

**Title:** ANESTHESIA RESIDENCY AFFECTS HEMODYNAMIC MONITORING IN CARDIAC SURGICAL PATIENTS

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**Introduction.** During adult open heart surgery more complete hemodynamic information is obtained through cardiac output measurements and derivation of indices. However, utilization of pulmonary artery catheters (PAC) for such measurements is not used equally in cardiac surgical programs. This study reports whether the presence of anesthesia residency training has an impact on the use of PAC for hemodynamic monitoring.

**Methods.** A questionnaire was mailed to 865 "cardiac" anesthesiologists in 560 U.S.A. cardiac surgical programs. The questionnaire was designed to evaluate the extent, methods, equipment and cost of adult cardiac intraoperative monitoring. A specific section evaluated the effect of anesthesia residency training on the extent of hemodynamic monitoring. Individual responses were compiled and then compared using the method of Chi square analysis.

**Results.** 560 anesthesiologists replied, representing 357 hospitals where an estimated 138,000 adult open heart procedures were performed in 1981. Of these, 204 physicians (36%) represented 125 hospitals (35%) supporting anesthesia residency training, and performing an estimated 53,000 cardiac cases per year. Insertion of PAC was considered indicative of the extent of hemodynamic monitoring. The effect of anesthesia residency training on the percentage of patients having PAC, the time of PAC insertion, the capability of PAC to measure cardiac output (CO), the frequency of CO measurements, and calculation of hemodynamic indices are illustrated.

TABLE I. PATIENTS WITH PAC (Percent)

	0-25%	25-100%
Residency	26	74
No Residency	48	52
	p<0.0001	

TABLE II. USE OF CARDIAC OUTPUT PAC(Percent)

	0-50%	50-99%	100%
Residency	7	13	81
No Residency	20	17	64
	p<0.0001		

TABLE III. TIME OF PAC INSERTION (Percent)

	Prior to OR	Pre-Anesth	Post-Anesth
Residency	12	69	18
No Residency	23	53	25
	p<0.0005		

TABLE IV. FREQUENCY OF MEASURING CARDIAC OUTPUT (Percent)

	Residency	No Residency	p
Pre-induction	70	30	=.000
Pre-incision	79	49	<.000
Pre-CPB	78	51	<.000
Post-CPB	87	70	<.000
Sternal Closure	70	50	<.000
ICU	74	74	.87

TABLE V. DERIVATION OF VARIABLES FROM CARDIAC OUTPUT (Percent)

	Yes	No
Residency	70	30
No Residency	53	47
	p=0.0001	

Statistical analysis was used between Residency and Non-Residency for each subgroup. The complication of PAC insertion significantly associated with anesthesia residency training was carotid artery puncture (14% vs 2%, p<.0001). When comparing 1) average time from skin incision to cardiopulmonary bypass, 2) average time from skin incision to closure for single valve replacement, and 3) for triple bypass graft procedures, the intervals were significantly longer where anesthesia residency programs exist (p<0.0001, <0.0001, and =0.002 respectively).

**Discussion.** Hemodynamic monitoring is more extensive for adult cardiac surgical patients in hospitals with anesthesia residency programs. This is confirmed by the significant increase in PAC insertion, PAC with CO capability, frequency of measurements, and calculation of hemodynamic indices. Although no data was collected to indicate the reason(s) for this significant relationship, several factors may be postulated. Residency training is a time for teaching invasive monitoring techniques. However, 54% of respondents stated residency per se was not an indication for PAC insertion. The intellectual stimulation of residency encourages more data collection. It is also possible that larger numbers of complicated procedures are referred to training centers, thus indicating more extensive hemodynamic monitoring. In addition more elaborate monitoring may have been indicated for the significantly longer intraoperative time intervals found in cardiac surgical programs with anesthesia residency training.