The Shocking Truth:
An Approach to Cardiogenic Shock

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CardioCase presentation

Chen's Chest Pains

Chen, 84, is a Chinese male with a prior history of MI. Twenty-five years ago, following his MI, he underwent coronary artery bypass grafting and remained asymptomatic and functionally unlimited until two weeks prior to his presentation. His past history is significant for non-small cell lung cancer, successfully resected in 1995.

Chen presents to the ER after being found somnolent by family members. His level of consciousness improves with the oxygen therapy provided by emergency medical services.

Upon arrival in the ER, he complains of retrosternal chest pain (6/10) associated with dyspnea and nausea. Furthermore, he admits to having a two-week history of retrosternal chest discomfort, occurring at rest and with exertion. He is unresponsive to acetaminophen therapy.

Focused physical examination findings include:

- Marked diaphoresis
- Cool mottled extremities
- Respiratory distress
- BP: 84/40 mmHg, equal in both arms
- Heart rate: 120 beats per minute
- Respiratory rate: 26 breaths per minute
- Oxygen saturation: 90% on 5 litres per minute O_2
- Jugular veinous pressure: 8 cm above the sternal angle
- Normal S1S2, no murmurs, no rubs and no other added sounds
- Crackles throughout the lower 1/2 of both lung fields
- Soft abdomen with no organomegaly

Chen's ECG (Figure 1) and chest X-ray (CXR) (Figure 2) are shown.

Continued on page 24.

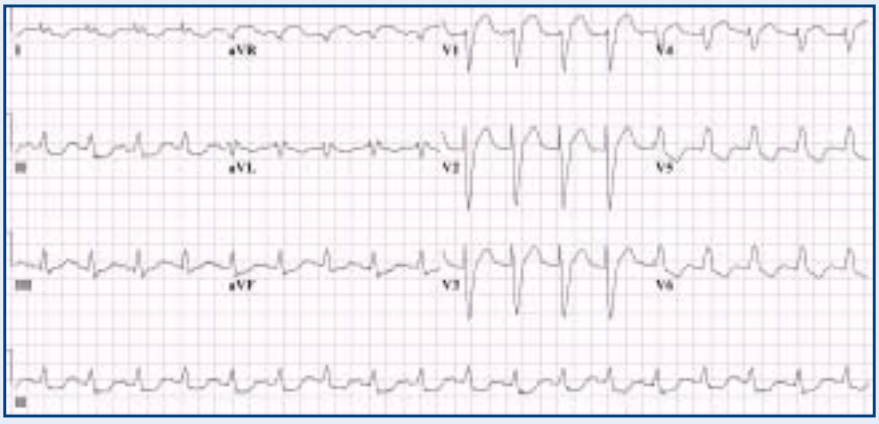

Figure 1. Chen's ECG.

CardioCase presentation

Chen's Chest Pain continued...

Chen's ECG (Figure 1) is consistent with a left bundle branch block. In the absence of previous ECGs for comparison, and in the presence of convincing symptoms, the ECG findings were considered to be acute.

Chen's CXR (anterior–posterior projection) (Figure 2) reveals surgical clips in the right upper lobe region from his previous lobectomy, bilateral interstitial infiltrates, peribronchial cuffing and a right-sided plural effusion.

For more on Chen, go to page 25.

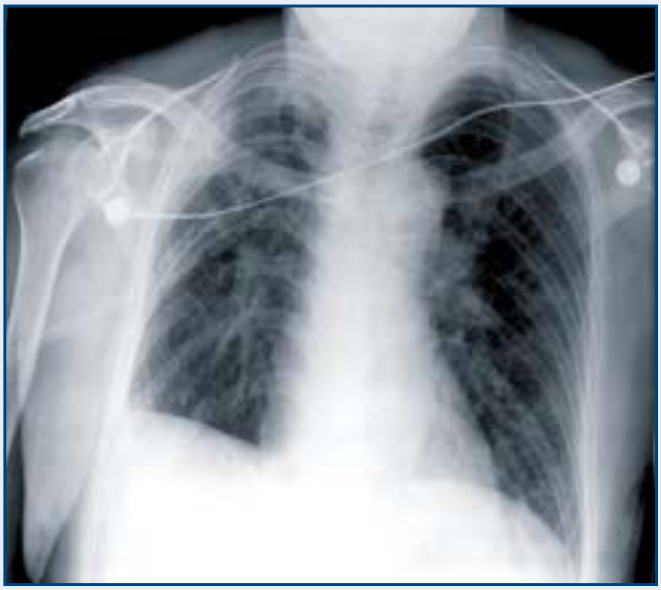

Figure 2. Chen's CXR.

What's your CardioCase diagnosis?

CardioCase discussion

What's wrong with Chen?

Chen has presented with shock (hypotension with evidence of end-organ dysfunction represented by his reduced level or consciousness and cool, mottled extremities). Shock is the physiologic state in which there is inadequate tissue perfusion to maintain normal function. Although clinical presentations of shock differ, physicians should always attempt to elicit the five cardinal features of shock:

- hypotension (systolic BP < 90 mmHg),
- oliguria,
- altered mental status,
- tissue hypoperfusion and
- metabolic acidosis.

Cardiogenic shock

Different types of shock exist; thus, it is important to attempt to identify the type of shock, as treatment strategies differ significantly (Table 1). In cardiogenic shock, inadequate tissue perfusion occurs as a result of cardiac dysfunction. Cardiac dysfunction, leading to shock, can result from a number of processes, including:

- arrhythmia,
- mechanical abnormalities,
- extra-cardiac obstruction and
- myopathic processes.

Severe left ventricular (LV) dysfunction, which may occur due to severe, extensive ischemia or infarct (especially anterior infarcts), is the most common cause of cardiogenic shock.

Table 1

Types of shock

- Hypovolemic
  - Fluid loss (diarrhea, urinary losses, sweat, vomiting, *etc.*)
  - Hemorrhage
- Cardiogenic
  - Arrhythmias (atria and ventricular)
  - Mechanical abnormality (valvular, papillary infarct/chordal rupture, ventricular septal rupture, free wall rupture)
  - Myopathic processes (cardiomyopathies, severe LV dysfunction)
- Distributive
  - Septic/systemic inflammatory response syndrome
  - Anaphylactic
  - Neurogenic
- Obstructive
  - Lungs: PE, tension pneumothorax, pulmonary hypertension
  - Heart: Constrictive pericarditis, tamponade

LV: Left ventricular
PE: Pulmonary embolism

More about Chen

Clinically and radiographically, Chen has signs of pulmonary congestion that makes distributive and hypovolemic shock unlikely and points towards a cardiac etiology. This narrows the differential diagnosis to two possibilities, obstructive vs. cardiogenic shock. This distinction can be difficult to make. However, given Chen's clinical presentation with convincing chest pain, previous history of coronary artery disease and the distant history of coronary artery bypass grafting, and a presumed new left bundle branch block, cardiogenic shock secondary to an acute MI must be high on the differential diagnosis.

Chen is intubated and ventilated due to progressive hypoxemia, and started on inotropes to support his BP. He is transferred urgently to the cardiac catheterization laboratory. His native coronary anatomy shows severe proximal three vessel, and investigation of his bypass grafts reveals a patent saphenous vein graft (SVG) to a large obtuse marginal artery (supplying the circumflex artery), an occluded SVG to the distal right coronary artery and a 100% occlusion of his SVG to the left anterior descending artery (LAD). The culprit vessel is thought to be the totally occluded LAD, based on the clinical presentation and ECG findings.

For Chen's followup, go to page 26.

In patients presenting to the hospital with an MI, cardiogenic shock is the leading cause of death. Cardiogenic shock complicates 5% to 10% of acute MIs and typically occurs within the first 24 hours. The mortality rates among patients developing cardiogenic shock in the setting of acute MI exceed 50%.

How do you treat cardiogenic shock?

In practice, cardiogenic shock exists as a spectrum. This spectrum can be sub-divided using pulmonary capillary wedge pressure (PCWP), with a high PCWP (> 18 mmHg) representing pulmonary congestion, and cardiac index (CI), with a low CI (< 2.2 L/mim/m2) representing systemic hypoperfusion. This sub-division using PCWP and CI was first described by Forrester *et al*. They described four classes of findings that may occur post-MI. The Forrester classification has similarities to the "Killip Classification," with Forrester Class I representing post-MI patients who have evidence of neither pulmonary congestion nor systemic hypoperfusion, and Forrester Class IV, representing patients with

DID YOU KNOW...

On average, venous bypass grafts have longevity of seven years, with arterial bypass grafts having an estimated longevity of 10 to 15 years.

About the authors...

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Table 2

Predictors of mortality in cardiogenic shock[1]

- Increasing age
- Prior MI
- Physical findings at the time of diagnosis (altered sensorium, cool and clammy skin)
- Oliguria

Table 3

Forrester's classfication of clinical and hemodynamic function after acute MI

CI, L/min/m2	Pulmonary capillary wedge pressure < 18 mmHg	Pulmonary capillary wedge pressure > 18 mmHg
> 2.2	**Class I** **Clinical Findings:** Normal (no pulmonary congestion, no systemic hypoperfusion) **Treatment:** Supportive **Mortality:** 2.2%	**Class II** **Clinical Findings:** Pulmonary congestion but no systemic hypoperfusion (*i.e.,* BP maintained, strong pulses, warm extremities) **Treatment:** Diuresis **Mortality:** 10.1%
< 2.2	**Class III** **Clinical Findings:** No pulmonary congestion (*i.e.,* JVP not elevated, lungs clear), but evidence of systemic hypoperfusion (hypotension, weak pulses, cool extremities) **Treatment:** Volume **Mortality:** 22.4%	**Class IV** **Clinical Findings:** Pulmonary congestion and systemic hypoperfusion (cardiogenic shock) **Treatment:** Intubation, inotrope support, intra-aortic balloon pump, revascularization, **Mortality:** 55.5%

CI: Cardiac index
JVP: Jugular veinous pressure

both pulmonary congestion and systemic hypoperfusion (cardiogenic shock). Forrester Classes II and III represent intermediate states. Forrester's classification is not only useful in predicting death following an MI (Table 2), but also helps to guide therapy for cardiogenic shock.

When pulmonary congestion and systemic hypoperfusion occur together (Table 3), as in Chen's case, mortality is shockingly high, ranging from 50% to 80%.[2] These critically ill, high-risk patients need aggressive treatment, often including inotropes, diuresis, mechanical ventilation, intra-aortic balloon pumping and revascularization, in addition to usual care post-MI.

Chen's Followup

Chen underwent placement of an intra-aortic balloon pump and had percutaneous coronary intervention (PCI) with placement of a stent to his LAD. Post-successful PCI, Chen was transferred to the cardiac care unit. Unfortunately, he developed progressive end-organ dysfunction and multisystem failure and ultimately expired four days later.

Chen's case illustrates the high mortality associated with cardiogenic shock (53% 30-day mortality in the urgent revascularization arm of the SHOCK trial), despite prompt and aggressive treatment.

Should a patient in cardiogenic shock be urgently revascularized?

In the 1980s and early 1990s, there were numerous non-randomized studies reporting significant mortality reductions in cardiogenic shock patients receiving early revascularization. However, it was not until the publication of the SHould we emergently revascularize Occluded Coronaries for cardiogenic shocK (SHOCK) trial in 1999 that these findings were verified by a randomized, controlled trial.

The SHOCK trial enrolled 302 patients with cardiogenic shock following an acute MI. Patients were eligible for randomization if the onset of cardiogenic shock was < 12 hours prior to randomization and the onset of cardiogenic shock from MI < 36 hours. Patients were randomized to either initial medical stabilization (including insertion of an intra-aortic balloon bump) vs. urgent revascularization (by either percutaneous

coronary intervention [PCI] or coronary artery bypass grafting within six hours of randomization). Patients randomized to urgent revascularization had an absolute mortality reduction of 13% (50% vs. 63%) at six months.[2] This mortality benefit persisted at one year.

Importantly, a follow-up study revealed the vast majority (87%) of surviving shock patients had good to excellent functional capacity (New York Heart Association Class I or II). A 2002 task force of the American College of Cardiology and the American Heart Association gave a Class I recommendation to the performance of urgent revascularization in patients less than 75 years of age with an ST-elevation MI who develop cardiogenic shock. Patients admitted to hospitals without facilities for revascularization should be immediately transferred to a tertiary care centre with such facilities. *PCard*

Take-home message

- Cardiogenic shock is associated with a high mortality, with rates exceeding 50%.
- Differentiating between the different types of shock can be difficult, but should begin with conducting a focused history and physical examination.
- The Forrester classification is a good way to characterize the spectrum of cardiogenic shock, with a wide range of mortality and varied treatment according to Forrester class.
- Where possible, patients in cardiogenic shock following MI should be referred to a centre capable of performing emergency revascularization.

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Resources
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