

## Surveys

# The pulmonary artery catheter in Australasia: a survey investigating intensive care physicians' knowledge and perception of future trends in use

I. G. JOHNSTON\*, J. F. FRASER†, S. SABAPATHY‡, P. S. KRUGER§

*Intensive Care Units, Gold Coast Hospital, Gold Coast and Prince Charles Hospital, Brisbane, Queensland, Australia*

### SUMMARY

*A survey was conducted to assess the knowledge and trends of use of the pulmonary artery catheter amongst intensive care practitioners in Australasia.*

*A 31-item multiple choice questionnaire, identical to one previously trialled in studies in the United States and Europe, was distributed to all registered intensive care specialists and trainees working in intensive care units in Australasia.*

*Five-hundred-and-forty-one questionnaires were distributed and 151 (27.9%) were returned, with an average mark of 82.7%±9.3% and a range of 53.3 to 100%. Total score was significantly associated with years of experience in intensive care ( $P < 0.04$ ), number of pulmonary artery catheters inserted ( $P < 0.015$ ) and whether or not the respondent had passed the Joint Faculty of Intensive Care Medicine examination ( $P < 0.01$ ). Scores were significantly higher amongst trainees ( $P < 0.0001$ ) and physicians who had passed the Joint Faculty of Intensive Care Medicine examination ( $P < 0.0001$ ). Overall, 44.9% of respondents indicated their use of the pulmonary artery catheter was decreasing, with 42.6% indicating their use was the same over the past five years. Sixty-one percent of respondents indicated they either agreed or strongly agreed with the statement that the use of echocardiography should supersede the use of the pulmonary artery catheter by intensive care specialists in the future.*

*We concluded that in this study, knowledge of the pulmonary artery catheter and its use is better in Australasia than in previous studies in North America and Europe. The majority of respondents in Australasia believe that echocardiography will supersede the use of the pulmonary artery catheter in the future.*

**Key Words:** pulmonary artery catheter, haemodynamic monitoring

Since the introduction of the pulmonary artery catheter (PAC) in 1970 by Swan et al<sup>1</sup>, the critical care community has embraced this device and the data which it can provide. Studies, initially retrospective and subsequently prospective randomised control trials, have failed to show that this device confers any advantage on the patients on whom it is used<sup>2-7</sup>; indeed a number of subsets, such

as acute coronary syndrome, tend to do worse with the addition of the pulmonary artery catheter<sup>2,6,8,9</sup>. The conundrum of how a device that provides so much data cannot improve outcome continues to provoke discussion, studies and consensus statements and calls for moratoria<sup>7,10-13</sup>. However, the PAC is never used in isolation—the information it provides merely guides diagnosis and therapy. The information it provides may be misinterpreted and the therapy that is chosen in response to the data may be deleterious. A proportion of studies involving PAC usage are linked to “goal directed therapies”, many of which have different end-points. Thus the benefit/harm which results from either the treatment effect or the catheter effect is difficult to extricate.

The use of the data obtained and derived from a PAC, however, is much more easily assessed in

\*M.B., Ch.B., F.R.C.A., F.A.N.Z.C.A., F.J.F.I.C.M., P.G.Dip.Echo., Intensive Care Specialist, Intensive Care Department, John Flynn Hospital, Tugun.

†M.B., B.S., M.R.C.P., F.J.F.I.C.M., Intensive Care Specialist, Department of Intensive Care, Prince Charles Hospital.

‡Ph.D., Lecturer, School of Physiotherapy and Exercise Science Gold Coast Campus, Griffith University.

§F.A.N.Z.C.A., F.J.F.I.C.M., Intensive Care Specialist, Department of Intensive Care, Princess Alexandra Hospital.

Address for reprints: Dr I. G. Johnston, 15 Hilleot Street Currumbin Waters, Qld. 4223.

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isolation. Medical and nursing PAC users have been focus of a number of studies in the United States and Europe<sup>15-18</sup>. These studies examined aspects of users' safety, knowledge and data interpretation in a multiple choice questionnaire format.

The intensive care postgraduate training system varies dramatically between Australasia and the U.S.A. and Europe. One body is responsible for the training and examination of all intensivists within Australia and New Zealand. Thus, extrapolation of results from the previous trials may be difficult to carry into Australasian practice. Also, following the studies conducted by Iberti and others, the consensus statement recommended that an educational program including development of standardised educational information was "urgently needed and gave this recommendation its highest priority"<sup>11</sup>. Despite this reasonable and evidence-based guideline, more recent trials indicate that use and interpretation of data derived from the PAC have not improved and may have deteriorated<sup>17,18</sup>. Knowledge relating to the PAC has never been investigated amongst intensive care practitioners in Australasia. Only one study in Australasia has looked at intensive care nurses' knowledge of the PAC<sup>19</sup>.

## MATERIALS AND METHOD

An identical questionnaire to that used to assess physicians' knowledge of the PAC in North America was used. Permission to use the questionnaire was obtained from one of the original developers and authors of the questionnaire. In addition to the original questionnaire, seven additional questions were set, some requesting demographic data and others regarding past, present and future intent of PAC use. The questionnaire was distributed by email as an attached Microsoft Word document and by post. Both versions were identical in content. The largest email database of intensive care specialists and trainees was used for email distribution. The email version of the questionnaire was sent to all persons on the database together with an introductory letter. The postal version was distributed four weeks after the email version, using the Joint Faculty of Intensive Care Medicine database of addresses for intensive care specialists and trainees. Following a pre-determined period of twelve weeks, the study was terminated. All questionnaires received after this time were excluded from final analysis.

Participation in the study was entirely voluntary.

The postal questionnaires were returned anonymously. Some of the email questionnaires were returned with the sender's email address. The questionnaire was downloaded and the email deleted to maintain anonymity.

The questionnaires were marked manually, the authors agreeing with the original answers from previous studies, excepting question 10 which was analysed and discussed separately.

## STATISTICAL ANALYSIS

The raw test scores were converted to percentages and mean test scores ( $\pm$  standard deviation) were calculated. The differences in mean scores within each demographic group were compared using univariate analysis of variance. Within group, trends were assessed with Spearman's rank correlation coefficient ( $\rho$ ). The data were also subjected to multifactorial analysis of variance using linear least-squares fitting procedures to assess for significant interactions or associations between the groups. A value of  $P < 0.05$  was considered significant. The Statistical Package for the Social Sciences (SPSS) software was used for all data analysis.

## RESULTS

In all, 541 questionnaires were distributed and 151 of these were returned, yielding a response rate of 27.9%. The average overall mark was 24.8 (82.7%  $\pm$  9.3%) with a range of 16 to 30, out of a possible total of 30.

TABLE 1  
*Intensive care experience against total questionnaire score*

ICU experience (y)	Number (%)	Mean score out of 30 (SD)	% Score (SD)
0-2	26 (17.2)	23.9 ( $\pm$ 2.7)	79.7 ( $\pm$ 9)
3-5	30 (19.8)	24.5 ( $\pm$ 3.1)	81.7 ( $\pm$ 10.4)
6-10	30 (19.8)	25.5 ( $\pm$ 2.0)	85.0* ( $\pm$ 6.6)
11-20	41 (27.1)	25.3 ( $\pm$ 3.1)	84.3** ( $\pm$ 10.5)
20+	24 (15.8)	24.4 ( $\pm$ 2.4)	81.5 ( $\pm$ 8.0)

\*  $P=0.02$ , \*\*  $P=0.03$ .

## DISCUSSION

The questionnaire used had previously been validated as a tool for assessing PAC knowledge and use<sup>16</sup>. The overall scores, the in-training scores and

TABLE 2  
Completion of intensive care examinations against total questionnaire score

Completion of FFICANZCA/FJFICM examination	Number (%)	Score (SD)	%Score (SD)
No	54 (35.8)	24.1 ( $\pm 2.6$ )	80.3 ( $\pm 8.8$ )
Yes	97 (64.2)	25.2 ( $\pm 2.8$ )	84.0* ( $\pm 9.4$ )

\*  $P < 0.01$ .

TABLE 3  
Number of PACs inserted against total questionnaire score

Total number of PACs inserted	Number (%)	Score (SD)	% Score (SD)
0-5	16 (10.6)	23.2 (3.0)	77.4 ( $\pm 10.0$ )
6-20	18 (11.9)	24.8 (2.0)	82.6 ( $\pm 6.5$ )
21-50	28 (18.5)	24.5 (3.1)	81.8 ( $\pm 10.2$ )
51-100	31 (20.5)	25.1 (2.9)	83.7* ( $\pm 9.7$ )
100+	58 (38.4)	25.2 (2.6)	84.1** ( $\pm 8.7$ )

\*  $P = 0.012$ , \*\*  $P = 0.002$ .

TABLE 4  
Trends of PAC use over the last five years

Frequency of PAC use over the past five years	Number	%
Increasing	19	12.6
Staying the same	65	43.0
Decreasing	67	44.4

TABLE 5  
Responses to the question "For the future do you think the use of echocardiography by intensive care specialists should supersede the use of PACs?"

	Number	%
Disagree strongly	9	6.0
Disagree	49	32.5
Agree	71	47.0
Agree strongly	22	14.6

TABLE 6  
Respondents' answers to question 10 (Figure 1)

Answer	Number	%
10 mmHg	34	22.5
20 mmHg	114	75.5
30 mmHg	2	1.3
40 mmHg	1	0.7
50 mmHg	0	0

TABLE 7  
Comparison of results with previous questionnaires, North America (16) and European (18)

	In training	Completed training	Overall
North American (n=496)	64.4	73.7	66.7
European (n=451)	67.3	76.1	72.2
Australasian (n=151)	80.3 *	83.9**	82.7***

Scores expressed as percentages.

\* $P < 0.0001$ , \*\* $P < 0.0001$ , \*\*\* $P < 0.0001$ .

the completed training scores were all significantly higher in this study than in the North American and European studies (Table 7).

All participants in this study were either registered as a trainee or were Fellows of the Joint Faculty of Intensive Care Medicine. The Faculty presides over the training and formal examination process. This training process has been established for over 30 years and completion of this program is a mandatory requirement for admission to the Faculty. Over 80% of specialists working in intensive care units (ICU) in Australasia are Fellows of the Joint Faculty and this number is increasing. Postgraduate training and examinations, in intensive care specifically, have a much lower prevalence in North America and Europe.

The method of administration of this study did differ from the method used in the two previous studies. In both the North American study and the European study, the questionnaire was 'imposed' upon the participants unannounced after consent had been obtained from the ICU director. In practice this occurred at department meetings. Limited details of 'examination' conditions i.e. quarantine/collaboration were clarified in either study and no time limit was set for completion.

In this study, participation was individually voluntary and no time limit was set. Quarantine, collaboration with colleagues and reference to text books could not be monitored. The answers themselves were not easily available and were obtained by the authors directly from the original authors. Theoretically, however, some participants given time and application could access materials to increase their mark and introduce bias toward a higher mark.

In this study, all intensive care trainees and Fellows were contacted to participate. This would theoretically give a more realistic reflection of

knowledge at a provider level in the average unit in Australasia. Of course a higher level of participation would sharpen this reflection of the real state of knowledge. And it could be argued that those confident in their knowledge would be more likely to respond, thus elevating the scores. However, the North American study recruited from 13 ICUs that had originally developed the questionnaire and the European study only from ICUs eligible for training.

There was a significant correlation between greater level of experience and higher score ( $P < 0.04$ ). This is similar to the findings in the North American trial. Similarly, those respondents who had inserted or supervised insertion of more PACs scored a significantly higher mark ( $P < 0.02$ ). This was also a significant correlation in the previous two trials.

Following publication of the answers to the questionnaire, some debate centred on the actual correct answer to the question regarding the wedge pressure for a pulmonary artery tracing (Figure 1).

From the debate there appeared to be no clear consensus of opinion as to the correct answer. Both the previous questionnaires in North America and Europe considered 20 mmHg to be correct. The authors of this paper however consider 10 mmHg to be "probably" nearest the correct response. This concurs with Marik et al<sup>20</sup> that following pulmonary artery occlusion by the balloon, time is required for equilibration of pressure within the pulmonary circulation. Marik suggests three respiratory cycles could be necessary for this. Thus we suggest that the trend in this trace is for the actual pulmonary artery occlusion pressure (PAOP) to likely be nearer 10 mmHg. The actual responses by the respondents are given in Table 7. Therefore to maintain comparability with the previous two

studies, this question was excluded from analysis. If the answer of 20 mmHg were to be accepted as the correct response as in the previous studies, the average mark would have been 82.3% vs. 82.7% correct. What this controversy underlines is the confusion surrounding the actual meaning and interpretation of the PAOP. When does the PAOP reflect the true state of pressure in the left atrium after occlusion? What is the rate of reactivity and compliance of the pulmonary vascular bed and is it uniform in a population?

And equally importantly if intensivists did reach a consensus of opinion, could the operators at the coalface consistently and accurately read the real PAOP in different patients' settings, e.g. the ventilated and non-ventilated state? All three studies suggest not.

If we do find a raised PAOP for example, what does this mean for our patients? It could mean any of a number of pathologies, e.g. mitral valve disease, global myocardial dysfunction, regional wall motion abnormalities, fluid overload, pericardial tamponade, etc. Theoretically one could estimate the theoretical equalisation of pressures in the tamponade situation, or look for regurgitant waves on the PAOP trace in severe mitral regurgitation. But in tamponade where is the collection? Is it localised or global? Is the mitral regurgitation eccentric? Is it due to a prolapsed valve, a vegetation or myocardial ischaemia?

All these questions and answers to them may be more accurately diagnosed using direct visualisation of structures and how they are performing using echocardiography. Colreavy et al<sup>21</sup> reached a specific diagnosis in 67% of echo studies. There is some growing evidence that the specific state of myocardial performance<sup>22,27</sup> and preload<sup>23</sup> can be reliably estimated using echocardiography in a critical care setting to specifically diagnose the

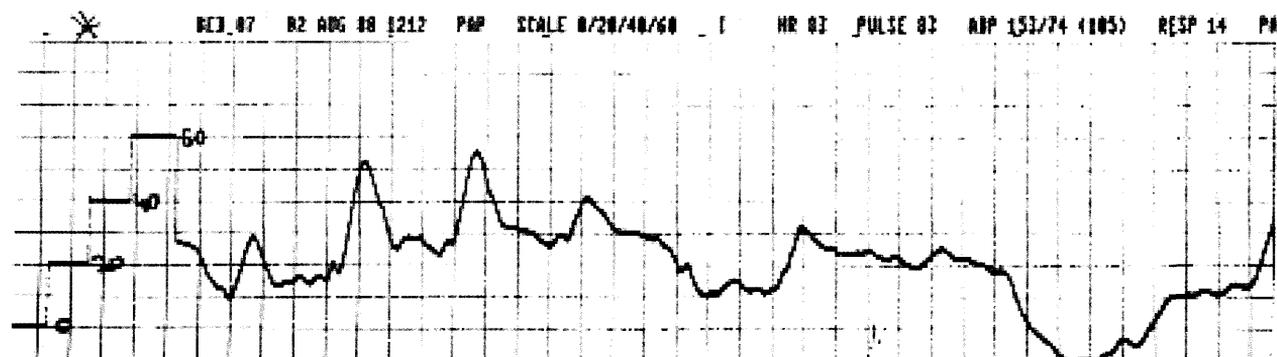


FIGURE 1: Pulmonary artery tracing used in question 10 of the questionnaire. "What is the pulmonary artery wedge pressure from this pulmonary artery trace in this spontaneously breathing patient?"

'choke' point in the circulation. This appears to be the intention of the majority of intensive care practitioners in Australasia, with 61.8% agreeing with the statement that "echocardiography by intensive care specialists should supersede the use of the pulmonary artery catheter". Interestingly, Bossone et al<sup>24</sup> found 11% of patients studied had unsuspected critical cardiac abnormalities on echocardiography such as vegetations, aortic dissection or severe valve disease. Such lesions are difficult or impossible to detect with a PAC.

Other proposed methods to assess and diagnose circulatory inadequacy suffer from complications of non-specificity; yes there is something wrong with the heart but what specifically: e.g. peripherally inserted continuous cardiac output monitors or Rivers<sup>25</sup> centrally placed SVO<sub>2</sub> monitors?

In North America, cardiac and vascular anaesthetists most frequently preferred the PAC to transoesophageal echocardiography, however only 11% had had any formal training<sup>26</sup>.

The trend over the last five years for participants in this trial was a reduction in the number of PACs inserted, 44.9% reporting a lower rate of use, 12.5% increasing, with 42.6% indicating their insertion rate had remained the same. This appears to be in line with worldwide data of a 9% decline in PAC use in Japan, the U.S.A. and Europe over the last 10 years. This trend would be appear to be likely to continue in Australasia with increasing emergence of ultrasound to provide specific and perhaps safer<sup>28</sup> diagnosis in critical and often complex cardiovascular states.

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