic BP< 80-90 mmHg

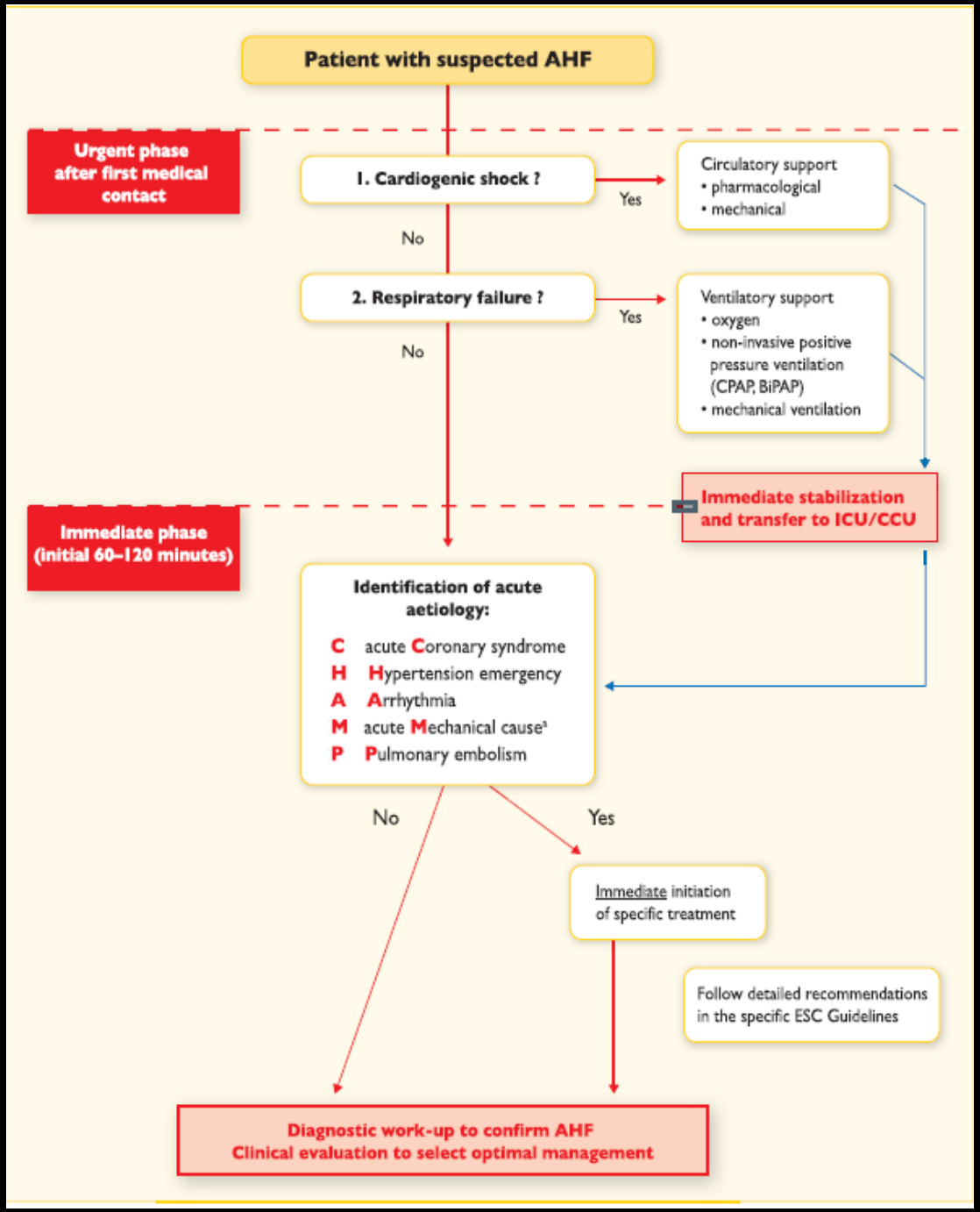


- Persistence after correction of non cardiac factors (hypovolemia, hypoxia, acidosis)
- LVEDP ≥ 18 mmHg
- Evidence of primary cardiac abnormality
- Cardiac index ≤ 1.8 L/min/m^2

Management of cardiogenic shock

- Echocardiogram
- *Invasive* hemodynamic monitoring
- Optimize LV filling pressure
- Inotropic agents
- Mechanical hemodynamic support
  - intraaortic balloon pump (IABP)
  - ECMO
- Correct cause

Initial management of a patient with acute heart failure



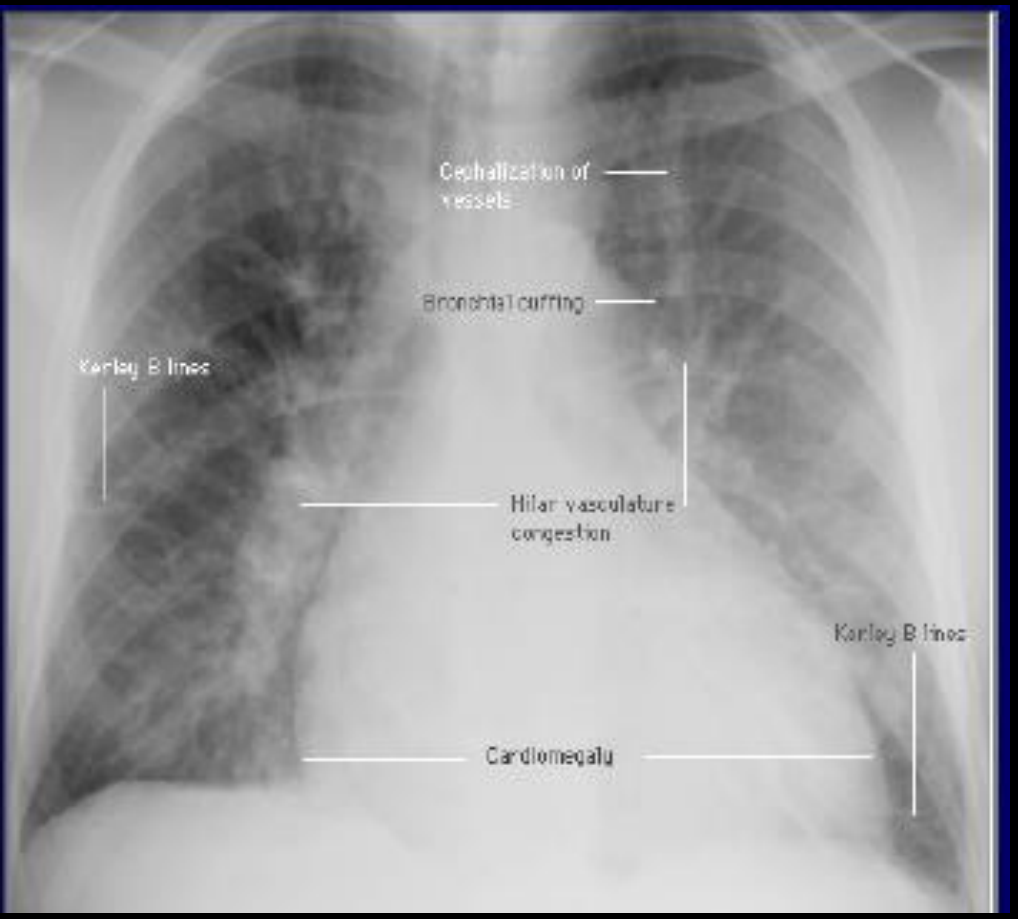
Diagnosis of AHF: Limited accuracy of signs and symptoms

VARIABLE	SENSITIVITY	SPECIFICITY	ACCURACY
History of HF	62	94	90
Dyspnea	56	53	54
Orthopnea	47	88	72
Rales	56	80	70
S3	20	99	66
JVD	39	94	72
Edema	67	68	68

Remes. (1991), *Eur Heart J,* 12: 315-321

Freda. (2002). *Emer Med Rep,* 23(7): 1-13

CXR in AHF



- Misses cadiomegaly in 20% of echo proven cardiomegaly.
- ADHF patients had no sign of congestion in 18.7% of ED CXR
- Never rule out AHF with CXR

RAPID MEASUREMENT OF B-TYPE NATRIURETIC PEPTIDE IN THE EMERGENCY DIAGNOSIS OF HEART FAILURE

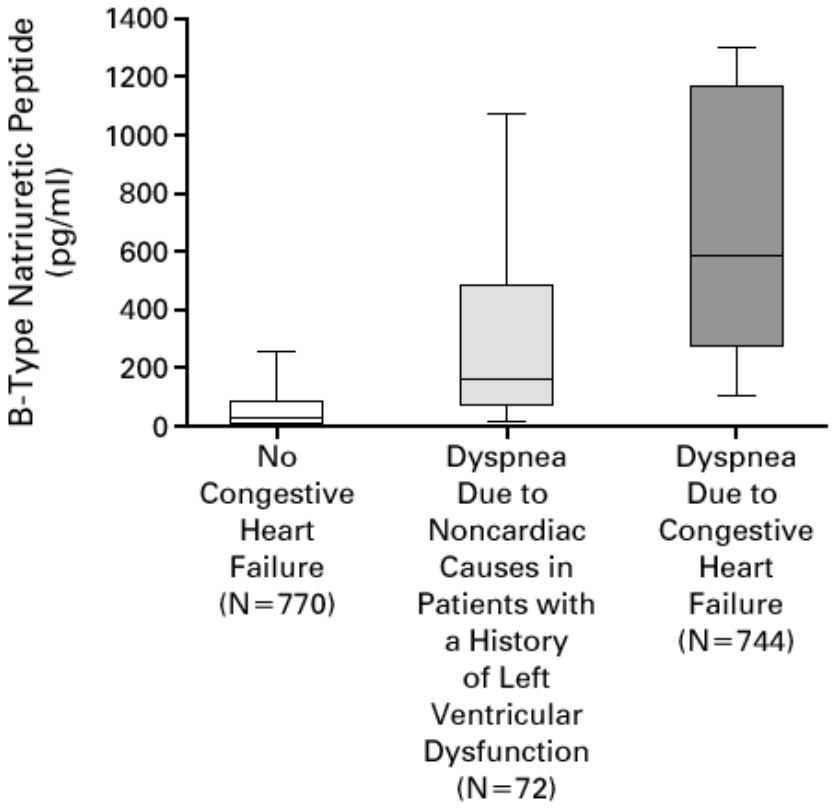
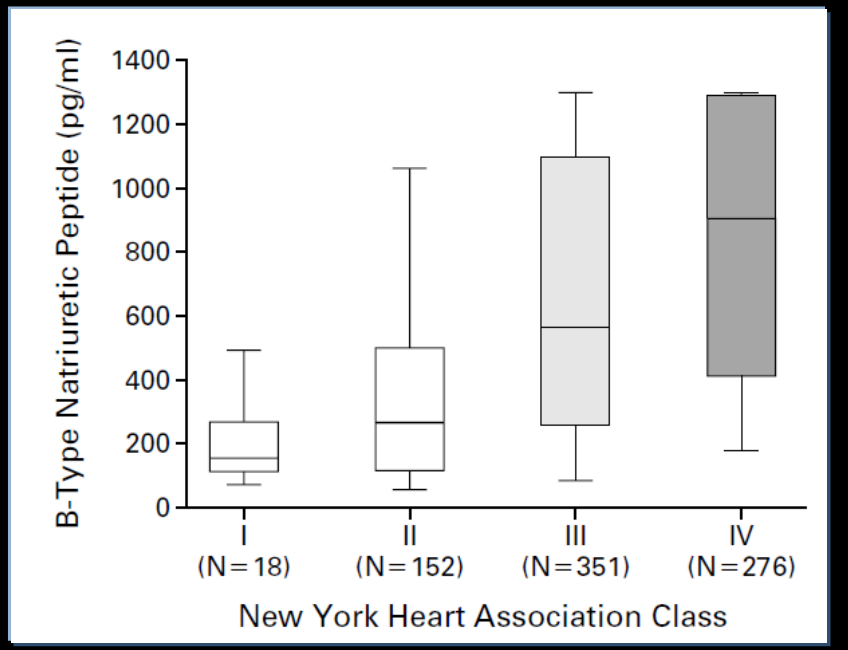


Figure 1. Box Plots Showing Median Levels of B-Type Natriuretic Peptide Measured in the Emergency Department in Three Groups of Patients.

Boxes show interquartile ranges, and I bars represent highest and lowest values.



Meisel AS, et al N Eng J Med 2002

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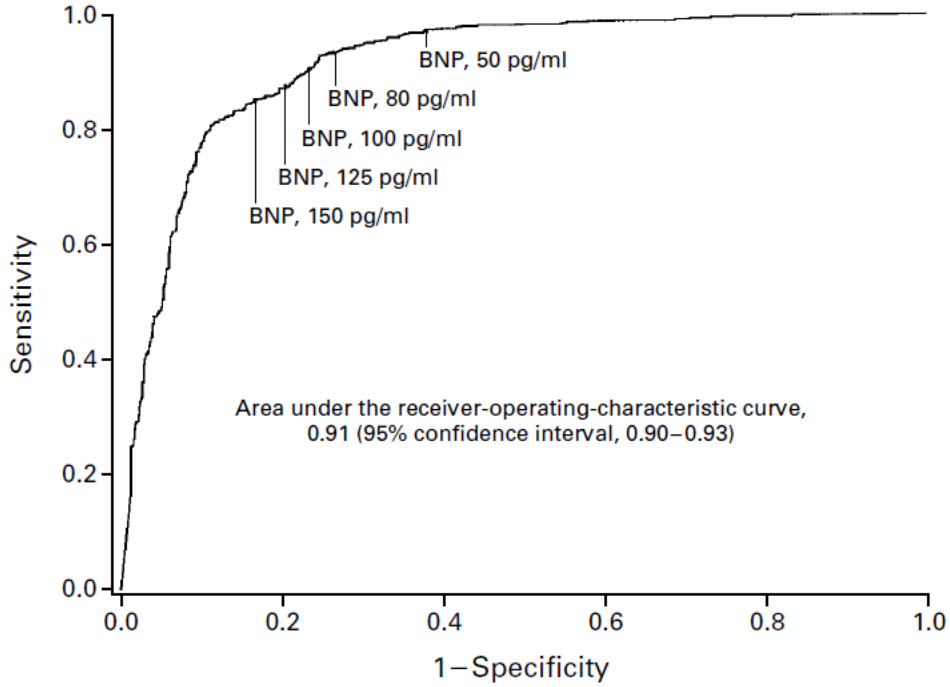


50	97 (96–98)	62 (59–66)	71 (68–74)	96 (94–97)	79
80	93 (91–95)	74 (70–77)	77 (75–80)	92 (89–94)	83
100	90 (88–92)	76 (73–79)	79 (76–81)	89 (87–91)	83
125	87 (85–90)	79 (76–82)	80 (78–83)	87 (84–89)	83
150	85 (82–88)	83 (80–85)	83 (80–85)	85 (83–88)	84

Differentiate between HF and other cause of dyspnea

A ‘rule out’ test – very high negative predictive value

Meisel AS, et al N Eng J Med 2002

RAPID MEASUREMENT OF B-TYPE NATRIURETIC PEPTIDE IN THE EMERGENCY DIAGNOSIS OF HEART FAILURE

Differentiate between HF and other cause of dyspnea

PREDICTOR	P VALUE	ODDS RATIO (95% CI)*
Age	0.04	1.02 (1.00–1.03)
History of congestive heart failure	<0.001	11.08 (6.55–18.77)
History of myocardial infarction	<0.001	2.72 (1.63–4.54)
Rales	<0.001	2.24 (1.41–3.58)
Cephalization of vessels	<0.001	10.69 (5.32–21.47)
Edema	<0.001	2.88 (1.81–4.57)
Jugular venous distention	0.04	1.87 (1.04–3.36)
B-type natriuretic peptide ≥100 pg/ml	<0.001	29.60 (17.75–49.37)

*The odds ratio reflects the odds for patients with the characteristic in question, as compared with those without the characteristic. The odds ratio for age represents the exponent for each year of age in the logistic equation. CI denotes confidence interval.

Meisel AS, et al N Eng J Med 2002

BNP added on standard Dx reduced time to treatment in acute dyspnea

End Point	B-Type Natriuretic Peptide Group (N=225)	Control Group (N=227)	P Value
Time to treatment — min			0.03†
Median	63	90	
Interquartile range	16–153	20–205	
Time to discharge — days			0.001†
Median	8.0	11.0	
Interquartile range	1.0–16.0	5.0–18.0	
Hospitalization — no. (%)	169 (75)	193 (85)	0.008
Admission to intensive care — no. (%)	33 (15)	54 (24)	0.01
Cost of intensive care — $			0.07
Median	874	1,516	
95% Confidence interval	423–1,324	989–2,043	
Total treatment cost — $			0.006
Median	5,410	7,264	
95% Confidence interval	4,516–6,304	6,301–8,227	
In-hospital mortality — no. (%)	13 (6)	21 (9)	0.21‡
30-day mortality — no. (%)	22 (10)	28 (12)	0.45‡
30-day readmission rate — no. (%)	26 (12)	23 (10)	0.63

Mueller, C et al. NEJM 2004

Natriuretic peptides in HF diagnosis: ESC 2016

Acute HF Rule out thresholds:

- BNP < 100 pg/mL
- NT-proBNP < 300 pg/mL

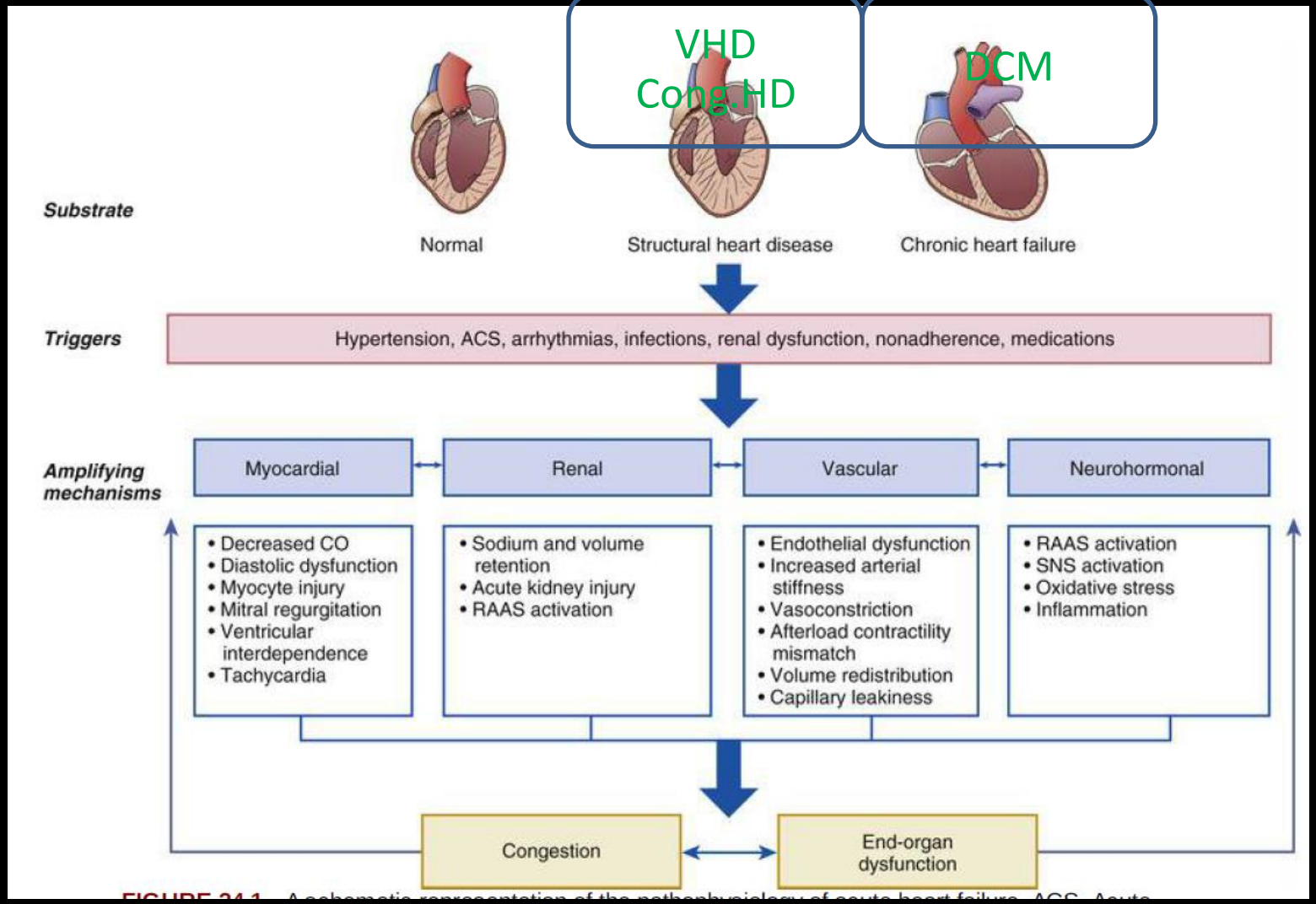
- ***Acute HF Rule in thresholds:***
  - *BNP > 500 pg/ml*
  - *NT-proBNP*
    - *450 (age <*
    - *900*
    - *1800*

Factors affecting natriuretic peptides

Higher Natriuretic Peptide Levels Than Expected	Lower Natriuretic Peptide Levels Than Expected
Increasing age*	Obesity
Acute coronary syndrome*	Flash pulmonary edema
Renal insufficiency	Pericarditis/tamponade
RV dysfunction*	Genetic polymorphisms
Atrial fibrillation	End-stage cardiomyopathy
Pulmonary hypertension*	
Pulmonary embolism*	
Anemia/high-output states*	
Sepsis	
Mitral regurgitation*	

Chow SL et al. circulation 2017

A schematic representation of the pathophysiology of acute heart failure



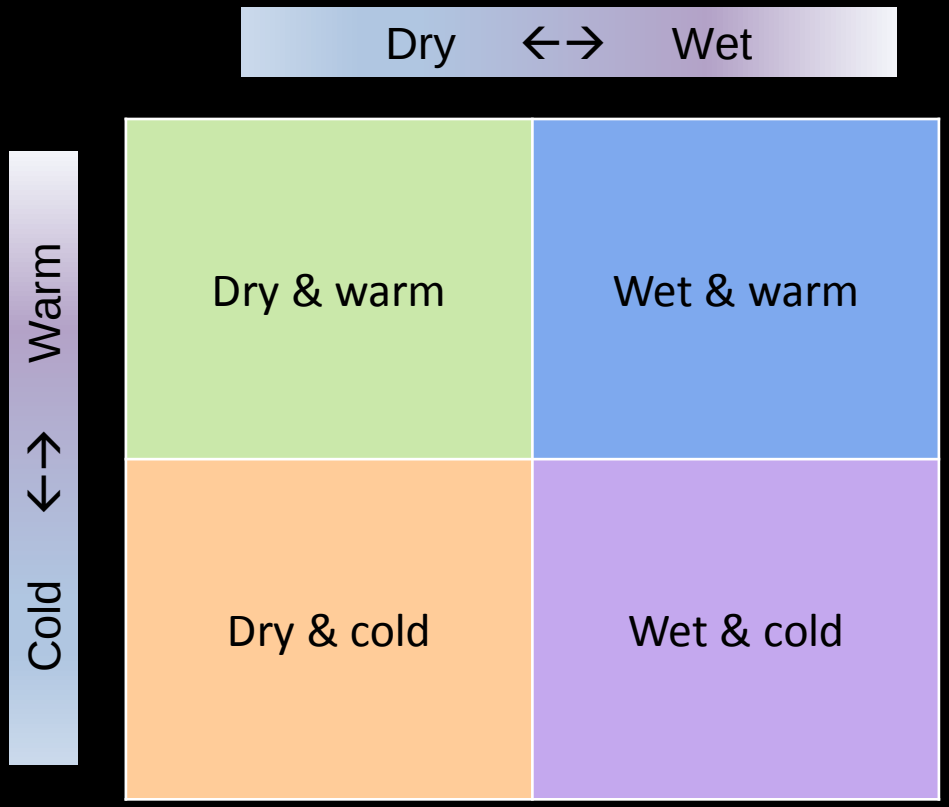
Substrates of HF

- 40 y/o W with worsening DOE 1 weeks
- AF, R 111 bpm
- BP 90/60 mmHg
- JVD+
- Loud S1,loud P2
- DRM gr III apex

- 60 y/o M with worseing DOE 1 week
- AF, HR 110 bpm
- BP 90/60mmHg
- JVD +
- Soft S1, S3+
- PSM Gr II apex

Different substrates, different pathway

Evaluation based on fluid status and tissue perfusion may be helpful to guide treatment: Thai HF Guideline



Wet & Warm	
Cardiac profile	Vascular profile

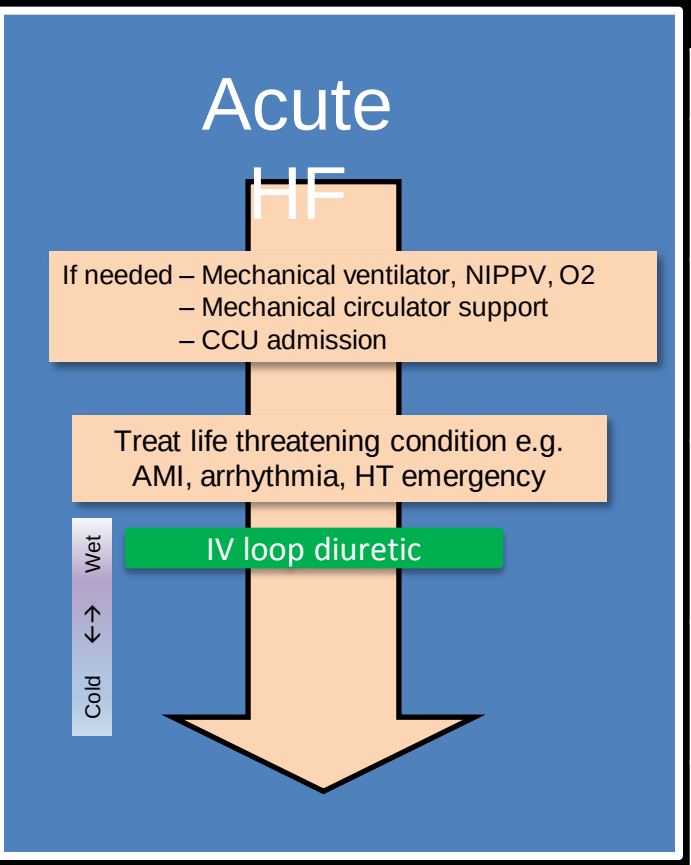
- “cardiac type” for patients with fluid accumulation
- “vascular type” for patients with elevated BP without fluid accumulation

Clinical trials in AHF

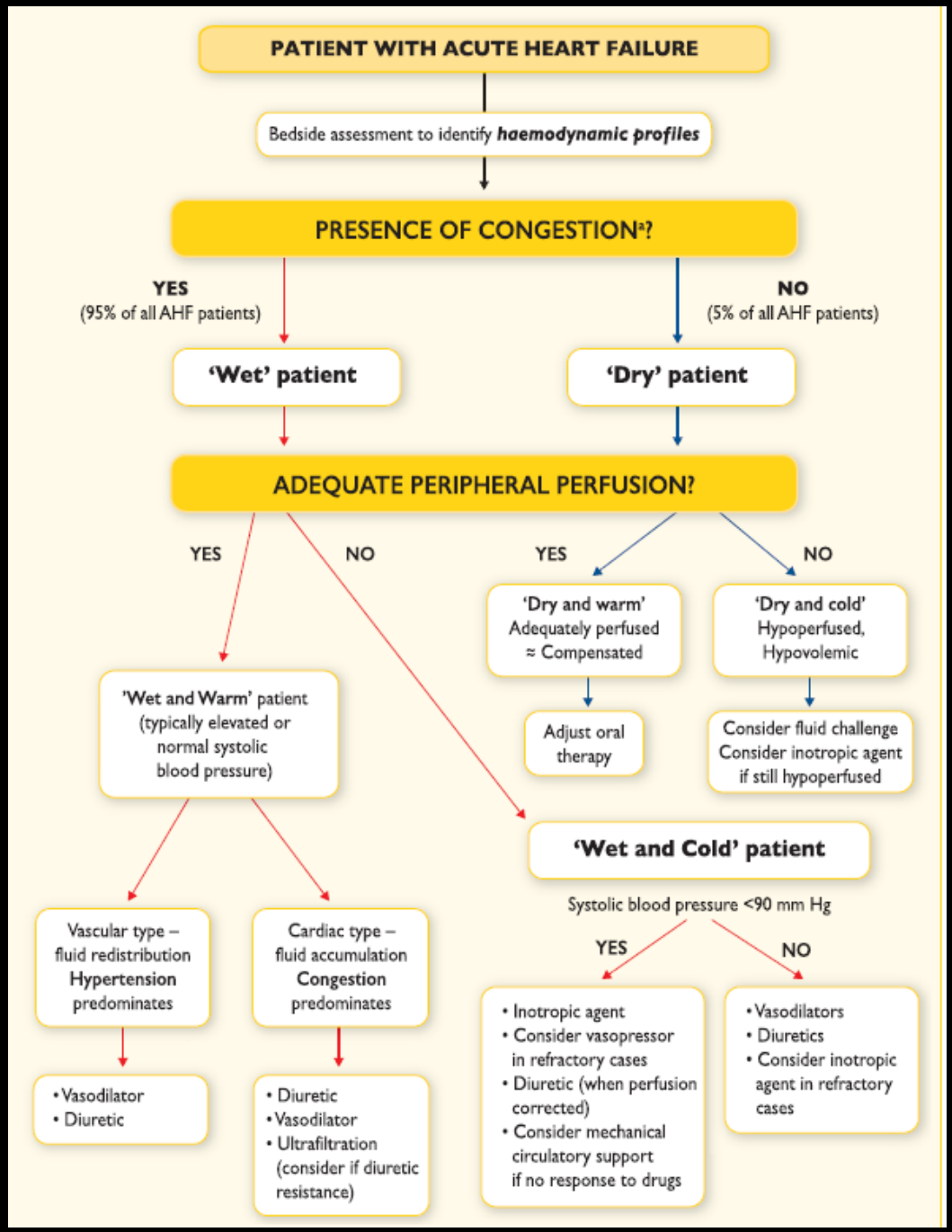
Trial name	Patient population	Intervention	Primary endpoint	Significant effect?
OPTIME-CHF[1]	951 patients admitted with exacerbation of systolic HF	i.v. **milrinone** vs pbo for 48 hours	Length of hospitalization for CV causes	✘
VERITAS[2]	1,448 patients hospitalized with AHF	i.v. **tezosentan** vs pbo for 24–72 hours	Change in dyspnea, incidence of death and worsening HF at 7 days	✘
SURVIVE[3]	1,327 patients hospitalized with AHF	i.v. **levosimendan** vs dobutamine	All-cause mortality at 180 days	✘
EVEREST[4]	4,133 patients hospitalized with AHF	**Tolvaptan** 30 mg once-daily vs pbo for 60 days	All-cause mortality and CV death or hospitalization for HF	✘
ASCEND-HF[5]	7,141 patients hospitalized for AHF	i.v. **nesiritide** vs pbo for 24 hours–7 days	Change in dyspnea and 30-day all-cause mortality or HF hospitalization	✘
PROTECT[6]	2,033 patients hospitalized for AHF	i.v. **rolofylline** vs pbo for up to 3 days	Composite of survival, HF status and renal function	✘
RELAX-AHF	1,161 patients hospitalized for AHF	i.v. serelaxin vs. pbo 48 hr	Dyspnea improvement	√
RELAX-AHF2	6,600 patients hospitalized for AHF	i.v. serelaxin vs. pbo 48 hr	CV death or WHF in 180 days	**X**

1. Cuffe et al. JAMA 2002;287:1541–7; 2. McMurray et al. JAMA 2007;298:2009–19;
3. Mebazaa et al. JAMA 2007;297:1883–91; 4. Konstam et al. JAMA 2007;297:1319–31;
5. O'Connor et al. N Engl J Med 2011;365:32–43; 6. Massie et al. N Engl J Med 2010;363:1419–28

Acute Heart Failure Management - Diuretic use



Recommendations	COR	LOE
Intravenous loop diuretic is recommended in patients with signs and symptoms of fluid overload to reduce congestive symptoms.	I	C
In patients not receiving oral diuretics, initial 20-40 mg intravenous furosemide is recommended. For those who receive oral diuretics, initial equivalent dose is recommended for intravenous furosemide.	I	B
Intravenous loop diuretics can be given either as intermittent boluses or as a continuous infusion, and the dose and duration should be adjusted according to patients' symptoms and clinical status.	I	B
It is recommended to regularly monitor urine output, body weight, renal function and electrolytes daily during use of intravenous diuretics.	I	C
Intravenous loop diuretics dose adjustment should be considered according to individual's renal function.	IIa	C



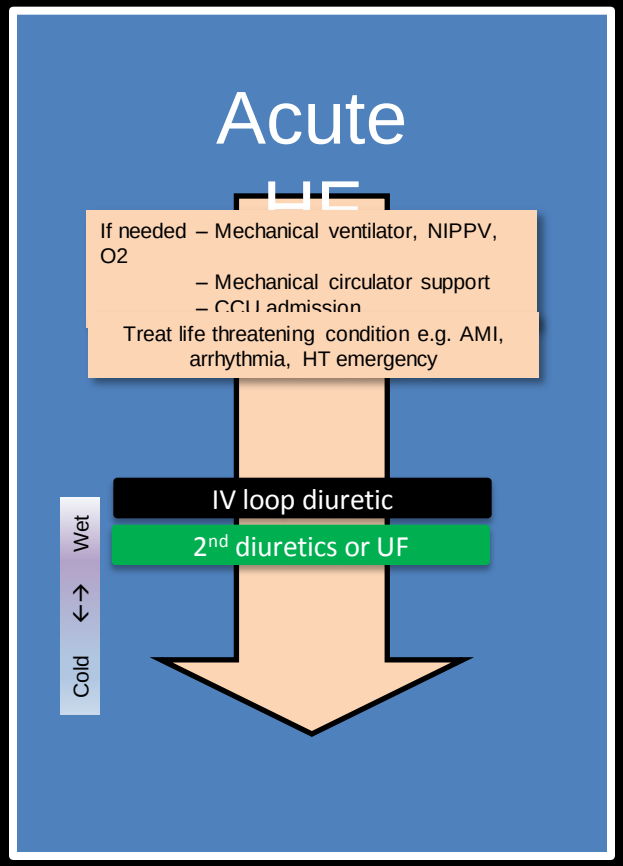
Management of patients with acute heart failure based on clinical profile during an early phase

Management of volume overload

Furosemide: standard dose, intermittent bolus or continuous infusion
Combination of diuretics (sequential blockage)
Ultrafiltration

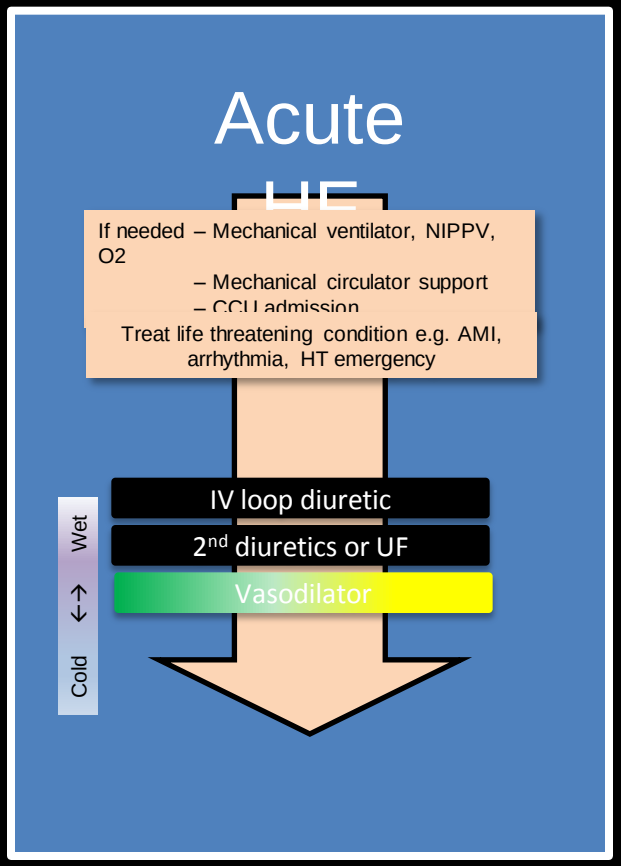
SEVERITY OF VOLUME OVERLOAD	DIURETIC	DOSE (mg)	COMMENTS
Moderate	Furosemide, or	20-40, or up to 2.5 times oral dose	IV administration preferable in symptomatic patients
	Bumetanide, or	0.5-1.0	Titrate dose according to clinical response.
	Torsemide	10-20	Monitor Na^+, K^+, creatinine, BP
Severe	Furosemide, or	40-160, or 2.5 times oral dose 5-40 mg/hr infusion	Intravenously
	Bumetanide, or	1-4/0.5-2 mg/hr infusion (max, 2-4 mg/hr, limit 2-4 hr)	Bumetanide and torsemide have higher oral bioavailability than furosemide, but IV administration preferable in AHF.
	Torsemide	20-100/5-20 mg/hr	
	Ultrafiltration	200-500 mL/hr	Adjust ultrafiltration rate to clinical response; monitor for hypotension; consider hematocrit sensor.
Refractory to loop diuretics	Add HCTZ, *or*	25-50 twice daily	Combination with loop diuretic may be better than very high dose of loop diuretics alone.
	Metolazone, *or*	2.5-10 once daily	Metolazone more potent if creatinine clearance <30 mL/min
	Chlorothiazide, *or*	250-500 mg IV 500-1000 mg PO	
	Spironolactone	25-50 once daily	Spironolactone best choice if patient not in renal failure and normal or low serum K^+, although may not be very potent
In case of alkalosis	Acetazolamide	0.5	Intravenously
Refractory to loop diuretics and thiazides	Add dopamine (renal vasodilation), *or*		
	dobutamine or milrinone (inotropic agent)		
	Ultrafiltration, or hemodialysis if coexisting renal failure		

Acute Heart Failure Management
- In case of diuretic resistant



Recommendations	COR	LOE
In patients with insufficient diuretic response •Reevaluate patients' clinical status for tissue perfusion and volume status. (COR I, LOE C) •Low sodium diet (Na <2 gram/day) is recommended in patients with recurrent or refractory volume overload despite appropriate diuretics therapy. (COR I, LOE C) •Increase dose of loop diuretics. (COR I, LOE B) •Switch from intermittent bolus to continuous infusion of loop diuretics. (COR IIa, LOE C) •Combination of loop diuretic with either thiazide-type diuretic or spironolactone should be considered in patients with insufficient diuretic response. (COR Iia, LOE ?) •Tolvaptan (V2-receptor antagonist) should be considered in patients with congestion and/or hyponatremia. It should be given for a short duration. (COR IIa, LOE B) •Ultrafiltration may be considered in refractory congestion who failed to response to diuretics-based strategy. (COR IIb, LOE B)	See text	See text

Acute Heart Failure Management
- Intravenous vasodilator

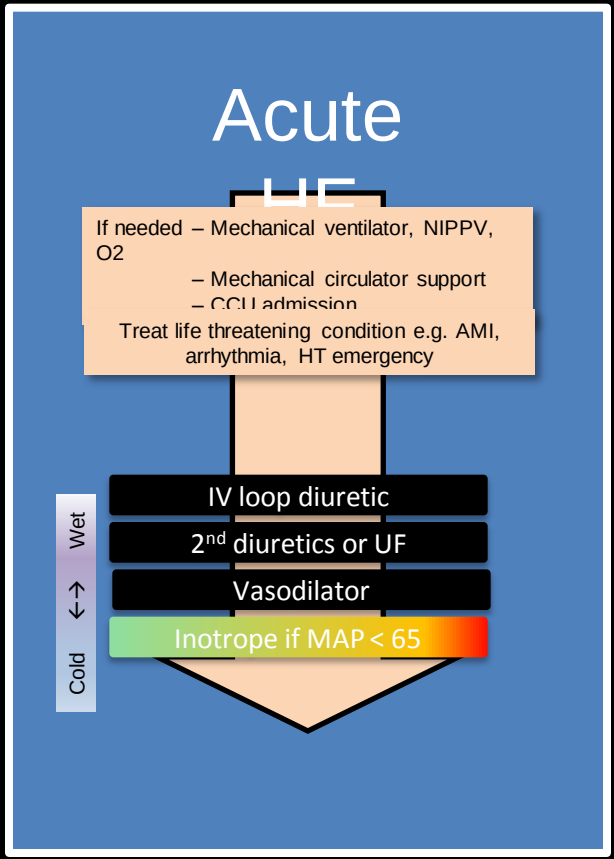


Recommendations

Intravenous vasodilators such as sodium nitroprusside, nitroglycerine should be considered

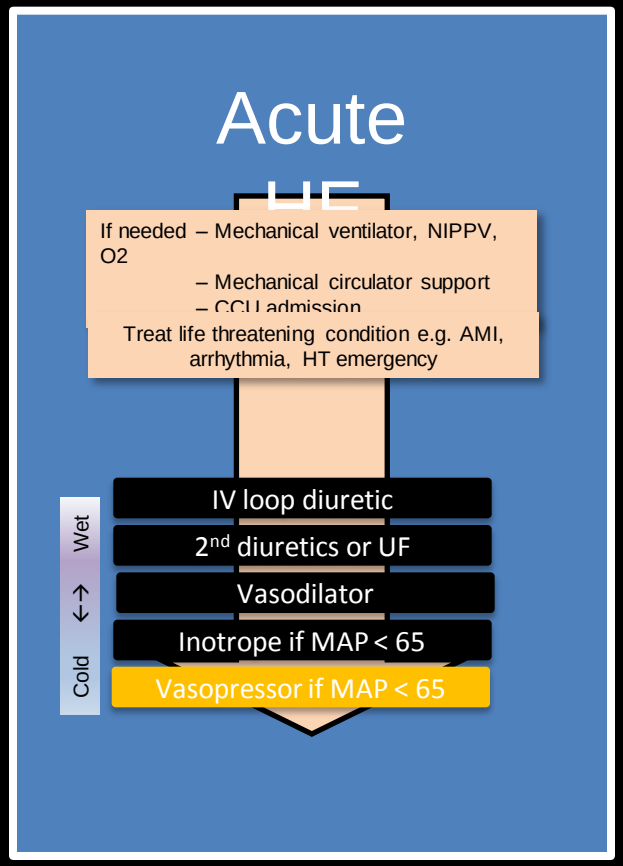
- Blood pressure monitoring is recommended during intravenous vasodilator used. (COR I, LOE C)
- For warm and wet (vascular type), for congestive symptoms relief in patients with normal or elevated blood pressure (SBP > 90 mmHg). (COR IIa, LOE B)
- Patients with signs/symptoms of hypoperfusion and congestion (Cold and wet) with SBP > 90 mmHg, intravenous vasodilators should be considered with caution. (COR IIa, LOE C)
- Intravenous sodium nitroprusside should be avoided in patients with acute myocardial ischemia or renal insufficiency. (COR IIa, LOE C)

Acute Heart Failure Management - Inotropic agents



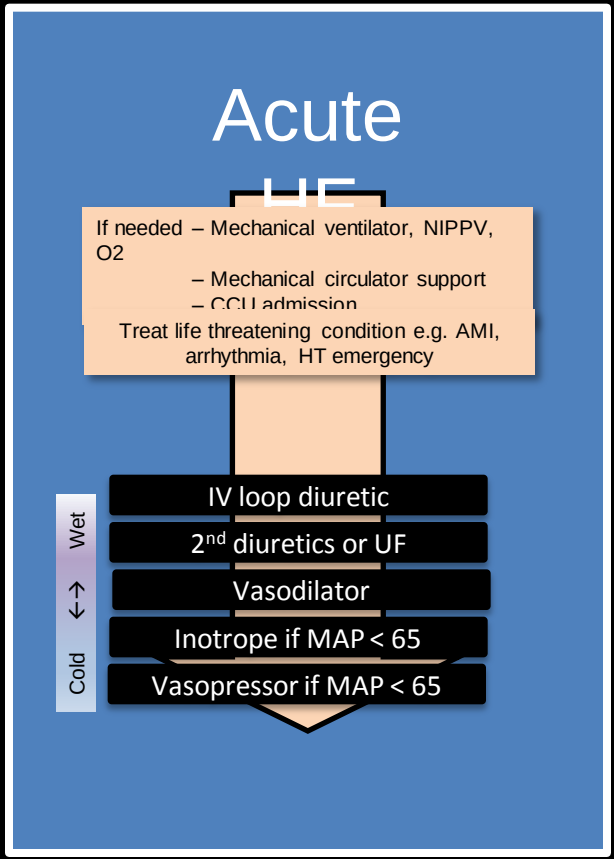
Recommendations
Use **inotropic agents** in patients with following conditions; •Cardiogenic shock (COR I, LOE C) •Signs/symptoms of hypoperfusion and/or end organ damage with hypotension (MAP < 65 mmHg) despite adequate filling status. (COR I, LOE C) •Refractory AHF with inadequate response to intravenous loop diuretics or vasodilators. (COR IIb, LOE C) •Intravenous infusion of milrinone or levosimendan may be considered to reverse the effects of beta blocker if beta blocker is considered as the cause of hypoperfusion. (COR IIb, LOE C) •Monitoring of ECG and BP closely during intravenous inotropes infusion. (COR I, LOE C)
Inotropic agents are not routinely recommended unless in symptomatic hypotension or hypoperfusion because of safety concerns.

Acute Heart Failure Management - Vasopressors



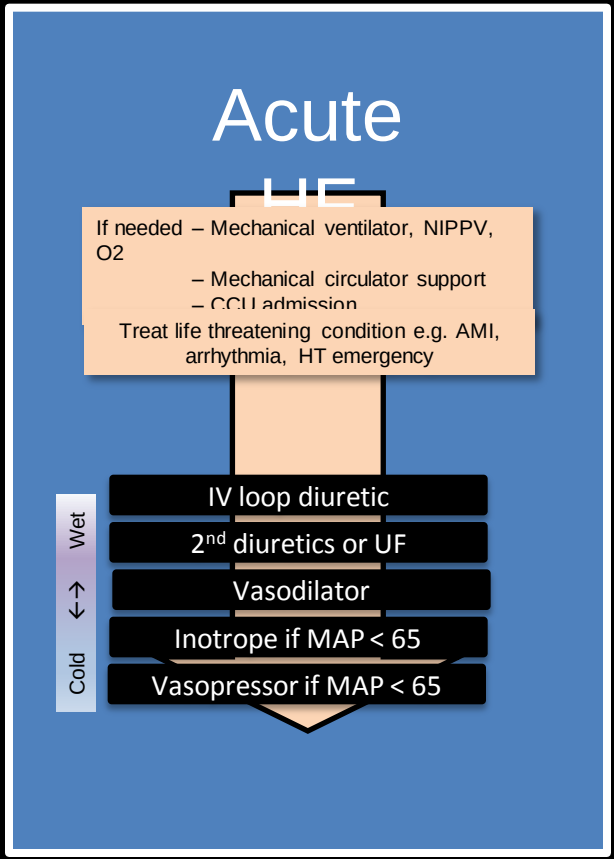
Recommendations
Vasopressors (e.g. norepinephrine) may be considered in patients with cardiogenic shock, despite treatment with inotropic agents.

Acute Heart Failure Management - Others



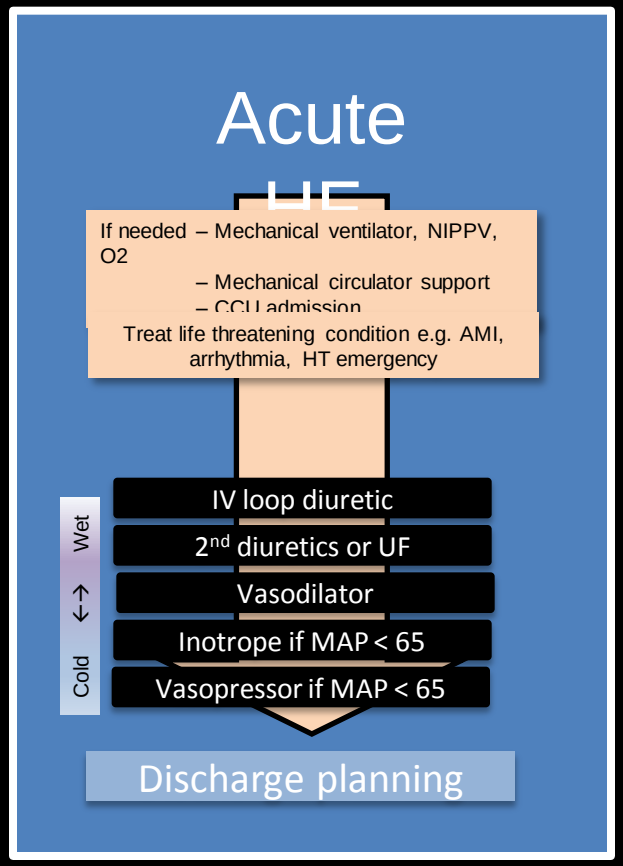
Recommendations
General management •Optimal medical treatment (OMT) for chronic heart failure is recommended to apply in AHF patients with HFrEF after hemodynamic stabilization and no contraindication. I (A) •Pre-discharge evaluation and optimization ofal medical therapy are recommended. I (,C) •Multidisciplinary HF management should be consulted especially in high-risk AHF patients. (IIa (,C) •Venous thromboembolism should be assessed and managed accordingly. IIa (C)

Acute Heart Failure Management - Others



Recommendations	COR	LOE
Pulmonary artery pressure monitoring may be considered in the following: •Persistent hypotension and/or worsening renal function with inadequate assessment of left ventricular filling pressure. IIa (due to setting) (C) •To assess pulmonary artery pressure and pulmonary vascular resistance for heart transplantation or mechanical circulatory support device. IIa (C) •Refractory heart failure despite standard treatment of intravenous diuretics, intravenous inotropes, intravenous vasodilator. IIba (C) •Invasive hemodynamic monitoring and right heart catheterization are not routinely recommended in AHF. III (B)	See text	See text
Mechanical circulatory support should be considered in patients with cardiogenic shock despite adequate medical therapy. IIa (C) General management Optical medical treatment (OMT) for chronic heart failure is recommended to apply in AHF patients with HFrEF after hemodynamic stabilization and no contraindication. . I (A) Pre-discharge evalulation and optimization of oral medical therapy are recommended. I (,C) Multidisciplinary HF management should be consulted especially in high-risk AHF patients. (IIa (,C) Venous thromboembolism should be assessed and managed accordingly. IIa (C)	IIa	C

Acute Heart Failure Management - Discharge planning



- Discharge planning should be considered when patients' clinical status is stable. Patients and caregiver education should be provided.
- Multidisciplinary HF management should be consulted especially in high-risk AHF patients.

Table X. Predischarge evaluation topics

1. Identify underlying and precipitating causes
2. Patients' clinical status: volume and perfusion
3. Optimization of medication
4. Guideline directed device therapy
5. Patients and caregivers education emphasize on signs and symptoms of worsening of HF and management
6. Follow up schedule including telephone follow up in high risk HF patients

Acute Heart Failure Management - Summary