

Title: A DOUBLE LUMEN TRANSTHORACIC PULMONARY ARTERY CATHETER FOR MEASUREMENT OF CARDIAC OUTPUT IN INFANTS AND NEONATES

Authors: D.L. Wessel, M.D., E.M. Elixson, R.N., D.D. Hansen, M.D., and P.R. Hickey, M.D.

Affiliation: The Departments of Anesthesia, Cardiology and Cardiac Surgery, The Children's Hospital and The Departments of Anaesthesia, Pediatrics and Surgery, Harvard Medical School, Boston, MA.

## INTRODUCTION

Monitoring intracardiac and pulmonary artery pressures has assumed an increasingly important role in the management of children following repair of congenital heart disease. Technical limitations related to patient size and intracardiac anatomy have limited the use of transvenously placed, flow directed, balloon-tipped catheters in these patients. Transthoracically placed pulmonary artery catheters are feasible and safe<sup>1</sup> but have not been previously available in combination with a thermistor for measurement of cardiac output by thermodilution technique for the smallest children. We report our initial experience with a newly designed transthoracic double lumen pulmonary artery catheter/thermistor for measurement of pressure and cardiac output in small infants and newborns.

## METHODS

With parental informed consent, 42 patients were selected for placement of the catheter. The patients varied in age from 2 days to one year (median, 4 months), and in body surface area from  $0.19M^2$  to  $0.46M^2$  (median,  $0.29M^2$ ). These included 8 neonates in the first week of life. All patients underwent complete repair of their congenital heart disease on cardiopulmonary bypass (CPB).

Prior to weaning off CPB a 3.0F double lumen catheter with a radiopaque thermistor was advanced through a needle into the infundibulum of the right ventricle and passed into the pulmonary artery. Left and right atrial pressure lines were placed similarly and all catheters were exteriorized and sutured to the skin.

Pulmonary artery pressure was monitored continuously in the intensive care unit and a cardiac output computer was connected to the catheter, giving a digital read-out and a permanent record of the cardiac output curve. Triplicate determinations of cardiac output were made using 1.0 ml injections into the right atrial line of iced 5% dextrose in water. Measurements were conducted over a wide range of hemodynamic conditions imposed on each patient.

## RESULTS

Two catheters were cracked or kinked during placement and could not be used for monitoring in the intensive care unit (ICU). One catheter was inadvertently pulled out shortly after arrival in the ICU. Three patients had evidence of residual intracardiac shunts (2 left-to-right; 1 right-to-left) as evidenced by the contour of the cardiac output curves, and oxygen saturation and pressure data. These residual defects were confirmed by cardiac catheterization or re-operation.

In the remaining 36 patients there were 567 measurements of cardiac output during 189 hemodynamic manipulations. For determination of reproducibility the three measured outputs were expressed as a percent of their mean value and variability for each patient entry was calculated. The standard deviation of the 567 measurements was 4.8%. Consequently, 95% of the measurements of cardiac output were within 10% of the mean value.

There were no major complications clearly related to the catheter, including retention of the line or excessive bleeding. One infant bled 30 ml into the chest tube after catheter removal but did not require transfusion or intervention. The majority of catheters were removed on the first postoperative day and 5 had a dampened wave form at that time which was inadequate for accurate assessment of pulmonary artery to right ventricle pullback pressure gradients. One patient had a blood culture positive for staphylococcus epidermidis 2 days after the catheter was removed; this may have been unrelated to the catheter. One patient had blood-tinged secretions from the endotracheal tube which could have resulted from catheter induced trauma in the pulmonary artery.

## CONCLUSIONS

We feel that monitoring pulmonary artery pressure in selected neonates and infants provides vital hemodynamic information during the immediate postoperative period following cardiac surgery. The use of a transthoracic double lumen thermodilution catheter provides additional valuable data regarding vascular resistances, low cardiac output and residual intracardiac shunts. The reproducibility of these measurements is good and in our initial experience the risks are low.

## REFERENCES

1. Gold JP, Jonas, RA, Lang P., et al: Transthoracic intracardiac monitoring lines in pediatric surgical patients: A ten-year experience. *Ann Thorac Surg* 42: 185-195, 1986