The Current Practice of Intra-Aortic Balloon Counterpulsation: Results From the Benchmark Registry

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OBJECTIVES
This study presents clinical data from the first large registry of aortic counterpulsation, a computerized database that incorporates prospectively gathered data on indications for intra-aortic balloon counterpulsation (IABP) use, patient demographics, concomitant medication and in-hospital outcomes and complications.

BACKGROUND
The intra-aortic balloon pump (IABP) is widely used to provide circulatory support for patients experiencing hemodynamic instability due to myocardial infarction, cardiogenic shock, or in very high risk patients undergoing angioplasty or coronary artery bypass grafting. Between June 1996 and August 2000, 203 hospitals worldwide (90% U.S., 10% non-U.S.) collected 16,909 patient case records (68.8% men, 31.2% women; mean age 65.9 ± 11.7 years).

RESULTS
The most frequent indications for use of IABP were as follows: to provide hemodynamic support during or after cardiac catheterization (20.6%), cardiogenic shock (18.8%), weaning from cardiopulmonary bypass (16.1%), preoperative use in high risk patients (13.0%) and refractory unstable angina (12.3%). Major IABP complications (major limb ischemia, severe bleeding, balloon leak, death directly due to IABP insertion or failure) occurred in 2.6% of cases; in-hospital mortality was 21.2% (11.6% with the balloon in place). Female gender, high age and peripheral vascular disease were independent predictors of a serious complication.

CONCLUSIONS
This registry provides a useful tool for monitoring the evolving practice of IABP. In the modern-day practice of IABP, complication rates are generally low, although in-hospital mortality remains high. There is an increased risk of major complications in women, older patients and patients with peripheral vascular disease. (J Am Coll Cardiol 2001;38:1456–62)

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The intra-aortic balloon pump (IABP) is the most widely used of all circulatory assist devices today (1). The IABP was first employed 30 years ago as a treatment of last resort for a mortally ill patient suffering from cardiogenic shock (2,3). Today, this treatment modality is routinely used in a wide range of serious cardiovascular conditions, ranging from hemodynamic stabilization in patients suffering from complications of acute myocardial infarction (AMI) or cardiogenic shock, to very high risk patients undergoing angioplasty or coronary artery bypass grafting (CABG) (4–6).

As potential clinical applications of counterpulsation continue to expand, there is an increasing need to prospectively document the current clinical experience with IABP. No study has extensively documented the indications, clinical outcomes, patient hemodynamics, concomitant medications, complications, risk factors and insertion techniques associated with IABP. Therefore, a comprehensive, prospective, multicenter computerized database program was developed: the Benchmark Counterpulsation Outcomes Registry. The present report summarizes the development and implementation of the registry, and reviews cumulative data compiled from 17,540 IABP records from 16,909 patients between the initiation of data collection in June 1996 and August 2000.

METHODS
The Benchmark Counterpulsation Outcomes Registry was started in June 1996, initially included 22 contributing clinical centers, and presently includes 243 institutions in 18 countries. An independent steering committee (Appendix A) designed and implemented the investigator-initiated registry. Datascope Corp. (Fairfield, New Jersey) provided funding for the database, and the sites included in the registry were institutions that used intra-aortic balloons (IABs) manufactured by Datascope Corp. Patient popula-
Abbreviations and Acronyms
AMI = acute myocardial infarction
BSA = body surface area
CABG = coronary artery bypass graft
IAB = intra-aortic balloon
IABP = intra-aortic balloon pump
LOS = length of stay
PVD = peripheral vascular disease

Data handling in the Benchmark Registry. Data from consecutive IABP cases were being reported by each participating site. Randomly selected data-base case histories from 21 hospitals with 2,339 patient records were audited and compared to actual local site records. The audit involved 485 (20.7%) records entered in 1999. Seventy items were checked from each record, resulting in an audit of 33,950 entries. Check-box items had at least a 95% accuracy (lower 95% confidence bound), and dates had at least a 90% accuracy. In addition, virtually all IABP cases were being reported by each participating hospital.

RESULTS
Clinical variables and indications. Between June 1996 and September 2000, 16,909 individual IABP patients were enrolled in the database. Of the enrolled patients, 68.8% were male, 31.2% were female and the mean age was 65.9 years (Table 1). From the perspective of clinical history, 25.6% of patients had diabetes, 11.9% had peripheral vascular disease (PVD), 30.6% had experienced a prior myocardial infarction and 14.6% had undergone prior CABG surgery. In 15.4% of patients, the presenting symp-
Table 1. Baseline Demographics

<table>
<thead>
<tr>
<th></th>
<th>Total Population (n = 16,909)</th>
<th>Diagnostic Catheterization Only (n = 1,576)</th>
<th>Catheterization and PCI Only (n = 3,382)</th>
<th>Surgery</th>
<th>No Intervention or Revascularization Noted (n = 1,186)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr, mean (SD)</td>
<td>65.9 (11.7)</td>
<td>66.2 (12.2)</td>
<td>65.5 (12.4)</td>
<td>66.5 (10.8)</td>
<td>63.4 (13.5)</td>
</tr>
<tr>
<td>Proportion of women (%)</td>
<td>31.2</td>
<td>31.7</td>
<td>31.9</td>
<td>31.0</td>
<td>37.4</td>
</tr>
<tr>
<td>BSA m², mean (SD)</td>
<td>2.0 (0.2)</td>
<td>2.0 (0.3)</td>
<td>2.0 (0.2)</td>
<td>2.0 (0.2)</td>
<td>1.9 (0.2)</td>
</tr>
<tr>
<td>History of diabetes (%)</td>
<td>25.6</td>
<td>26.1</td>
<td>24.1</td>
<td>27.9</td>
<td>22.2</td>
</tr>
<tr>
<td>PVD (%)</td>
<td>11.9</td>
<td>11.9</td>
<td>9.8</td>
<td>13.5</td>
<td>11.0</td>
</tr>
<tr>
<td>Previous MI (%)</td>
<td>30.6</td>
<td>30.1</td>
<td>28.0</td>
<td>33.8</td>
<td>25.5</td>
</tr>
<tr>
<td>Previous CABG (%)</td>
<td>14.6</td>
<td>14.6</td>
<td>16.9</td>
<td>13.4</td>
<td>20.9</td>
</tr>
</tbody>
</table>

BSA = body surface area; CABG = coronary artery bypass graft; MI = myocardial infarction; PCI = percutaneous coronary intervention; PVD = peripheral vascular disease.

toms involved the left main coronary artery, while 28.5% had triple-vessel disease. Some of the patients only underwent diagnostic catheterization procedures (9.3%) or percutaneous coronary intervention procedures (23.0%); the majority of procedures were surgical (60.7%; 89.4% of the surgical patients were undergoing CABG). Of the total 16,909 patients, 13,020 (77%) underwent cardiac catheterization and 4,833 (28.6%) underwent percutaneous coronary intervention. The majority of procedures were surgical (60.7%; 89.4% of the emergency department (0.2%) and other locations (8.8%). Patients received either 40 ml (77.3%), 34 ml (21.5%) or other size balloons (1.2%). Insertion technique involved a sheath in 79.7% of patients, and employed a 9.5F (78.4%) or an 8F catheter (21.6%; 8F devices have been available since June 1, 1997). The insertion was accomplished percutaneously in 95.4% of cases. The approach was right femoral (63.3%), left femoral (35.6%) or an alternate approach (1.1%). The mean duration of IABP in the overall registry cohort was 53 h (median = 41 h, most frequent time = 24 h, range from 5 min to 89 days).

**In-hospital balloon-related complications.** The incidence of balloon-related complications in the overall registry cohort was low (Table 3). Major complications of balloon counterpulsation were defined as severe bleeding, major limb ischemia, balloon leak or in-hospital mortality related to IABP. A total of 2.6% of all patients experienced at least one major complication.

Limb ischemia (defined as reduced arterial flow as manifested by diminished pulse) occurred in 2.9% of cases, but major limb ischemia (loss of pulse, loss of sensation, abnormal limb temperature or pallor requiring surgical intervention, arterial repair or amputation) was reported in

Table 2. Indications for Use

<table>
<thead>
<tr>
<th></th>
<th>Total Population (n = 16,909)</th>
<th>Diagnostic Catheterization Only (n = 1,576)</th>
<th>Catheterization and PCI Only (n = 3,382)</th>
<th>Surgery</th>
<th>No Intervention or Revascularization Noted (n = 1,186)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support and stabilization (%)</td>
<td>20.6</td>
<td>21.4</td>
<td>54.4</td>
<td>9.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Cardiogenic shock (%)</td>
<td>18.8</td>
<td>33.1</td>
<td>23.7</td>
<td>12.3</td>
<td>23.8</td>
</tr>
<tr>
<td>Weaning from cardiopulmonary bypass (%)</td>
<td>16.1</td>
<td>0.4</td>
<td>0.1</td>
<td>24.9</td>
<td>31.4</td>
</tr>
<tr>
<td>Preop: high risk CABG (%)</td>
<td>13.0</td>
<td>4.6</td>
<td>0.2</td>
<td>22.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Refractory unstable angina (%)</td>
<td>12.3</td>
<td>15.3</td>
<td>8.3</td>
<td>15.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Refractory ventricular failure (%)</td>
<td>6.5</td>
<td>9.1</td>
<td>2.5</td>
<td>5.9</td>
<td>15.7</td>
</tr>
<tr>
<td>Mechanical complication due to AMI (%)</td>
<td>5.5</td>
<td>9.8</td>
<td>7.0</td>
<td>4.2</td>
<td>5.2</td>
</tr>
<tr>
<td>Ischemia related to intractable VA (%)</td>
<td>1.7</td>
<td>1.6</td>
<td>1.5</td>
<td>1.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Cardiac support for high risk general surgery patients (%)</td>
<td>0.9</td>
<td>2.1</td>
<td>0.2</td>
<td>0.5</td>
<td>4.3</td>
</tr>
<tr>
<td>Other (%)</td>
<td>0.8</td>
<td>0.7</td>
<td>0.2</td>
<td>0.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Intraoperative pulsatile flow (%)</td>
<td>0.4</td>
<td>0.1</td>
<td>0.1</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Missing indication (%)</td>
<td>3.3</td>
<td>1.8</td>
<td>1.9</td>
<td>1.2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

AMI = acute myocardial infarction; CABG = coronary artery bypass graft; PCI = percutaneous coronary intervention; VA = ventricular arrhythmias.
only 0.9% of patients. Balloon leak occurred in 1.0% of cases. The incidence of severe bleeding (bleeding at the balloon insertion site leading to hemodynamic compromise and requiring a transfusion or surgical intervention) was 0.8%. Of the balloon insertions, 2.6% were unsuccessful due to a balloon leak, poor inflation of a balloon, poor augmentation or difficulties associated with balloon insertion (Table 4). The incidence of in-hospital mortality related to IABP was 0.05%. Not surprisingly, overall in-hospital mortality in this seriously ill population was high (21.2%, 11.6% with the balloon in place). The mean length of stay (LOS) in this cohort was 14 days (median = 10 days, most frequent LOS = 7 days, range from 1 day to 384 days).

Multivariate logistic regression analysis was used to identify significant independent predictors of a major complication of IABP, including death related to IABP, major limb ischemia, severe bleeding or balloon leak. Of the 15 variables screened, only female gender, PVD, small body surface area (BSA) (<1.65 m²) and higher age (≥75 years) significantly increased the risk of a major complication. Table 5 identifies the risk factors in order by odds ratio.

**DISCUSSION**

The major finding of this study is that the incidence of major balloon-related complications is encouragingly low (2.8%). Advances such as percutaneous insertion and smaller-diameter catheters have considerably reduced the incidence of serious vascular complications (7–23). In addition, the incidence of unsuccessful IABP due to balloon leak, poor inflation, poor augmentation or insertion difficulty was extremely low (2.3%), and to our knowledge, no previous study has examined this issue.

**Complications and risk factors.** The overall complication rates noted in this real-world observational experience compare favorably with other published observational experiences (Table 6) (24–26). Both major limb ischemia (0.9%) and major bleeding (0.8%) are lower than in the previously reported experiences; this may be due to use of smaller catheters and advances in the use of heparin and glycoprotein inhibitors. Use of the IABP has been shown to reduce recurrent ischemia (24) and improve overall clinical outcomes (4). In the present study, the actual number of deaths attributable to IABP failure or insertion is approximately 5 in 10,000, with a low incidence of other balloon-related complications, suggesting that IABP is a low risk therapeutic option in a high risk patient cohort. In fact, previous studies report low balloon-related mortality, and there seems to be less balloon-related mortality over time (Table 6) (27).

Sheathless insertion techniques have not replaced the

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**Table 3. Summary of Outcomes/Complications**

<table>
<thead>
<tr>
<th>Total Population (n = 16,909)</th>
<th>Diagnostic Catheterization Only (n = 1,576)</th>
<th>Catheterization and PCI Only (n = 3,882)</th>
<th>Surgery</th>
<th>No Intervention or Revascularization Noted (n = 1,186)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital mortality (%)</td>
<td>21.2</td>
<td>32.2</td>
<td>18.4</td>
<td>16.8</td>
</tr>
<tr>
<td>Mortality—balloon in place (%)</td>
<td>11.6</td>
<td>17.6</td>
<td>10.1</td>
<td>9.2</td>
</tr>
<tr>
<td>IABP-related mortality* (%)</td>
<td>0.05</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Amputation†</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Major limb ischemia‡ (%)</td>
<td>0.9</td>
<td>0.6</td>
<td>0.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Any limb ischemia (%)</td>
<td>2.9</td>
<td>3.2</td>
<td>1.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Severe access site bleeding (%)</td>
<td>0.8</td>
<td>0.8</td>
<td>1.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Any access site bleeding (%)</td>
<td>2.4</td>
<td>2.7</td>
<td>4.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Balloon leak (%)</td>
<td>1.0</td>
<td>0.9</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Composite outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major IABP complication§ (%)</td>
<td>2.8</td>
<td>2.8</td>
<td>2.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Any IABP complication¶ (%)</td>
<td>7.0</td>
<td>7.6</td>
<td>7.5</td>
<td>7.1</td>
</tr>
<tr>
<td>Any unsuccessful IABP* (%)</td>
<td>2.3</td>
<td>2.5</td>
<td>1.7</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*Individual patients may have more than one reason for an unsuccessful IABP.

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**Table 4. Unsuccessful IABP**

<table>
<thead>
<tr>
<th>Total Population (n = 389)</th>
<th>Diagnostic Catheterization Only (n = 39)</th>
<th>Catheterization and PCI Only (n = 66)</th>
<th>Surgery</th>
<th>No Intervention or Revascularization Noted (n = 32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balloon leak (%)</td>
<td>52.2</td>
<td>60.6</td>
<td>35.3</td>
<td>52.1</td>
</tr>
<tr>
<td>Poor inflation (%)</td>
<td>21.7</td>
<td>16.2</td>
<td>35.5</td>
<td>20.0</td>
</tr>
<tr>
<td>Difficult insertion (%)</td>
<td>13.0</td>
<td>4.0</td>
<td>5.9</td>
<td>16.0</td>
</tr>
<tr>
<td>Poor augmentation (%)</td>
<td>39.1</td>
<td>40.4</td>
<td>35.3</td>
<td>40.1</td>
</tr>
</tbody>
</table>

*CABG = coronary artery bypass graft; PCI = percutaneous coronary intervention.*
traditional insertion techniques, although this may change in the future. The Benchmark experience to date has only recently (since June 1997) included 8F devices, but usage rates of these smaller catheters are expected to increase as more centers seek to reduce access site injury.

Previous studies have implicated patient size, diabetes and PVD as major IABP risk factors, but have generally been small and retrospective in nature. Multivariate logistic regression (not stepwise) on the present data establish that female gender, PVD, BSA (<1.65 m²) and age (≥75 yrs) remain the four prominent, independent predictors of a serious IABP complication. These four high risk groups may become a focus of efforts to improve clinical outcomes and to reduce IABP complications.

Indications. The American College of Cardiology/American Heart Association guideline indications for IABP use include preparation for angiography and revascularization in cardiogenic shock, wean from cardiopulmonary bypass, primary/tertiary care institution, catheter size and left vessel main involvement.

IABP Complications and In-Hospital Mortality

Table 5. Risk Factors for Major Complications of IABP

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Estimated Odds Ratio (Presence/Absence)</th>
<th>95% Confidence Limits</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVD</td>
<td>1.968</td>
<td>1.557, 2.487</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female</td>
<td>1.737</td>
<td>1.414, 2.134</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BSA &lt;1.65 m²</td>
<td>1.453</td>
<td>1.095, 1.926</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Age ≥75 yrs</td>
<td>1.289</td>
<td>1.048, 1.585</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

*The chi-square was highly significant (p < 0.001); however, the concordance index was only 60%. The following variables were tested, but were not significant: primary intervention, history of diabetes, previous myocardial infarction, previous coronary artery bypass graft, indications for use (cardiogenic shock, wean from cardiopulmonary bypass), primary/tertiary care institution, catheter size and left vessel main involvement.

BSA = body surface area; IABP = intra-aortic balloon pump; PVD = peripheral vascular disease.

Table 6. IABP Complications and In-Hospital Mortality

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Dates</th>
<th>Major Bleed</th>
<th>Major Limb Ischemia</th>
<th>Balloon-Associated Mortality</th>
<th>Hospital Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present study</td>
<td>16,909</td>
<td>1996–2000</td>
<td>0.8%</td>
<td>0.9%</td>
<td>0.05%</td>
<td>21.2%</td>
</tr>
<tr>
<td>Makhoul et al. (7)</td>
<td>436</td>
<td>1971–1985</td>
<td>1.1%</td>
<td>8.3%</td>
<td>0.5%</td>
<td>NR</td>
</tr>
<tr>
<td>Iversen et al. (13)</td>
<td>395</td>
<td>1973–1986</td>
<td>NR</td>
<td>10.9%</td>
<td>NR</td>
<td>47%</td>
</tr>
<tr>
<td>Gottlieb et al. (11)</td>
<td>206</td>
<td>1980–1982</td>
<td>NR</td>
<td>10%</td>
<td>0.5%</td>
<td>33%</td>
</tr>
<tr>
<td>Arafa et al. (25)</td>
<td>509</td>
<td>1980–1994</td>
<td>2.0%</td>
<td>7.5%</td>
<td>0.6%</td>
<td>49.1%</td>
</tr>
<tr>
<td>Alderman et al. (12)</td>
<td>106</td>
<td>1983–1986</td>
<td>NR</td>
<td>14.2%</td>
<td>0.9%</td>
<td>17.9%</td>
</tr>
<tr>
<td>Barnett et al. (8)</td>
<td>580</td>
<td>1983–1990</td>
<td>NR</td>
<td>11.9%</td>
<td>0.5%</td>
<td>44%</td>
</tr>
<tr>
<td>Eltchaninoff et al. (17)</td>
<td>231</td>
<td>1985–1990</td>
<td>3.5%</td>
<td>3.9%</td>
<td>0</td>
<td>NR</td>
</tr>
<tr>
<td>Busch et al. (26)</td>
<td>472</td>
<td>1985–1995</td>
<td>3.2%</td>
<td>27.5%</td>
<td>0%</td>
<td>28.3%</td>
</tr>
<tr>
<td>Funk et al. (15)</td>
<td>294*</td>
<td>1986–1987</td>
<td>NR</td>
<td>11.7%</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Kvitlevski et al. (22)</td>
<td>144</td>
<td>1986–1989</td>
<td>NR</td>
<td>10.4%</td>
<td>NR</td>
<td>17%</td>
</tr>
<tr>
<td>Miller et al. (16)</td>
<td>404†</td>
<td>1987–1989</td>
<td>NR</td>
<td>10%</td>
<td>NR</td>
<td>30%</td>
</tr>
<tr>
<td>Př et al. (27)</td>
<td>129</td>
<td>1988–1992</td>
<td>14.7%†</td>
<td>4.6%</td>
<td>0</td>
<td>49.6%</td>
</tr>
<tr>
<td>Tartar et al. (20)</td>
<td>126</td>
<td>1988–1992</td>
<td>3.2%</td>
<td>12.8%‡</td>
<td>0</td>
<td>23.8%</td>
</tr>
<tr>
<td>Gol et al. (21)</td>
<td>493</td>
<td>1988–1993</td>
<td>5.1%</td>
<td>14%</td>
<td>2.6%</td>
<td>53.2%</td>
</tr>
<tr>
<td>Patel et al. (9)</td>
<td>691</td>
<td>1993–1995</td>
<td>3.5%</td>
<td>4%</td>
<td>0.4%</td>
<td>NR</td>
</tr>
<tr>
<td>Winters et al. (23)</td>
<td>870</td>
<td>1993–1996</td>
<td>6.9%</td>
<td>3.3%</td>
<td>0.2%</td>
<td>NR</td>
</tr>
<tr>
<td>Cohen et al. (10)</td>
<td>1119</td>
<td>1993–1997</td>
<td>4.6%</td>
<td>3.3%</td>
<td>0.4%</td>
<td>NR</td>
</tr>
</tbody>
</table>

*9 died acutely. †48 died acutely. ‡Combined major and minor. §30-day mortality. IABP = intra-aortic balloon pump; NR = not reported.
Study limitations. The limitations of the present study are those inherent in any large-scale retrospective observational registry. This is not a randomized trial; rather, it is a detailed description of ongoing and evolutionary clinical practice. Most of the data were collected prospectively, however, some were collected based on review of patient charts and records. The data have not been 100% validated, but in contrast to other large-scale observational registries, the Benchmark registry has gone to considerable effort to validate the data. Finally, given the large number of participating clinical institutions, there are site-to-site variations in personnel and resources allocated to the registry, individual practice patterns and patient populations.

Retrospective analyses of risk factors should be regarded with caution because there is not necessarily a cause and effect relationship with the risk factors associated with major complications. However, the data strongly suggest the need for greater care and clinical attention in treating patients who are small, female, have PVD or who are at least 75 years of age, in view of their increased risk for experiencing a major complication of IABP.

Summary. In this analysis of 16,909 patients enrolled from June 1996 to August 2000, the incidence of major complications was relatively low (2.8%) as were incidences of unsuccessful IABP (2.3%). In addition, the most frequent indication for use of IABP was for hemodynamic support in the catheterization laboratory, while use of IABP during the indication for use of IABP was for hemodynamic support in unsuccessful IABP (2.3%). In addition, the most frequent indication for use of IABP was for hemodynamic support in the catheterization laboratory, while use of IABP during CABG procedures remained relatively low. Female gender, small BSA, high age and PVD were independent predictors of a serious complication of IABP.

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APPENDIX B

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has recently introduced the ORYX™ initiative to integrate performance measures into the accreditation process and establish a data-driven continuous survey to complement standards-based assessment. The JCAHO has accepted the Benchmark Counterpulsation Outcomes Registry as having met the initial criteria for inclusion in the ORYX™ initiative, which measures clinical performance as a part of the future accreditation process. A total of 8 Benchmark measures of clinical outcome have been accepted by the Joint Commission for accreditation purposes in connection with the ORYX™ initiative.

APPENDIX C: PARTICIPATING SITES

Australia (1 Participant)
Alfred Hospital; Prahran, Victoria, Australia

Belgium (5 Participants)
Centre Hospitalier Sart Tilman; Liege, Belgium
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Foothills Provincial General; Calgary, Canada
Hospital St-Luc; Montreal, Quebec, Canada
Institut De Cardiologie De Montreal; Montreal, Canada
Kingston General Hospital; Kingston, Ontario, Canada
London Health Service University Campus-Windemer; London ON, Canada
London Health Services Victoria Campus-South St.; London ON, Canada
Royal University Hospital; Saskatoon, Saskatchewan, Canada
Sudbury Regional Hospital; Sudbury, Ontario, Canada
Vancouver Hospital & Health Sciences Center; Vancouver, British Columbia, Canada

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CHU Toulouse Hopital Rangueil; Toulouse, France
Hopital de la Timone; Marseille, France
Hopital Louis Pradel; Bron, France
Hopital Pasteur; Nice, France
Hopital Saint Joseph; Marseille, France
Institut Jacques Cartier; Massy, France

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Herzzentrum Lahr/Baden; Lahr, Germany
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Weezenlanden Hospital; JW Zwolle, Netherlands

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Morningside Hospital; Johannesburg, South Africa
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Sweden (1 Participant)
University Hospital; Lund, Sweden

Switzerland (2 Participants)
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La Tour Hospital; Meyrin, Geneva, Switzerland

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Bristol Royal Infirmary; Bristol, United Kingdom
Cardiothoracic Center Liverpool; Liverpool, United Kingdom
Freeman Hospital; Newcastle Upon Tyne, United Kingdom
Glenfield Hospital; Leicester, United Kingdom
Harefield; Harefield, United Kingdom
Hull Royal Infirmary; Hull, United Kingdom
Morrison; Swansea, United Kingdom
Nottingham City; Nottingham, United Kingdom
Royal Sussex County; Brighton East Sussex, United Kingdom
South Cleveland Hospital; Middlesborough, Cleveland, United Kingdom
The London Chest Hospital; London, United Kingdom
The Royal Brompton Hospital; London, United Kingdom
Walsgrave; Walsgrave, United Kingdom
Wythenshaw Hospital; Wythenshaw, Manchester, United Kingdom

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Downey Community Hospital; Downey, CA
Good Samaritan Hospital; Los Angeles, CA
Grossmont Hospital; La Mesa, CA
Holy Cross Medical Center; Mission Hills, CA
Kaweah Delta District Hospital; Visalia, CA
Long Beach Memorial Med. Ctr.; Long Beach, CA
Providence of St. Joseph's Medical Center; Burbank, CA
Santa Barbara Cottage Hospital; Santa Barbara, CA
Sharp Memorial Hospital; San Diego, CA
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Columbia West Florida; Pensacola, FL
Florida Hospital-Orlando; Orlando, FL
Florida Medical Center; Ft. Lauderdale, FL
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Munroe Regional Medical Center; Ocala, FL
Naples Community Hospital; Naples, FL
North Ridge Medical Center; Ft. Lauderdale, FL
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