"Good" nutrition → ? PE. Popliteal only 29 proximal not recorded

A STUDY OF 605 FATAL PULMONARY EMBOLISMS AND TWO SUCCESSFUL EMBOLECTOMIES

F. LINDER, M.D., F.A.C.S., W. SCHMITZ, A. ENCKE, M. TREDE, and H. H. STORCH,

Heidelberg, Germany

WHEREAS the risk of postoperative shock, bleeding, and infection has been significantly lowered during the past decades, thromboembolic complications remain as some serious and insufficiently solved surgical problems. This fact applies equally to diagnostic and to therapeutic aspects of the problem. It appeared worth while, therefore, to examine the collected data from 605 fulminant pulmonary embolisms which were observed in the surgical department of the University of Heidelberg during the past 50 years—1915 to 1964—and which were confirmed at autopsy. Recently, 2 successful pulmonary embolectomies have been performed in the same department.

The total number of fatal pulmonary embolisms in our series corresponded to the 0.2 per cent of all hospitalized patients, and to the 5.3 per cent of the total mortality rate during the last half century. An analysis of 5 year groups showed a clear relationship between the frequency of embolism and the nutritional state of the population at large (Fig. 1). The lowest incidence of embolism was registered during the postwar years with a relative and absolute minimum between 1945 and 1949. The lowest value was recorded in 1947 with 0.04 per cent compared with 0.45 per cent in 1932 and 0.38 per cent in 1955. A steep rise in the incidence of embolism coincided with the improvement in the general nutritional state between 1925 and 1929 and 1950 and 1960. This finding corresponds satisfactorily with the figures of other observers. The nutrition of the individual patients appeared to be less significant. Overweight and normal patients of this series were equal in risk. Only the poorly nourished seemed to have a better chance. On the other hand, cachexia due to a neoplasm in no way improved the prognosis, since more than 40 per cent of the fatal embolisms occurred in patients with tumors.

Whereas body weight carried only a scant prognostic significance, the correlation between embolism and age was unequivocal (Fig. 2). Beyond the fourth decade, the incidence of embolism rose continually. This fact was particularly striking if the average age of all patients at operation was taken into consideration. An analysis of the last 3 decades demonstrated a considerable difference between the "fat" and "lean" years. On the basis of the number of operations carried out on men and women during the same period of time, a slight preponderance of embolism was observed in the females.

The incidence of postoperative embolism during the years 1920 to 1928 and 1934 to 1964 was 0.26 per cent of all operations performed. A comparison of various operative procedures (Table I) showed that the highest rate of embolism occurred after abdominal operations, including hernioplasties, 55.9 per cent. Next in frequency were urologic operations with 14.7 per cent and thoracic procedures with 8.3 per cent. It must be stressed, however, that almost two-thirds of the patients who underwent thoracic surgery suffered from malignant tumors.

On the other hand, though, cardiac procedures carried a low risk of thrombo-

From the Department of Surgery of the University of Heidelberg, Germany.

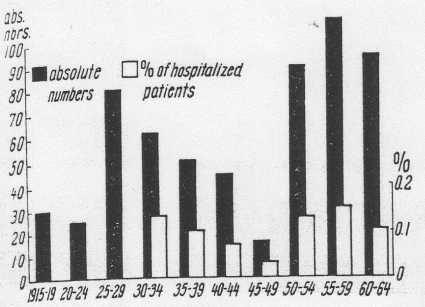

FIG. 1.

FIG. 1. Massive pulmonary embolisms in the period from 1915 to 1964, giving absolute figures and percentages of all hospitalized patients in 5 year groups. Note the depression in war and postwar times.

FIG. 2. Risk of pulmonary embolism with rising age. Each 1,000 operations in 1929, 1939, and 1964 were considered to give a representative average of the age at operation of all patients. The differentiation of the last 3 decades again marks the "fat" and "lean" years.

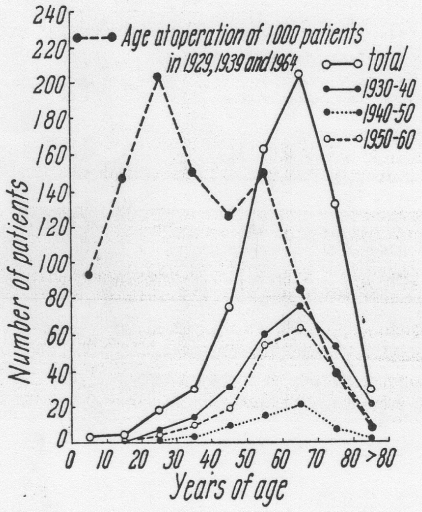

FIG. 2.

bolism. Of 1,000 cardiac procedures, fatal pulmonary embolism was encountered only twice, after mitral commissurotomy and after extirpation of a ventricular aneurysm. Procedures on the lower extremities consisted largely of the surgical treatment of fractures and amputations in the elderly, with an embolic occurrence rate of 8.5 per cent. In only 1 patient was a malignant lesion involved. The lowest incidence of embolism was observed after thyroidectomies, with only 3 fulminating embolisms occurring among 6,000 patients during the entire study period.

Postoperative embolism was most frequent between the fifth and twelfth days, with a peak between the ninth and tenth days. Twenty-five of 343 embolisms, during the last 30 years, occurred, however, within the first 3 postoperative days. The causative thrombosis probably originated during the preoperative period of bed rest.

The time interval between the onset of acute massive pulmonary embolism and death was less than 10 minutes in 76.2 per cent of the 343 patients about whom exact data were available from the charts. Only 17.2 per cent survived for more than half an hour. In 97 per cent of 378 patients examined, the embolus originated in the lower half of the body. Thrombosis was found in the pelvic region in 24.3 per cent, in the femoral veins in 58.4 per cent, and in the veins of the calf in only 14.3 per cent. This information correlated with the finding that among those in whom embolism occurred between 1950 and 1960, varicose veins were found in only 4.83 per cent. Forty-six of 377 patients or 12.2 per cent demonstrated clinical signs of thrombosis or thrombophlebitis before the onset of acute embolism. In only 43 patients, 11.4 per cent, was a small, premonitory pulmonary infarction noted.

These data, as well as the many studies published in the literature, indicate that the prophylaxis and therapy of acute pulmonary embolism remain a serious problem. Established prophylactic measures include stimulation of the general circulation, particularly its venous component by physical and medical therapy, and postoperative

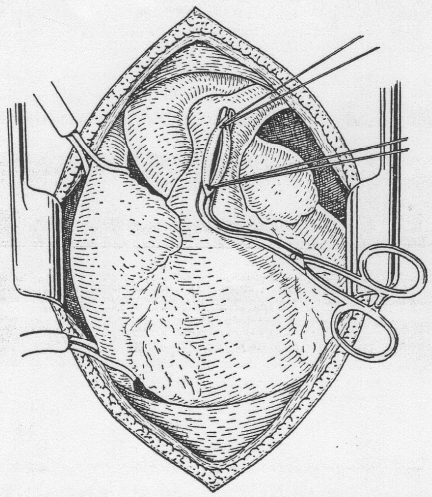

FIG. 3. Inflow occlusion of the superior and inferior venae cavae. The pulmonary artery is opened between a clamp for embolectomy.

anticoagulant prophylaxis which, according to the studies of Dick and his associates and those of Cramer and Pohlhaus, is undoubtedly of value if applied to all patients. The problems of organization, personnel, and material posed by such a comprehensive prophylactic program are, however, considerable. A recent questionnaire published at the German Surgical Congress of 1965 showed that only 3 per cent of all German surgical departments with more than 100 beds carried out this prophylactic measure

TABLE I.—INCIDENCE OF POSTOPERATIVE PULMONARY EMBOLISM AT THE SURGICAL CLINIC OF HEIDELBERG UNIVERSITY, 1920 TO 1928 AND 1934 TO 1964

Region of operation	*Fatal embolism*	*Per cent*
Head	23	5.9
Neck	5	1.3
Thorax	32	8.3
Abdomen	216	55.9
Urogenital diseases except gynecologic	57	14.7
Upper extremities	10	2.6
Lower extremities	33	8.5
Spine	5	1.3
Miscellaneous	6	1.5
Total	387	100.0
Included malignant lesions	161	42.7

(7). The value of ligature of the vena cava is still being debated. We have had only limited experience with this particular procedure.

Largely, thanks to advances in general and cardiovascular surgery, Trendelenburg's operation has seen a certain renaissance within recent years. Whereas in the decades following the original success of Kirschner in 1924 only a few embolectomies were successful, a survey of all successful embolectomies reported by Encke and his colleagues (4) showed an increasing number of such fortunate patients within the last few years. Admittedly, exact figures are not available on the number of unsuccessful attempts at embolectomy, and this applies even more to those operations carried out under a mistaken diagnosis of pulmonary embolism. However, it was possible to collect from the world literature records of 95 long term survivors after pulmonary embolectomy.

With regard to the technique, 2 rival methods command the field. First, there is the method of longitudinal sternotomy with inflow occlusion of the venae cavae as reported by Vossschulte and his associates. The second method relies on embolectomy with the aid of extracorporeal circulation which, of course, was originally designed by Gibbon for this purpose. In the acute and dramatic instance, the former method seems to carry the advantage of speed. Furthermore, every general surgeon armed with the surgical virtues of decisiveness and manual dexterity can perform this classical emergency procedure without need of a complicated apparatus. Doubtless, the disposable easily assembled oxygenator introduced by Cooley (1) will be of value in more specialized hospitals.

At the surgical department of the University of Heidelberg, 6 attempts at pulmonary embolectomy were made between October 1964 and December 1965. Two patients survived and have remained symptom free for 2 years. A third patient, a female 65 years of age, died 6 weeks after

operation from bronchopneumonia and general exhaustion. In each patient, the simple inflow occlusion of the venae cavae was carried out. (Fig. 3).

REPORTS OF PATIENTS

PATIENT 1. On 23 September 1964, an appendectomy was performed on a female patient 32 years of age who in 1954 suffered a small pulmonary infarction which occurred after a delivery and who in 1962 had a thrombosis in both legs. At operation, no signs of thrombophlebitis or thrombosis were present. The postoperative course was uneventful up to the sixth day. She was able to get out of bed 24 hours postoperatively. On 29 September 1964, she noted a pain in the loin on the right side. Results of a urinalysis and of an intravenous pyelogram were negative. Apart from uncharacteristic complaints, there was no clinical or roentgenographic evidence of a pulmonary infarction in this patient.

On 1 October 1964, the patient suddenly collapsed as a result of a brief cardiac arrest which was successfully treated by external cardiac massage. Subsequently, a state of shock persisted with chest pain, dyspnea, and cyanosis. With oxygen therapy, norepinephrine drip, and heparin, a transient improvement was noted in the general condition of the patient. The blood pressure could no longer be maintained with vasoactive amines. The electrocardiogram showed signs of acute cor pulmonale. The roentgenogram of the chest showed a clear left lung. Four hundred thousand units of thrombolysin and 400,000 Christensen units of streptokinase resulted in no improvement, and an embolectomy was therefore performed. During the induction of anesthesia, there was renewed cardiac arrest. Immediate thoracotomy through a median sternotomy for manual cardiac massage produced return of spontaneous cardiac action. Under inflow occlusion of the venae cavae which lasted 2½ minutes, an embolus measuring 4 by 1.5 centimeters was removed from the left pulmonary artery. The operation was carried out under full fibrinolysis. A tracheotomy was performed and artificial respiration begun. Postoperatively, fibrinolysis was continued. After 10 hours, heparin therapy was instituted. Under antibiotic and postoperative anticoagulant treatment, the further course of the patient was uneventful. She was discharged from the hospital on 19 November 1964 and 2 years later she is healthy and is employed full time as a nurse's aide.

PATIENT 2. In a male patient 42 years of age, the right testis was removed in November 1963 because of testicular carcinoma. Roentgenotherapy was continued until 1964. The patient was admitted to the hospital on 2 February 1965 for surgical treatment of an infected superficial radiation ulcer of the right groin. There was no histologic evidence of a recurrence of the malignant lesion. On 5 February 1965, a plastic procedure was performed for the defect. After an uneventful postoperative course with early ambulation, he suddenly collapsed on the ninth postoperative day.

The electrocardiogram indicated an acute cor pulmonale, and a roentgenogram of chest showed strikingly clear lung fields bilaterally. After instillation of thrombolysin, an embolectomy was performed, and under venous inflow occlusion for a period of 90 seconds, massive emboli were removed from both pulmonary arteries. Immediately after embolectomy, strong spontaneous cardiac action returned. Apart from a right pleural infusion, the postoperative course was free from complications. On hospital discharge, the wound in the groin had practically healed. At present, 1½ years postoperatively, he is free of complaints with no clinical or roentgenographic evidence of a tumor recurrence.

The incidence of and problems posed by fulminating pulmonary embolism have changed little in the past half century. The diagnostic difficulties might be demonstrated by the fact that in our series, of 206 fatal pulmonary embolisms confirmed at autopsy only half were diagnosed clinically. Furthermore, in 33 patients, the clinical diagnosis of embolism could not be confirmed by the pathologist. We think, that in spite of the renaissance of Trendelenburg's operation and the development of new procedures, the best hope for an effective reduction in the rate of occurrence of pulmonary embolism lies in a meticulous prophylaxis by physical measures and by anticoagulant drugs.

SUMMARY

Six hundred and five fatal fulminating pulmonary embolisms were encountered in the surgical department of the Medical School of the University of Heidelberg during the last half century. Statistics revealed special relationships concerning age, sex, general and individual nutritional state, type of operative procedure, postoperative onset, and origin of the embolism. Two of 6 embolectomies were successful having been carried out by a median sternotomy with inflow occlusion of the venae cavae, without extracorporeal circulation. So far, 95 suc-