The aims of this study were to look for the variability in the treatment of circulatory shock and to assess the extent to which this variability was reduced by pulmonary artery catheterization (PAC). At three international conferences in 1997–1998 (European Society of Critical Care Medicine, French Language Society for Critical Care [Société de Réanimation de Langue Française], and Society of Critical Care Medicine), a real-life clinical case was discussed in meetings among physicians and a panel of experts, with assistance from an expert computer program. A total of 417 physicians took part in the discussions. Following the clinical presentation, only 38% of physicians suggested the same treatment as the experts, and 35% suggested potentially harmful treatments. Complete hemodynamic data from PAC significantly decreased the range of suggested treatments, improved agreement among physicians themselves as well as the agreement between physicians and experts, and decreased the number of potentially harmful propositions. However, whereas almost 80% of participants finally agreed on the treatment after one to three invasive hemodynamic sets of measurements, at least 10% persisted in suggesting potentially harmful treatments. PAC improved interphysician agreement, but our data suggest that yet greater agreement could be achieved by improving the theoretical training of practitioners.

Key words: hemodynamics; medical intelligence; right-heart catheterization

Abbreviations: ESICM = European Society of Critical Care Medicine; PAC = pulmonary artery catheterization; PEEP = positive end-expiratory pressure; PWP = pulmonary wedge pressure; SCCM = Society of Critical Care Medicine; SRLF = Société de Réanimation de Langue Française; $\text{SvO}_2$ = mixed venous saturation

Although > 3,000 publications in the medical literature focus on pulmonary artery catheterization (PAC) and > 45 million pulmonary artery catheters have been used since 1970, the method remains a matter of controversy. There is strong evidence that PAC is helpful in the management of circulatory disorders, especially when continuous monitoring is required. However, the lack of controlled studies, due to numerous methodologic difficulties, precludes a confident evaluation of the beneficial impact of PAC on survival. Four studies, all with serious methodologic weaknesses, found that PAC was associated with greater mortality. Because of these uncertainties, and as part of a trend calling for evidence-based medicine and cost control, current practices regarding PAC have been challenged. Controlled studies are required to resolve this issue. Nevertheless, when analyzing the potential adverse effects of PAC, it is necessary to determine what is due to the tool and what is due to misuse of the tool. Ways to improve PAC use have been periodically reviewed. Benefits may be greater when PAC is used by physicians who have the theoretical knowledge needed to interpret PAC data in an optimal manner. PAC may have fewer adverse effects in the hands of clinicians who follow guidelines and are proficient in interpreting PAC data.

There are many reasons to believe that the reproducibility of diagnoses based on hemodynamic data are poor even among experienced intensivists.
It follows that physicians may differ regarding the management they feel is optimal in a given patient with or without PAC. We designed a study to look for variability in opinions about the best treatment in a real-life case and to assess the extent to which this variability was reduced by PAC.

**Materials and Methods**

On three different occasions, we asked physicians attending a conference and experts to discuss a real-life clinical case, and also noted diagnoses and treatment objectives suggested by an expert computer program (Hemodyln; P. Squara; Enghien, France) during the meetings.22,23 The meetings took place as part of the official program of three international conferences held in 1997–1998: the 10th meeting of the European Society of Critical Care Medicine (ESICM; Paris, France; September 6, 1997), the 26th meeting of the French Language Society for Critical Care (Socie´te´ de Re´animation de Langue´ Francais´e [SRLF]; Paris, France; January 26, 1998), and the 27th meeting of the Society of Critical Care Medicine (SCCM; San Antonio, TX; February 6, 1998). Physicians attending these conferences were invited to register for the meetings, and during the meetings an interactive voting system was used to capture all participant answers in a computer.

After a 10-min introduction, including a brief presentation of the experts (listed in the Appendix) and of the expert Hemodyln software, participants were familiarized with the interactive voting system using three questions with a limited list of responses displayed on a screen: (1) is your homeland (one answer allowed), (2) what is your main medical specialty (one answer allowed), and (3) what is/are, in your opinion, the most important PAC parameter(s) [one or more answers allowed]? The results of the voting were displayed immediately. A real-life case was then presented. This case was the same at the three meetings and was retrospectively considered of low complexity by the experts. It was a typical history of acute hypertensive pulmonary edema in a patient with normovolemic hypertensive cardiomyopathy in whom excessively aggressive emergency treatment induced critical hypovolemia and venous vasodilatation.

The case presentation was displayed on a screen using a video projector, and the computer captured all radio signal-transmitted answers. Participants were asked to vote after the presentation of clinical data (Table 1), and after the subsequent presentation of PAC data recorded 2 h, 14 h, and 27 h after hospital admission of the patient (PAC time points 1, 2, and 3, respectively; Table 2). Thus, votes were recorded on four occasions. On each of these occasions, participants were asked to choose one or more treatments among nine possibilities. The treatment actually administered and the clinical course between the two PAC time points were described (Table 3); based on this information, the participants were asked to suggest treatment changes. After each vote, the opinions of experts were displayed. The objectives and diagnoses generated by Hemodyln program were then displayed and freely discussed by the experts and participants. Finally, the experts were asked to classify the treatments suggested by the participants as “acceptable” or “potentially harmful.”

**Data Analysis**

Although the κ concordance test allows standardization of agreement between two judges, no statistical tool is available for standardizing agreement between two groups of judges. Consequently, we expressed between-group agreement as the ratio of the number of concordant votes over the total number of votes. The variability in suggested treatments was expressed as the proportion of participants who selected each answer. Categories (participants, characteristics, and suggested treatments) were compared using the χ² test. We used Bonferroni’s correction to compensate multiple comparisons.

**Results**

A total of 560 physicians attended the meetings: 248 physicians at the ESICM meeting, 62 physicians at the SRLF meeting, and 250 physicians at the SCCM meeting. The small number of physicians at the SRLF meeting was due to a technical problem that delayed the meeting by 1 h. Of these 560 physicians, 417 physicians participated in the voting: 167 physicians at the ESICM meeting, 58 physicians at the SRLF meeting, and 192 physicians at the SCCM meeting. These 417 participants were from 29 countries, most of which were in Western Europe (n = 199), North America (n = 132), Eastern Europe (n = 20), Northern Europe (n = 18), Japan (n = 17), and South America (n = 14). Their areas of interest were distributed as follows: critical care (n = 220), anesthesiology (n = 91), pulmonology (n = 38), cardiology (n = 27), emergency medicine (n = 21), pediatrics (n = 7), and others (n = 13).

Cardiac output was believed by the vast majority

---

**Table 1—Summary of the Clinical Presentation**

<table>
<thead>
<tr>
<th>Medical history</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of 70 yr</td>
</tr>
<tr>
<td>Chronic arterial hypertension with hypertensive cardiomyopathy</td>
</tr>
<tr>
<td>Several episodes of acute pulmonary edema</td>
</tr>
<tr>
<td>Sudden major nocturnal dyspnea</td>
</tr>
<tr>
<td>First medical examination (at home)</td>
</tr>
<tr>
<td>Acute pulmonary edema; SpO₂ of 75%</td>
</tr>
<tr>
<td>No peripheral edema; no fever</td>
</tr>
<tr>
<td>BP, 190/120 mm Hg</td>
</tr>
<tr>
<td>Initial treatment (at home)</td>
</tr>
<tr>
<td>Sedation, intubation, and mechanical ventilation</td>
</tr>
<tr>
<td>IV bolus of 40 mg furosemide</td>
</tr>
<tr>
<td>IV bolus of 1 mg nitrate followed by a continuous IV infusion of 1 mg/h</td>
</tr>
<tr>
<td>10 μg/kg/min of dobutamine</td>
</tr>
<tr>
<td>Admission to the emergency department</td>
</tr>
<tr>
<td>Clinical signs of shock; oliguria</td>
</tr>
<tr>
<td>BP, 90/60 mm Hg; heart rate, 120 beats/min; nitrate infusion stopped</td>
</tr>
<tr>
<td>Chest radiograph showing bilateral infiltrates</td>
</tr>
<tr>
<td>PaO₂, 53 mm Hg; SaO₂, 96% with FiO₂ of 1; lactate, 3.4 mEq/L</td>
</tr>
<tr>
<td>Electrocardiography showing sinus tachycardia; otherwise normal</td>
</tr>
<tr>
<td>Echocardiography showing LV hypertension and hypertrophy; no dilatation; RV normal</td>
</tr>
</tbody>
</table>

SpO₂ = pulse oximetric saturation; SaO₂ = arterial oxygen saturation; FiO₂ = fraction of inspired oxygen; LV = left ventricular; RV = rightventricle.
†The three PAC time points were at 2 h, 14 h, and 27 h, respectively.

Table 2—Summary of the Hemodynamic Data 2 h After Hospital Admission

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemodynamics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAP, mm Hg</td>
<td>4</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>PWP, mm Hg</td>
<td>4</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>PAPm, mm Hg</td>
<td>12</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>Pam, mm Hg</td>
<td>70</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>HR, beats/min</td>
<td>123</td>
<td>110</td>
<td>99</td>
</tr>
<tr>
<td>CI, L/min/m²</td>
<td>2.04</td>
<td>2.19</td>
<td>2.40</td>
</tr>
<tr>
<td>Blood gas analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fio₂, %</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Hb, g/dL</td>
<td>14.2</td>
<td>13</td>
<td>12.8</td>
</tr>
<tr>
<td>PaO₂, mm Hg</td>
<td>111</td>
<td>157</td>
<td>145</td>
</tr>
<tr>
<td>Sat₂, %</td>
<td>0.99</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PVO₂, mm Hg</td>
<td>27</td>
<td>38</td>
<td>45</td>
</tr>
<tr>
<td>SvO₂, %</td>
<td>0.51</td>
<td>0.58</td>
<td>0.69</td>
</tr>
<tr>
<td>C(a-v)O₂, %</td>
<td>9.4</td>
<td>7.7</td>
<td>5.6</td>
</tr>
<tr>
<td>VO₂, mL/min/m²</td>
<td>191</td>
<td>165</td>
<td>135</td>
</tr>
<tr>
<td>pH</td>
<td>7.31</td>
<td>7.38</td>
<td>7.41</td>
</tr>
<tr>
<td>PaCO₂, mm Hg</td>
<td>41</td>
<td>38</td>
<td>36</td>
</tr>
<tr>
<td>HCO₃⁻, mmol/L</td>
<td>21</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Lactate, mmol/L</td>
<td>4.1</td>
<td>1.9</td>
<td>0.7</td>
</tr>
</tbody>
</table>

*RAP = right arterial pressure; PAPm = mean pulmonary artery pressure; Pam = mean arterial pressure; HR = heart rate; CI = cardiac index; Hb = hemoglobin; PVO₂ = mixed venous oxygen tension; C(a-v)O₂ = arteriovenous oxygen content difference; VO₂ = oxygen uptake. See Table 1 for expansion of other abbreviation.

†The three PAC time points were at 2 h, 14 h, and 27 h, respectively, after hospital admission.

Table 3—Summary of Course and Treatments Administered

<table>
<thead>
<tr>
<th>Treatment after the first PAC time point</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>500 mL of crystalloid</td>
<td></td>
</tr>
<tr>
<td>Decrease in the dobutamine infusion rate</td>
<td></td>
</tr>
<tr>
<td>from 10 to 5 μg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Treatment after the second PAC time point</td>
<td></td>
</tr>
<tr>
<td>Additional 500 mL of crystalloid</td>
<td></td>
</tr>
<tr>
<td>Dobutamine infusion stopped</td>
<td></td>
</tr>
<tr>
<td>Nicardipine infusion started at 1 mg/h</td>
<td></td>
</tr>
<tr>
<td>Treatment after the last PAC time point</td>
<td></td>
</tr>
<tr>
<td>No change; weaning from mechanical ventilation</td>
<td></td>
</tr>
</tbody>
</table>

Table 4—Dispersion of Suggested Treatments Before PAC Insertion

<table>
<thead>
<tr>
<th>Variables</th>
<th>ESICM</th>
<th>SRLF</th>
<th>SCCM</th>
<th>Experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentially harmful suggestions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diuretics</td>
<td>25</td>
<td>17</td>
<td>23</td>
<td>0†</td>
</tr>
<tr>
<td>Dobutamine↑</td>
<td>36</td>
<td>21</td>
<td>29</td>
<td>0†</td>
</tr>
<tr>
<td>Vasodilators</td>
<td>17</td>
<td>17</td>
<td>18</td>
<td>0†</td>
</tr>
<tr>
<td>PEEP</td>
<td>40</td>
<td>34</td>
<td>31</td>
<td>10†</td>
</tr>
<tr>
<td>Acceptable suggestions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do not know</td>
<td>27</td>
<td>29</td>
<td>23</td>
<td>0†</td>
</tr>
<tr>
<td>Vasopressors</td>
<td>25</td>
<td>36</td>
<td>23</td>
<td>5†</td>
</tr>
<tr>
<td>Dobutamine↓</td>
<td>13</td>
<td>12</td>
<td>21</td>
<td>0†</td>
</tr>
<tr>
<td>Dobutamine↑</td>
<td>16</td>
<td>16</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Filling</td>
<td>36</td>
<td>43</td>
<td>39</td>
<td>100†</td>
</tr>
</tbody>
</table>

*Data are presented as %. ↑ = increase titration; ↓ = decrease titration; ↔ = no change in titration.
†p < 0.05 for intergroup comparisons.

Discussion

We found considerable variability in the initial treatments suggested by physicians for a patient investigated using noninvasive means, including echocardiography. Only 38% of nonexperts suggested fluid administration, which was the treatment recommended by all the experts (100%). Our method did not enable us to identify the participants who suggested each treatment and, therefore, did not provide information on treatment combinations. However, > 35% of participants...
suggested at least one potentially harmful treatment. In particular, 35% of participants suggested positive end-expiratory pressure (PEEP), which was the potentially harmful treatment suggested most often.

Providing PAC data in addition to the clinical presentation and echocardiography findings had the following effects: (1) the range of suggested treatments became narrower, (2) agreement between participants and experts improved, (3) agreement among participants improved, and (4) the proportion of potentially harmful treatments decreased. However, the proportion of participants who suggested at least one potentially harmful treatment remained > 15% after PAC time point 1, > 10% after PAC time point 2, and equal to 10% after PAC time point 3.

Our results are in agreement with previous findings. It has been shown that PAC data are more accurate than clinical assessment in evaluating the hemodynamic status of patients.\cite{24,25,26} that PAC data may be more relevant than clinical investigation,\cite{23,27,28,29,30} and that PAC leads to major changes in therapeutic strategies.\cite{31,32}

Our findings raise several questions. The first issue is the extent to which our participants were representative of the overall population of physicians who use PAC. We had no indication on the credentials of participants and/or on the number of times they used PAC annually. However, all participants identified themselves as practitioners, suggesting that they used PAC in their everyday practice. In addition, we found no differences in suggested treatments according to country of origin and/or area of interest. Last, it is unlikely that physicians who go to international meetings form a subgroup with less expertise than the overall PAC user population. Thus, our cohort of participants is probably more representative of real PAC users than investigators of controlled studies that most often represent a minority of international experts.

A second point worthy of discussion is whether the data provided to the participants were sufficient to enable a full understanding of the case. All relevant data about the medical history, occurrence of the acute episode, and initial clinical examination were carefully explained, as were all findings from an extensive evaluation including lactate, blood gas analysis, and echocardiography. Participants were told at the beginning of the presentation that the presentation described a simple, real-life case, devoid of unusual complexity. We used slides, a method to which international conference participants are accustomed and believed to be receptive.

In addition, the time spent on presenting the case was probably longer than the time usually spent on reviewing PAC data at the bedside.

Third, to provide accurate information on how well physicians use PAC data, our case had to be

\begin{table}[h]
\centering
\caption{Dispersion of Suggested Treatments After PAC Time Point 1*}
\begin{tabular}{lcccc}
\hline
Variables & ESICM & SRLF & SCCM & Experts \\
\hline
Potentially harmful suggestions & & & & \\
Diuretics & 31 & 21 & 24 & 0 \\
Dobutamine ↑ & 10 & 9 & 8 & 0 \\
Vasodilators & 7 & 7 & 8 & 0 \\
PEEP & 17 & 14 & 13 & 0 \\
Acceptable suggestions & & & & \\
Do not know & 2 & 0 & 0 & 0 \\
Vasopressors & 8 & 12 & 7 & 0 \\
Dobutamine ↔ & 6 & 9 & 6 & 0 \\
Dobutamine ↓ & 22 & 22 & 22 & 20 \\
Filling & 56 & 67 & 66 & 100 \\
\hline
\end{tabular}
\end{table}

*Data are presented as %. See Table 4 for definitions.

\begin{table}[h]
\centering
\caption{Dispersion of Suggested Treatments After PAC Time Point 2*}
\begin{tabular}{lcccc}
\hline
Variables & ESICM & SRLF & SCCM & Experts \\
\hline
Potentially harmful suggestions & & & & \\
PEEP & 12 & 9 & 8 & 0 \\
Diuretics & 1 & 0 & 3 & 0 \\
Dobutamine ↑ & 7 & 10 & 13 & 0 \\
Dobutamine ↔ & 15 & 15 & 13 & 0 \\
Vasopressors & 7 & 9 & 5 & 0 \\
Do not know & 7 & 9 & 8 & 0 \\
Acceptable suggestions & & & & \\
Filling & 75 & 78 & 76 & 100 \\
Dobutamine ↓ & 31 & 24 & 24 & 20 \\
Vasodilators & 17 & 17 & 13 & 20 \\
\hline
\end{tabular}
\end{table}

*Data are presented as %. See Table 4 for definitions.

\begin{table}[h]
\centering
\caption{Dispersion of Suggested Treatments After PAC Time Point 3*}
\begin{tabular}{lcccc}
\hline
Variables & ESICM & SRLF & SCCM & Experts \\
\hline
Potentially harmful suggestions & & & & \\
Diuretics & 10 & 14 & 8 & 0 \\
Dobutamine & 3 & 5 & 3 & 0 \\
Vasopressors & 0 & 0 & 0 & 0 \\
Do not know & 2 & 5 & 1 & 0 \\
Acceptable suggestions & & & & \\
Filling & 9 & 9 & 8 & 0 \\
Vasodilators ↑ & 12 & 17 & 18 & 0 \\
Vasopressors ↔ & 69 & 60 & 63 & 90 \\
Vasopressors ↓ & 15 & 17 & 13 & 10 \\
PEEP & 0 & 0 & 0 & 0 \\
\hline
\end{tabular}
\end{table}

*Data are presented as %. See Table 4 for definitions.

\*p < 0.05 for intergroup comparisons.
representative of the cases in which PAC is commonly used. The patient had a circulatory disorder requiring emergency treatment. There was a combination of shock and acute pulmonary edema, a situation that raises therapeutic challenges particularly with regard to whether fluid administration is warranted, and in which the use of PAC is widely accepted. Although, most experts immediately made the correct diagnosis and all suggested fluid administration, 10% also suggested PEEP, which was finally considered potentially harmful.

The echocardiographic data from the patient were described to the participants and experts. Despite the evidence of hypertrophic cardiomyopathy with limited heart filling, it became obvious during the debate that many participants were reluctant to administer fluid to patients with severe acute pulmonary edema without prior PWP measurement and without coupled monitoring of PWP and cardiac output during a filling test. This observation illustrates the importance ascribed by physicians to PWP measurement as a valuable tool for medical decision making, although the limitations of this measurement are well known.

The reasons for the significant level of persisting disagreement between participants and experts regarding the appropriate treatment deserve discussion. It has been shown that many PAC users have insufficient theoretical knowledge of hemodynamics and that data collection is frequently inadequate. However, the disagreement about the simple case presented in our study cannot be explained by mistakes or by a misunderstanding of some formulas such as resistance or work indexes. Rather it suggests poor reasoning. Although representative of PAC users, participants to our study were probably not all experienced intensivists. The answers to the question on which parameter(s) are most important support this hypothesis. The majority of participants selected cardiac output and PWP as the most important hemodynamic variables; few believed that "all variables" were important. Experts usually make a systematic analysis of a specific observed situation, then try to fit this analysis to several theoretical pathophysiologic models. They also test the fit of the case to the model by looking for additional relevant variables. There is strong evidence that expert problem solving in medicine is dependent on prior specific experience and on elaborated conceptual knowledge applicable to the occasional problematic situation. In contrast, "nonexperts" proceed with basic pattern recognition using few variables and limited knowledge, an approach that carries a large risk of error. In addition, when nonexperts correctly identify the appropriate pathophysiologic model, they may encounter difficulties in determining the appropriate hemodynamic objective in a given patient and situation (ie, the cardiac output needed, the oxygen uptake needed, etc.). This problem of interpractitioner variability is not limited to PAC but has been observed with many other diagnostic tools, such as radiography, CT, angiography, and echocardiography.

For these tools, various computerized signal processing techniques have been developed to decrease interobserver variability. Use of a computer program to assist in PAC data interpretation is a similar approach.

Some prospective randomized studies are expected to investigate the impact of PAC on mortality. Variability in PAC use may have a major influence on the results of these studies. In our study, only 80% of PAC-guided strategies provided patients with a chance of improvement, 10% had no effect, and 10% were harmful. A risk ratio of 0.8 for PAC-guided therapeutic strategies compared with non-PAC-guided strategies has been reported. If we hypothesize that treatments with no effects yield a risk ratio of 1 and harmful treatments yield a risk ratio of 1.2, an heterogeneity in the treatments as seen in our study may cause a 30% decrease in the potential beneficial effects of PAC on mortality. In addition, it is reasonable to hypothesize that the side effects of PAC are inversely related to the benefits, ie, that nonexperts obtain fewer benefits and more side effects. This illustrates the importance of defining criteria for optimal PAC use before starting multicenter studies.

Thus, 25 years after the introduction of PAC and despite thousands of scientific publications, our data showed unacceptable variability in treatments and an alarmingly high rate of potentially harmful treatment decisions in participants to three major international meetings in intensive care medicine.

Postgraduate training authorities should take this finding into account. Current and future studies aimed at determining the value of PAC should address the issue of inadequate physician knowledge about PAC data interpretation. A recent report of the National Heart, Lung, and Blood Institute and the US Food and Drug Administration has emphasized the need for collaborative education of physicians and nurses in performing, obtaining, and interpreting information from the use of PAC. The use of a computer program that assists in the interpretation of hemodynamic data has been proposed to improve treatment decisions homogeneity.
ACKNOWLEDGMENT: We thank Dr. Patrick Godard for assistance, Professor Didier Payen for reviewing the article, and all the participants.

APPENDIX

Study Participants

ESCIM Meeting: Professor Antonio Artigas (Spain), Professor David Bennet (United Kingdom), Professor Alfred Connors (United States), Professor Didier Payen (France), Professor Claude Perret (Switzerland), Professor Peter Kadermacher (Germany), Professor Heinz Steltzer (Austria), and Professor Jean Louis Vincent (Belgium).

SRLF Meeting: Professor Jean François Dhainaut (France), Professor David Martin (France), Professor Didier Payen (France), Professor Claude Perret (Switzerland), and Professor Jean Louis Teboul (France).

SCCM Meeting: Professor David Bennet (United Kingdom), Professor Elaine Daily (United States), Professor Loren Nelson (United States), Professor Didier Payen (France), Professor William Peruzzi (United States), Professor William Sibbald (Canada), and Professor Jean Louis Vincent (Belgium).

REFERENCES

22. Sibbald W, Keenan S. Show me the evidence: a critical review of the pulmonary artery catheter. JAMA 1993; 276:918
23. Sibbald W, Keenan S. Show me the evidence: a critical review of the pulmonary artery catheter. JAMA 1993; 276:918
30. Sibbald W, Keenan S. Show me the evidence: a critical review of the pulmonary artery catheter. JAMA 1993; 276:889–918
variability in applying a radiographic definition for ARDS.

Chest 1999; 116:1347–1353

36 Fletcher BD, Glicksman AS, Gieser P. Interobserver variabil-
ity in the detection of cervical-thoracic Hodgkin’s disease by

variability in CT and MR staging of lung cancer. J Comput
Assist Tomogr 1993; 17:841–846

38 DeRouen TA, Murray JA, Owen W. Variability in the analysis

39 Bounameaux H, Prins TR, Schmitt HE, et al. Venography of
the lower limbs: pitfalls of the diagnostic standard; the ETIT

40 Lafitte S, Dos Santos P, Kerouani A, et al. Improved reliabil-
ity for echocardiographic measurement of left ventricular
volume using harmonic power imaging mode combined with
contrast agent. Am J Cardiol 2000; 85:1234–1238

41 National Heart, Lung, and Blood Institute, and Food and
JAMA 2000; 283:2568–2572

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