ANAEASTHESIA

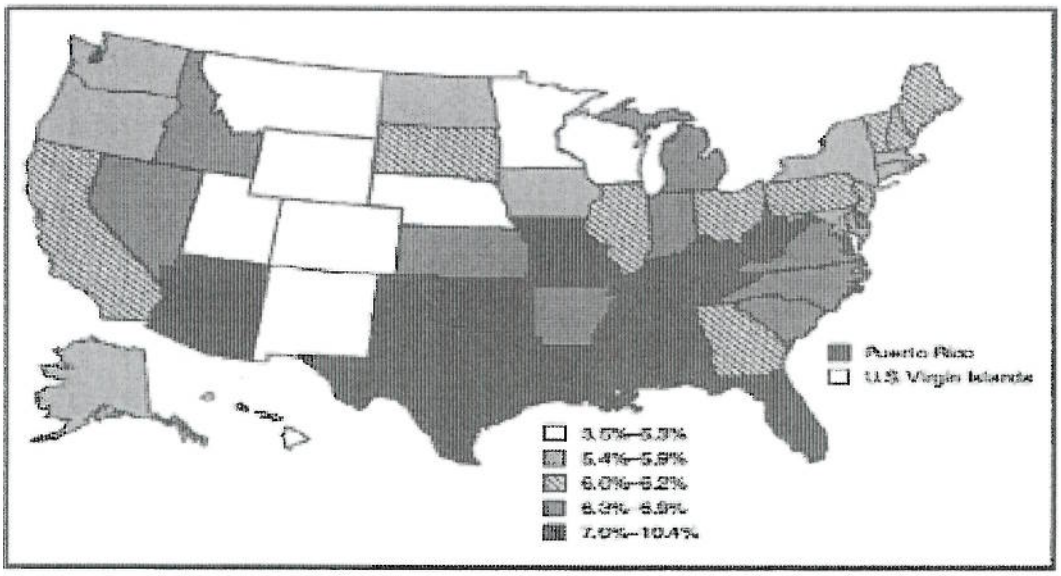
Cardiac Anesthesia Elective Report 2-29th May 2011

-Arjun Devanesan

Comparing the pattern of cardiac disease in the US and England

Coming to the United States I was curious to see whether there was a similar pattern of cardiac disease to England. However, it is difficult to make any general assumptions about the demographics or epidemiology of cardiovascular disease (CVD) in the US based on my limited experience at Massachusetts General Hospital (MGH). The patients I saw at MGH were mostly elderly and Caucasian despite the city's ethnically diverse population, but this cannot be said to represent the US in general as population demographics and disease burden vary widely both from state to state and within individual cities (see figure below). This is similar to the CVD prevalence in England though I tended to see a far more ethnically mixed group of patients in England. This prompted my inquiry into disparities in healthcare provision in the US. I found that lower-income uninsured individuals are far less likely to be treated in a large academic hospital such as MGH than affluent individuals with private health insurance. According to one report, Black patients receive fewer effective cardiac drugs and procedures, even when insured and treated by specialists and tertiary hospitals (E.D. Peterson et al 1997). Between 1987 and 1994 annual reductions in coronary heart disease mortality were only about half as great among black men (2.5 percent) as among white men (4.7 percent) (W.D. Rosamond et al 1998). This disparity is also seen in England. In England, death rates from coronary heart disease have declined faster among more affluent persons. Cardiac death rates among men in unskilled manual occupations are 40 percent higher than for nonmanual workers, and the wives of manual workers have nearly twice the risk that wives of nonmanual workers have (John Z. Ayanian and Thomas J. Quinn 2001). It is interesting that such a disparity should exist in both privatized and nationalized health systems and may reflect deeper social issues common to both countries.

FIGURE. Self-reported prevalence* of history of myocardial infarction or angina/coronary heart disease among adults aged ≥18 years — Behavioral Risk Factor Surveillance System, United States, 2005

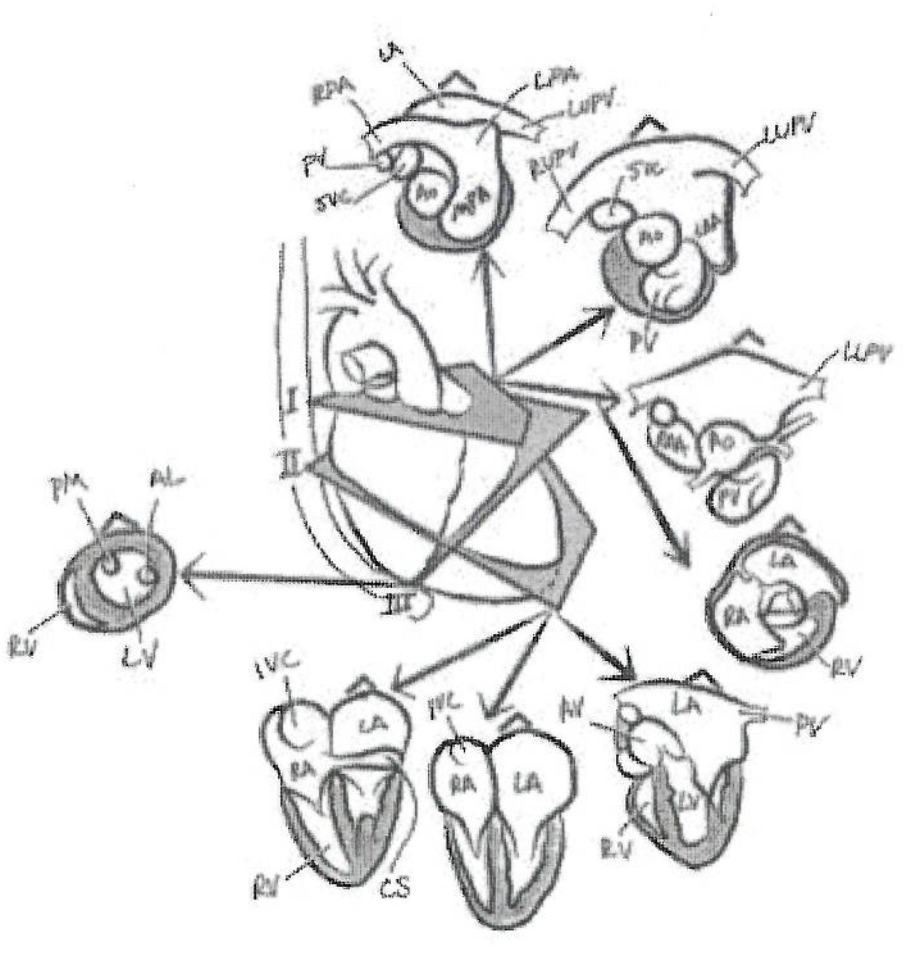


* Age adjusted to the 2000 U.S. standard population of adults.

Learning about cardiac anatomy and physiology for anesthesia

My second objective coming to learn about cardiac anesthesia was to improve my understanding of cardiac anatomy and physiology in the context of anesthesia. One tool that helped me learn about cardiac anatomy was the trans esophageal echocardiogram (TEE). This allowed me to visualize cardiac anatomy *in vivo*, watch the motion of the ventricles beating and the movement of blood through the valves of the heart. By using the TEE probe myself to try to visualize different parts of the heart in different planes (see figure below) I also gained a more three-dimensional understanding of cardiac anatomy and how the heart sits in the body.

The TEE is also important for cardiac anesthesia because different valvular lesions and ventricular function have implications for the type of anesthesia used. During surgery, however, the TEE is mainly used to visualize the lesions of interest to the surgeon. This includes checking the aorta for calcifications, which would make cannulating for cardiopulmonary bypass difficult and dangerous, checking for aortic insufficiency, which would allow flow of cardioplegic solution into the ventricle during bypass instead of the coronary arteries, checking for a patent foramen ovale and thrombus in the left atrial appendage, which could be closed during surgery, and visualizing the valvular lesion to be operated on.



Understanding cardiac physiology is important in cardiac anesthesia because it helps tailor anesthetic technique to the cardiovascular status of the patient in order to maintain hemodynamic homeostasis during surgery, maintain effective cardiac output, and minimize myocardial oxygen demand and the risk of myocardial ischemia. Different valvular lesions have different haemodynamic implications. For example, patients with aortic stenosis are particularly dependant on their preload to maintain cardiac output. In the case of severe aortic stenosis, using propofol as an induction agent can be dangerous because of its vasodilatory effects and therefore a drug like etomidate may be more appropriate. In the case of aortic insufficiency, however, it is important to maintain preload as well, but it is also important to decrease afterload in order to maximize outflow from the heart.

Understanding cardiac physiology also helps in determining the appropriate fluid management for a patient undergoing cardiac surgery. When a patient is put on cardiopulmonary byspass, 1.5L of crystalloid solution from the machine is added to the patient's circulation. This can cause significant hemodilutional anemia. In anticipation of that, one tries to give as little fluid as possible before bypass and a patient's blood pressure is usually maintained with vasopressors or vasodilators. However, if a patient is dehydrated and volume deplete before bypass, they can be increased responsiveness to vasopressors and surgical stimulus and it can be very difficult to control their blood pressure. It is important to control the blood pressure and heart rate in patients with ischemic heart disease because hypertension and tachycardia both increase myocardial oxygen demand and can cause ischemia in patients with coronary artery disease. Therefore a judicious delivery of fluids before bypass can be beneficial.

<u>Compare anesthetic techniques in England and the US</u>

Hemodynamic monitoring in cardiac surgery

In order to accurately titrate fluids and vasopressors, various intraoperative haemodynamic measurements are used. Continuous arterial blood pressure is measured with and arterial catheter usually placed in the right radial artery. Central venous pressures and pulmonary artery pressures are measured with a swan-ganz catheter, which is also able to deliver vasopressors and other drugs centrally. Cardiac output can also be periodically measured during surgery using the cold hemodilution method and the Fick principle. Using the mean arterial pressure, central venous pressure and cardiac output we are able to calculate systemic vascular resistance as well. The SVR is useful in titrating vasopressors when coming off bypass. Contact between the patient's blood and the bypass machine tubing triggers an inflammatory response and as a result causes vasodilation. In order to maintain blood pressure post-bypass it is important to maintain SVR.

While I have never seen cardiac surgery performed in England, I believe that much of it is conducted similarly. However, pulmonary artery catheters are not commonly used in England though central venous catheters are and trans-esophageal Doppler ultrasound probes are more commonly used to measure cardiac output.

I had never seen a Swan-Ganz catheter inserted before and I found the experience of learning how to insert and interpret right sided and pulmonary artery pressures (see figure below) extremely interesting.

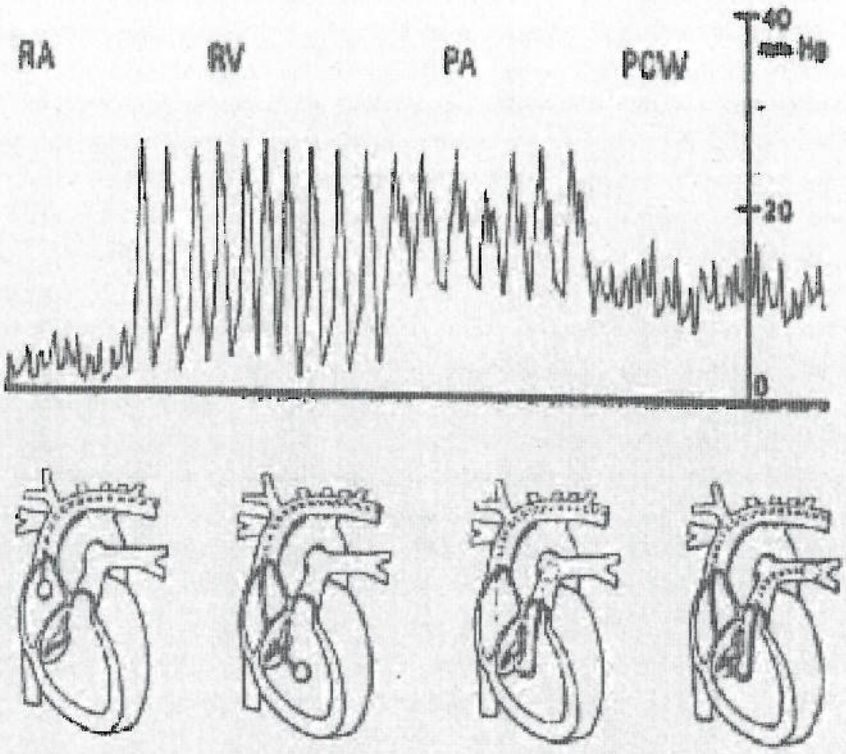


Fig. 1. Characteristic intracardiac pressure wave forms during passage through the heart

Methods of induction

Having never seen cardiac surgery in England I can only compare cardiac anesthetic techniques I have seen here with anesthesia in general and vascular surgery which I have seen in England. The induction agents I saw most commonly used were propofol and etomidate. Propofol was sometimes used in combination with fentanyl to reduce the dose of propofol required or with phenylephrine to counteract the vasodilatory effects of propofol. In England I have seen propofol used in combination with remifentanyl for in the same way. For muscle relaxation I have only seen vecuronium and succinylcholine, known in England as suxamethonium chloride, being used. In England I have seen many more different muscle relaxants used, including rocuronium and atracurium. Rocuronium tends to be favored in large English hospitals for rapid sequence induction because of its quick onset and the availability of Sugammadex, which is a chelating agent and allows for rapid reversal of paralysis. Unfortunately, Sugammadex is not yet licensed in the US.

Maintenance of anesthesia

In England I have seen total intravenous anesthesia with propofol and remifentanyl infusions becoming increasingly common even for long procedures. Here, however, the duration and cost of intravenous anesthetic agents means that maintenance of general anesthesia is usually achieved with isoflurane gas. One interesting thing that I have seen used here but not in England is the SED line, which is a frontal EEG, measured intraoperatively to measure depth of anesthesia. This has been shown to be useful in cardiac surgery in preventing awareness and memory of surgery. In cardiac surgery hypnosis tends to be maintained with as light as possible because of the hemodynamic effects of most hypnotic agents. Therefore it is important to monitor depth of anesthesia to minimize the incidence of awareness during surgery. I found this to be a fascinating instrument.

I have found cardiac surgery to be an exciting and fascinating challenge to effective anesthesia. It has taught me cardiovascular physiology in a new dynamic setting and I have learned many new practical skills as well. I hope that this knowledge and set of skills will help me in whatever medical specialty I choose to follow.

References:

E.D. Peterson et al., "Racial Variation in the Use of Coronary-Revascularization Procedures: Are the Differences Real? Do They Matter?" New England Journal of Medicine 336, no. 7 (1997): 480–486

W.D. Rosamond et al., "Trends in the Incidence of Myocardial Infarction and in Mortality Due to Coronary Heart Disease, 1987 to 1994," New England Journal of Medicine 339, no. 13 (1998): 861–867

John Z. Ayanian and Thomas J. Quinn, Quality Of Care For Coronary Heart Disease In Two Countries, Health Affairs, 2001 vol. 20 no. 3 55-67

JR Neyer et al. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report 2007 / 56(06); 113-118