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Management Strategies and Determinants of Outcome in Acute Major Pulmonary Embolism: Results of a Multicenter Registry

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Objectives. **The present study investigated current management strategies as well as the clinical course of acute major pulmonary embolism.**

Background. **The clinical outcome of patients with acute pulmonary embolism who present with overt or impending right heart failure has not yet been adequately elucidated.**

Methods. **The 204 participating centers enrolled a total of 1,001 consecutive patients. The inclusion criteria were based on the clinical findings at presentation and the results of electrocardiographic, echocardiographic, nuclear imaging and cardiac catheterization studies.**

Results. **Echocardiography was the most frequently performed diagnostic procedure (74%). Lung scan or pulmonary angiography were performed in 79% of clinically stable patients but much less frequently in those with circulatory collapse at presentation (32%, $p < 0.001$). Thrombolytic agents were given to 478 patients (48%), often despite the presence of contraindications (193 [40%] of 478). The frequency of initial thrombolysis was significantly higher in clinically unstable than in normotensive patients (57% vs. 22%, $p < 0.001$). Overall in-hospital mortality rate ranged from 8.1% in the group of stable patients to 25% in those presenting with cardiogenic shock and to 65% in patients necessitating cardiopulmonary resuscitation. Major bleeding was reported in 92 patients (9.2%), but cerebral bleeding was uncommon (0.5%). Finally, recurrent pulmonary embolism occurred in 172 patients (17%).**

Conclusions. **Current management strategies of acute major pulmonary embolism are largely dependent on the degree of hemodynamic instability at presentation. In the presence of severe hemodynamic compromise, physicians often rely on the findings of bedside echocardiography and proceed to thrombolytic treatment without seeking further diagnostic certainty in nuclear imaging or angiographic studies.**

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The prognosis of acute pulmonary embolism is still poorly understood (1). Patients with pulmonary embolism who are not hypotensive or in need of emergency therapeutic procedures, such as thrombolysis or pulmonary embolectomy, generally have a benign clinical course (2–4). In contrast, in-hospital mortality is considerably higher in those patients who present with clinical (5,6) or echocardiographic (7) evidence of acute right heart failure.

Diagnostic and therapeutic strategies for acute pulmonary thromboembolism have largely been influenced by the clinical presentation and the degree of hemodynamic instability of the patient population studied as well as by the logistics of the medical arena (8). These interactions are complex, and their impact on patient management and outcome has been difficult to assess. In an attempt to resolve these issues, the present registry focused on current management strategies as well as on the clinical outcome of patients with major pulmonary embolism in a large setting of community hospitals. The objective of the study was to test the following hypotheses: 1) The extent of diagnostic workup and, in particular, the frequency of nuclear imaging or pulmonary angiographic studies for definite confirmation of pulmonary embolism decrease as the severity of hemodynamic instability at presentation increases; 2) patients who are most hemodynamically unstable (i.e., in cardiogenic shock or in need of cardiopulmonary resuscitation at the time of diagnosis) are those who most frequently receive aggressive treatment, especially early thrombolysis; and 3) the degree of clinical and hemodynamic instability due to acute right heart failure is the most important determinant of in-hospital mortality.

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Abbreviations and Acronyms

ECG = electrocardiogram, electrocardiographic
UPET = Urokinase in Pulmonary Embolism Trial
PIOPED = Prospective Investigation of Pulmonary Embolism Diagnosis

Methods

Study patients. The Management Strategy and Prognosis of Pulmonary Embolism Registry (MAPPET) was conducted between September 1993 and December 1994 (9,10). Within this time period, the 204 participating centers throughout Germany (see Appendix) registered a total of 1,001 consecutive patients with a diagnosis of major pulmonary embolism that was made according to predefined criteria. Inclusion criteria for entry into the registry included the following clinical, echocardiographic and cardiac catheterization findings signifying acute right heart failure or pulmonary hypertension due to pulmonary embolism, or both: 1) *arterial hypotension*, defined as systolic blood pressure <90 mm Hg or a pressure drop of at least 40 mm Hg for a time period >15 min, if not due to new-onset arrhythmia, hypovolemia or sepsis; 2) *cardiogenic shock*, in which the presence of arterial hypotension as defined in criterion 1 was accompanied by clinical signs of organ hypoperfusion and hypoxia (altered level of consciousness, urine output <30 ml/h, cold and clammy extremities); 3) *circulatory collapse* necessitating cardiopulmonary resuscitation; 4) at least two of the following two-dimensional and Doppler echocardiographic findings indicating acute right ventricular pressure overload or pulmonary hypertension *in the absence of* left ventricular or mitral valve disease (11,12): a) *right ventricular dilation* (i.e., right ventricle appearing larger than the left ventricle from the apical or subcostal view), b) paradoxic septal wall motion, c) loss of inspiratory collapse of inferior vena cava, d) tricuspid regurgitation jet velocity >2.8 m/s or >2.5 m/s in the absence of inspiratory collapse of the inferior vena cava; and 5) diagnosis of *precapillary pulmonary hypertension* (mean pulmonary artery pressure >20 mm Hg in the presence of normal pulmonary artery occlusion pressures) by right heart catheterization.

Patients with clinically suspected pulmonary embolism were included in the registry if they met at least one of the criteria 1 to 5 at presentation, together with: 1) a diagnostic pulmonary angiogram, or 2) a lung scan indicating high probability of pulmonary embolism, or 3) at least three of the following findings obtained from clinical examination, blood gas analysis or the electrocardiogram (ECG): a) syncope; b) tachycardia (heart rate >100 beats/min); c) dyspnea or tachypnea (>24 breaths/min or need for mechanical ventilation) or both; d) arterial hypoxemia (partial arterial pressure of oxygen <70 mm Hg while breathing room air or <80 mm Hg under supplemental oxygen of at least 2 liters/min) in the absence of pulmonary infiltrates on chest x-ray film; and e) ECG signs of right heart strain (at least one of the following: complete or incomplete right bundle branch block, S waves in lead I combined with Q waves in lead III or T wave inversion in the precordial leads V_1 to V_3). Patients were not included in the registry if tachycardia or hypotension was judged to be due to hypovolemia or sepsis, or if acute respiratory failure could be explained by the presence of extensive pulmonary infiltrates on chest X-ray film.

All decisions concerning the diagnostic workup and treatment were made by the clinicians caring for each patient. The steering committee took every care not to exert any influence on the management strategy followed in the participating hospitals.

Data acquisition. Complete information on the clinical course as well as the diagnostic and therapeutic management of the patients entering the registry was obtained by means of a standardized questionnaire (case report form) sent to the participating centers by the steering committee. Data were collected on 1) clinical symptoms and signs of the patients at diagnosis, including arterial blood gases and chest roentgenograms; 2) presence of underlying diseases or predisposing factors for pulmonary thromboembolism; 3) findings of the diagnostic procedures performed for confirmation of right heart pressure overload or direct imaging of the embolic obstruction, including ECG, echocardiographic and nuclear imaging studies; right heart catheterization and pulmonary angiography; 4) treatment given to patients (heparin anticoagulation, thrombolysis, surgical pulmonary embolectomy, catheter thrombus fragmentation, caval filter implantation); and 5) in-hospital clinical course of patients (duration of hospital stay, recurrent venous or arterial thromboembolic events, bleeding complications, medication on discharge from the hospital or causes of death and autopsy findings for those who died in the hospital phase). *Major bleeding* was prospectively defined as bleeding that required red cell transfusions or discontinuation of treatment, or as hemorrhagic stroke confirmed by computed tomography or autopsy.

Definition of patient groups. The consensus conference of the steering committee prospectively defined four patient groups of increasing clinical and hemodynamic instability, indicating increasing severity of acute right heart failure: *Group 1* = Patients with acute pulmonary embolism and evidence of right ventricular pressure overload or pulmonary hypertension on the echocardiogram, or with confirmation of precapillary pulmonary hypertension on right heart catheterization, in the absence of arterial hypotension at presentation. *Group 2* = Patients presenting with arterial hypotension (systolic blood pressure <90 mm Hg or a pressure drop of at least 40 mm Hg for a time period >15 min) but without clinical signs of cardiogenic shock or the need for catecholamine support of blood pressure (except for dobutamine, ≤5 mg/kg body weight per min). *Group 3* = Patients with arterial hypotension accompanied by cardiogenic shock or judged by the attending physicians to require the administration of catecholamines. *Group 4* = Patients with circulatory collapse who underwent cardiopulmonary resuscitation at presentation.

The study patients were classified into one of these four

Table 1. Clinical Findings at Diagnosis in 1,001 Study Patients

Age >65 yr	516 (52)
Men/women	590/411
Ratio	1.43:1
Acute onset of symptoms (<48 h)	696 (70)
Dyspnea	958 (96)
Syncope	354 (35)
Tachycardia (pulse rate >100/min)	710 (71)
Arterial hypotension (SBP <90 mm Hg)	341 (34)
Recent major operation (within 10 days)	274 (27)
Recent major trauma or fracture (within 10 days)	106 (11)
Pregnant	14 (1.4)
History of	
Venous thrombosis	289 (29)
Pulmonary embolism	117 (12)
Congestive heart failure	316 (32)
Chronic pulmonary disease	105 (11)
Cancer	122 (12)
Stroke	22 (2.2)

Data presented are number (%) of patients, unless otherwise indicated. SBP = systolic blood pressure.

groups by the coordinating center at study entry. To avoid selection bias, the collaborating physicians were unaware of this classification during the recruitment phase.

Statistical analysis. For descriptive purposes, mean values ± SD were calculated for continuous variables and absolute and relative frequencies for discrete variables. Differences between characteristics of the patient groups were univariately tested for significance by means of the Fisher exact test for discrete variables and the Kruskal-Wallis rank test for continuous variables. Multiple logistic regression was used to investigate the independent effect of clinical characteristics at presentation on the extent of diagnostic workup (i.e., on whether lung scan or pulmonary angiography was performed for definite confirmation of pulmonary embolism) (13). Only those variables that reached $p < 0.2$ in univariate testing were considered in the multiple logistic regression model. Data processing and analysis were performed with the Statistical Analysis System (SAS). All significance tests were two-tailed, with $p < 0.05$ considered to indicate statistical significance.

Results

The clinical characteristics of 1,001 patients with major pulmonary embolism who fulfilled the entry criteria are shown in Table 1. The mean age of the patients at diagnosis was 63 ± 15 years. Most patients (70%) had an acute onset of symptoms (<48 h), and 784 (78%) had at least one known risk factor for venous thromboembolism in their history.

Diagnostic strategy. The absolute and relative frequencies with which invasive and noninvasive diagnostic methods were used in each group are shown in Table 2. The majority of the registry patients (74%) underwent two-dimensional and Doppler echocardiographic studies. The presence of right heart pressure overload or pulmonary hypertension, or both, was thus established in 303 Group 1 patients (74%), 221 Group 2 patients (70%), 69 Group 3 patients (68%) and 115 Group 4 patients (65%). In contrast, 227 study patients (23%) had invasive confirmation of pulmonary hypertension by right heart catheterization.

Table 2. Diagnostic Workup

Diagnostic Method	Group 1 (n = 407)	Group 2 (n = 316)	Group 3 (n = 102)	Group 4 (n = 176)
ECG	405 (99.5%)	312 (99%)	102 (100%)	162 (92%)
Echo	325 (80%)	230 (73%)	69 (68%)	117 (66%)
Lung scan	278 (68%)	189 (60%)	58 (57%)	42 (24%)
Right heart cath	119 (29%)	73 (23%)	26 (26%)	43 (24%)
Pulm angio	92 (23%)	46 (15%)	14 (14%)	24 (14%)
Search for DVT (B-mode and/or Doppler US or phlebography)	357 (88%)	248 (79%)	76 (75%)	70 (40%)

Data presented are number (%) of patients. Cath = catheterization; DVT = deep venous thrombosis; Echo = echocardiogram; ECG = electrocardiogram; Pulm angio = pulmonary angiogram; US = ultrasound. See Methods for explanation of study groups.

Thromboembolic pulmonary vessel occlusion was confirmed by angiography in 174 patients (17%), by a high probability lung scan in 549 (55%) and by at least one of these imaging studies in 68% of the patients included in the present registry. However, performance of angiographic or scintigraphic studies strongly depended on the severity of clinical and hemodynamic instability at presentation, ranging from 79% in Group 1 to 32% in Group 4 ($p < 0.001$). Overall, the number of diagnostic studies performed (Table 2) decreased from 3.9 procedures/patient in Group 1 to 2.6 procedures/patient in Group 4 ($p < 0.001$).

As shown in Table 3, age >65 years, acute onset of

Table 3. Baseline Clinical Findings and Severity of Hemodynamic Instability in Patients With and Without Lung Scan or Pulmonary Angiogram*

	Pts Without Lung Scan/ Pulm Angio (n = 334)	Pts With Lung Scan/ Pulm Angio (n = 648)	p Value
Age >65 yr	195 (58%)	313 (48%)	0.003
Acute onset of symptoms†	263 (79%)	419 (65%)	< 0.001
Arterial hypotension (SBP < 90 mm Hg)	243 (73%)	322 (50%)	< 0.001
Tachycardia (pulse rate > 100/min)	259 (78%)	436 (67%)	< 0.001
Need for catecholamines	138 (41%)	106 (16%)	< 0.001
Endotracheal intubation	106 (32%)	44 (6.8%)	< 0.001
Cardiopulmonary resuscitation	87 (26%)	30 (4.6%)	< 0.001

*Only those clinical characteristics for which statistically significant differences were found by univariate analysis are included. †Onset of symptoms was defined as acute if it preceded diagnosis of pulmonary embolism by not more than 48 h. Data presented are number (%) of patients (Pts). Other abbreviations as in Tables 1 and 2.

Table 4. Treatment of Acute Major Pulmonary Embolism

Treatment	Group 1 (n = 407)	Group 2 (n = 316)	Group 3 (n = 102)	Group 4 (n = 176)
Heparin anticoagulation	399 (98%)	302 (96%)	95 (93%)	153 (87%)
Thrombolysis				
Early*	93 (23%)	68 (22%)	41 (40%)	117 (67%)
Late	79 (19%)	58 (18%)	4 (3.9%)	18 (10%)
Surgical embolectomy	2 (0.5%)	3 (1%)	1 (1.0%)	2 (1.1%)
Thrombus fragmentation	7 (1.7%)	4 (1.3%)	3 (2.9%)	12 (6.8%)
Caval filter implantation	30 (7.4%)	16 (5.1%)	1 (1.0%)	4 (2.3%)
No specific treatment	3 (0.7%)	2 (0.6%)	0	5 (2.8%)

*Defined as thrombolytic treatment within 24 h of diagnosis of pulmonary embolism. Data presented as number (%) of patients.

symptoms (within 48 h), clinical signs of hemodynamic instability (tachycardia, arterial hypotension, need for catecholamine support of blood pressure) and cardiopulmonary resuscitation were all found by univariate analysis to be significantly more frequent in patients without definite confirmation of pulmonary embolism by lung scan or angiography. Multiple logistic regression analysis revealed that diagnosis of major pulmonary embolism at the bedside (i.e., based on clinical findings and echocardiography) was independently associated with the following clinical characteristics at presentation: age >65 years ($p = 0.001$), pregnancy ($p = 0.033$), arterial hypotension ($p < 0.001$), tachycardia ($p < 0.001$), need for endotracheal intubation ($p = 0.003$) and need for cardiopulmonary resuscitation ($p = 0.009$).

Treatment of pulmonary embolism. Almost every patient included in the present study received specific treatment for pulmonary embolism (Table 4). In addition to conventional anticoagulation with heparin in doses adjusted to achieve therapeutic prolongation of the activated partial thromboplastin time (95% of patients), 478 patients (48%) underwent thrombolytic treatment. Early thrombolysis (i.e., within 24 h of diagnosis of pulmonary embolism) was more frequently performed in patients with hemodynamic instability at presentation (57% Group 3 or 4 patients) than in patients with more hemodynamic stability belonging to Group 1 or 2 (22%, $p < 0.001$). As shown in Table 5, the attending physicians frequently judged that the severity of pulmonary embolism warranted the use of thrombolytic agents, even in the presence of contraindications to thrombolysis.

Table 5. Contraindications to Thrombolytic Treatment in 1,001 Registry Patients

Contraindication	Present*	Thrombolytic Treatment Despite Contraindication†
Age >75 yr	194 (19)	57 (29)
Recent major operation‡	111 (11)	38 (34)
Recent major trauma‡	27 (2.7)	14 (52)
Pregnancy	14 (1.4)	6 (43)
Cancer	122 (12)	41 (34)
Previous stroke	22 (2.2)	4 (18)
Cardiopulmonary resuscitation	118 (12)	88 (75)
At least 1 of the above	474 (47)	193 (41)

*Number (%) of study patients. †Number (%) of subgroup. ‡As in Table 1.

After diagnosis of venous thromboembolism, a caval filter was implanted more frequently in Group 1 or 2 patients than in Group 3 or 4 patients (6.4 vs. 1.8%, $p < 0.001$). Finally, more aggressive therapeutic procedures, such as catheter thrombus fragmentation or emergency surgical embolectomy, were performed only in isolated cases (Table 4).

In-hospital course and mortality. The overall in-hospital mortality rate was 22%. There was a substantial increase in the mortality rate from 8.1% in patients with hemodynamic stability at presentation (Group 1) to 65% in patients necessitating cardiopulmonary resuscitation (Group 4: $p < 0.001$ vs. Group 1). In most cases (91%), death occurring during the in-hospital phase was directly related to the thromboembolic event. Only few patients died of their underlying disease or due to complications of diagnostic or therapeutic procedures (0.9% and 1.0%, respectively).

Patients with definite confirmation of pulmonary embolism by pulmonary angiography or lung scan had a mortality rate of 11% as opposed to 45% in those patients in whom these diagnostic procedures were not performed ($p < 0.001$). The mortality of patients with and without scintigraphic or angiographic confirmation of pulmonary embolism within each group is shown in Figure 1.

Clinically apparent recurrence of pulmonary embolism was diagnosed in 172 study patients (17%). The recurrence rates were similar among the four patient groups. Arterial thromboembolic events as well as cerebral hemorrhage were observed in few patients in each group. Finally, the occurrence of other major bleeding episodes requiring red cell transfusions or discontinuation of treatment ranged from 7.4% to 12% (Table 6).

Discussion

In-hospital mortality of patients with major pulmonary embolism. Most previous trials on pulmonary embolism included hemodynamically stable patients who were able to tolerate an extensive diagnostic workup, including ventilation–

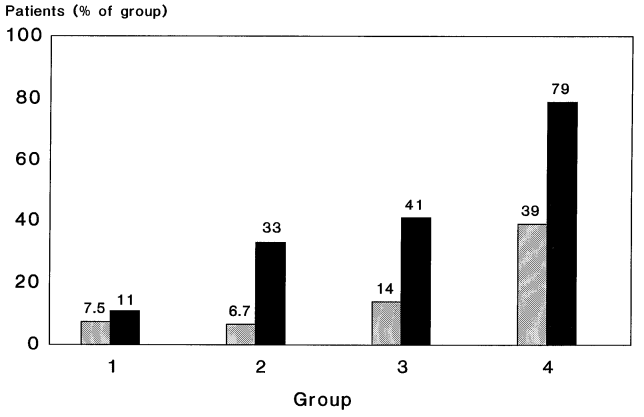

Figure 1. Overall in-hospital mortality in patients with confirmation of pulmonary embolism by lung scan or pulmonary angiography (**hatched bars**) compared with mortality rate in patients who did not undergo these procedures (**solid bars**). **Numbers above bars** denote percent of patients in each group. See Methods for explanation of study groups.

perfusion lung scan or pulmonary angiography, or both, for definite confirmation of pulmonary embolism (4,14,15). In contrast, the patients included in the present registry had major pulmonary embolism according to prospectively defined clinical and hemodynamic criteria. Overall, 93% of our patients had confirmation of pulmonary artery hypertension by right heart catheterization or evidence for acute right heart strain provided by ECG or echocardiographic findings. Furthermore, 28% of the patients were hemodynamically unstable at presentation, requiring catecholamine support of blood pressure or even cardiopulmonary resuscitation. The in-hospital mortality rate of this patient cohort was 22%, which is in accordance with the high (18% to 33%) mortality rates reported by other investigators in patients with massive pulmonary embolism (6,16) and considerably higher than the 8% and 9.5% mortality rate of the hemodynamically stable patients included in the Urokinase in Pulmonary Embolism Trial (UPET) (14) and Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) (15) trial, respectively.

Impact of hemodynamic instability on diagnostic workup. The mortality of patients in whom lung scan or pulmonary angiography was performed to confirm pulmonary embolism was 11%, much lower than the 45% mortality rate of the patients in whom the diagnosis of acute pulmonary embolism was made on the basis of high clinical suspicion supported by echocardiographic signs of acute right heart pressure overload. The reason for the unfavorable outcome of the patients not undergoing scintigraphic or angiographic procedures was shown to be their hemodynamic instability at presentation, which prohibited extensive diagnostic workup. Certainly, diagnostic inaccuracy of bedside clinical and echocardiographic evaluation alone remains a possibility in some of these unstable patients. In contrast, the low mortality of the patients who underwent nuclear imaging or angiographic studies in our registry closely approaches the mortality of the patients in the UPET (14) and PIOPED (15) trials and thus indicates that diagnostic strategies seeking definite confirmation of pulmonary embolism may lead to "selection" of a patient cohort with a relatively benign clinical outcome.

That the majority (74%) of the registry patients underwent echocardiography at presentation signifies an important trend in the diagnostic approach to patients with clinically suspected pulmonary embolism. Bedside echocardiography, aided by the ECG and chest X-ray findings, is a useful tool for differential diagnosis between acute pulmonary embolism and other potentially life-threatening cardiovascular or pulmonary disorders (e.g., acute myocardial infarction, pericardial tamponade, aortic dissection or fulminant pneumonia). Moreover, it permits rapid, noninvasive and reliable detection of right heart pressure overload resulting from major pulmonary embolism (12). This information is of particular importance for risk stratification of patients (7,9,17) as well as for identification of potential candidates for thrombolytic treatment (10,18,19).

The frequency of search for deep-vein thrombosis by noninvasive or phlebographic studies was 88% in clinically stable patients but remained high even in the group with initial hypotension (75%). This practice obviously emphasizes the

Table 6. In-Hospital Clinical Course

Event	Group 1 (n = 407)	Group 2 (n = 316)	Group 3 (n = 102)	Group 4 (n = 176)
Overall mortality	33 (8.1%)	48 (15%)	25 (25%)	114 (65%)
Death due to PE	29 (7.1%)	43 (14%)	23 (23%)	106 (60%)
Death due to underlying disease	3 (0.7%)	3 (1.0%)	1 (1.0%)	2 (1.1%)
Death due to complications of diagnostic procedures or treatment	1 (0.3%)	2 (0.6%)	1 (1.0%)	6 (3.4%)
Nonfatal events				
Recurrent PE	57 (14%)	61 (19%)	22 (22%)	32 (18%)
Arterial thromboembolism	5 (1.2%)	4 (1.3%)	0	5 (2.8%)
Cerebral bleeding	1 (0.3%)	3 (1.0%)	0	1 (0.6%)
Other major bleeding*	30 (7.4%)	24 (7.6%)	12 (12%)	21 (12%)

*Bleeding requiring red cell transfusion or discontinuation of therapeutic anticoagulation or thrombolytic treatment.
Data presented are number (%) of patients. PE = pulmonary embolism.

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concern of clinicians for the presence of a significant peripheral venous clot burden and the risk of recurrent pulmonary embolism (20).

Treatment of major pulmonary embolism. Nearly every second patient included in the present study received a thrombolytic agent. The rate of thrombolytic treatment (48%) was thus much higher than the 6% rate reported in the PIOPED study (15). This difference can be attributed to the hemodynamic instability of our patient cohort, as well as to the echocardiographic demonstration of right heart pressure overload in most of our patients. Both factors are regarded as indications for thrombolytic therapy in patients with acute pulmonary embolism (18,19), although a favorable effect of thrombolysis on patient outcome in this setting remains to be confirmed by a prospective, randomized trial (21,22). As hypothesized, the frequency of thrombolytic treatment in our patients was strongly associated with the degree of clinical instability at presentation and was as high as 77% in the most unstable group. In contrast, catheter thrombus fragmentation or surgical pulmonary embolectomy was performed infrequently, even in the most unstable patient group or in those patients with contraindications to thrombolysis. These emergency procedures thus seem to play a minor role in the setting of community hospitals.

In almost every fifth patient in Group 1 or 2 (i.e., in those patients who did not require catecholamine support of arterial blood pressure), the initial treatment with intravenous heparin anticoagulation was subsequently changed in favor of a thrombolytic regimen. This policy might either reflect a treatment failure of heparin or the uncertainty of the clinicians when confronted with hemodynamically stable patients with acute pulmonary embolism and evidence of right heart pressure overload. From our data it was not possible to clarify this issue, which will have to be addressed by future trials.

Finally, the observation that pulmonary embolism occurred within 10 days of major operation in as many as 27% of our patients is certainly disturbing and implies that much further work is needed to prevent postoperative pulmonary embolism.

Conclusions. The present registry demonstrates that the management strategy and in-hospital outcome of patients with major pulmonary embolism is closely related to the severity of hemodynamic instability at the time of presentation. Increasing clinical instability results in a decrease in the frequency with which lung scans or invasive pulmonary angiograms are obtained to definitely confirm pulmonary embolism. Increasing clinical instability also urges physicians to proceed to "rescue" thrombolytic treatment, even in the presence of contraindications to thrombolysis. To our knowledge, the results of the present study thus provide, for the first time, an accurate reflection of current management strategies in patients with major pulmonary embolism. Furthermore, these results can prove especially helpful in planning prospective, randomized trials that will clarify the impact of widely used treatment modalities, especially thrombolysis, on the outcome of patients with acute pulmonary embolism.

Appendix

Participating Centers and Physicians for the Management and Prognosis of Pulmonary Embolism Registry (Germany)

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