EMERGENCIES IN GENERAL PRACTICE**PULMONARY EMBOLISM**

BY

R. B. HUNTER, M.B.E., M.B., Ch.B., F.R.C.P.Ed., M.R.C.P.*Professor of Pharmacology and Therapeutics, University of St. Andrews, Queen's College, Dundee*

Pulmonary embolism is thought to be the cause of death in 3% of hospital patients who are examined *post mortem*, but in only one-third of these is the diagnosis made before death. This fact stresses the difficulty in making the diagnosis of this serious and often fatal condition. In a significantly large number of cases pulmonary embolism is not the sudden dramatic incident of acute dyspnoea, chest pain, and circulatory collapse.

Aetiology

The one condition which is essential for pulmonary embolism is that a clot should form in any portion of the cardiovascular system peripheral to the pulmonary artery, and parts of this become detached and be carried by the blood stream into the pulmonary tree. The vast majority of emboli actually come from the deep veins of the legs, some from the pelvic veins, a few from the right side of the heart or from the venous channels in the upper extremities. The facts which are known about the disease are that it occurs principally in patients strictly confined to bed, and that it is rare in patients under 30 years of age. It is as common in medical as in surgical cases, with a notably high incidence among those with heart disease, though in 90% of these the origin of the clot is in the peripheral veins.

Two factors seem to be important in the initiation of deep vein thrombosis, one is slowing of the blood stream, and the other is injury to the vessel wall. Rest in bed produces slowing of the blood stream. Congestive heart failure also results in slowing of the circulation, and when due to mitral stenosis or myocardial infarction appears to be particularly apt to lead to venous thrombosis. Injury to the vessel wall may be of recent origin as in trauma, or there may be chronic insufficiency of the calf veins with distortion and dilatation of the venous channels. Such a state of affairs occurs temporarily during pregnancy, and predisposes the patient to thrombosis.

A small group of cases do occur in apparently healthy, ambulatory individuals, many of whom have recurring episodes of calf-vein thrombosis. It is said that this group, which is rare, is composed predominantly of males, but in my experience these patients are equally often females. Nearly one-third of them develop pulmonary embolism, and when this state of affairs occurs in ambulant patients it is important to consider the possibility of neoplastic disease and thromboangiitis obliterans.

Four events may result from sudden obstruction of the blood flow in the pulmonary arterial system: (1) the development of pulmonary infarction due to the obstruction; (2) the development of acute cor pulmonale because of a sharp rise in right ventricular pressure; (3) peripheral vascular collapse; and (4) the onset of certain cardiac disorders. It must be stressed, however, that pulmonary infarction, cor pulmonale, or cardiac disorders may occur without any dramatic incident. Anoxia may also result and be of sudden or gradual onset in any particular case.

Clinical Picture

The clinical features in any patient with this condition depend on the preponderance of the different factors mentioned, the size of the vessels occluded, movement of the emboli within the pulmonary vessels, and the state of the heart and lungs prior to the onset.

Pain may be due to disturbances in the pulmonary circulation, to pleural involvement, or to impairment of the coronary circulation. Fortunately from the diagnostic point of view, chest pain occurs in 75% of cases, in two-thirds of which it is pleuritic in nature, because of involvement of the pleura overlying the infarction, and in one-third anginal. It has been claimed that the latter is due to reduced coronary blood flow.

Fever occurs in over two-thirds of the patients and a sharp rise of temperature associated with leucocytosis may suggest a diagnosis of pneumonia. The fever does not, however, respond to the administration of antibiotics. Occasionally fever is the principal clinical manifestation of pulmonary embolism, perhaps associated with minimal chest signs on auscultation and a radiograph which is passed as normal.

Breathlessness may result from bronchospasm, immobility or diminished respiratory excursion of the diaphragm, anoxia, pulmonary infarction, or impairment of cardiac function, but it is important to remember that breathlessness may not be present.

Physical signs in the lungs may be absent in spite of chest pain and breathlessness, or, on the other hand, a massive area of infarction associated with a large pleural effusion may dominate the clinical picture, and if, as often happens, the pleural fluid is blood-stained, the diagnosis of pulmonary neoplasm may be entertained.

Cough is almost as common as dyspnoea, occurring in one-third of the patients, but haemoptysis, which is thought to be one of the classical features, is evident in only one-quarter of the cases.

Occasionally the presenting picture is one of acute cor pulmonale without any history of deep venous thrombosis or complaint of chest pain or haemoptysis. Under these circumstances there may be prominent pulsation over the pulmonary artery, dilatation and pulsation of the jugular veins, and cyanosis. In these cases a loud pericardial friction rub may be heard over the pulmonary area. This clinical picture may persist for days or weeks, or may be transient, particularly if right heart failure supervenes. Paroxysmal auricular fibrillation, paroxysmal auricular tachycardia, high-grade auriculo-ventricular block, and bundle-branch block may occur as part of the clinical picture.

Sudden chest pain and fever are therefore the commonest presenting features of pulmonary embolus and may on occasion be found without any other symptoms or signs. The diagnosis may be obvious or very difficult. I recently attended the post-mortem examination of a patient who was twice in my wards with "pneumonia." Pulmonary embolism was suspected because the response to antibiotics was unsatisfactory, but no confirmatory evidence could be found on detailed clinical, radiological, or cardiographic examinations. After her second admission she was sent to a convalescent home, where she died suddenly from a massive embolus. At post-mortem examination a solid clot extended from the deep calf veins to the inferior vena cava.

In the physical examination of the case of suspected embolism care has to be exercised, and on no account should the patient be asked to breathe deeply to facilitate auscultation of the chest. Death has occurred under such circumstances following the sucking of a large clot into the chest. The administration of adequate laxatives is also important to avoid straining at stool.

It will be evident from this account that the clinical picture may simulate many other disorders, more commonly pneumonia, acute myocardial infarction, pleurisy with effusion, pulmonary neoplasm, acute heart failure, or asthma.

Electrocardiographic examination is of great value in distinguishing acute pulmonary embolism from myocardial infarction, particularly when the patient complains of substernal pain. In pulmonary embolism there is usually electrocardiographic evidence of acute right ventricular stress. The changes are maximal within the first three days and may persist for weeks. In 15% of cases there is transient right bundle-branch block, making differentiation from myocardial infarction very difficult. A normal electrocardiogram, however, does not exclude pulmonary embolism.

Radiological Examination of the Chest.—When embolism occurs without infarction there may be a segmental area of increased translucency owing to absence of vascular shadows in the ischaemic area. Rounded or wedge-shaped shadows may be visible when infarction occurs. There may be no radiological signs or a massive area of consolidation. Radiological signs are so variable that I doubt the wisdom of moving a patient in domiciliary practice for this examination alone.

Diagnosis and Prognosis

It is obvious that a massive pulmonary embolus occurring without warning or signs of deep vein thrombosis cannot be anticipated and prevented. In my experience, however, more than half the cases which develop a pulmonary embolus have symptoms or signs before the major accident which are disregarded, some by the patient—such as pain in the calf; some by his medical attendant—unexplained pyrexia, slight chest pain, or a short attack of breathlessness—because many physicians still hesitate to consider the diagnosis without severe breathlessness, chest signs, and haemoptysis. The realization that pulmonary embolism may occur without dramatic symptoms and signs is all-important, and in such patients anticoagulant therapy should be instituted when deep vein thrombosis or a small pulmonary embolus is suspected. All seriously ill persons should have regular and frequent examinations of the calves for tenderness.

Published results suggest that 40% of patients who experienced a minor incident had a major embolism, and half of them died before the institution of anticoagulant therapy. In my experience, 18% of patients who had an embolus had a second one in spite of adequate anticoagulant therapy. The death rate in these treated cases was, however, greatly reduced, being in the region of only 2%. Anticoagulant therapy is therefore a major advance in the treatment of pulmonary embolism.

Treatment

Cases fall commonly into two clinical groups from the point of view of treatment. (1) The small embolus associated with chest pain, some rise of temperature, and perhaps slight breathlessness. Morphine, 15–20 mg. ($\frac{1}{4}$ – $\frac{1}{2}$ gr.), should be given initially by subcutaneous injection to allay distress and anxiety and anticoagulant therapy instituted. If such cases are not treated there is a risk of a second major embolus and also the danger of extension of the clot in the pulmonary tree giving rise to the gradual development of cor pulmonale or a large area of infarction without any further major incidents. Many cases in this category are diagnosed as pneumonia and are found resistant to treatment for that condition. (2) A large embolus, producing shock, acute breathlessness, pleural or substernal pain, cyanosis, and a fall of blood pressure. Morphine, 20 mg. ($\frac{1}{2}$ gr.), and atropine, 1 mg. (1/60 gr.), should be given by subcutaneous injection immediately and heparin is also urgent (see below). Morphine, 15 mg., may be repeated in one hour if considered necessary. Oxygen therapy is indicated if anoxia is marked.

Further treatment depends on developments. The patient may require treatment for cardiac failure or the intravenous injection of 0.5 g. of aminophylline for bronchospasm. In patients who have a large lung infarct it is wise to give antibiotics prophylactically.

When is it desirable to move the patient to hospital? Cases which have had a small embolism without shock or collapse can usually be moved at any convenient time, but they should be under the influence of heparin when this is done. Those who have suffered a massive embolism with shock and circulatory collapse are not fit to move. The temptation must be resisted to rush these cases to hospital for anticoagulant treatment. Difficult though the treatment may be to carry out in the home, therapy as detailed below should be carried out there until the patient is sufficiently recovered to withstand the stress of the journey.

Anticoagulant Therapy

Heparin is the drug of choice for the initial treatment of pulmonary embolism, and 15,000 units should be given intravenously by the practitioner whenever the diagnosis is made, and 10,000 units at six-hourly intervals thereafter. It is safe to administer heparin in this way, and control clotting times are unnecessary. Heparin prevents extension of the clot and promotes its resorption; it also has a vasodilator action. Its administration should be continued for three to five days. At a suitable time during this period the patient should be transferred to hospital for coumarin therapy. Heparin is of less value than coumarin-type anticoagulants in producing recanalization in the thrombosed vessel, both in the lungs and in the deep calf veins. It is unfortunate that coumarin treatment requires laboratory control, but it can be perfectly well carried out in the home if the laboratory facilities are at hand.

On the last day of heparin treatment 100 mg. of phenylindanedione (P.I.D.) should be given twice by mouth. The following morning the one-stage clotting test* is carried out, and further dosage of P.I.D. determined. During the first week of P.I.D. therapy daily estimations by the one-stage clotting test are required, but thereafter weekly or fortnightly estimations are usually sufficient. Over 70% of patients are maintained satisfactorily with a dose of 50 mg. a day. In the cases in which there are no further complications therapy should be continued till the patient has been fully ambulant for about a week or until there is resolution in the area of pulmonary infarction. The most remarkable improvement often occurs in an area of lung apparently irreparably damaged. When there is persistence of lung signs or evidence of acute cor pulmonale, treatment may have to be continued at home or in hospital with weekly laboratory checks for months. Some of our patients who required six to eight months' treatment have made a complete functional recovery.

In cases with recurrent pulmonary emboli, particularly when associated with mitral stenosis or migrating thrombophlebitis, permanent out-patient anticoagulant therapy should be considered.

Contraindications to Therapy.—Anticoagulant therapy is contraindicated under the following circumstances: if the patient is known to have a duodenal ulcer, malignant disease, advanced hepatic or renal disease, or any bleeding diathesis. It is also probably wise to avoid this form of therapy in severe hypertension if there is a history of cerebral thrombosis or if cerebral embolism has occurred within the previous fortnight.

Prevention

Early ambulation after operation or illness is desirable. Breathing exercises and foot and leg movements should be carried out in all patients confined to bed. These need not be elaborate, can easily be carried out in the home, and do not require the supervision of a physiotherapist. Flexion

*Quick, A. J., Stanley-Brown, M., and Bancroft, F. W., *Amer. J. med. Sci.*, 1935, 190, 501.

and extension of the ankle and knee-joints, together with clockwise and anticlockwise rotation of the feet, carried out two or three times a day is all that is required. In patients with a previous history of deep vein thrombosis, or thought to be likely subjects for thrombosis, knee-length elastic stockings should be fitted and worn during the period of bed rest. Thigh-length elastic stockings are undesirable because they wrinkle at the knee and may themselves traumatize the veins. Wilkins and his colleagues (*New Engl. J. Med.*, 1952, 246, 360) have shown that this simple procedure is sufficient to increase the blood flow in the calf veins and reduce the incidence of thrombosis. Patients with a history of deep venous thrombosis who are too ill to carry out leg exercises efficiently should be given anticoagulant drugs prophylactically and the foot of the bed should be elevated. A superficial vein thrombosis is not an indication for anticoagulant therapy. In fact, such treatment is contraindicated when phlebitis is present. But it must be remembered that patients in this group may also have damaged calf veins and may develop deep thrombosis. In pregnancy it is almost certain that patients have abnormally dilated deep veins and a careful watch must be kept when superficial thrombosis occurs.

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THE QUEEN AT HAMMERSMITH HOSPITAL

To mark the jubilee of the Hammersmith Hospital and the twentieth anniversary of the inauguration of the Postgraduate Medical School of London, which is associated with it, the QUEEN paid a visit to both institutions on June 6. Her Majesty was received at the entrance to the hospital by the MINISTER OF HEALTH (Mr. Iain Macleod), and proceeded at once to the School, where she was first shown documents relating to its opening by George V in 1935, one of his last public engagements. She then proceeded to one of the wards, where postgraduate students, including those from the Commonwealth and Empire, were in attendance. Three special exhibits were inspected by Her Majesty. The first was the metabolic unit, built last year for the investigation of metabolic disorders, including the effect of radiation upon the human body. The second was the Medical Research Council unit, a new building containing besides research laboratories an 8-million-volt linear accelerator and a 45-in. (1.1-m.) medical cyclotron. The third was the exhibition illustrating the research work of the School in the fields of surgery, medicine, obstetrics and gynaecology, and pathology. In the surgery section a display which caught the eye was the artificial heart-lung machine. The effect of operation and anaesthesia on the circulation was also ingeniously shown. The medical exhibit included a mass spectrometer for the instantaneous analysis of respired gases. Another exhibit was designed to demonstrate advances in the treatment of hypertension with new drugs. In the pathology section there were displays of improved vaccines for the treatment of chronic staphylococcal infections, and of the mechanisms of inheritance and variation in bacteria. Finally, the Queen spent some time in the wards and paid a visit to the nurses' home.

Correspondence

Because of the present high cost of producing the Journal, and the great pressure on our space, correspondents are asked to keep their letters short.

The Ban on Heroin

SIR,—The banning of heroin seems to have produced in your correspondence columns a good deal of heat without much light. On the one hand we have the decision of an international committee, composed of not inconsiderable clinicians and pharmacologists, including members of the Narcotics Commission of the U.S.A. whose exhaustive researches on the addiction problem entitle them to a careful hearing; on the other hand we have the conviction of a number of distinguished clinicians that heroin is sometimes the only effective analgesic. The path of therapeutics is strewn with rejected remedies once held to be of great clinical importance, but there has been more than one instance where hasty generalizations largely on negative evidence have led to the unjustified condemnation of a remedy. In two instances to which I am referring, cod-liver oil and liquid extract of ergot, clinicians persisted in using them, and eventually their effectiveness was objectively established by the discovery of the vitamin content of the first and the ergometrine content of the second. Heroin is, however, to be banned without evidence of the kind that could objectively establish whether the clinical impressions of your correspondents are soundly based or not. A final trial of an analgesic, as any pharmacologist who has worked with them knows, can only be carried out on the clinical case. The particular claim made for heroin would entail difficult and protracted work, but the issue at stake, the relief of the agony of the dying, is so important that an attempt at a controlled trial should be made. The size and nature of the list of substitutes for heroin suggested show that the kernel of the problem has been missed. These substitutes are, it is true, remarkably similar qualitatively. They all reproduce the specific actions of morphine, but there are quantitative differences in their action. For example, their relative action in depressing respiration is not proportional to their analgesic activity. There is an *a priori* reason for supposing that the claim for retaining heroin may be sound. The effect of the morphine group in alleviating pain is almost certainly not a specific annulment of the impulses transmitted through pain fibres but a cerebral action related to the sense of euphoria produced. It is just because of its outstanding euphoric effect and consequent addiction production that the use of heroin is to be abolished.

Is the social evil of heroin addiction in this country sufficiently large to outweigh the therapeutic advantage which heroin may possess? After all, the social evil of addiction to alcohol is far graver, not only in this country but in others, than addiction to narcotic drugs. The community has decided, however, that the solace the majority get from alcohol justifies the use of strict regulation rather than abolition as a means of diminishing its use by that abnormal section of the community which may become addicts.—I am, etc.,

London, N.W.1.

J. TREVAN.

"Half-minute" Thermometers

SIR,—I think it is universally believed not only by the medical and nursing professions but by the entire population that when a thermometer is inscribed as "half-minute" it indicates the manufacturer's assurance that it will register the temperature of a human being in that space of time. We all know that this is not true. But we have grown up to it from the nursery, and I have no recollection of hearing a discussion as to how the manufacturers arrive at this figure or if it has any other meaning.

I heard an explanation a year or two ago which was new to me. I was told that "half-minute" had nothing to do