*British Heart Journal*, 1973, 35, 647–650.

# The Swan–Ganz catheter in the cardiac laboratory

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*The availability of the Swan-Ganz catheter, a soft, radiopaque, balloon-tipped, flow-directed catheter, is a significant advance in diagnostic cardiac catheterization. The ease and safety of passage of this catheter from superior vena cava to pulmonary artery is remarkable. We report our experience with this catheter and suggest that its use in diagnostic cardiac catheterization become routine.*

In 1970, Swan and associates reported on their results in catheterization of the right heart with a soft, flow-directed, balloon-tipped catheter of their design. Using the 5F size catheter the pulmonary artery was rapidly and safely catheterized in 95 per cent of patients in intensive care situations without the aid of fluoroscopy.

The availability of the Swan-Ganz catheter (Edwards Laboratories, 624 Dyer Road, Santa Ana, California) has led to a change in our approach to cardiac catheterization, and the purpose of this report is to describe our experience with this catheter in routine cardiac catheterization in the cardiovascular laboratory.

In the sicker patient, particularly when the right atrium is enlarged, the performance of a right heart catheterization represents in many cases the most hazardous part of the procedure when carried out with orthodox, semi-rigid catheters such as the Cournand or Lehman catheter. The reason for this is the need to form a loop by pushing the catheter against the right atrial wall. Not infrequently this manoeuvre leads to supraventricular tachycardia, and in a proportion of these the whole study is jeopardized or abandoned. Further, frightening ventricular arrhythmias are frequently precipitated by semi-rigid catheters impinging against the right ventricular endocardium.

It has, therefore, become our policy to practise and teach that when the important data required are those from the left heart (e.g. coronary arteriography, aortic valve function) the right heart catheter should not be advanced beyond the superior vena cava until the relevant left-sided data have been obtained.

With the advent of the Swan-Ganz catheter, however, we are now able to perform the right heart catheterization quickly and with minimal risk, and with minimal fluoroscopy time, obtaining the necessary right-sided pressures and samples. We believe the Swan-Ganz catheter is a significant advance and has been adopted as routine in our laboratories.

Received 6 December 1972.

## Technique

An antecubital cut-down is performed and the 7F Swan-Ganz catheter is introduced into the vein in the usual fashion. The catheter is passed to the right atrium with fluoroscopy (the catheter body is radiopaque). The balloon is inflated with air (when there is a possibility of balloon-rupture producing systemic air embolism, carbon dioxide should be used) and rapidly traverses the tricuspid valve to the right ventricle and pulmonary artery propelled by the flow of blood. With the balloon deflated the catheter can be wedged in the conventional manner, or alternatively, balloon inflation will produce a satisfactory wedge pressure with the catheter in the pulmonary artery.

Alternatively, the catheter can be introduced percutaneously into a femoral vein by the technique of Desilets and Hoffman (1965) using a 6F sheath for the 5F catheter and an 8F sheath for the 7F catheter. Rapid catheterization of the pulmonary artery can be readily obtained in this fashion.

## Results

In the past few months we have performed right heart catheterization in 103 patients without a single instance of sustained arrhythmia or failure to catheterize the pulmonary artery. These patients represent the usual diversity of cardiac catheterization patients and include 8 patients with significant tricuspid regurgitation and 19 patients with severe pulmonary hypertension. Fig. 1 is a frame of a 35 mm cinefluorogram showing the catheter with the balloon inflated in the right ventricular outflow area.

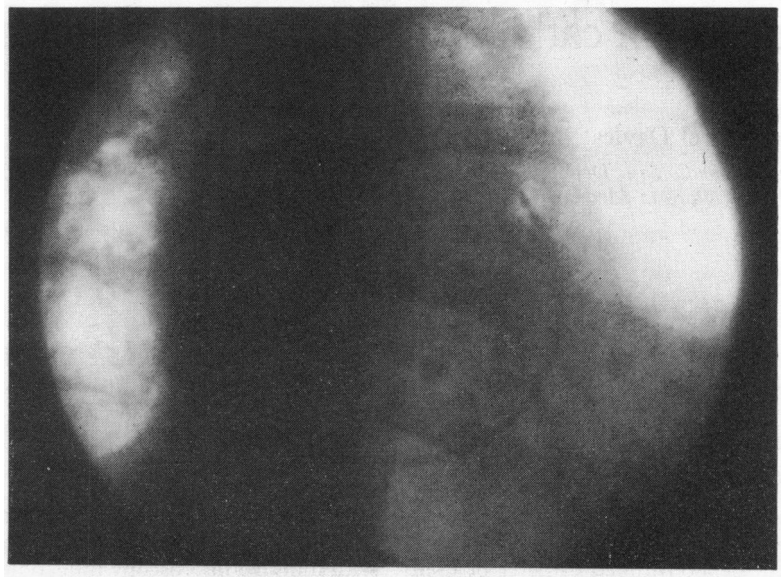

FIG. 1 *35 mm cinefluorogram exposed in the anteroposterior projection showing the tip of the Swan-Ganz catheter with balloon inflated in the outflow tract of the right ventricle.*

The time of passage from the right atrium to the pulmonary artery averages 10 seconds. As a rule, no ventricular premature beats are provoked.

Right ventricular pressure can be recorded as the catheter traverses this chamber without interference from premature beats. Fig. 2 is a continuous recording of catheter passage from the right atrium to the pulmonary artery in a patient with an atrial septal defect and mild valvular pulmonary stenosis.

The pressures recorded with the 7F catheters are

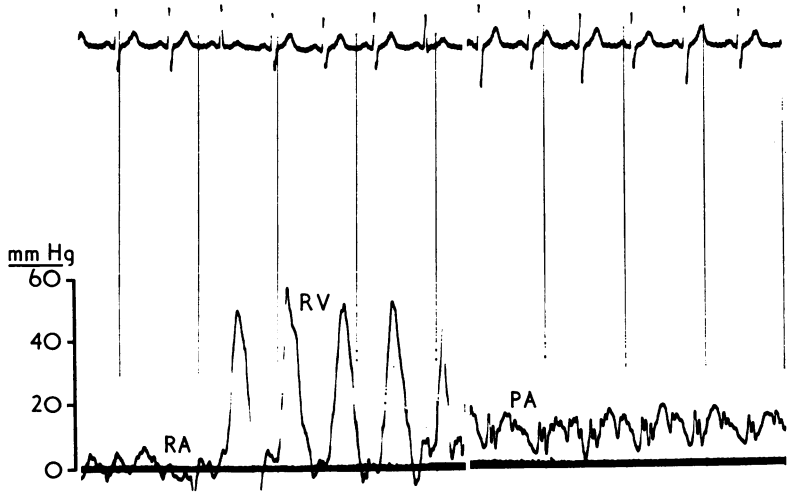


FIG. 2 *Continuous record of the Swan-Ganz catheter passage from the right atrium (RA) to the pulmonary artery (PA) with balloon inflated in a patient with an atrial septal defect. Right ventricle (RV) – pulmonary artery gradient is 33 mmHg. Paper speed is 25 mm per sec with 1 sec time lines. Note that the catheter traverses the right ventricle in 4 beats.*

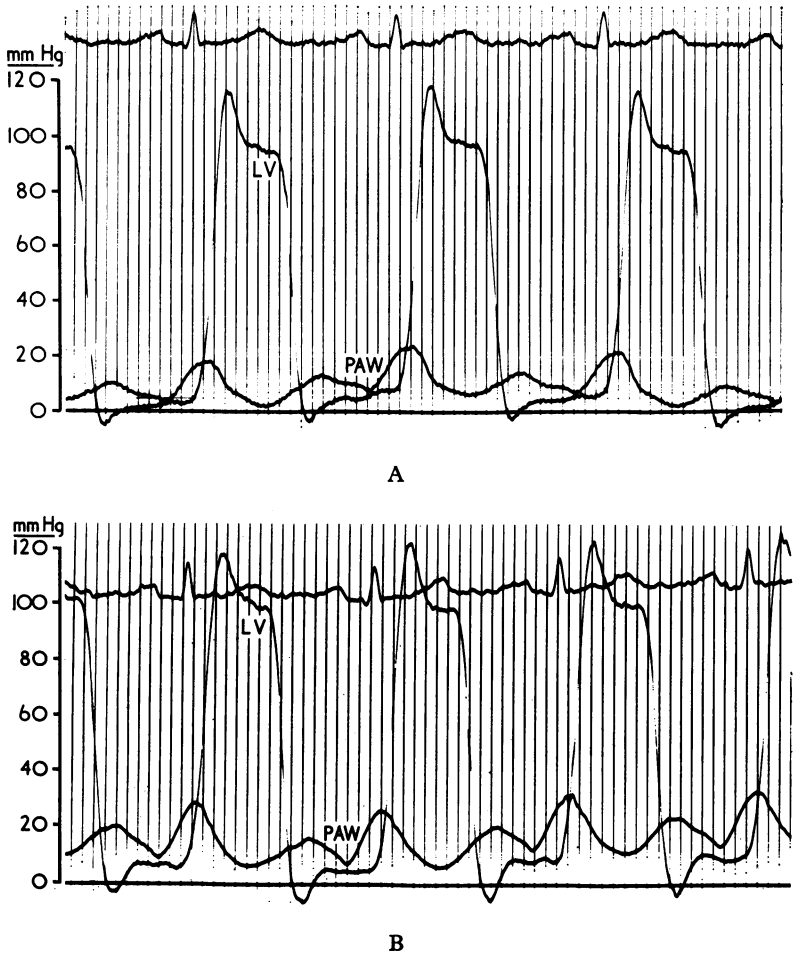


FIG. 3 *Pulmonary artery wedge (PAW) pressures obtained with a 7F Cournand catheter (3A) and with a 7F Swan-Ganz catheter, with balloon deflated (3B) in a patient with mild mitral stenosis. Paper speed is 75 mm per sec with 0·04 sec time lines. Left ventricular (LV) pressure is also depicted.*

of good quality. Fig. 3 is a record of wedge pressure obtained with a 7F Swan-Ganz catheter with balloon deflated and with a 7F Cournand catheter, in a patient with mild mitral stenosis. Fig. 4 shows the comparison pressure tracings of a Swan-Ganz catheter wedged in conventional fashion (with the balloon deflated) and a 'wedge' pressure obtained in the right pulmonary artery with balloon inflated. The ability to record a satisfactory wedge pressure without actually wedging the catheter, often quite difficult in severe pulmonary hypertension, is a distinct advantage of the Swan-Ganz catheter, though, in these patients, we have always been able to obtain a conventional wedge pressure, including the 19 patients with severe pulmonary hypertension.

The 5F and 7F catheters are also perfectly adequate for injection of indocyanine green dye and for obtaining blood samples.

We obtain an average of 10 uses per catheter which, considering its advantages, is acceptable for its price.

## Discussion

We believe that the Swan-Ganz catheter represents a significant advance in cardiological practice. We have been pleased with the ease and gentleness of right heart catheterization even in the ill cardiac patient and in the patient with significant tricuspid regurgitation.

Our results confirm those of Swan *et al.* (1970)

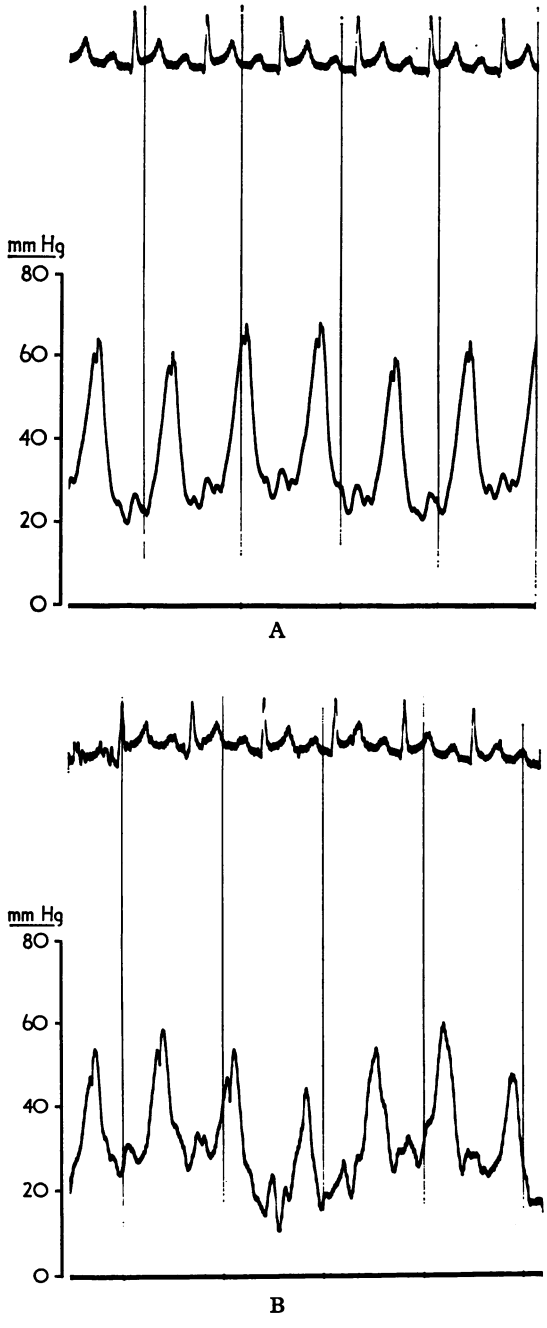


FIG. 4 *Pulmonary artery wedge pressures obtained with a 7F Swan-Ganz catheter in a patient with severe mitral regurgitation. The pressure recorded in 4A is with the catheter wedged (balloon deflated) and in 4B a satisfactory wedge pressure is obtained with the catheter in the right pulmonary artery and the balloon inflated.*

who reported on the value of this catheter in the catheterization laboratory though their emphasis was on its value in intensive care settings without the necessity of fluoroscopy. As suggested by Swan *et al.* (1970), the value of the flotation catheter in complex congenital heart disease, e.g. transposed great vessels, has recently been confirmed by Kelly, Krovetz, and Rowe (1971).

We first became interested in the Swan-Ganz catheter as a safe, simple method of catheter placement in the wedge position or in the distal pulmonary artery for the performance of scintillographic left heart angiocardiography (Kirch *et al.*, 1972; Matthews *et al.*, 1972). The ease and safety of catheterization of the pulmonary artery with this catheter allow us to consider this technique as atraumatic.

This report is not intended to minimize the significance of the Swan-Ganz catheter in intensive medicine settings; in fact, we find that this catheter performs very well in such situations. For example, the problem of acute myocardial infarction with pulmonary oedema and the presence of a loud apical murmur suggesting either ruptured intraventricular septum or mitral regurgitation is easily differentiated with the Swan-Ganz catheter. Pulmonary artery oxygen content and pulmonary artery wedge pressure and contour can quickly and safely be obtained at the bedside.

The performance characteristics of the Swan-Ganz catheter in a wide variety of cardiac catheterization situations suggest that its use in cardiac laboratories should be encouraged. Its use has become routine in our laboratories.

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