Solutions to Homework – Module 10

1. [15 points] With reference to the term "mean circulatory pressure" …

   A. What is the definition of the term?

   P_{mc} is the equilibrium pressure in the cardiovascular system at zero flow.

   B. If all other physiological variables remain the same, how (increase, decrease, remain the same) is mean circulatory pressure affected by a change in venous compliance? Briefly explain.

   There is an inverse relationship between P_{mc} and vascular compliance; if venous compliance increases (decreases) P_{mc} decreases (increases) – see B&L[6+], Figure 19-4; B&L[7], Figure 19.4. Explanation: An increased venous compliance means that the veins are "softer"; it takes less pressure to allow them to hold the given volume of blood. So, P_{mc} goes down if venous compliance goes up (if volume stays the same).

   C. If all other physiological variables remain the same, how (increase, decrease, remain the same) is mean circulatory pressure affected by a change in circulating blood volume? Briefly explain.

   There is a direct relationship between blood volume and P_{mc} (assuming vascular compliance does not change) – if blood volume increases P_{mc} will increase – see B&L[6+], Figure 19-4; B&L[7], Figure 19.4. Explanation: If blood volume goes up (and venous compliance does not change) more pressure is needed to "force" the additional blood into the veins (venous volume has to increase; that takes additional force (pressure))

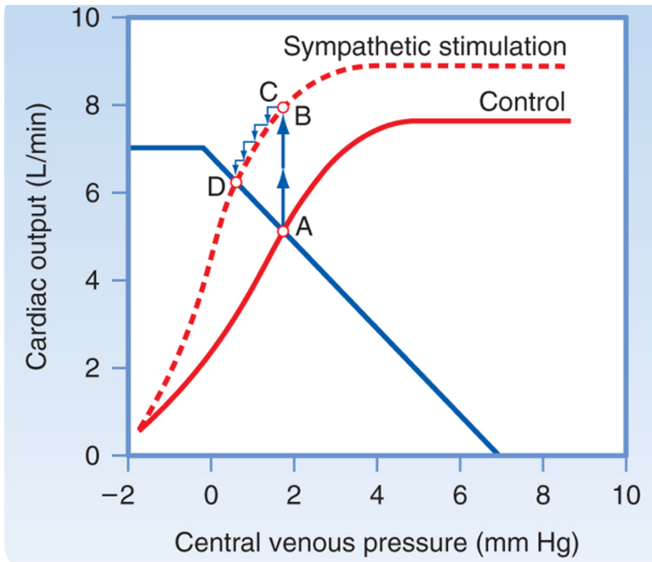
2. [20 points] If drawn on the same set of axes, what is the significance of the point at which the vascular function curve and the cardiac function curve intersect?

   The intersection of the cardiac function curve and the vascular function curve is the equilibrium point at which the cardiovascular system operates – it describes the cardiac output and central venous pressure at which, for the given conditions, the cardiac and venous systems are "matched". See B&L[6+], page 398; B&L[7], page 415.

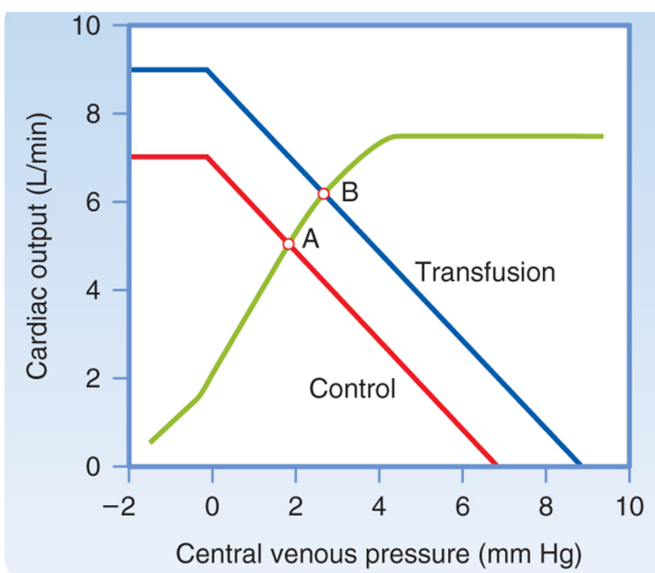
3. [20 points] Sketch a vascular function curve and a cardiac function curve on a common set of axes. Show (sketch) and briefly explain the effect(s) of systemic (i.e., whole body) sympathetic stimulation.

Rev 1, 4/13/16 – add clarifying language to question 3 and revise text of footnote 1.
Rev 2, 10/30/17 - cosmetics and update refs to include B&L[7].
Rev 3, 4/18/18 - correct typo in Q2 response; no change to content.
Rev 4, 11/6/18 - update to 601, clarifications to response 3, cosmetic changes. No other content changes.

If we consider sympathetic stimulation applied only to the heart[1] (not to the vasculature) we would see something similar to slide 3 of video 2 …



If we consider sympathetic stimulation applied only to the vasculature[1] (not to the heart) we would see something similar to video 2, slide 4 happening to the vascular function curve (VFC) – the sympathetic stimulation would have the same effect on the vascular function curve as an increase in blood volume (vascular compliance is decreased by sympathetic stimulation). If the cardiac function curve (CFC) is not changed then the intersection point of the cardiac function and vascular function curves moves up and to the right.



[1] This is NOT the statement of the problem – the problem mentions “systemic (i.e., whole body) sympathetic stimulation” – it does NOT limit the stimulation to only the heart (or to only the vasculature).

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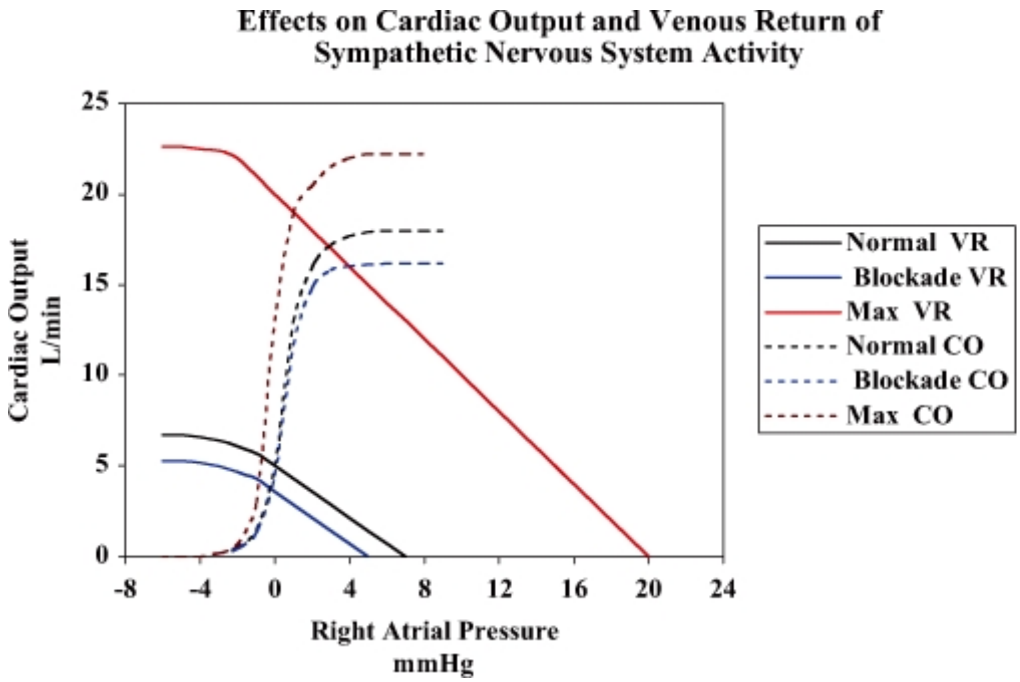
So – if we considered the effect of sympathetic stimulation on both the heart and the vasculature we would see something like[2]



and the equilibrium point would move from the intersection of the normal CFC and normal VFC curves to the intersection of the max CFC and max VFC curves; that is, up and to the right[3].

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[2] Figure copied from http://www.ncbi.nlm.nih.gov/books/NBK54474/?report=printable on 19 November 2014.

[3] It is possible, depending on the slopes of the sympathetically-stimulated CFC and VFC curves, that the intersection point of the two curves may shift left a bit, rather than right.

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