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A DEVICE FOR THE PREVENTION OF
PHLEBOTHROMBOSIS AND PULMONARY EMBOLISM

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Pulmonary embolism has long remained the most serious complication which occurs after major surgery. The problem has been studied for over a hundred years in an attempt to lessen the tragic mortality which frequently is unexpected and occurs in patients who otherwise are in good health with a normal life expectancy. Phlebothrombosis has been recognized as the antecedent of embolism since the work of Virchow, Frykholm, Bauer, and Homans. While it has been known that the veins of the legs and pelvis are the common origin of the clots, the pulmonary embolus frequently is the first sign of trouble. Ochsner, McLachlin, Robertson, Lam, and others have shown that only about 50% of patients who developed emboli showed any evidence whatsoever of phlebothrombosis before the pulmonary emboli occurred.

Our Surgical Staff has always been acutely interested in the problem of pulmonary embolism. McClure and Lam in 1940 obtained some of the early heparin and were the first to report on its clinical use in this country. Following the teachings of Bauer and Homans, it is our practice to examine, twice daily, the legs of patients in the post-operative state for signs of tenderness and to carefully note the course of the post-operative temperature and pulse. When positive findings are noted, the patient is treated either by superficial femoral vein ligation as advocated by Allan, or by anti-coagulants. In recent years, we have used anticoagulants in treating the great majority of patients. Early post-operative exercises in bed and early ambulation have been carefully practiced and have been of significant importance in the prevention of pulmonary complications.

In spite of all the above precautions, the deaths from pulmonary embolism continue, most often when they are least expected. This is understandable because the clots in the veins of the leg and pelvis give symptoms only when they become attached to the vein wall and the greatest danger of pulmonary embolism is already passed.

Irrespective of the site of venous thrombosis and the possibility of detecting it before pulmonary embolism has occurred, it is generally accepted that venous stasis in the lower extremities is the prime factor in venous thrombosis and subsequent pulmonary embolism. We believe that venous stasis may occur whenever a patient is bedridden, but most commonly occurs during an operation and in the first 24 hours thereafter. Several methods have been devised to decrease the stasis of blood which occurs in the leg veins during surgery. McLachlin and McLachlin described a method of preventing stasis by electrically stimulating the calf muscles during surgery. This caused contraction of the muscles which are the "normal peripheral venous heart." Wrapping the legs during and after surgery has been popular from time to time.

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Brush and others

We have recently made use of the pump which we devised for the treatment of lymphedema. By placing each leg in a pumping boot extending up to the groin prior to the operation and utilizing the pump during the operation and for the first twelve to twenty four hours thereafter, venous stasis is prevented. Figure I shows the apparatus as it is applied. Air is pumped into the boot and then exhausted in a rhythmic cycle. This gentle upward compression has the effect of emptying the leg veins every minute.

We have to date been using this method chiefly in patients who have had venous thrombosis and pulmonary embolism after a previous operation. These people, we believe, are particularly susceptible to trouble when a subsequent operation is done, and thus are candidates for this management. It will, of course, take a large series of patients to prove statistically the value of this apparatus, but we are encouraged by our work to date.

Figure 1

Pumping Boots in Place on a Patient for Prevention of Venous Stasis.

*This apparatus is made by the Jobst Institute, Toledo, Ohio.
Phlebothrombosis and Pulmonary Embolism

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