

## EDITOR'S NOTE



### Dr. Manoj Durairaj

Heart Transplant Surgeon, MS, MCh. (AIIMS, New Delhi), FACC.

Director, Marian Cardiac Centre and Research Foundation.

Program Director, Department of Heart and Lung Transplantation, Sahyadri Hospitals, Pune.

Dear Colleagues,

At the outset I would record my thanks to Dr Bagirath Raghuraman, Program Director Heart transplant, Narayana Institute of Cardiac Sciences, Bangalore, for accepting to be the guest author for the July issue of The Revival. Dr Bagirath has enumerated the indications for the use of the Swan Ganz catheter in congestive heart failure. He has rightly said in his article that the 'absolute numbers generated by the pulmonary artery catheter are the "Gold Standard" and leaves no ambiguity in the mind of the end user'.

**Editor's tip:** In our unit insertion of a PAC is the standard practice for all patients presenting with congestive heart failure. It is a crucial instrument for not only monitoring their haemodynamics but titrating the doses of inotropes. It is a useful guide for timely insertion of Mechanical Circulatory Support in patients with cardiogenic shock. We electively use the PAC for patients with Reduced ejection fraction undergoing both coronary artery bypass surgery and valve surgery. We perform the Cardiac catheterisation prior to heart transplant via a PAC inserted in the cardiac recovery room. This helps us in borderline PVR patients to start Milrinone and gives us a more accurate assessment of a reversible PVR number over a 24 hour period.

- Dr. Manoj Durairaj  
Editor "The Revival"

## SUB EDITOR



### Dr. Talha Meeran

MBBS, MD, FACC, Consultant Cardiologist, Dept of Advanced Cardiac Sciences and Cardiac Transplant, Sir HN Reliance Foundation Hospital, Mumbai.

Dear Colleagues,

In this issue, Dr Bagirath has taken on a challenging and controversial topic in cardiology.

The ESCAPE trial from JAMA 2005 led to an unfortunate decline in the PA catheter use even in the cardiac ICU. However, the ESCAPE trial had major pragmatic drawbacks. One major criticism was including patients that were not sick enough by excluding VAD and MCS patients. For further reading, I would recommend the CSWG paper by A. Garan et al from JACC HF 2020 demonstrating how PAC usage can beneficially impact in-hospital mortality in a more contemporary and more morbid cohort. The PA catheter remains an important instrument in solving the puzzle of cardiogenic shock and advanced heart failure.

Sincerely,  
Dr. Talha Meeran  
Sub Editor "The Revival"

## PRESIDENTIAL MESSAGE



### Prof. (Dr) V. Nandakumar

Director & Chief, Division of Cardio Vascular/Thoracic Surgery & Cardiac Transplantation, Metromed International Cardiac Centre, Calicut, Kerala.

Dear Colleagues,

Greetings!  
July issue of 'The Revival' brings out the article on 'Use of Swan Ganz catheter and hemodynamic monitoring in congestive heart failure by Dr.Bagirath. Pulmonary artery catheterisation using Swan Ganz catheter has revolutionized management of critically ill patients. Although its usage has come down in recent years, especially after more frequent application of echocardiography in the intensive care

rooms, it is still the gold standard since it utilizes continuous hemodynamic data which shows the trend, which in turn helps to decide the plan of management

Dr. Bhagirath has covered the topic well with special emphasis on indications, guidelines and how it is useful in managing patients with cardiac failure.

- Prof. (Dr) V. Nandakumar  
President

Please call or write to us:

Call: 9822322072, 9167048815,  
[manojdurairaj@hotmail.com](mailto:manojdurairaj@hotmail.com),  
[talha.meeran@gmail.com](mailto:talha.meeran@gmail.com)

Link for membership,  
<http://www.sfht.org/application.html>

Special thanks to  
Dr. Bagirath Raghuraman for authoring this month's article.

Designed by Maithili Kulkarni

# USE OF SWAN GANZ CATHETER AND HEMODYNAMIC MONITORING IN CONGESTIVE HEART FAILURE



**Dr. Bagirath Raghuraman**  
MD, DNB, DM

Dr. Bagirath Raghuraman is presently working as Senior Consultant interventional and Transplant Cardiologist, Program Director, Heart Transplant, at Narayana Institute of Cardiac Sciences, Narayana Health City, Bangalore. Apart from training in Interventional Cardiology at The Rotenburg Cardiovascular Clinic at Fulda, Germany, he underwent training in advanced management of heart failure and cardiac transplantation at Papworth hospital, Cambridge, United Kingdom. He also underwent training in the use of cardiac assist devices in the management of heart failure at the University of Minnesota, Minneapolis, USA. Apart from this, he underwent training in Balloon pulmonary angioplasty for Chronic thromboembolic hypertension (CTEPH) at the Tokyo Medical University Hospital, Tokyo, Japan.

His area of expertise apart from interventional cardiology has been management of heart failure, mechanical circulatory support devices, cardiac resynchronisation therapy and cardiac transplantation.

## Introduction:

Pulmonary artery catheters or the Swan-Ganz catheters are balloon floatation catheters that are used for the evaluation and management of critically ill patients, and for the evaluation of unexplained dyspnoea or pulmonary hypertension. They are useful for collecting detailed hemodynamic data, including direct assessment of filling pressures and cardiac output, and also for calculation of pulmonary and systemic vascular resistance

## Pulmonary artery catheter (PAC) can be used to make the following measurements:

1. Central venous pressure (CVP)
2. Right-sided intracardiac pressures (right atrium, right ventricle)
3. Pulmonary arterial pressure (Pap)
4. Pulmonary capillary occlusion pressure (PCOP; pulmonary capillary wedge pressure [PCWP])
5. Cardiac output (CO)
6. Mixed venous oxyhaemoglobin saturation (SvO<sub>2</sub>)

## The PAC can indirectly measure the following calculated parameters:

- $SVR = 80 \times [\text{Mean artery pressure} - \text{CVP}] / \text{CO}$
- Pulmonary vascular resistance ( $PVR = 80 \times [\text{mean Pap} - \text{PCWP}] / \text{CO}$ )
- Cardiac index ( $CI = \text{CO} / \text{body surface area}$ )
- Stroke volume index ( $SVI = \text{CI} / \text{heart rate}$ )

- Left ventricular stroke work index (LVSWI =  $[\text{mean systemic artery pressure} - \text{PCWP}] \times \text{SVI} \times 0.136$ )
- Right ventricular stroke work index (RVSWI =  $[\text{mean Pap} - \text{CVP}] \times \text{SVI} \times 0.136$ )
- Oxygen delivery ( $\text{DO}_2 = \text{CI} \times 13.4 \times \text{haemoglobin concentration} \times \text{arterial oxygen saturation}$ )
- Oxygen uptake ( $\text{VO}_2 = \text{CI} \times 13.4 \times \text{haemoglobin concentration} \times [\text{arterial oxygen saturation} - \text{venous oxygen saturation}]$ )

## The indications for hemodynamic monitoring are:

1. Unexplained or unknown volume status in shock
2. Severe cardiogenic shock (eg, acute valvular disease, suspected pericardial tamponade)
3. Indicated in patients with discordant right and left ventricular failure.
4. Suspected or known pulmonary artery hypertension - Indicated for the hemodynamic differential diagnosis of pulmonary hypertension.
5. Indicated to assess response to therapy in patients with precapillary and mixed types of pulmonary hypertension.
6. Indicated for cardiac transplantation or ventricular assist device workup.
7. Severe underlying cardiopulmonary disease (eg, congenital heart disease, left-to-right shunt, severe valvular disease, pulmonary hypertension) who are undergoing corrective or other surgery.
8. Indicated in patients with severe chronic heart failure requiring inotropic, vasopressor, and vasodilator therapy.

9. Invasive hemodynamics is indicated in patients with high cardiac output, low SVR, elevated PCWP and RA pressure
10. Indicated in some patients with systolic heart failure such as fulminant myocarditis and peripartum cardiomyopathy where there is a possibility of recovery.
11. Indicated in selected patients with cardiogenic shock or other severe hemodynamic collapse, with anuria or oliguria, or with uncertain hemodynamic parameters and inadequate response to therapy.
12. Uncertainty regarding hemodynamics after therapy:
  - Possibility of right left mismatch
  - Investigate intrinsic pulmonary hypertension
  - Investigate unusually low or high SVR
  - Recurrent or refractory symptoms
  - Cardio - renal syndrome
13. Failure to wean from intravenous inotropic infusions.
14. Uncertainty regarding baseline hemodynamic profile
  - Symptoms and severity are disproportionate to clinical examination, often requiring assessment during exercise.
  - Ambiguity regarding clinical assessment
15. Management of Decompensated Heart Failure with uncertain contribution from other conditions:
  - A. Cardiac causes
    - Ongoing ischemia
    - Primary valvular heart disease
  - B. Noncardiac causes:
    - Severe pulmonary involvement
    - Renal insufficiency
    - Hepatic insufficiency
    - Sepsis

C. Postoperative respiratory insufficiency or hypotension unresponsive to treatment (refractory hypotension)

In patients with advanced heart failure, invasive hemodynamics can be used to achieve the following therapeutic targets:

1. LV filling pressure (reflected by PCWP) of <16 mm Hg
2. RA pressure < 8 mm Hg
3. SVR between 1000 - 1200 dynes-sec/cm<sup>-5</sup>

Multiple studies (large, small, randomized and meta-analyses) have reconfirmed that there is no benefit in terms of either

hospital stay or survival by the use of invasive hemodynamic monitoring. As a consequence of this finding, most societal guidelines no longer support their routine use. However, many clinicians who monitor critically ill patients, value the information obtained from PAC placement in selected patients as discussed above.

### Common challenges faced by a cardiologist managing heart failure:

1. Patient has worsening renal parameters.
2. Patient has persistent hypotension despite maximal doses of inotropes.
3. Patient is not improving on treatment – whether patient is refractory to medications?
4. Unable to optimize the patient and make him/her suitable for cardiac transplantation.
5. How to minimize the side effects of the medications?
6. How to titrate the dosages so that I can give the right dose of medications?
7. When can I wean off intravenous supports – not too early / not too late?

### How is hemodynamic monitoring done?

1. Right internal jugular vein access
2. Sheath inserted by Seldinger technique.
3. A Swan Ganz direct flow catheter is inserted into the sheath over a guidewire and maneuvered and positioned in the pulmonary artery.
4. The pressure transducer of the Swan Ganz catheter is connected to a Continuous cardiac output monitor.
5. Arterial access – radial or femoral sheath for arterial pressure monitoring
6. After catheter placement, measurement is taken with patient's bed head end angle of 30°





The goal of hemodynamic tailored therapy is to achieve low or near normal filling pressures without a drop in cardiac output or peripheral perfusion. This can be achieved by a careful balance of inotropes, vasodilators, and diuretics.

### The 2013 ACCF/AHA and 2010 HSFA guidelines

The guidelines reiterate that there is no benefit in the routine use of invasive hemodynamic monitoring in normotensive patients who are being treated for ADHF who have a good response to vasodilators and diuretics.

**The HSFA guidelines** recommends invasive hemodynamic monitoring in the following clinical scenarios:

- Heart failure which is refractory to therapy
- Uncertain volume status and cardiac filling pressure
- Significant hypotension (Systolic BP < 80 mm Hg) or worsening renal insufficiency during therapy
- Requirement to assess degree and reversibility

of pulmonary hypertension, as part of cardiac transplantation work up.

- To document adequate hemodynamic response to inotropic therapy, where long-term outpatient infusion therapy is indicated or planned.

### Risks and complications of invasive hemodynamic monitoring:

1. Bleeding
2. Infection
3. Arrhythmias
4. Rare catastrophic events like Pulmonary artery rupture
5. Pulmonary infarction.

### Clinical Trial evidence:

The Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness (ESCAPE) was a randomized controlled trial that enrolled 433 patients with severe and symptomatic heart failure despite adequate therapy. The patients were randomized to receive therapy guided by clinical assessment and PAC versus clinical assessment alone. The results showed that the use of PAC did not significantly alter the days alive and out of hospital during the first 6 months (133 versus 135 days), duration of hospitalization (8.7 versus 8.3 days) or mortality (43 versus 38 deaths) as compared to clinical assessment alone. The results of the ESCAPE trial led to a decline in the use of PAC in AHF management.

### The final word:

Echocardiography does compare with PAC to a certain extent which is outlined by the skill of the echocardiographer. However, the absolute numbers generated by a PAC are the "Gold Standard" and leaves no ambiguity in the mind of the end user.

Both the ACC / AHA and the ESC guidelines suggest that invasive hemodynamic monitoring is potentially useful in selected patients with persistent heart failure symptoms despite standard therapies, require vasopressor support, or have uncertain volume or perfusion status.

## **PRESIDENT**

**DR V NANDAKUMAR**

Mob: 9843015888

Email: [drvnandakumar@gmail.com](mailto:drvnandakumar@gmail.com)

## **PRESIDENT ELECT**

**DR RONY MATHEW**

Mob: 9846097812

Email: [drronymathew@yahoo.com](mailto:drronymathew@yahoo.com)

## **VICE PRESIDENTS**

**DR JULIUS PUNNEN**

Mob: 9980072785

Email: [jpunnen@hotmail.com](mailto:jpunnen@hotmail.com)

**DR AJITKUMAR V K**

Mob: 9895153684

Email: [ajitkumarvk@yahoo.com](mailto:ajitkumarvk@yahoo.com)

## **SECRETARY**

**DR JABIR ABDULLAKUTTY**

Mob: 9447011773

Email: [drjabi@yahoo.co.in](mailto:drjabi@yahoo.co.in)

## **JOINT SECRETARY**

**DR RAJAGOPAL S**

Mob: 9747606600

Email: [srajagovindam@gmail.com](mailto:srajagovindam@gmail.com)

## **TREASURER**

**DR PRAVEEN G PAI**

Mob: 9847334434

Email: [praveen.pai.g@gmail.com](mailto:praveen.pai.g@gmail.com)

## **PAST PRESIDENTS**

**DR P P MOHANAN**

Mob: 9846076006

Email: [drppmohanan@yahoo.com](mailto:drppmohanan@yahoo.com)

**DR JOSE CHACKO PERIAPURAM**

Mob: 9847043224

Email: [joseperiapuram@hotmail.com](mailto:joseperiapuram@hotmail.com)

**DR GEEVAR ZACHARIAH**

Mob: 9846066816

Email: [geevartzachariah@gmail.com](mailto:geevartzachariah@gmail.com)

## **MEMBERS**

**DR C G BAHULEYAN**

Mob: 9447344882

Email: [bahuleyan2001@yahoo.co.uk](mailto:bahuleyan2001@yahoo.co.uk)

**DR P CHANDRASEKHAR**

Mob: 9443047152

Email: [chanpad@gmail.com](mailto:chanpad@gmail.com)

**DR COL JAMES THOMAS**

Mob: 9892797060

Email: [thomasdrjames@yahoo.in](mailto:thomasdrjames@yahoo.in)

**DR JACOB ABRAHAM**

Mob: 9847128123

Email: [jacobraham1@gmail.com](mailto:jacobraham1@gmail.com)

**DR JAYAGOPAL P B**

Mob: 9847023777

Email: [jaigopallakshmi@gmail.com](mailto:jaigopallakshmi@gmail.com)

**DR KARTHIK VASUDEVAN**

Mob: 9845281450

Email: [karvasudevan@gmail.com](mailto:karvasudevan@gmail.com)

**DR C S HIREMATH**

Mob: 9481119646

Email: [hiremth.cs@sss.hms.org.in](mailto:hiremth.cs@sss.hms.org.in)

**DR MANOJ DURAIRAJ**

Mob: 9822322072

Email: [manojdurairaj@hotmail.com](mailto:manojdurairaj@hotmail.com)

**DR RAJESH RAMANKUTTY**

Mob: 9846005737

Email: [drrajesh\\_mr@yahoo.com](mailto:drrajesh_mr@yahoo.com)

**DR V K CHOPRA**

Mob: 9560898900

Email: [chopravk@gmail.com](mailto:chopravk@gmail.com)

**DR TALHA MEERAN**

Mob: 9167048815

Email: [talha.meeran@gmail.com](mailto:talha.meeran@gmail.com)