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## Learning objectives

- Recognize the need for early identification of cardiogenic shock (CS) and its underlying etiology to develop an appropriate treatment plan
- Understand the differences between CS attributed to acute myocardial infarction (AMI) vs. acute heart failure



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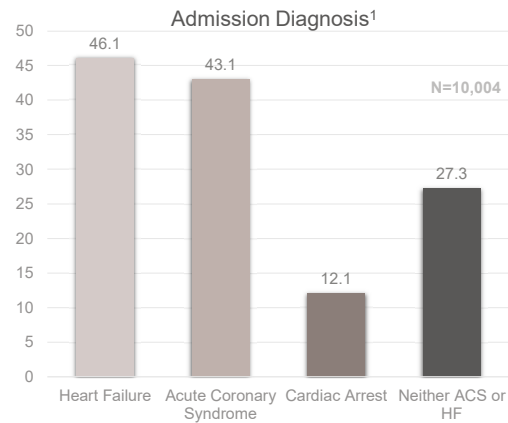
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## Understanding the subtle details in shock

- The most common causes of cardiogenic shock (CS) remain acute myocardial infarction and heart failure shock<sup>1</sup>
- There is much about cardiogenic shock that remains poorly understood<sup>2</sup>
- Cardiogenic shock is a complex and highly morbid condition — a cycle of injury comprised of cardiac and systemic decompensation that yields only additional decompensation and further injury<sup>2</sup>
- Early recognition and intervention to interrupt the devastating “cardiogenic shock spiral” is critical to survival<sup>2</sup>



1. Jentzer JC, van Diepen S, Barsness GW. Cardiogenic Shock Classification to Predict Mortality in the Cardiac Intensive Care Unit. *J Am Coll Cardiol*. 2019 Oct 29;74(17):2117-2128.  
 2. Jones TL, Nakamura K, McCabe JM. Cardiogenic shock: evolving definitions and future directions in management. *Open Heart* 2019;6:e000960.

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## Evaluating response to therapy

### Medications

- Critically ill patients with hemodynamic instability refractory to intravenous (IV) fluids typically require vasoactive medications
  - Vasopressors increase systemic vascular resistance (SVR) and blood pressure
  - Inotropes increase cardiac output (CO)
- Evidence regarding effective ways to titrate vasopressors and inotropes is largely absent from the literature
- Historically titration of vasoactive medications has been based on clinical endpoints such as:
  - Mean arterial pressure (MAP) > 60 mm Hg
  - Urine output > 0.5 ml/kg/h
  - Cardiac index (CI) > 2.5 L/min/m

The clinician has the responsibility and must strike a fine balance between maintaining hemodynamic stability and adequate perfusion, while using the minimal amount of drug necessary

1. Allen, John M. PharmD, BCPS Understanding Vasoactive Medications: Focus on Pharmacology and Effective Titration *Journal of Infusion Nursing*; March/April 2014 - Volume 37 - Issue 2 - p 82-86.

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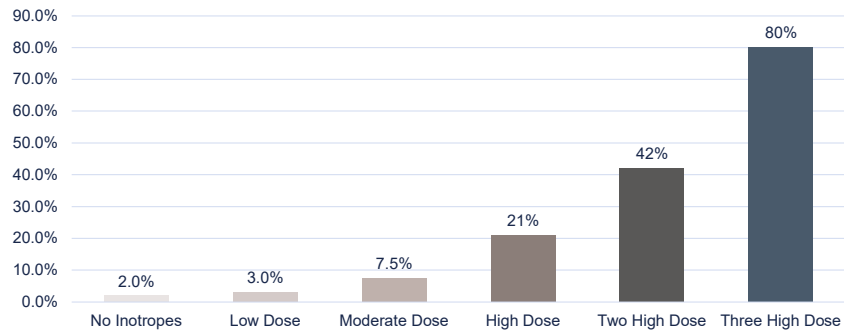
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## Vasoactive medications in shock

Initial treatment of cardiogenic shock (CS) often relies on inotropes or vasodilators, but escalating doses may have harmful effects<sup>1,2</sup>

Mortality risk according to level of inotrope support<sup>3</sup>



1. Doll JA, Ohman EM, Patel MR, et al. A team-based approach to patients in cardiogenic shock. *Catheter Cardiovasc Interv.* 2016;88(3):424-33.

2. Zeymer U, Bueno H, Granger CB, et al. Acute Cardiovascular Care Association position statement for the diagnosis and treatment of patients with acute myocardial infarction complicated by cardiogenic shock: A document of the Acute Cardiovascular Care Association of the European Society of Cardiology. *European Heart Journal: Acute Cardiovascular Care.* 2020;9(2):163-197. Samuels LE, Kaufman MS, Thomas MP, et al. Pharmacological criteria for ventricular assist device insertion following postcardiotomy shock: experience with the ablated BVS system. *J Card Surg.* 1999;14:2880293.

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# Acute MI Cardiogenic Shock

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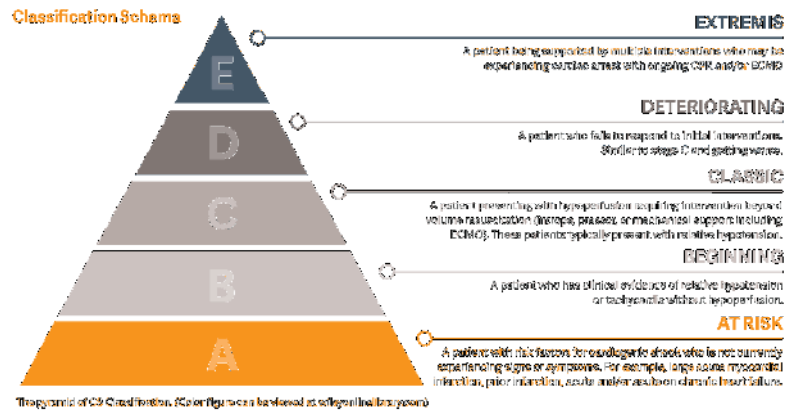
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## Identification is critical

### Stages of cardiogenic shock



Baran DA, Glines CL, Bailey S, et al. SCAI clinical expert consensus statement on the classification of cardiogenic shock. *Catheter Cardiovasc Interv.* 2019;94:29-37.

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## Definition of cardiogenic shock

SCAI Shock Stage	Patient Description
Stage E (Extremis)	Circulatory collapse requiring multiple interventions and support
Stage D (Deteriorating)	Escalation of symptoms, fails to respond to treatment
Stage C (Classic)	Hypoperfusion requiring intervention (vasoactive medications or use of mechanical circulatory support)
Stage B (Beginning)	Relative hypotension or tachycardia without hypoperfusion
Stage A (At risk)	Not currently showing signs or symptoms but at risk

Patarroyo Aponte MM, Manrique C, Kar B. Systems of Care in Cardiogenic Shock. *Methodist DeBakey Cardiovasc J.* 2020;16(1):50-56. doi:10.14797/mdcj-16-1-50

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## Treatment for the cardiogenic shock patient

- Timely recognition
- Team approach
- Invasive hemodynamics monitoring
- Minimize inotropes/vasopressors
- Coronary reperfusion
- Ventricular support
- Circulatory support
- Recovery



<https://www.uhhospitals.org/for-clinicians/articles-and-news/articles/2019/02/life-saving-care-when-every-second-counts>

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## Individualize treatment and evaluation

- Increasing MAPs with vasoactive drugs can have potentially harmful effects<sup>1</sup>
- Permissive hypotension vs. the use of vasoactive agents needs to be evaluated<sup>1</sup>
- Assessment of end-organ and tissue perfusion response to individualized targets should include<sup>2</sup>:
  - Arterial lactate
  - Mixed or central venous oxygen saturations
  - Renal function (creatinine and urinary output)
  - Liver function tests
  - Mental status
  - Temperature
  - Invasive hemodynamic parameters



1. Zeymer U, Bueno H, Granger CB, et al. Acute Cardiovascular Care Association position statement for the diagnosis and treatment of patients with acute myocardial infarction complicated by cardiogenic shock: A document of the Acute Cardiovascular Care Association of the European Society of Cardiology. *European Heart Journal: Acute Cardiovascular Care*. 2020;9(2):183-197.

2. Kosaraju A, Pendola VS, Hai O. Cardiogenic Shock. [Updated 2020 Jun 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-.

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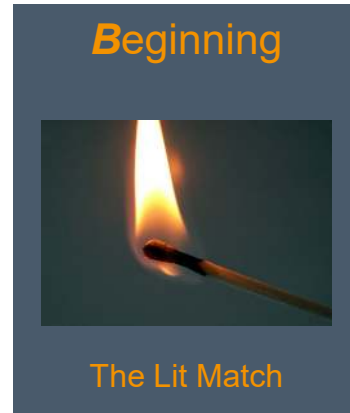
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## Case study

Mr. Sal is a 67-year-old man with long history including CABG 10 years ago. He presents with:

- Angina
- Positive troponin
- Blood pressure of 94/70 mmHg
- Heart rate 100 beats per minute (BPM)
- His normal blood pressure runs 140/70 mmHg
- He is scheduled to undergo diagnostic catheterization later in the day
- This is considered **Stage B**



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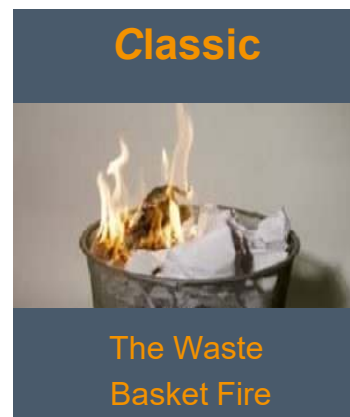
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## Case study

- Later that day, in the catheterization laboratory, he becomes more tachycardic (heart rate 110 BPM), with reduced urine output
- A PA catheter is placed and his cardiac index is 1.8/m<sup>2</sup> with a wedge pressure of 29 mmHg
- He would be judged to be **Stage C** at this point
- During thrombectomy, the patient has ventricular fibrillation and requires a single 200 joule shock
- Low dose inotrope is started and the intervention completed successfully. An IABP is placed at the end of the case
- This becomes what is labeled as an "a" modifier, signifying a cardiac arrest



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## Case study

- Later that night in the intensive care unit, the patient's urine output continues to decline and the continuous cardiac index assessment remains below 2 L/min/m<sup>2</sup> despite increasing inotropes and IABP 1:1
- The patient is now in **Stage D<sub>A</sub>** and plans are made to escalate percutaneous support
- Mr. Sal's case is not unusual and patients often go between the different stages of shock



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# Acute Heart Failure Shock

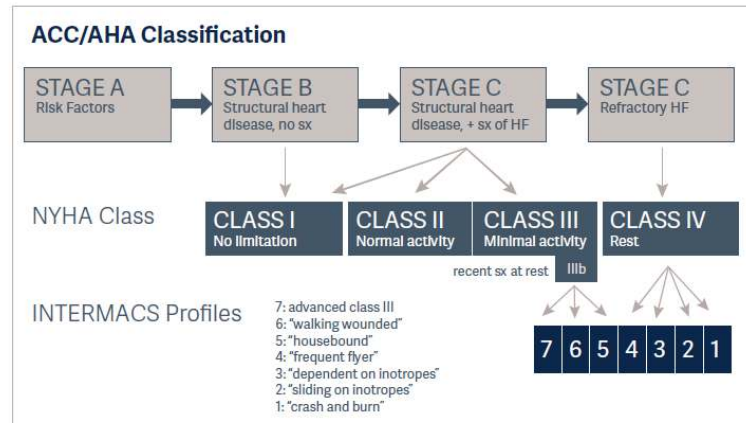
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## Heart failure classification



Modified from MGH-Docs/WhiteBook-2019-2020

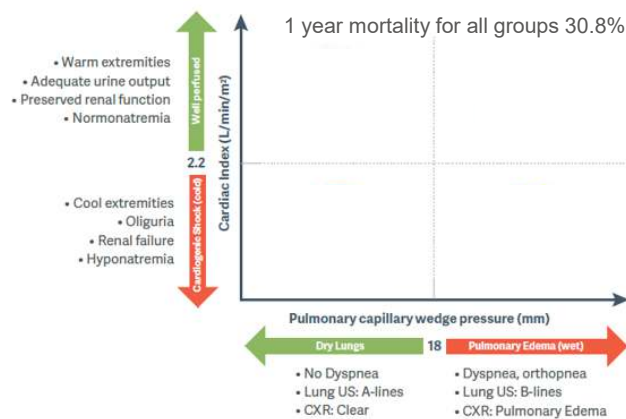
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## Patient characteristics



Javaloyes, P., Miró, Ó., Gil, V., Martín-Sánchez, et al. Clinical phenotypes of acute heart failure based on signs and symptoms of perfusion and congestion at emergency department presentation and their relationship with patient management and outcomes. *Eur J Heart Fail* 2019, 21: 1353-1365.

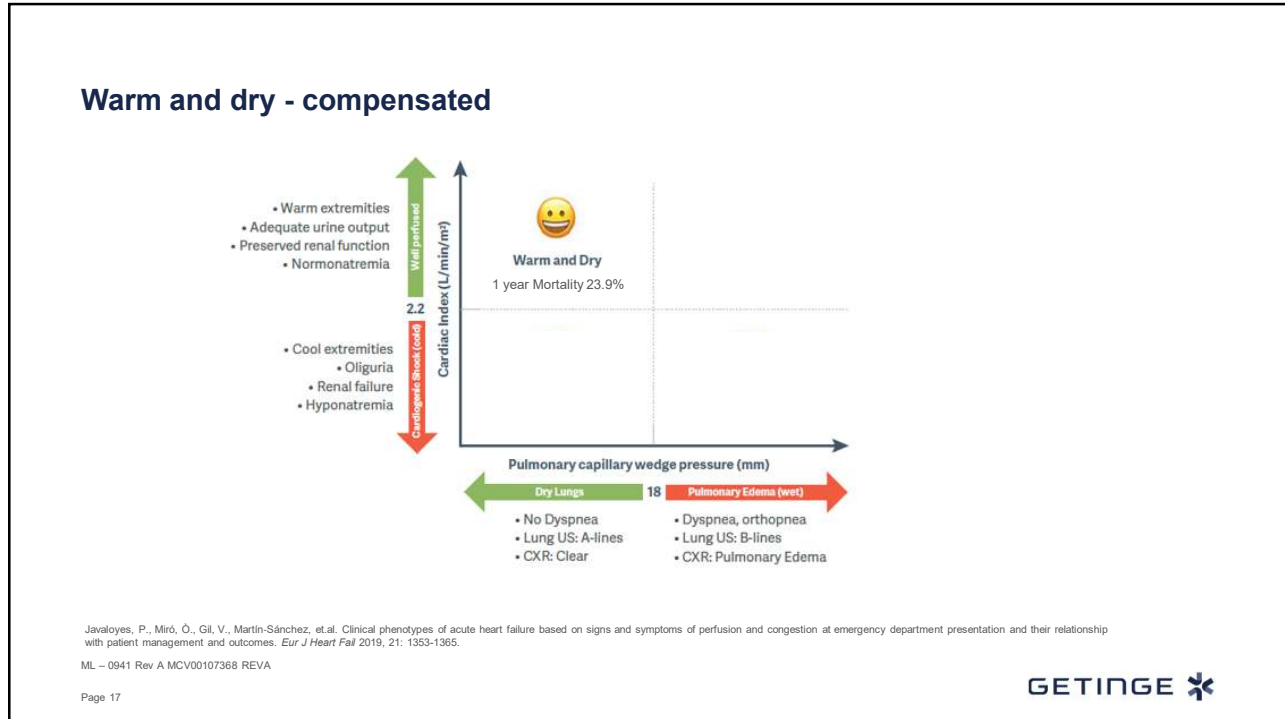
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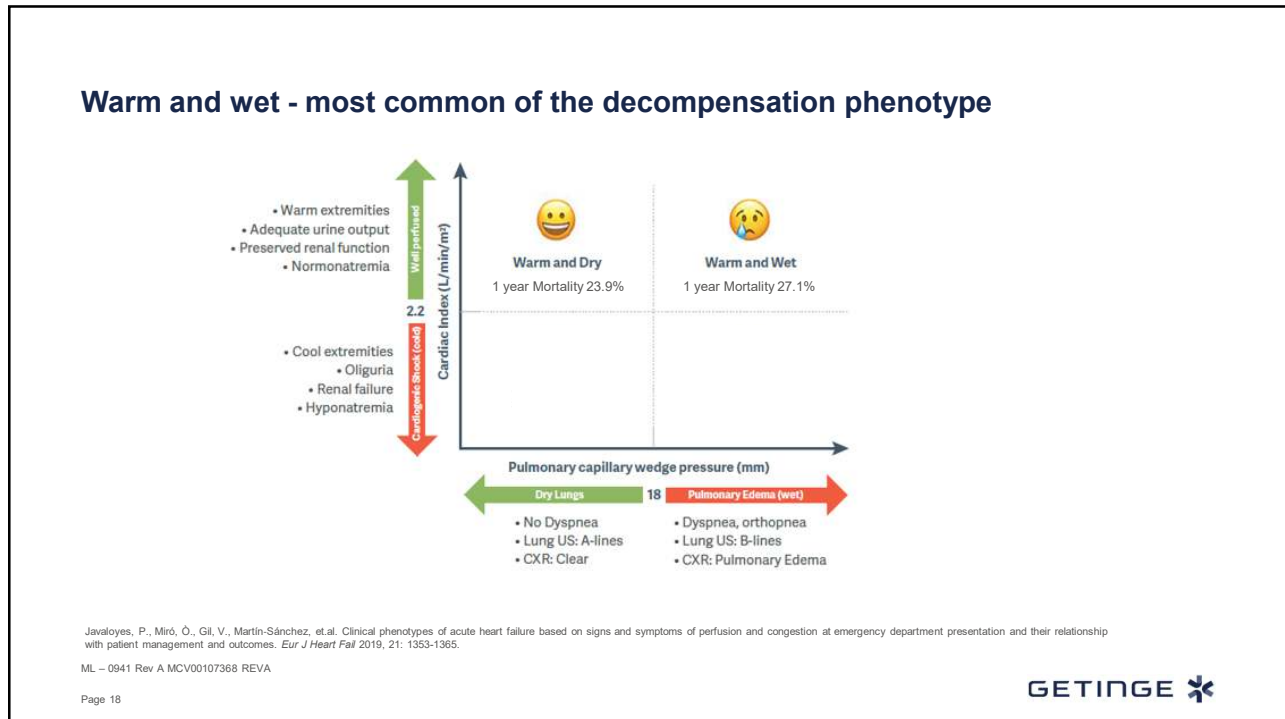


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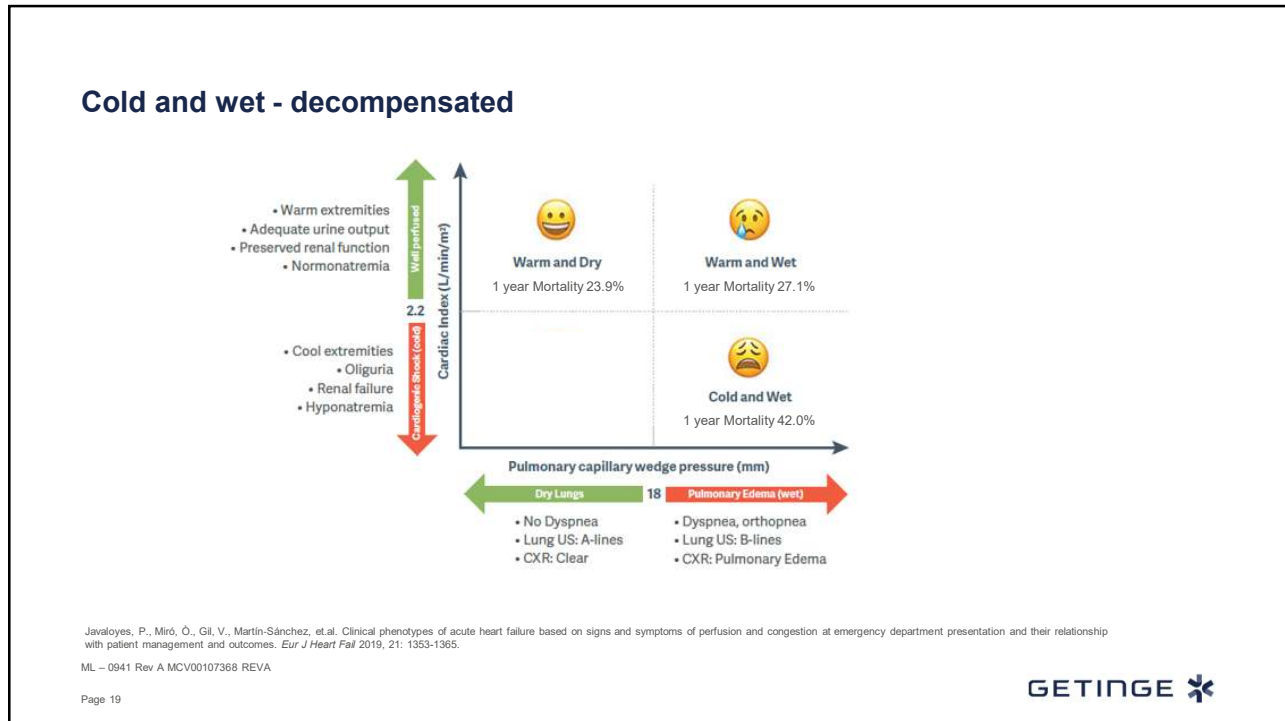




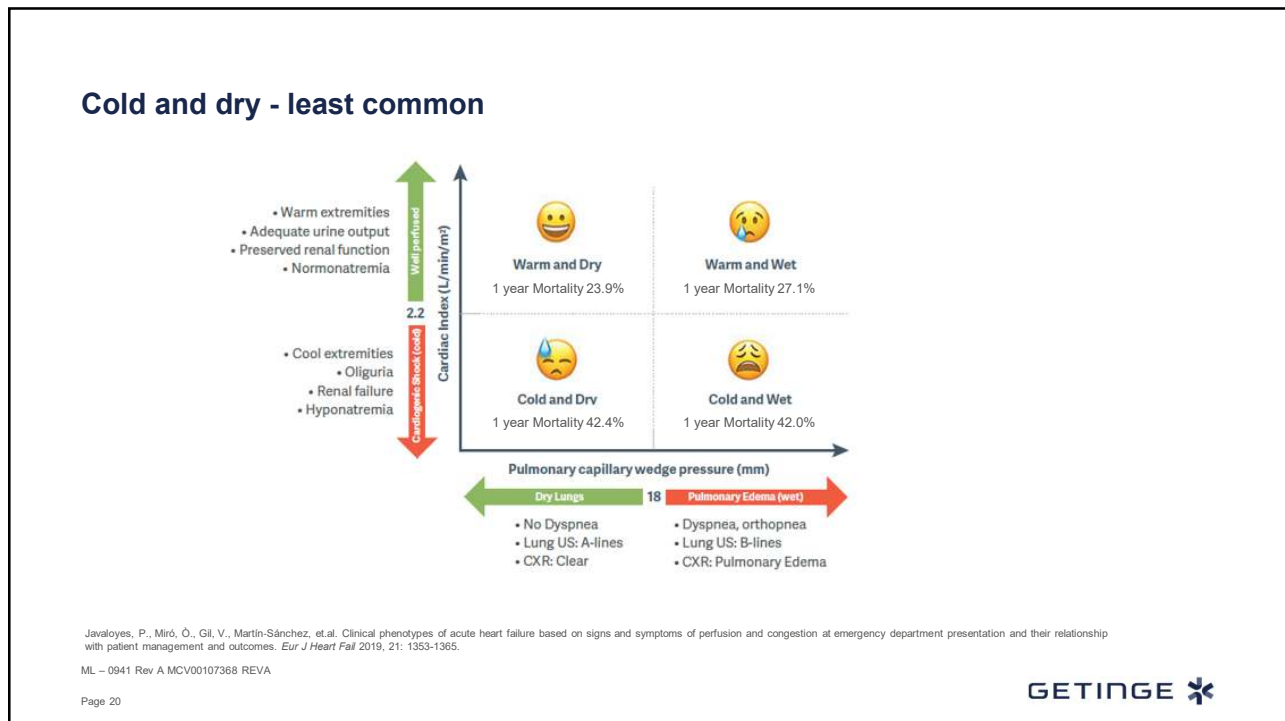
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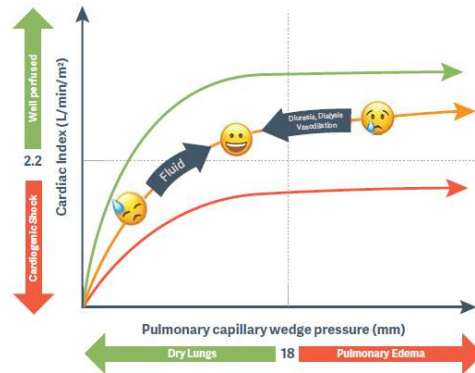
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## Treatment strategies

- The goal of caring for the acute heart failure patient is to find the balance between wet and dry<sup>1</sup>
- The patient with unrecognized cardiogenic shock will generally fail to respond to non-intensive therapy, running in circles<sup>1</sup>
- Frequent assessment to evaluate treatment strategy is important<sup>2</sup>
- Unsatisfactory responses to treatment (persistent low saturation, low blood pressure, low diuresis) should be communicated to the physician<sup>2</sup>



1. <https://emcrit.org/ibcc/cht/>  
 2. Mebazaa, A., Yilmaz, M.B., Levy, P. et. al. Recommendations on pre-hospital & early hospital management of acute heart failure: a consensus paper from the Heart Failure Association of the European Society of Cardiology, the European Society of Emergency Medicine and the Society of Academic Emergency Medicine. *Eur J Heart Fail*, 2015 17: 544-558.  
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## Nurse role in acute heart failure management

- Rapid triage to appropriate environment for safe clinical care: coronary care unit, cardiology ward or general medical ward
- Objective monitoring for change in signs and symptoms and responses to treatment
- Prompt recognition and reporting of relevant changes in clinical status
- Patient and family education
- Discharge planning and referral to multidisciplinary management team



Mebazaa, A., Yilmaz, M.B., Levy, P. et. al. Recommendations on pre-hospital & early hospital management of acute heart failure: a consensus paper from the Heart Failure Association of the European Society of Cardiology, the European Society of Emergency Medicine and the Society of Academic Emergency Medicine. *Eur J Heart Fail*, 2015 17: 544-558.  
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# Clinical Evidence for IABP Therapy

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## Pharmacological treatment vs. mechanical circulatory support (MCS)

**Early utilization of mechanical circulatory support instead of escalating doses of inotropes and vasopressors might avoid the downward spiral seen in patients with cardiogenic shock<sup>2</sup>**

- Use of inotropes and vasoactive drips are common first line treatment options for cardiogenic shock for either acute MI or heart failure etiologies<sup>1</sup>
- Escalating doses of vasopressors and inotropes are associated with increased mortality<sup>2</sup>
- Mechanical circulatory support can be used as a bridge-to-decision to<sup>2</sup>:
  - Recovery
  - Palliation
  - Heart transplant or
  - Durable left ventricular assist device



1. Zeymer U, Bueno H, Granger CB, et al. Acute Cardiovascular Care Association position statement for the diagnosis and treatment of patients with acute myocardial infarction complicated by cardiogenic shock. A document of the Acute Cardiovascular Care Association of the European Society of Cardiology. *European Heart Journal: Acute Cardiovascular Care*. 2020;9(2):183-197.

2. Hajjar, LA, Teboul, JL. Mechanical Circulatory Support Devices for Cardiogenic Shock: State of the Art. *Crit Care* 23, 76 (2019). <https://doi.org/10.1186/s13054-019-2368-y>

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## Risk vs. benefit

Recent observational studies from large national, independent databases have shown a decrease in mortality, lower bleeding complications, and lower stroke rates at a lower cost with IABP's compared to pVADs<sup>1,2</sup>

- There is a lack of evidence demonstrating a difference in mortality between pVADs or IABP therapy<sup>1,2,3</sup>
- Data supports a lower risk of complications associated with IABP therapy vs. pVADs<sup>1,2</sup>
- The risk of complications with MCS increases with longer duration of support<sup>3</sup>
- Careful monitoring of labs, hemodynamic parameters, and echocardiography should be performed repeatedly to assess for the possibility of device weaning or the need for escalation<sup>3</sup>



1. Dhruva SS. Association of Use of an Intravascular Microaxial Left Ventricular Assist Device vs Intra-aortic Balloon Pump With In-Hospital Mortality and Major Bleeding Among Patients With Acute Myocardial Infarction Complicated by Cardiogenic Shock *JAMA*. 2020;323(8):734-745. doi:10.1001/jama.2020.0254
2. Amin AP, Spertus JA, Curtis JP, et al. The evolving landscape of Impella use in the United States among patients undergoing percutaneous coronary intervention with mechanical circulatory support. *Circulation* 2020;141:273-284
3. Kapur NK, Whitehead EH, Thayer KL and Pahuja M. The science of safety: complications associated with the use of mechanical circulatory support in cardiogenic shock and best practices to maximize safety [version 1; peer review: 2 approved]. *F1000Research* 2020, 9(Faculty Rev):794.

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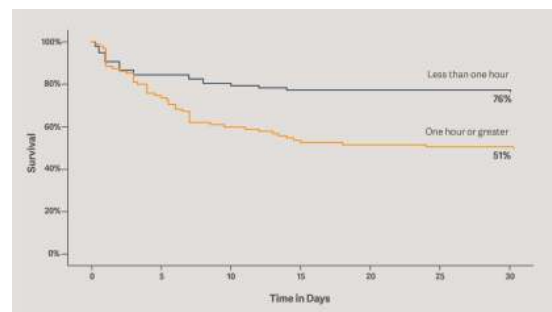
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## Initiate early

30-day survival was 76% when IABP was placed within <1 hour of onset of CS<sup>1</sup>

- The study from Gul is one of the few studies evaluating the impact of early initiation of IAB therapy in the shock patient<sup>1</sup>
- The positive outcome of early initiation of IAB therapy is comparable to retrospective studies demonstrating better survival with early placement of Impella<sup>1</sup>
- The authors conclusion raises the question: is it the device or the timing and care surrounding the patient that makes the difference?



Randomized controlled study (n=193)<sup>1</sup>

Gul et al. Usefulness of Intra-aortic Balloon Pump in Patients with Cardiogenic Shock, *Am J Cardiol*. 2019 Mar 1;123(5):750-756. doi: 10.1016/j.amjcard.2018.11.041. Epub 2018 Dec 4.

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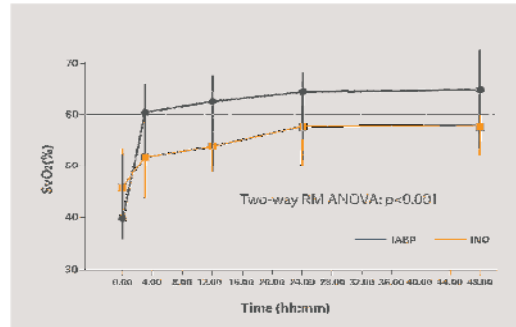
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## IABP vs. inotropes (INO) in decompensated heart failure and low output

Primary IABP utilization was associated with a direct hemodynamic benefit relative to administration of inotropes.

- Heart failure shock differs from AMI shock. Patient presentation and treatment strategies are not the same
- This pivotal study shows the positive impact IABP has on multiple parameters including increased diuresis, BNP reduction, and increased cardiac power output
- The use of the 50cc IABP resulted in significant improvement in organ perfusion assessed by  $SVO_2$



Randomized controlled study (n=32)

den Uijl et al. Primary Intra-aortic Balloon Support versus Inotropes for Decompensated Heart Failure and Low Output: A Randomized Trial *EuroIntervention* 2019;15:586-593.

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## Key points

- Cardiogenic shock is a complicated condition that may lead to impaired end-organ function and life-threatening multisystem organ failure
- Shock is not one-size fits all
- Diagnosis and treatment of CS will only improve when:
  - Standardized protocols for early recognition and appropriate management are implemented
  - When regionalized systems of care are coordinated, staffed, and properly trained to serve this vulnerable patient population



Patarroyo Aponte MM, Manrique C, Kar B. Systems of Care in Cardiogenic Shock. *Methodist Debakey Cardiovasc J*. 2020;16(1):50-56. doi:10.14797/mdcj-16-1-50

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**Identify**  
Rapidly identify the critical care needs of your patient and deploy tailored interventions

**Initiate**  
Early placement of an appropriate MCS may be considered after initial interventions fail to stabilize the patient

**Evaluate**  
Patients should be continually assessed and treatment adjusted as needed

**Escalate**  
If there is a need for increasing inotropes, consider escalation of therapy and transfer to a higher level facility

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**Ventilation Webinar: Introduction to Bi-Vent/APRV**

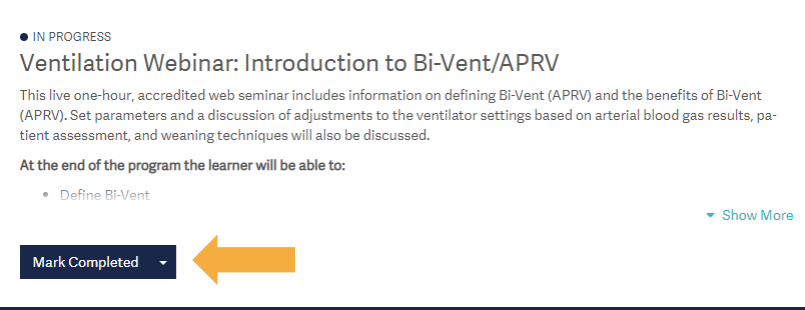
This live one-hour, accredited web seminar includes information on defining Bi-Vent (APRV) and the benefits of Bi-Vent (APRV). Set parameters and a discussion of adjustments to the ventilator settings based on arterial blood gas results, patient assessment, and weaning techniques will also be discussed.

**At the end of the program the learner will be able to:**

- Define Bi-Vent

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