

Using Consensus Guidelines to Individualize Patient Care for Acute Decompensated Heart Failure: A Case-Based Approach

Michael A. Crouch, Pharm.D., BCPS

One of Four Continuing Education Programs
in the Series, “Acute Decompensated Heart
Failure: Integrating Consensus Guidelines and
Individual Patient Characteristics into Optimal
Treatment Regimens”

Recorded August 1, 2006
Chicago, Illinois

Using Consensus Guidelines to Individualize Patient Care for Acute Decompensated Heart Failure: A Case-Based Approach

Target Audience

This continuing education program is beneficial for pharmacists and pharmacy managers in all practice settings who are involved in improving care for patients with ADHF.

Program Description

Now that consensus guidelines from the Heart Failure Society of America (HFSA) and European Society of Cardiology (ESC) for the treatment of acute decompensated heart failure (ADHF) are finally available, how does one apply those guidelines to individual patients? What about patients who do not fit in the standard categories described in the guidelines? Using a case-based approach, therapeutic strategies for patients with distinct presentation characteristics of ADHF will be discussed in this program. Included is a patient with a classic “warm and wet” presentation, as well as patients exhibiting signs of hypotension, diuretic resistance, and the cardiorenal syndrome. Treatment and monitoring strategies will focus on recommendations from the consensus guidelines, along with clinical pearls that will help practitioners tailor therapy to meet the individual needs of patients.

Learning Outcomes

After listening to this program, the participant should be able to:

- Describe the clinical signs and symptoms of patients with ADHF where pulmonary congestion (“warm and wet”) is the primary hemodynamic abnormality.
- Using consensus guidelines from HFSA and ESC, apply treatment strategies for patients with ADHF where pulmonary congestion is the primary hemodynamic abnormality.
- Identify modified treatment strategies for common clinical dilemmas involving patients with ADHF with variable clinical presentations.

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Program Faculty

Michael A. Crouch, Pharm.D., BCPS (AQ Cardiology)

Associate Professor of Pharmacy and Medicine
School of Pharmacy
Virginia Commonwealth University, MCV Campus
Richmond, Virginia

Michael A. Crouch, Pharm.D., BCPS, is an Associate Professor of Pharmacy and Medicine at Virginia Commonwealth University School of Pharmacy on the Medical College of Virginia (VCU/MCV) campus. He provides clinical service in the Heart Center of the VCU Health System (VCUHS), including the cardiology wards and the coronary care unit.

Dr. Crouch received his Bachelor of Science degree in pharmacy from the University of North Carolina and his Doctor of Pharmacy degree from the Medical University of South Carolina. Before joining the faculty at VCU/MCV, he completed a pharmacy practice residency at Wake Forest University Baptist Medical Center and an adult internal medicine pharmacy residency with cardiology emphasis at the Medical University of South Carolina. He is a board-certified pharmacotherapy specialist, with added qualifications in cardiology.

Dr. Crouch has dedicated much of his professional career to the advancement of pharmacy students in both Doctor of Pharmacy and Master of Science degree programs, as well as pharmacy residents. He has received numerous teaching honors and awards, most notably the VCU School of Pharmacy Excellence in Teaching award three times. He is the Program Director for the adult medicine/cardiology pharmacy residency program at VCUHS.

Dr. Crouch's research interests focus on pharmacoepidemiology, guideline adherence, teaching methodologies, and techniques to improve patient adherence and drug safety. He has published numerous articles and textbook chapters in these areas, and he is a frequent speaker on the national level. Dr. Crouch serves on various editorial and scholarly boards, including the editorial advisory board for *Annals of Pharmacotherapy*. He is an active member of the American Society of Health-Systems Pharmacists, Virginia Society of Health-System Pharmacists, and American College of Clinical Pharmacy.

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Dr. Crouch declares that he has served as a consultant and has received honoraria from educational grants funded by Scios Inc.

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1. Type **www.ashp.org/advantage/ce/** in your internet browser.
2. If you have previously logged in to the ASHP Advantage site, then you need only enter your e-mail address and password.

If you have not logged in to the ASHP Advantage site before, click on “Create Account” and follow the brief instructions to set up a user account and password. You will only need to create your account once to have access to register, take CE tests, and process CE online from ASHP Advantage in the future.

3. After logging in, you will see the list of activities for which CE is available. To process CE for one of the activities in the list, click on the “Start” button next to the name of the activity. This activity is listed under “ADHF Series.”
4. Click on the radio button next to the correct answer for each question. Once you are satisfied with your selections, click “Finish CE” to process your test and complete the remaining steps to print your CE statement.
5. Repeat the above steps for each Podcast activity in which you participate.

If you have any problems processing your CE, contact ASHP Advantage at support@ashpadvantage.com.

*Except that this site does not support the AOL Web browser.

Using Consensus Guidelines to Individualize Patient Care for Acute Decompensated Heart Failure: A Case-Based Approach

Abbreviations Used in Case Descriptions

ACE = angiotensin-converting enzyme
ARB = angiotensin receptor blocker
ALT = alanine aminotransferase
APAP = acetaminophen
aPTT = activated partial thromboplastin time
AST = aspartate aminotransferase
BNP = B-type natriuretic peptide
BP = blood pressure
BUN = blood urea nitrogen
CABG = coronary artery bypass graft
CAD = coronary artery disease
CI = cardiac index
Cl = chloride
CO = cardiac output
CO₂ = carbon dioxide
COPD = chronic obstructive pulmonary disease
CPAP = continuous positive airway pressure
CXR = chest -ray
DES = drug-eluting stent
DM = diabetes mellitus
DVT = deep venous thrombosis
ECG = electrocardiogram
ED = emergency department
EF = ejection fraction
GERD = gastroesophageal reflux disease
Hct = hematocrit
Hg = hemoglobin
HF = heart failure
HJR = hepatojugular reflex
h/o = history of
HR = heart rate
HTN = hypertension
INR = international normalization ratio
JVD = jugular venous distension
K = potassium
LV = left ventricular
LVEF = left ventricular ejection fraction
LVH = left ventricular hypertrophy
LVS = left ventricular systolic
MI = myocardial infarction
MPTA = medications prior to admission
Na = sodium
NKDA = no known drug allergies
O₂ Sat = saturated oxygen
OA = osteoarthritis
PA = pulmonary artery

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PAC = pulmonary artery catheter
PCI = percutaneous coronary intervention
PDEI = phosphodiesterase inhibitor
PCWP = pulmonary capillary wedge pressure
PND = paroxysmal nocturnal dyspnea
RA = right atrium
Rx = Prescription
RR = respiratory rate
RV = right ventricle
SBP = systolic blood pressure
SCr = serum creatinine
SOB = shortness of breath
VS = vital signs
SVR = systemic vascular resistance
WBC = white blood cell

Format of Reporting Laboratory Results

Na	Cl	BUN	Glucose
K	CO ₂	SCr	

WBC	Hg	Platelets
	Hct	

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Learning Objectives

- Describe the clinical signs and symptoms of patients where pulmonary congestion (“warm and wet”) is the primary hemodynamic abnormality
- Using consensus guidelines from the Heart Failure Society of America (HFSA) and the European Society of Cardiology (ESC), apply treatment strategies for the above clinical scenario
- Identify common clinical dilemmas and modified treatment strategies when patients present with signs of hypoperfusion, hypotension, diuretic resistance, and/or cardiorenal syndrome

Acute Decompensated Heart Failure

- 50% of patients have a systolic blood pressure (SBP) >140 mmHg
- 46% have a preserved left ventricular ejection fraction (LVEF)
- Multiple co-morbidities are present
 - Hypertension (HTN): 73%
 - Coronary artery disease (CAD): 57%
 - Diabetes mellitus (DM): 44%
 - Atrial fibrillation: 31%
 - Chronic obstructive pulmonary disease (COPD) or asthma: 31%
 - Chronic renal insufficiency: 30%

Adams KF et al. *Am Heart J.* 2005; 149:209-16.
Fonarow GC et al. *JAMA.* 2005; 293:572-80.

Acute Decompensated Heart Failure (cont)

- In-hospital mortality during hospitalization varies greatly based on baseline blood urea nitrogen (BUN), SBP, and serum creatinine (SCr)

Fonarow GC et al. *JAMA.* 2005; 293:572-80.

Case 1

Case 1

JM is a 65-year-old African American man with a significant cardiac history, who presents to the ED with worsening dyspnea on exertion. He reports experiencing intermittent SOB over the last week, but it abruptly worsened today. He also complains of occasional chest pain and nocturnal cough.

He has a past medical history of HTN (x 20 yrs), COPD, osteoarthritis, dyslipidemia, coronary artery disease (MI with stent placement one year ago [DES]), and heart failure.

He smoked in the past (40 pk yrs, none x 2 yrs) and drinks alcohol occasionally.

Case 1: History and Physical Exam

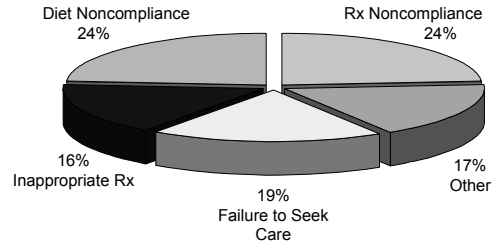
He reports a history of angioedema with lisinopril.

MPTA include: Atorvastatin 40 mg daily
Aspirin 81 mg daily
Clopidogrel 75 mg daily
Valsartan 40 mg twice daily
Furosemide 40 mg daily
Meloxicam 7.5 mg daily (Rx for 1 mo)

VS: BP 154/100 mmHg, HR 88 bpm, RR 22, 96% O₂Sat

In the ED, physical examination reveals significant rales bilaterally, peripheral edema, and mild JVD.

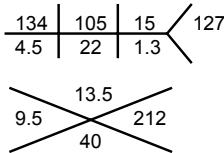
Causes of Hospital Readmission



Vinson J. *Am Geriatr Soc.* 1990; 38:1290-5.

Case 1: Test Results

Relevant laboratory data include:



Troponin <0.1 ng/mL
INR 1.0
aPTT 34 sec
BNP 879 pg/mL
AST 48 U/L
ALT 42 U/L

ECG: no acute changes; LVH based on voltage criteria
CXR: hyperaerated lung fields with interstitial edema and evidence of cardiac compromise

ADHF Signs and Symptoms

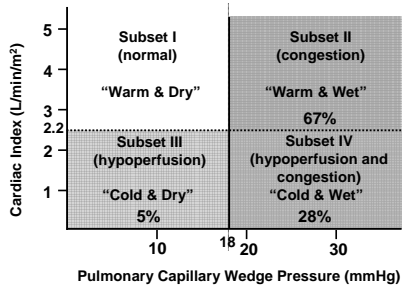
Volume Overload

- **Dyspnea on exertion**
- Orthopnea
- Paroxysmal nocturnal dyspnea (PND)
- Early satiety
- Nausea/vomiting
- **Rales**
- **Peripheral edema**
- **↑ Jugular venous pressure (JVP)**
- (+) Hepatojugular reflex (HJR)
- Hepato-/splenomegaly
- Ascites

Hypoperfusion

- Fatigue
- Altered mental status
- Narrow pulse pressure
- Hypotension
- Cool extremities
- Worsening renal function

Hemodynamic Subsets in ADHF



Nohria A et al. *JAMA.* 2002; 287:628-40.

B-type Natriuretic Peptide (BNP)

Heart Failure Society of America

The diagnosis of decompensated heart failure (HF) should be based primarily on signs and symptoms. (Strength of Evidence = C) When the diagnosis is uncertain, determination of BNP or NT-proBNP concentration should be considered... (Strength of Evidence = A)

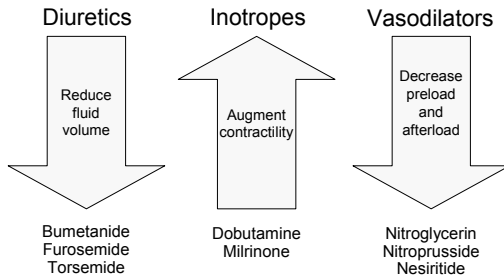
European Society of Cardiology

"Decision cut points of 300 pg/mL for NT-ProBNP and 100 pg/mL for BNP have been proposed..."

NT-proBNP = N-terminal pro-BNP

Adams KF et al. *J Card Fail.* 2006; 12:10-38.
Niemi MS et al. *Eur Heart J.* 2005; 26:384-416.

Conventional Treatments in ADHF



Diuretics

Heart Failure Society of America

It is recommended that patients admitted with ADHF and evidence of fluid overload be treated initially with loop diuretics usually given intravenously rather than orally. (Strength of Evidence = B)

European Society of Cardiology

Administration of diuretics is indicated in patients with acute and acutely decompensated heart failure in the presence of symptoms secondary to fluid retention. (Class I, level of evidence B)

Adams KF et al. *J Card Fail.* 2006; 12:10-38.
Niemenen MS et al. *Eur Heart J.* 2005; 26:384-416.

Diuretics (cont)

Variable	Furosemide	Metolazone
Diuretic type	Loop	Thiazide-related
Dosing	<u>Furosemide naïve</u> 40 mg i.v. push x 1 dose <u>Outpatient furosemide</u> Daily oral dose as i.v. (maximum of 180 mg)	2.5-10 mg orally
Goals	≥500 mL urine output within 2 hour (≥250 mL if SCr >2.5 mg/dL)	Increased urine output
Monitoring	Symptom relief, intake/output, daily weight, vital signs, BUN, SCr, electrolytes	Symptom relief, intake/output, daily weight, vital signs, BUN, SCr, electrolytes

DiDomenico RJ et al. *Ann Pharmacother.* 2004; 38:649-60.

Vasodilators

Heart Failure Society of America

In the absence of symptomatic hypotension, intravenous nitroglycerin, nitroprusside, or nesiritide may be considered as an addition to diuretic therapy for rapid improvement of congestive symptoms in patients admitted with ADHF. Frequent blood pressure monitoring is recommended with these agents. (Strength of Evidence = B).

European Society of Cardiology

Vasodilators are indicated in most patients with acute heart failure as first line therapy, if hypoperfusion is associated with adequate blood pressure and signs of congestion with low diuresis, to open the peripheral circulation and lower pre-load.

Adams KF et al. *J Card Fail.* 2006; 12:10-38.
Niemenen MS et al. *Eur Heart J.* 2005; 26:384-416.

Vasodilators (cont)

Variable	Nitroglycerin	Nitroprusside	Nesiritide
Mechanism of action	Vasodilator (venous > arterial)	Vasodilator (venous and arterial)	Vasodilator (venous and arterial)
Dosing	5-10 mcg/min (titrate every 5 min)	0.3 mcg/kg/min (titrate upward)	2 mcg/kg i.v. bolus, 0.01 mcg/kg/min
Monitoring	Symptom relief, vital signs, urine output		
Limitations	Hypotension Headache Tachyphylaxis Reflex tachycardia Titration required	Hypotension Toxic metabolites Reflex tachycardia Difficult titration Coronary "steal"	Hypotension Unresolved issues (worsening renal function, mortality)

DiDomenico RJ et al. *Ann Pharmacother.* 2004; 38:649-60.
Niemenen MS et al. *Eur Heart J.* 2005; 26:384-416.

Hebeler RJ Jr et al. 7th Scientific Forum on QOC and Outcomes Research. 2006 May 9.

Inotropic Agents

Heart Failure Society of America

"The use of inotropes should be severely limited."

European Society of Cardiology

Inotropic agents are indicated in the presence of peripheral hypoperfusion (hypotension, decreased renal function) with or without congestion or pulmonary edema refractory to diuretics and vasodilators at optimal doses. (Class IIa, level of evidence C)

Adams KF et al. *J Card Fail.* 2006; 12:10-38.
Niemenen MS et al. *Eur Heart J.* 2005; 26:384-416.

Case 1: Treatment

The patient was given furosemide 40 mg i.v., followed by a second i.v. dose of 80 mg. Resolution of symptoms was marginal.

Initiate i.v. vasodilator: nitroglycerin, nitroprusside, or nesiritide.

Monitor for symptomatic relief, intake and output, daily weight, vital signs, BUN, serum creatinine, and electrolytes.

Case 1: Treatment and Discharge

The addition of nesiritide to diuretic therapy resulted in symptomatic improvement. The blood pressure remained stable at 140/88 mmHg and the nesiritide continued for approximately 48 hours. An echocardiogram reveals an ejection fraction of 40%.

As the patient nears discharge, the outpatient drug regimen must be enhanced. Discontinue meloxicam as it can cause fluid retention (use scheduled APAP). Counsel patient on continued smoking cessation.

Optimize the chronic heart failure regimen

- Continue furosemide (titrate dose)
- Continue valsartan (increase dose to 80 mg twice daily)
- Initiate low-dose β -blockers (e.g., carvedilol, metoprolol XL)

ACC/AHA Heart Failure Clinical Performance Measures: Inpatient

1. Evaluation of left ventricular (LV) systolic function
2. Angiotensin-converting enzyme (ACE) inhibitor or angiotensin receptor blocker (ARB) for left ventricular systolic dysfunction
3. Anticoagulant at discharge for HF patients with atrial fibrillation
4. Discharge instructions
5. Adult smoking cessation advice/counseling

Bonow RO et al. *J Am Coll Cardiol.* 2005; 46:1144-78.

Case 2

Case 2

SC is a 55-year-old Caucasian woman with known heart failure, who presents to clinic with severe SOB, particularly when lying down, and fatigue. She has a significant history of multiple ADHF hospitalizations, oftentimes due to noncompliance and dietary indiscretion. She ran out of furosemide three days earlier.

She has a past medical history of CAD (MI 4 yrs ago and CABG), heart failure (EF=25% by echo 1 month ago), HTN, DM (type 2 x 5 yrs), dyslipidemia, h/o breast cancer, and pulmonary hypertension.

She does not smoke or drink alcohol.

Case 2: History and Physical Exam

She has NKDA. MPTA include:

Pravastatin 40 mg daily
Aspirin 81 mg daily
Metoprolol XL 100 mg daily
Lisinopril 10 mg daily
Furosemide 40 mg twice daily
Amlodipine 10 mg daily
Rosiglitazone 4 mg daily

VS: BP 92/66 mmHg, HR 92 bpm, RR 18, 94% O₂Sat

In the ED, physical examination reveals pulmonary and peripheral edema, as well as altered mentation.

Case 2: Test Results

Relevant laboratory data include:

132	102	20	174				
3.8	25	1.5					
 <table border="1"> <tr> <td>12.5</td> <td>178</td> </tr> <tr> <td>8.2</td> <td>38</td> </tr> </table> 				12.5	178	8.2	38
12.5	178						
8.2	38						

Troponin <0.1 ng/mL
 INR 1.0
 aPTT 34 sec
 BNP 1547 pg/mL
 AST 38 U/L
 ALT 42 U/L

ECG: no acute abnormalities; evidence of a previous MI
 CXR: enlarged cardiac silhouette, development of bilateral plural effusions, and reticulonodular pattern suggestive of pulmonary edema

Case 2: Treatment

In the ED, SC received 80 mg of i.v. furosemide with approximately 200 mL urine output over the next two hours. She continued to have difficulty breathing and another dose of i.v. furosemide was given.

The patient was transferred to the cardiology floor for further treatment. Repeat vitals show a BP of 90/68 mmHg. She is placed on telemetry and a repeat chem-7 is pending. Old records reveal she has a baseline SCr of 1.0 mg/dL.

ADHF Signs and Symptoms

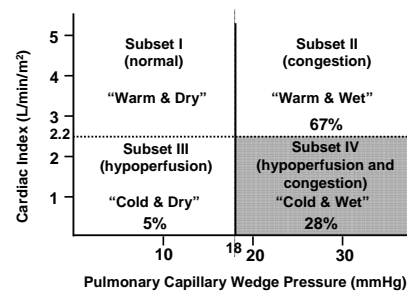
Volume Overload

- Dyspnea on exertion
- Orthopnea
- PND
- Early satiety
- Nausea/vomiting
- Rales
- Peripheral edema
- ↑ JVP
- (+) HJR
- Hepato-/splenomegaly
- Ascites

Hypoperfusion

- Fatigue
- Altered mental status
- Narrow pulse pressure
- Hypotension
- Cool extremities
- Worsening renal function

Hemodynamic Subsets in ADHF



Nohria A et al. *JAMA*. 2002; 287:628-40.

General Therapeutic Approaches in Acute Heart Failure

Hemodynamic characteristic

Cardiac index (CI)	Decreased	Decreased
Pulmonary capillary wedge pressure (PCWP)	High	High
SBP	>85 mmHg	<85 mmHg
Outline of therapy	Vasodilator and i.v. diuretic Consider inotrope	Consider inotrope and i.v. diuretic
Decreased CI: <2.2 L/min/m ²		
PCWP: low if <14 mmHg, high if >18-20 mmHg		

Nieminen MS et al. *Eur Heart J*. 2005; 26:384-416.

Inotropic Agents

Heart Failure Society of America

Inotropes may be considered to relieve symptoms and improve end-organ function in patients with advanced HF... and diminished peripheral perfusion or end-organ dysfunction (low output syndrome), particularly if these patients have marginal systolic blood pressure (<90 mm Hg)... (Strength of Evidence = C)

European Society of Cardiology

Inotropic agents are indicated in the presence of peripheral hypoperfusion (hypotension, decreased renal function) with or without congestion or pulmonary edema refractory to diuretics and vasodilators at optimal doses. (Class IIa, level of evidence C)

Adams KF et al. *J Card Fail*. 2006; 12:10-38.
 Nieminen MS et al. *Eur Heart J*. 2005; 26:384-416.

Inotropic Agents (cont)

Variable	Dobutamine	Milrinone
Mechanism of action	β -receptor agonist	Type III phosphodiesterase (PDE) inhibitor
Dosing	2.5 to 20 mcg/kg/min	0.375 to 0.75 mcg/kg/min
Monitoring	Symptom relief, vital signs, ECG, urine output	
Limitations	Tachycardia Proarrhythmia Mortality concerns	Tachycardia Proarrhythmia Mortality concerns Hypotension
Vasodilator	No	Yes
Use in patients taking β -blockers	No?	Yes
Renal accumulation (decreased renal function)	No	Yes

DiDomenico RJ et al. *Ann Pharmacother.* 2004; 38:649-60.

β -Blockers

Heart Failure Society of America

It is recommended that β -blocker therapy be continued in most patients experiencing a symptomatic exacerbation of HF during chronic maintenance treatment. (Strength of Evidence = C)

European Society of Cardiology

In patients with overt acute HF and more than basal pulmonary rales, β -blockers should be used cautiously. Among patients whom ongoing ischemia and tachycardia are present, intravenous metoprolol can be considered. (Class IIa, level of evidence B)

Adams KF et al. *J Card Fail.* 2006; 12:10-38.
Niemenen MS et al. *Eur Heart J.* 2005; 26:384-416.

Phosphodiesterase Inhibitors

European Society of Cardiology

Type III PDE inhibitors are indicated when there is evidence of peripheral hypoperfusion with or without congestion refractory to diuretics and vasodilators at optimal doses, and a preserved systemic blood pressure. (Class IIb, level of evidence C)

These agents may be preferred to dobutamine in patients on concomitant β -blocker therapy, and/or with an inadequate response to dobutamine. (Class IIa, level of evidence C)

Niemenen MS et al. *Eur Heart J.* 2005; 26:384-416.

Case 2: Treatment (cont)

Treatment entails i.v. furosemide and sodium/water restriction; amlodipine is discontinued.

So long as the blood pressure remains above 90 mmHg (85 mmHg according to ESC guidelines), the next course of therapy is an i.v. vasodilator. Alternative treatment, particularly based on response to initial therapy, includes an inotropic agent (i.e., milrinone because of chronic β -blocker therapy).

Monitoring consists of symptomatic relief, intake and output, daily weight, vital signs, BUN, serum creatinine, and electrolytes (ECG if inotropic agent started).

Case 2: Treatment and Discharge

Symptomatic improvement occurred upon administration of nitroglycerin and diuretic therapy. The blood pressure remained stable at 88/62 mmHg. The most recent serum creatinine is 1.3 mg/dL and potassium is 4.5 mmol/L.

As the patient nears discharge, adjust the outpatient drug regimen. Discontinue rosiglitazone as it can cause fluid retention and use glipizide as an alternative.

Optimize the chronic heart failure management

- Continue furosemide (titrate dose)
- Continue metoprolol XL 100 mg daily (outpatient titration)
- Continue lisinopril 10 mg daily (outpatient titration)
- Initiate spironolactone 25 mg daily

Discharge Criteria for Patients with ADHF

All patients

- Precipitating factors addressed
- Near optimal volume status achieved
- I.V.-to-oral conversion of diuretic
- Education completed
- Near optimal drug therapy
- Follow-up clinic visit scheduled for 7-10 days

Patients with advanced HF or recurrent HF admissions

- Stable oral regimen for 24 hrs
- No i.v. inotrope or vasodilator for 24 hrs
- Ambulated before discharge
- Postdischarge management plans completed
- Referral for disease management

Adams KF et al. *J Card Fail.* 2006; 12:10-38.

Case 3

Case 3

FP is a 56-year-old Caucasian man brought to the hospital via ambulance after acutely becoming short of breath at home. The dyspnea has increased over the past couple days, particularly on exertion. He has been sleeping in a recliner as the SOB significantly worsens when supine. He was admitted to the hospital for ADHF one month ago.

His past medical history consists of CAD (MI 8 years ago, CABG), HTN, DM, COPD, dyslipidemia, h/o atrial fibrillation, h/o DVT (3 yrs ago), depression, GERD, & heart failure (EF=10 to 15% by echo last month).

He smoked in the past, but has stopped for "years" and he abstains from alcohol, as directed.

Case 3: History and Physical Exam

He is allergic to penicillin. MPTA include:

- Vytorin 10/40 mg daily
- Aspirin 325 mg daily
- Carvedilol 12.5 mg twice daily
- Enalapril 5 mg daily
- Furosemide 80 mg twice daily
- Glipizide, atrovant, albuterol, escitalopram, esomeprazole

VS: BP 80/62 mmHg, HR 102 bpm, RR 28, 88% O₂Sat

In the ED, physical examination revealed high JVP, peripheral edema, crackles ¼ up lung fields bilaterally, and wheezes.

Case 3: Test Results

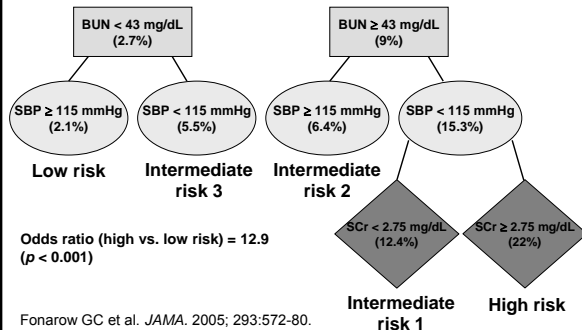
Relevant laboratory data include:

129	111	52	167
3.2	18	3.4	
10.3			
11.5		154	
31			

- Troponin <0.1 ng/mL
- INR 1.0
- aPTT 33 sec
- BNP 3864 pg/mL
- AST 75 U/L
- ALT 68 U/L

Per old records, his baseline SCr is 1.5-1.8 mg/dL
 ECG: no acute abnormalities; sinus tachycardia
 CXR: enlarged cardiac silhouette, edema bilaterally

Risk Stratification for In-Hospital Mortality



ADHF Signs and Symptoms

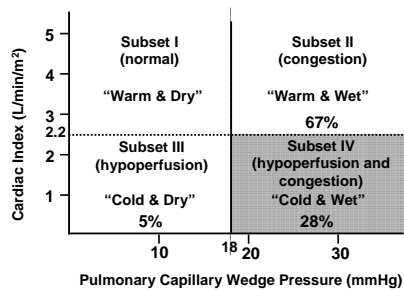
Volume Overload

- Dyspnea on exertion
- Orthopnea
- PND
- Early satiety
- Nausea/vomiting
- Rales
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- ↑ JVP
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- Ascites

Hypoperfusion

- Fatigue
- Altered mental status
- Narrow pulse pressure
- Hypotension
- Cool extremities
- Worsening renal function

Hemodynamic Subsets in ADHF



Nohria A et al. *JAMA*. 2002; 287:628-40.

Case 3: Treatment

In the ED, ventilatory support was provided (CPAP and 2L O₂) along with 100 mg i.v. furosemide. Another dose of furosemide is given (160 mg i.v.) after insufficient urinary output.

He continues to have symptoms and urine output remains low. He is transferred to the coronary care unit for further evaluation and another dose of furosemide (160 mg i.v.) is given.

Diuretic Resistance

Heart Failure Society of America

When congestion fails to improve in response to diuretic therapy, the following options should be considered:

- Sodium and fluid restriction
- Increased doses of loop diuretic
- Continuous infusion of a loop diuretic, or
- Addition of a second type of diuretic orally (metolazone or spironolactone) or intravenously (chlorothiazide).

A fifth option, ultrafiltration, may be considered.
(Strength of Evidence = C)

Adams KF et al. *J Card Fail*. 2006; 12:10-38.

Inotropic Agents

Heart Failure Society of America

Intravenous inotropes (milrinone or dobutamine) may be considered to relieve symptoms and improve end-organ function in patients with advanced HF characterized by LV dilation, reduced LVEF, and diminished peripheral perfusion or end-organ dysfunction (low output syndrome), particularly if these patients have marginal systolic blood pressure (<90 mm Hg)... (Strength of Evidence = C)

Adams KF et al. *J Card Fail*. 2006; 12:10-38.

Case 3: Treatment (cont)

Dobutamine 5 mcg/kg/min is started, along with furosemide infusion. Carvedilol is discontinued (wheezes on physical examination and initiation of dobutamine).

A pulmonary artery catheter (PAC) is placed to better ascertain volume status and cardiac filling pressures.

Invasive Monitoring

Heart Failure Society of America

Invasive hemodynamic monitoring should be considered in a patient (Strength of Evidence = C)

- Who is refractory to initial therapy
- Whose volume status and cardiac filling pressures are unclear
- Who has clinically significant hypotension (typically SBP <80 mm Hg) or worsening renal function during therapy, or
- In whom documentation of an adequate hemodynamic response to the inotropic agent is necessary when chronic outpatient infusion is being considered

Adams KF et al. *J Card Fail*. 2006; 12:10-38.

Case 3: Treatment (cont)

The results of the PAC show:

CO = 3.2 L/min

CI = 1.65 L/min/m²

RA = 12 mmHg

RV = 41/21 mmHg

PCWP = 32 mmHg

PA = 47/32 mmHg

SVR = 1550 dyne*sec/cm⁵

VS: BP 86/62 mmHg, HR 84 bpm

Case 3: Treatment (cont)

Initiate a vasodilator: nitroglycerin or nesiritide (avoid nitroprusside due to renal dysfunction)

Case 3: Treatment and Discharge

Upon administration of furosemide, dobutamine, and i.v. nitroglycerin therapy, the patient showed symptomatic improvement. Blood pressure remains stable and the most recent serum creatinine is 3.0 mg/dL.

After stabilization, dobutamine and nitroglycerin are withdrawn.

He is subsequently transferred to the floor and prepares for discharge.

- Continue enalapril (dose twice daily or change to daily ACE inhibitor; outpatient titration)
- Continue furosemide (change to oral dosing & titrate)
- Initiate low dose metoprolol XL (wheezes on physical exam)

Key Points

- Recognize and treat precipitating factors
- Use clinical assessment to guide and adjust intravenous treatment
- Monitor for adverse drug events
- Enhance chronic pharmacotherapy with emphasis on agents demonstrated to improve survival (e.g., ACE inhibitors, β -blockers, aldosterone antagonists)
- Provide patient and family education
- Establish regular follow-up care

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Self-Assessment Questions

1. Which of the following statements best describes patients with acute decompensated heart failure (ADHF)?
 - a. Concomitant hypertension is more common than coronary artery disease.
 - b. A majority of patients have a systolic blood pressure (SBP) less than 100 mmHg.
 - c. A preserved left ventricular ejection fraction is uncommon.
 - d. Added together, drug and dietary non-compliance accounts for less than 25% of hospital readmissions.
2. All of the following signs and symptoms suggest volume overload in a patient with ADHF *except*
 - a. Dyspnea on exertion.
 - b. Peripheral edema.
 - c. Cool extremities.
 - d. Rales.
3. What hemodynamic subset is most common in patients with ADHF?
 - a. Warm and dry.
 - b. Warm and wet.
 - c. Cold and dry.
 - d. Cold and wet.
4. Which statement best describes the role of measuring B-type natriuretic peptide (BNP) concentrations in patients with ADHF?
 - a. BNP concentrations should be obtained in all patients with ADHF.
 - b. NT-proBNP is preferred over BNP.
 - c. The decision cut point for NT-proBNP is 100 pg/mL.
 - d. BNP or NT-proBNP should be obtained if the diagnosis of ADHF is uncertain.
5. When using a diuretic in patients with ADHF and normal renal function, which of the following statements is most correct?
 - a. The initial furosemide dose should be 100 mg i.v.
 - b. Metolazone should be routinely used in patients receiving i.v. furosemide.
 - c. Goal urine output after the initial i.v. diuretic dose is >500 mL over two hours.
 - d. In-hospital mortality is lower in individuals receiving i.v. diuretics.
6. Vasodilators are indicated in most patients with acute heart failure as first line therapy, if hypoperfusion is associated with adequate blood pressure and signs of congestion with low diuresis.
 - a. True.
 - b. False.

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7. Which of the following agents has the dose-limiting effect known as tachyphylaxis?
 - a. Nitroprusside.
 - b. Nitroglycerin.
 - c. Nesiritide.
 - d. Hydralazine.

8. Which of the following signs or symptoms suggest hypoperfusion in ADHF?
 - a. Orthopnea.
 - b. Nausea and vomiting.
 - c. Worsening renal function.
 - d. Peripheral edema.

9. Milrinone is different from dobutamine because it can cause
 - a. Tachycardia.
 - b. Proarrhythmia.
 - c. Vasodilation.
 - d. Symptom relief.

10. It is recommended that β -blockers being used for chronic ADHF maintenance therapy be discontinued in most patients experiencing an acute symptomatic exacerbation of heart failure.
 - a. True.
 - b. False.

11. Which of the following variables suggest a high risk of in-hospital mortality in patients with ADHF?
 - a. Blood urea nitrogen (BUN) < 43 mg/dL.
 - b. SBP \geq 140 mmHg.
 - c. BNP < 300 pg/mL.
 - d. Serum creatinine (SCr) \geq 2.75 mg/dL.

12. If a patient with ADHF receives repeated doses of an i.v. diuretic and fails to achieve the desired therapeutic effect and still has symptoms of congestion, the patient most likely has developed
 - a. Pulmonary hypertension.
 - b. Diuretic resistance.
 - c. Improved renal function.
 - d. Neurohormonal deactivation.

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13. Which of the following statements best describes the usefulness of invasive hemodynamic monitoring in patients with ADHF?
- a. Has a positive effect on clinical status and mortality.
 - b. Can be used to adjust ADHF therapy.
 - c. May be associated with a lower rate of adverse events.
 - d. Should be considered for patients who are refractory to initial therapy.