

Title: PULMONARY ARTERY WEDGE PRESSURE COMPARED TO LEFT ATRIAL PRESSURE IN CARDIAC SURGICAL PATIENTS

Authors: E. A. Hessel II, M.D., M. G. Bazaral, M.D., R. Stewart, M.D., F.G. Estafanous, M.D.

Affiliation: Departments of Cardiothoracic Anesthesiology and of Thoracic and Cardiovascular Surgery, The Cleveland Clinic Foundation, 9500 Euclid Avenue, Cleveland, Ohio 44106

**Introduction.** Recently Mammana, et al presented data indicating that the pulmonary artery wedge pressure (PAWP) does not reflect left atrial (LA) pressure after cardiac surgery.<sup>1</sup> Our study was designed to measure the differences between the PAWP and LAP after cardiac surgery and to identify factors associated with discrepancies.

**Methods.** This study was institutionally approved and subjects gave informed consent. Seventeen patients were studied in the O.R. and postop (Group I). The PA lumen of the PA catheter, and the LA catheter were connected alternately via a manifold to a single calibrated transducer (Bentley 800) zeroed at the mid-axillary line (MAL). An amplifier with a digital display (E for M) was used. Arterial pressure, ECG, PA or LA pressure and airway pressure were also recorded on a four-channel recorder. The average of 3 pressures measured at end-expiration were used for each data point. PAWP and LAP were measured in the O.R. prior to bypass, after bypass, after sternal closure, and in the ICU 1, 4, and 8 h postop. At 1 and 4 h while the catheter was wedged, a supine lateral chest x-ray (with a marker on the MAL), and a wedged PA blood gas were obtained. Anesthesia was induced and maintained with fentanyl supplemented with a muscle relaxant and enflurane or halothane. Measurements were made during controlled ventilation ( $V_t$  8-12 ml/kg, rate 8-10/min). Postop, 5-8 cm H<sub>2</sub>O PEEP was used. Bypass was conducted utilizing membrane oxygenators and crystalloid prime. Eight other patients who returned from the O.R. with PA and LA lines had PAWP and LAP and other data similarly recorded only at 1, 4 and 8 hours postop (Group II).

**Results:** Of the 25 Group I and II patients, 7 underwent valve surgery, and 18 underwent CABG alone. Eighteen had moderate or severe LV dysfunction and 3 had pulmonary hypertension. Bypass averaged  $92 \pm 20$  min (mean  $\pm$  1 SD), and average hematocrit at end of bypass was  $24 \pm 3$ . Most were on nitroprusside postop and 2 received inotropic drugs. Results in Group I patients are summarized in Table 1. Sixty-nine pairs of PAWP and LAP determinations were made in Group I and II patients postop. PAWP averaged  $1 \pm 1$  mmHg above LAP (range -1 to 5); PAWP was within 1 mmHg of LAP 55 times, 2 mmHg above 8 times, 3 mmHg above 5 times and 5 mmHg above LAP once. The correlation between PAWP and LAP at 4 h postop is shown in Figure 1. No difference in correlation was noted in patients with LAP > 10 or in those with PAWP  $\geq$  25 mmHg.

The O<sub>2</sub> saturation from the wedged catheters was 99-100% 17 times; 85-98% 11 times and < 85% 19 times. The average difference between PAWP and LAP was similar in these three groups (1.5, 1, and 1 mmHg respectively).

Lateral chest x-rays (Group I) showed the transducer zeroing point (MAL) to be within 2 cm of the anterior border of the LA (estimated as the position of PA catheter at the SVC-RA junction) in

15/16 patients, and averaged  $0.4 \pm 1.5$  cm below this border in the group. The tip of the wedged catheter was at or below the anterior border of the LA and in Zone III in all cases.

**Discussion.** We found a close correlation and a low incidence of discrepancy between PAWP and LAP. Correlation remained excellent in the early postop period. All catheters wedged at or below mid-atrial level and were in Zone III. The MAL was a good estimate of mid-atrial level. Wedge blood gases were not helpful in predicting correspondence of PAWP to LAP. Our data show that PAWP reflects LAP even after cardiac surgery and cardiopulmonary bypass.

#### References:

Mammana RB, Hiro S, Levitsky S, Thomas PA, Plachetka J: Inaccuracy of pulmonary capillary wedge pressure when compared to left atrial pressure in the early postsurgical period. J Thorac Cardiovasc Surg 84:420-425, 1982.

TABLE I.	PRE-BYPASS	POST-BYPASS	POSTOPERATIVELY		
			1 HOUR	4 HOURS	8 HOURS
MAP	79 $\pm$ 8*	76 $\pm$ 8	83 $\pm$ 14	77 $\pm$ 7	78 $\pm$ 9
CI	2.4 $\pm$ 0.6	3.2 $\pm$ 0.7	2.8 $\pm$ 0.9	3.5 $\pm$ 1.0	3.3 $\pm$ 1.1
CVP	10 $\pm$ 4	11 $\pm$ 3	10 $\pm$ 3	12 $\pm$ 4	12 $\pm$ 4
PA MEAN	21 $\pm$ 6	22 $\pm$ 5	20 $\pm$ 8	24 $\pm$ 6	24 $\pm$ 6
PAWP	14 $\pm$ 6	14 $\pm$ 4	12 $\pm$ 5	14 $\pm$ 5	14 $\pm$ 6
LAP	13 $\pm$ 6	13 $\pm$ 4	11 $\pm$ 5	13 $\pm$ 5	14 $\pm$ 6
PAWP-LAP (RANGE)	1 $\pm$ 1 (-3 to 2)	0 $\pm$ 1 (0 to 1)	1 $\pm$ 1 (-1 to 3)	1 $\pm$ 1 (-1 to 3)	1 $\pm$ 1 (0 to 2)
r (PAWP vs LAP)	0.99 (.97-1.0)	0.99 (.97-1.0)	0.95 (.83-.97)	0.98 (.86-.98)	0.99 (.96-1.0)

\*mean  $\pm$  1 SD  $\pm$  95% confidence interval

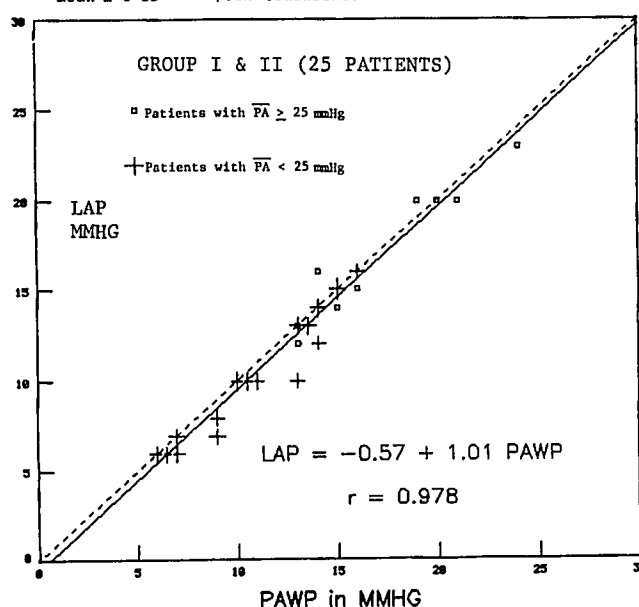


Figure 1. PAWP vs LAP, 4 HOURS POSTOPERATIVELY