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Acute Decompensated Heart Failure

A Pharmacologic Review

Josmi Joseph ▼ Aeman Choudhury ▼ Sean P. Kane

Chronic heart failure (CHF) is a growing disease in the United States. Exacerbations of CHF can lead to acute decompensated heart failure (ADHF) and hospitalizations. Nurses play a key role in the treatment of ADHF as they administer medications, monitor patients' response to therapy, and can prompt providers to alter therapy if therapeutic outcomes are not being achieved. Nurses also play a vital role in discharge education for patients who are hospitalized for ADHF, as they can counsel patients on ways to reduce further hospitalizations. It is important for nurses to understand and recognize symptoms of ADHF, pharmacologic treatments for ADHF, and common etiologies of ADHF to help improve patient outcomes.

Background

Prevalence and Impact

Chronic heart failure (CHF) affects 6.2 million Americans and is a growing disease, with 8 million Americans projected to be diagnosed with heart failure by 2030 (Hollenberg et al., 2019). The estimated total cost for heart failure in 2012 was $30.7 billion (Benjamin et al., 2019). Heart failure was noted to be the primary diagnosis for 1 million hospital discharges and the secondary diagnosis for 2 million hospital discharges (Hollenberg et al., 2019). One quarter of patients with a heart failure hospitalization are readmitted within 30 days of discharge and nearly half are readmitted within 6 months. Of these readmissions, one quarter are deemed to be preventable, and programs such as the Hospital Readmission Reduction Program, created by the Centers for Medicare & Medicaid Services, have been implemented to reduce the readmission rates of certain disease states including heart failure (Khan et al., 2021). Furthermore, patients who are admitted with heart failure have a 20%–30% risk of death within 1 year. Therefore, the goals of care should be to not only get patients to baseline but also to optimize their therapy before being discharged to prevent readmissions (Hollenberg et al., 2019).

Common Etiologies of Acute Decompensated Heart Failure

Acute decompensated heart failure (ADHF) can be defined as new or worsening heart failure symptoms that require medical attention such as a hospitalization or emergency department visit. About 25% of heart failure admissions are due to left ventricular dysfunction following a large myocardial infarction, whereas about 70% of admissions are due to worsening CHF. Common etiologies of ADHF include nonadherence to dietary restrictions, nonadherence to medications, use of nonsteroidal anti-inflammatory drugs, concurrent illness, and disease progression of heart failure (Rodgers & Reed, 2017). It is important to determine whether decompensation is due to disease progression or nonadherence to diet and/or medication regimens to properly adjust medications for discharge and prevent readmissions. The different subtypes of ADHF along with treatment options based on patient presentation are outlined in Figure 1 and Table 1.

Pharmacologic Therapies

Fluid Management

Loop diuretics are the first-line therapy option for patients who display symptoms of fluid overload ("wet") and need diuresis. The goal is to induce a net fluid loss of 1–2 L per day. Some patients with advanced heart failure may only tolerate 1 L of fluid loss daily (Rodgers & Reed, 2017). Overdiuresis should be avoided. Some signs of overdiuresis include profound electrolyte abnormalities, a reduction in cardiac output, symptomatic hypotension, or worsening renal function (Rodgers & Reed, 2017).

Among patients indicated for diuresis due to ADHF, intravenous loop diuretic therapy with furosemide or

Josmi Joseph, PharmD, PGY-2 Ambulatory Care Pharmacy Resident, Captain James A. Lovell Federal Health Care Center, North Chicago, IL.

Aeman Choudhury, PharmD, BCPS, BCACP, Home Based Primary Care, PGY2 Ambulatory Care Residency Program Director, Captain James A Lovell Federal Health Care Center, North Chicago, IL.

Sean P. Kane, PharmD, BCPS, Associate Professor, Pharmacy Practice, Assistant Dean for Assessment, Rosalind Franklin University of Medicine and Science, North Chicago, IL.

The authors have disclosed that they have no financial interests to any commercial company related to this educational activity.

Correspondence: Josmi Joseph, PharmD, Captain James A. Lovell Federal Health Care Center, 3001 Green Bay Road, North Chicago, IL 60064 (josmijoseph2020@gmail.com).

DOI: 10.1097/NOR.0000000000000864

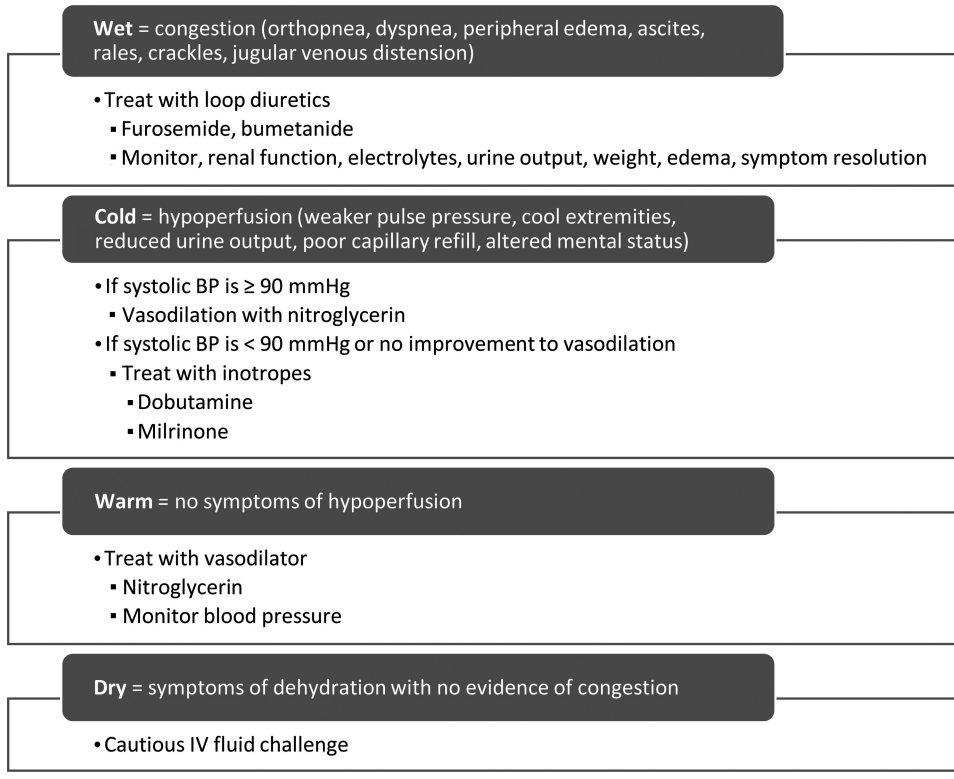

Figure 1. Symptoms for different subtypes and treatment options.

bumetanide is used often at double the equivalent dose of the patient's prior to admission regimen. The dose and frequency of a loop diuretic should be titrated based on a patient's response. Doses can be escalated, given more frequently, or given as a continuous infusion if adequate diuresis is not achieved. See Table 2 for examples of common diuretics used in ADHF. Nurses play a vital role in frequently assessing patients' response to diuretic therapy and alerting providers to ensure necessary dose changes are done promptly (Hollenberg et al., 2019).

For patients who do not achieve diuresis goals despite escalating loop diuretic doses, a thiazide or thiazide-like diuretic, such as oral metolazone or intravenous chlorothiazide, may be added to improve diuresis. This approach may provide benefit by providing blockade of sodium reabsorption at two distinct portions of the nephron—the ascending loop of Henle (with loop diuretics) and the distal tubule (with thiazide or thiazide-like diuretics). Due to the use of two concurrent diuretics, frequent monitoring of electrolytes and renal function is important with this approach (Hollenberg et al., 2019).

Once a patient has achieved diuresis goals and is back to a compensated, euvolemic status, intravenous diuretics can be transitioned to oral therapies at normal maintenance doses in anticipation of hospital discharge (Hollenberg et al., 2019).

Vasodilators

In patients with more severe symptoms or those with inadequate response to diuresis, nitroglycerin can be used as a vasodilator to decrease preload (thereby helping with pulmonary congestion) and decrease afterload (allowing for increased cardiac output). Due to a short

Table 1. The different Subtypes of ADHF

	Dry	Wet
Warm	Warm and dry • Compensated heart failure	Warm and wet • Make up most of the patients admitted with HF
Cold	Cold and dry • Fewer than 5% of admissions • Possible indication for invasive hemodynamic assessment due to unknown hemodynamic status	Cold and wet • Worst prognosis and common in end-stage heart failure

Note. ADHF = acute decompensated heart failure; HF = heart failure. Data from "2019 ACC expert consensus decision pathway on risk assessment, management, and clinical trajectory of patients hospitalized with heart failure: A report of the American College of Cardiology Solution Set Oversight Committee" by S. M. Hollenberg, L. Warner Stevenson, T. Ahmad, V. J. Amin, B. Bozkurt, J. Butler, L. L. Davis, M. H. Drazner, J. N. Kirkpatrick, P. N. Peterson, B. N. Reed, C. L., Roy, and A. B. Storrow, 2019, *Journal of the American College of Cardiology*, 74(15), p.p. 1966–2011. From *Pharmacotherapy: A pathophysiologic approach* (10th ed.) by J. E. Rodgers and B. N. Reed, 2017, McGraw Hill.

Table 2. Common Diuretics Used in Heart Failure With Their Respective Route of Administration

Drug Class	Generic Name	Route of Administration
Loop diuretics	Bumetanide	IV, PO
	Furosemide	IV, PO
	Torsemide	PO
Thiazide-type diuretics	Chlorothiazide	IV, PO
	Metolazone	PO

Note. IV = intravenous; PO = oral.

half-life of 1–3 minutes, a continuous infusion is recommended at a starting dose of 5–10 mcg/min, which may be increased every 3–5 minutes as tolerated to a maximum of 200 mcg/min (Rodgers & Reed, 2017). A dose-limiting side effect of nitroglycerin is hypotension. An important drug interaction to consider is phosphodiesterase-5 inhibitors, such as sildenafil, which can dangerously increase the vasodilator effects of nitroglycerin and should be avoided (Nitroglycerin, 2021).

Morphine is sometimes used in patients with acute cardiogenic pulmonary edema, dyspnea, and anxiety due to its effect in reducing preload and pulmonary capillary wedge pressure (Witharana et al., 2022). Clinical practice guidelines do not recommend the routine use of morphine for this indication due to the adverse effects associated with morphine, such as nausea, bradycardia, hypotension, and respiratory depression. There are no randomized controlled trials investigating the role of morphine for acute cardiogenic pulmonary edema and the observational data that exist suggest a potential for harm including an increase in in-hospital mortality, respiratory failure, and the need for vasoactive therapy.

Inotropes

Inotropes are reserved for patients with low cardiac output who cannot tolerate or are refractory to intravenous vasodilation. Inotropes are not first-line therapy for ADHF due to an increased risk of tachycardia, arrhythmias, and myocardial ischemia. Patients should be monitored for tachycardia and ventricular arrhythmias via cardiac telemetry while hospitalized. Dobutamine and milrinone are common inotropes used for patients with ADHF. Through different mechanisms, both inotropes result in an increase in cyclic adenosine monophosphate (AMP), which enhances cardiac contractility. Depending on the degree of cardiac output increase, both agents can potentially increase, decrease, or have a minimal impact on blood pressure (Rodgers & Reed, 2017).

Dobutamine activates β1 and β2 receptors to increase the production of cyclic AMP. Dobutamine works within minutes, and its peak effects can be seen in 10 minutes. An initial dose of 0.5–5 mcg/kg/min can be used and increased to 20 mcg/kg/min depending on tolerance and clinical response. Dobutamine should be slowly tapered to avoid rebound hypotension (Rodgers & Reed, 2017).

Milrinone works to decrease degradation of cyclic AMP by inhibiting phosphodiesterase-3. Milrinone has both inotropic and vasodilator effects and causes an increase in cardiac output. Compared to dobutamine, milrinone may decrease arterial blood pressure more substantially, so caution should be taken with patients who are hypotensive. An initial dose of 0.0625–0.125 mcg/kg/min can be used and increased depending on tolerance, clinical response, and renal function. The half-life is about 1 hour but can be as long as 6 hours for patients with renal impairment, so titration based on tolerance may be more difficult with milrinone compared to dobutamine. For patients with renal dysfunction, infusion rate should be decreased by 50%–70%. In patients who are concurrently taking β-blockers, milrinone may have an advantage over dobutamine, as the inotropic effects of milrinone do not rely on the β-receptor (Rodgers & Reed, 2017).

Table 3. Common Medications Used in the Management of Heart Failure and Reasons to Hold or Continue These Chronic Medications in an Inpatient Setting[a]

Class of Medication	Examples of Medications	Reasons to Hold
ACEi/ARB	Lisinopril Enalapril Losartan Valsartan	Acute kidney injury
Aldosterone antagonist	Spironolactone Eplerenone	Hypotension
ARNI	Sacubitril and Valsartan	Hyperkalemia
β-blocker	Metoprolol Carvedilol Bisoprolol	Bradycardia Hypotension Cardiogenic shock Unless contraindicated, discontinuation is associated with worse clinical outcomes
Cardiac glycoside	Digoxin	Unless contraindicated, discontinuation is associated with worse clinical outcomes
SGLT2 inhibitor	Canagliflozin Dapagliflozin Empagliflozin	Acute kidney injury Dehydration Diabetic ketoacidosis Hypotension Urinary tract or genital yeast infection

Note. ACEi = angiotensin-converting enzyme inhibitor; ARB = angiotensin II receptor blocker; ARNI = angiotensin receptor neprilysin inhibitor; SGLT2 = sodium-glucose cotransporter 2. Data from *Pharmacotherapy: A pathophysiologic approach* (10th ed.) by J. E. Rodgers and B. N. Reed, 2017, McGraw Hill.
[a]Note that this list is not all inclusive of the medications in each class but rather contains the common chronic heart failure medications including β-blockers and ARBs that have mortality benefit in the setting of heart failure.

Vasopressors

Vasopressors, such as norepinephrine and high-dose dopamine, are generally avoided for patients with ADHF

as these agents can increase systemic vascular resistance, but may be indicated for patients experiencing cardiogenic shock. These patients usually present with dangerously low blood pressure and hypoperfusion and are not candidates for either vasodilators or inotropes (Rodgers & Reed, 2017).

Use of Chronic Heart Failure Medication During ADHF Admission

Depending on the patient's presentation, some medications used in the management for CHF may need to be held. See Table 3 for a list of these common medications used in the management of CHF along with reasons patients should or should not hold these respective medications while admitted for ADHF.

Many CHF medications can cause hypotension and thus should be held while a patient is hospitalized. Other agents that can cause hyperkalemia or worsen renal function in the setting of an AKI and should be held. Beta blockers and digoxin are generally continued while patients are hospitalized as holding these medications may lead to worse outcomes (Rodgers & Reed, 2017).

Once a patient's heart failure has become compensated, initiation or re-initiation of guideline directed medical therapy should be strongly considered before hospital discharge instead of waiting for the first follow-up primary care physician visit to improve clinical outcomes and reduce readmission rates.

Conclusion

Nurses play a vital role in treating patients with ADHF, as they are the ones administering the medications and tracking the patient's response to therapy. Nurses can serve as advocates for their patients with frequent reassessment of therapy, and if necessary, prompting a prescriber to alter therapy if therapeutic outcomes are not being achieved. Discharge counseling regarding medication and dietary adherence is paramount to helping patients understand their condition and reduce the risk of hospital readmission. With a strong knowledge of the pharmacology of both CHF and ADHF medications, nurses are in a key position to make a positive impact on their patient's care both during hospitalization and after discharge as well as to help reduce hospital readmission rates.

References

Benjamin, E. J., Muntner, P., Alonso, A., Bittencourt, M. S., Callaway, C. W., Carson, A. P., Chamberlain, A. M., Chang, A. R., Cheng, S., Das, S. R., Delling, F. N., Djousse, L., Elkind, M. S. V., Ferguson, J. F., Fornage, M., Jordan, L. C., Khan, S. S., Kissela, B. M., Knutson, K. L., … American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. (2019). Heart disease and stroke statistics—2019 update: A report from the American Heart Association. *Circulation*, *139*(10), e56–e528. https://doi.org/10.1161/CIR.0000000000000659

Hollenberg, S. M., Warner Stevenson, L., Ahmad, T., Amin, V. J., Bozkurt, B., Butler, J., Davis, L. L., Drazner, M. H., Kirkpatrick, J. N., Peterson, P. N., Reed, B. N., Roy, C. L., & Storrow, A. B. (2019). 2019 ACC expert consensus decision pathway on risk assessment, management, and clinical trajectory of patients hospitalized with heart failure: A report of the American College of Cardiology Solution Set Oversight Committee. *Journal of the American College of Cardiology*, *74*(15), 1966–2011. https://doi.org/10.1016/j.jacc.2019.08.001

Khan, M. S., Sreenivasan, J., Lateef, N., Abougergi, M. S., Greene, S. J., Ahmad, T., Anker, S. D., Fonarow, G. C., & Butler, J. (2021). Trends in 30- and 90-day readmission rates for heart failure. *Circulation Heart Failure*, *14*(4), e008335. https://doi.org/10.1161/CIRCHEARTFAILURE.121.008335

Nitroglycerin. (2021, September 14). *Lexicomp*. https://online.lexi.com/lco/action/doc/retrieve/docid/patch_f/7377?cesid=5LnBwZ4kqs0&searchUrl=%2Flco%2Faction%2Fsearch%3Fq%3Dnitroglycerin%26t%3Dname%26va%3Dnitroglycerin

Rodgers, J. E., & Reed, B. N. (2017). Acute decompensated heart failure. In J. T. DiPiro, R. L. Talbert, G. C. Yee, G. R. Matzke, B. G. Wells, & L. Posey (Eds.), *Pharmacotherapy: A pathophysiologic approach* (10th ed.). McGraw Hill. https://accesspharmacy.mhmedical.com/content.aspx?bookid=1861&sectionid=146056502

Witharana, T. N., Baral, R., & Vassiliou, V. S. (2022). Impact of morphine use in acute cardiogenic pulmonary oedema on mortality outcomes: A systematic review and meta-analysis. *Therapeutic Advances in Cardiovascular Disease*, *16*, 17539447221087587. https://doi.org/10.1177/17539447221087587