The Spectrum of Pulmonary Embolism*

Clinicopathologic Correlations

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Pulmonary embolism (PE) is still underdiagnosed even in hospitalized patients. In our recent experience, out of 92 postmortem cases of massive or submassive PE, only 28% were diagnosed before death, whereas the false-positives accounted only for 3% of cases. Similar conclusions have been drawn from large-scale autopsy studies performed in Norway and in the United States. The most important causes of an incorrect diagnosis are failure to suspect PE, and the protean nature of the disease. Remarkable differences actually exist concerning the point of origin and the final localization, as well as the size and age of thromboemboli, the presence or absence of pulmonary infarction, and the underlying pathology. Often a fatal embolus is relatively small but hardly tolerated because of the underlying cardiopulmonary situation. Attention should be called to the frequent autopsy finding of multiple PEs and pulmonary infarctions of apparently different age. This finding is important since it indicates that these patients suffered successive embolizations and the eventual death might have been prevented if an early diagnosis had been made.

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In a recent large-scale Scandinavian study, the percentage of clinically diagnosed cases of pulmonary embolism (PE) was higher in the 1960s (22.1%) and 1970s (17.5%) than in the 1980 to 1984 period (12.6%), and this was most obvious in cases of PE as the sole cause of death. Another population-based study on PE as cause of death was done in New Mexico. Among the 812 postmortem documented cases of PE, only 34% were correctly diagnosed before death, compared with more than 15,000 autopsy-negative cases, in which individuals (2.5%) had been erroneously diagnosed clinically as having died from PE. In our recent experience (C. Gualtieriotti, C. Zogno, unpublished data, 1991) out of 92 post-mortem cases of massive or submassive PE observed from 1986 to 1989, only 28% were diagnosed before death. The false-positives accounted only for 3% of cases.

The question then arises: why does the diagnosis of PE so frequently elude the clinician? Among the various causes of an incorrect diagnosis, most important are the failure to suspect PE and the protean nature of the disease. The "spectrum" of PE can actually range from nonperceptible changes in the patient's well-being to sudden death. Pulmonary embolism is a protean disease because remarkable differences exist in terms of the following: (a) point of origin of thromboemboli; (b) final localization of thromboemboli; (c) size and age of thromboemboli; (d) presence of pulmonary infarction (PI); (e) underlying disease; and (f) age of patient.

As for the first point, Figure 1 illustrates the presumed point of origin of thromboemboli in a large autopsy series studied by our group in the 1980s. The point of origin of thromboemboli could be demonstrated only in 53% of 583 cases. Fully 86% of these 286 cases had one or more thrombosises in the district of inferior vena cava, more frequently at the level of femoral and iliac veins.

It must be pointed out, however, that (1) an exhaustive study of the leg veins during a postmortem examination is not routinely done for obvious "cosmetic" reasons, whereas thrombi within the veins of calf muscles are very common, even if they are less likely to cause significant PE; (2) in recent times, upper-extremity venous thrombosis increased as a result of invasive diagnostic and therapeutic proced-

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FIGURE 1. Localization of thrombosis as possible point of origin of pulmonary embolism. (286 proven cases out of 583: 53.16%). RH=right heart; SVC=superior vena cava; IVC=inferior vena cava.
Anatomic awareness of the preferred sites of PE and PI may facilitate the search for direct and indirect radiologic and angiographic signs of both events. It should be stressed, however, that location and magnitude of embolism during life cannot be directly inferred from localization and size of embolism at autopsy.

The localizations of PE involving at least one segmental pulmonary artery are shown in Figure 2, in order of decreasing frequency. It is evident that there is a prevalence of multiple over single localizations and a very marked preference for the right lung and for the lower lobes. Better still, we would like to call attention to the frequent autopsy finding of multiple PE and PI of apparently different age. This "heterochronic" quality of multiple infarcts was verified in at least 15% of our cases. This finding is important since it means that these patients suffered from successive embolizations and that eventual death might have been prevented if an early diagnosis had been made.

The age of the dislodged thrombus is important to its ultimate fate within the pulmonary arterial tree. Fresh thrombi are particularly susceptible to fragmentation in transit through the contracting right

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**Figure 2.** Localization of pulmonary embolism involving at least one segmental pulmonary artery.  
R=right; PA=pulmonary artery; L=left; ML=multiple localizations; SL=single localizations; RHL=right homolateral localizations; LHL=left homolateral localizations; MB=multiple bilateral localizations.
ventricle, thus producing multiple smaller emboli. Older organized thrombi are more likely to pass intact into the pulmonary circulation and to lodge in bifurcations, and therefore cause partial or total obstruction of major pulmonary vessels.

Often a fatal embolus is relatively small but hardly tolerated because of the underlying cardiopulmonary situation. For this reason also, an hemodynamic rather than anatomic stratification of prognosis proves to be suitable. In 1948 Neuhof already wrote the following: "Embolism of peripheral branches of the pulmonary arteries, leaving the main branches free, may produce symptoms of marked severity and may even cause death." Also in our experience covering 49 cases of sudden and unexpected death, pulmonary embolization often involved only peripheral and unilateral vessels.

The underlying pathologic condition found at autopsy in patients who died of PE in two different periods and in two different general hospitals in our city is summarized in Figure 3. There is a prevalence of heart disease (mainly congestive heart failure and arrhythmias) which partly accounts for the limited diagnostic contribution of some noninvasive tools, such as electrocardiography and echocardiography.

As far as age of the patient is concerned, Goldhaber et al observed an increased proportion of undiagnosed PE deaths in keeping with the more advanced age. As the population ages, and since even at home many elderly patients are scarcely mobile, there will be an increasing number of individuals susceptible to PE in the future.

In conclusion, we can quote Israel and Goldstein, who provided a clear definition of what our attitude should be in regard to the problems discussed herein: "Those who demand absolute proof before the diagnosis of pulmonary embolism is accepted and treatment instituted, may only too often have been provided with the only absolute proof, namely the autopsy."

REFERENCES