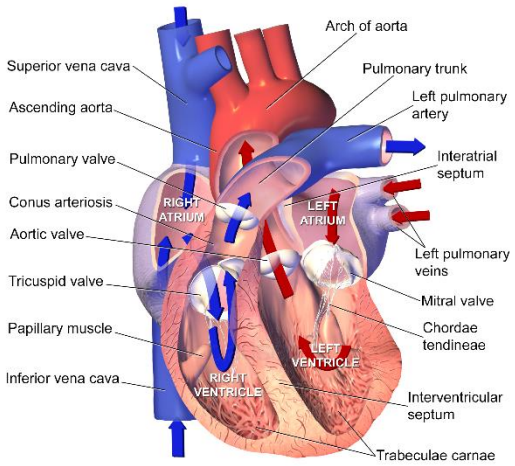
Calculation Skills: Dobutamine in Cardiogenic Shock

The British Heart, Lung and Blood Institute (2018) defines cardiogenic shock as 'occurring if the heart suddenly can't pump enough oxygen rich blood to the body'. The commonest cause of this sudden onset is acute, severe myocardial infarction (MI). The damage to the heart muscle restricts the left ventricles ability to pump blood into the aorta and round to the systemic circulation. This decrease in cardiac output results in a decrease in mean arterial pressure and reduced tissue and organ perfusion. If untreated this can lead to multiorgan failure and death. Even with interventions, mortality rate is high, with the American Heart Association reporting 27-51% despite evidenced based care (AHA 2017).

Although it can affect adults of any age it is more common as you get older and if you have a history of myocardial infarction or heart failure. Other diseases such as coronary artery disease, hypertension and diabetes can increase a person's risk factor for developing cardiogenic shock post MI.



Sectional Anatomy of the Heart Wikimedia Commons

Cardiogenic shock has a range of identifying signs and symptoms:

- Systolic Blood Pressure ≤90mmhg and reduced mean arterial pressure
- Reduced cardiac output
- Reduced end organ perfusion -> urine output
- Reduced tissue perfusion -> cool extremities
- Tachypnoea
- Loss of consciousness
- Tachycardia, pulse weak and thready
- Lactic acidosis

Dobutamine is often first line treatment in the initial management of cardiogenic shock. It is an inotropic drug, which alters the contractility of the heart. It acts as a stimulant of cardiac muscle through its action on beta adrenoreceptors located in the cardiac muscle. It is a synthetic amine structurally related to dopamine (EMC 2018) and has a positive inotropic effect through an agonist action at beta adrenoreceptors. It increases stroke volume and cardiac output and has some

chronotropic (rate affecting) action. The result is an elevation in cardiac output followed by increased arterial blood pressure and tissue and organ perfusion.

James is a 64-year-old gentleman 24 hours post myocardial infarction and is being looked after in the cardiology intensive care unit. He is intubated and ventilated. He is tachycardic at 125bpm with a blood pressure of 76/42. His pulse is weak and thready and he has cold hands and feet. He weighs 70kg and is to be commenced on a dobutamine infusion.

Prescribing Calculations

According to the British National Formulary (Joint Formulary Committee 2018) can be given at a dose of between 2.5-10micrograms/kg/min and adjusted to response accordingly.

You prescribe the starting dose of 2.5micrograms/kg/minute.

Part One

a) Work out the dose to be given for James based on his weight.
b) If the drug must be diluted in 5% glucose solution for administration at a strength of 0.5mg/ml, how much dobutamine is needed to give this strength in a volume of 500ml if the solution you have is 5mg/ml.

Part Two

You now have your solution of 0.5mg/ml in 500ml and need to give the dose per minute you worked out in part one.

a) How much does this equate to per hour?
b) What is the hourly rate based on your strength of 0.5mg/ml?

Part Three

After poor response you decide to increase the dose to 5micrograms/kg/minute. What are the new figures for the following

a) The dose to be given to James based on his weight
b) The amount to add to 500ml of 5% glucose to yield a strength of 0.5mg/ml
c) The dose per hour?
c) The hourly rate based on your strength of 0.5mg/ml?

References

American Heart Association (2017) Contemporary Management of Cardiogenic Shock, retrieved from https://www.ahajournals.org/doi/pdf/10.1161/CIR.0000000000000525 December 2018

British Heart, Lung & Blood Institute (2018) Cardiogenic Shock retrieved from https://www.nhlbi.nih.gov/health-topics/cardiogenic-shock December 2018

Electronic Medicines Compendium (2018) Dobutamine Pharmacology retrieved from https://www.medicines.org.uk/emc/product/6462/smpc#PHARMACOLOGICAL_PROPS December 2018

Joint Formulary Committee (2018) British National Formulary (2018-2019) Issue 76

Answers

Part One

a) Dose = 2.5micrograms x 70kg = 175micrograms given per minute
b) 0.5mg x 500ml = 250mg

Part Two

a) 175micrograms x 60minutes = 4500micrograms or 4.5mg per hour.
b) 4.5mg/0.5mg = 9ml per hour

Part Three

You are effectively doubling the dose, so the calculations are

a) 175 x 2 = 350
b) 250mg x 2 = 500mg
c) 4.5 x 2 = 9 mg/hour
d) 9 x 2 = 18ml/hour