Chapter 9

Supporting technologies

9.7 Pulmonary artery catheter

9.7.1 History

Michael Lategola and Hermann Rahn

Balloon-flotation pulmonary artery catheters were first used by the American physiologists Lategola and Rahn for pressure recording, blood sampling and vessel occlusion in experiments with dogs (Lategola and Rahn 1953). Since their balloon covered the distal tip they were only able to measure pressures proximal to the occluded vessel. Thermodilution cardiac output was first described in animals the following year (Fegler 1954).

Ronald Bradley

The first person to describe the use of a pulmonary-artery catheter in man was Ronald Bradley, a physician at St. Thomas’ Hospital, London (Bradley 1964). He used an extremely narrow catheter (0.63 mm diam) having no balloon, to determine pulmonary artery pressures and waveforms, and later went on to determine thermodilution cardiac output in man using a thermistor-tipped catheter (Branthwaite and Bradley 1968), and suggested the use of PA-diastolic pressure as an index of mean left-atrial pressure (Jenkins, Bradley and Branthwaite 1970). Bradley also wrote an excellent book on the physiology of heart failure (Bradley 1977).

Harold Swan and William Ganz

Bradley’s catheters had no balloon and were extremely difficult to position, and so the technique remained clinically impractical until Swan et al. (1970) developed the modern balloon-flotation catheter. Since Swan wished to determine left atrial pressure he arranged that pressures could be measured distal to the balloon. Oddly enough Swan fails to credit Bradley and Branthwaite (1968) with the thermodilution technique in man—instead he credits this to Ganz (Swan 1991).

Swan (1922–2005) graduated from St. Thomas’ Hospital Medical School, London, in 1945, and went on to become the Director of the Division of Cardiology at Cedars-Sinai Medical Center in Los Angeles, California. He has set on record the key early ideas and development of the flow-directed balloon-tipped catheter (Swan 1991; 2005) as follows.

In 1950 as a lecturer in physiology at St. Thomas’ Hospital of the University of London, I had come to know a young medical student, Ronald Bradley, who was completing a bachelor’s degree in physiology. I had noted a paper published in

In the fall of 1967, I had the occasion to take my (then young) children to the beach in Santa Monica. On the previous evening, I had spent a frustrating hour with an extraordinary pleasant but elderly lady in an unsuccessful attempt to place one of Bradley’s catheters. It was a hot Saturday and the sailboats on the water were becalmed. However, approximately half a mile offshore, I noted a boat with a large spinnaker well set and moving through the water at a reasonable velocity. The idea then came to to put a sail or a parachute on the end of a highly flexible catheter and thereby increase the frequency of passage of the device into the pulmonary artery. I felt convinced that this approach would allow for the rapid and safe placement of a flotation catheter without the use of fluroscopy and would solve the problem of arrhythmias.

... I had been appointed a consultant to the Edwards Laboratories, then a small manufacturing company whose products included the Starr-Edwards heart valve and the Fogarty embolectomy catheter. ... I brought my concept to the attention of Mr David Chonette and Mr Will Perrie. They had the facilities for extrusion of catheters of different sizes ... To test the concept, however, they had the ability to manufacture balloons (as for the Fogarty catheter) and suggested that, as a first effort, a double-lumen extruded catheter should be manufactured with one lumen available to inflate a flotation balloon. This proved to be acceptable and they agreed to fabricate five such catheters.

... As luck would have it, when the Edwards Laboratories delivered their first catheters, Willie [Ganz] was finishing an experiment with his animal in good condition. I brought the prize catheters to the laboratory and connected the pressure lumen to an appropriate strain gauge manometer. The catheter was then introduced via the exposed jugular vein into the right atrium and, observing with fluroscopy, the balloon was inflated. It immediately disappeared, and the technician reported no change in the recorded pressure. I immediately assumed an inadequacy of balloon tensile strength and mentally blamed faulty construction by the Edwards Laboratory. However, repeat visualization revealed that the catheter had migrated in one heartbeat through the right heart and was recording the wedge pressure in a distal pulmonary artery. Deflation of the balloon allowed its prompt return to the superior vena cava. ... Willie Ganz accepted the responsibility of clearing up the many technical details, but the concept was proved and the new device was born.

... A triple-lumen catheter allowed measurement of simultaneous pressures in the wedge position (the pulmonary occluded pressure) and in the right atrium. With a slight modification, a thermistor was inserted close to the guiding balloon and the thermodilution technique of Willie Ganz (Ganz et al. 1971) for determination of cardiac output was applied.

Swan (1991)

Swan (1922–2005) died on 7th February, 2005, and his last paper (Swan 2005) appeared in the October 2005 issue of Anesthesiology. A photograph of Swan can be found on the Anesthesiology web site.2


9.7.2 Decline in use

In recent years the use of pulmonary artery catheters has declined somewhat, partially owing to lack of good evidence that it improves outcome (ESCAPE committee 2005; Shah et al. 2005; Hall 2005), and partly owing to new non-invasive cardiac output monitoring devices (e.g., PiCCO, LiDCO, oesophageal doppler).

