Noninvasive Testing in the Diagnosis of Pulmonary Embolism

PIOPED Revisited

There have been myriad attempts to identify reliable, cost-effective, and readily available tests to use in the noninvasive diagnosis of pulmonary thromboembolism. In this issue of CHEST (see page 78), Stein and colleagues present their findings regarding the utility of arterial blood gas analysis as a diagnostic aid in pulmonary embolism. Their analysis is based on the well-known PIOPED data.

The chest radiograph, electrocardiogram, patient history and physical examination, and arterial blood gas analysis have all been examined in great detail to assess their value in aiding the diagnostic efforts in pulmonary thromboembolism. Despite great hopes of identifying an inexpensive, reliable, and readily available test to diagnose this common malady, significant inadequacies of both sensitivity and specificity have restrained enthusiasm for all such efforts to date. It is estimated that there are over 630,000 symptomatic cases of pulmonary embolism annually in the United States. Estimates of mortality attributable to pulmonary embolism in the United States annually range from 8,000 to 200,000 deaths.

Dead space determination, spirometry, and arterial blood gas analysis in combination, have been advocated as a useful tool in pulmonary embolism diagnosis. D-dimer, thrombin-antithrombin III complex, lactate dehydrogenase (LDH), serum glutamate oxaloacetate transaminase (SGOT), bilirubin, fibrinopeptide-A, and β-thromboglobulin levels have been reported useful in diagnosing pulmonary embolism. Virtually all clinical and laboratory findings neither diagnose nor exclude the diagnosis of pulmonary embolism. They merely serve to heighten suspicion of the diagnosis and prompt the clinician to pursue additional diagnostic studies.

Despite dozens of studies investigating numerous prospects, only the ventilation/perfusion lung scan, when interpreted using an accepted schema (such as the modified PIOPED criteria), has adequately documented diagnostic sensitivity and specificity to reliably exclude the diagnosis of pulmonary embolism, and in certain cases diagnose pulmonary embolism reliably. Clinical probability of pulmonary embolism based on an experienced clinician’s assessment can increase the diagnostic sensitivity of the ventilation/perfusion lung scan. How can we obtain the skill to make accurate clinical probability determinations? Such decision making prowess is indisputably the result of “good judgment.” Good judgment in turn, results from “experience.” Experience, unfortunately, is often the result of “bad judgment.” The hope is that by developing reliable ancillary tests the necessity for expert clinical judgment will become less critical in making this often elusive diagnosis.

Ventilation/perfusion lung scanning is not without its limitations. Despite the development of several sets of interpretation systems, there remains an unmistakable art to this craft. Interinterpreter analysis is not trivial. The test is not rapidly available at all hospitals, and it is not without expense.

In our era of cost consciousness, in the case of a relatively common condition such as pulmonary embolism, we would hope to avoid overuse of a test such as the ventilation/perfusion lung scan. Typically, less than one third of ventilation/perfusion lung scans detect or lead to the detection of pulmonary embolism. Because this is a common disease process in hospitalized patients, can be immediately life threatening, and can generally be effectively treated, it must be sought aggressively when suspected. Failure to do so may lead to preventable morbidity or mortality. I will leave cost analysis discussions to experts in that field, but I doubt anyone will disagree with my desire to have useful and reliable ancillary tests developed to aid the clinician in diagnosing pulmonary embolism.

It is also obvious that not all pulmonary emboli are equally sinister. If diagnosed promptly and treated appropriately, mortality is uncommon (2.5% to 8%), and pulmonary embolism rarely recurs. What is a “clinically significant” pulmonary embolism? This issue has evaded definition for decades. We can certainly describe a “life threatening” pulmonary embolism, but who can unequivocally label a pulmonary embolism clinically insignificant in a living patient? Autopsy studies have shown an 8 to 52% incidence of pulmonary embolism. Two to 14% of autopsied patients were thought to have had pulmonary emboli contribute to their death. Of these, only 16 to 38% were diagnosed with pulmonary embolism before death.

In patients without preexisting cardiopulmonary disease, the degree of hypoxia and elevation of pulmonary vascular resistance correlate fairly well with the degree of pulmonary artery occlusion by thrombus. This relationship does not hold as well in patients who do have preexisting cardiopulmonary disease. This decreases the value of arterial blood gas data in this group. Unfortunately, this is one of the groups at increased risk of developing this disease.

Pulmonary arteries are often intentionally occluded during surgical procedures. This is generally well tolerated. Occlusion of that same main or lobar pulmonary artery by a thromboembolism may have significant physiologic consequences. The differences in response seem related to the release of humoral mediators. A recent review details the physiologic mech-
organisms believed responsible for the gas exchange abnormalities often accompanying pulmonary embolism.\textsuperscript{12} The reader is directed there for a detailed discussion.

Stein et al have redemonstrated, and quite convincingly, that the arterial blood gas test has only limited utility in aiding in the diagnosis of pulmonary embolism. This counters some other recent findings.\textsuperscript{13} It is not the “Holy Grail” we seek. We should not abandon this quest, but rather continue to redirect our search in new and innovative directions. One day this great scourge of mankind will lose some of its mystique; our ability to tame it will improve, and our patients will be well served by our efforts.

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\textbf{REFERENCES}


\textbf{Intermittent Pneumatic Compression for the Prevention of Venous Thromboembolism}

Intermittent pneumatic leg compression is an effective method for preventing postoperative deep vein thrombosis. Because deep vein thrombosis is the precursor for pulmonary embolism, it has been assumed that this widely used modality is effective in reducing the frequency of fatal and nonfatal pulmonary embolism.\textsuperscript{14}

Administration of low dose subcutaneous heparin is also an effective method for preventing postoperative deep vein thrombosis and historically has been the most widely used prophylactic approach.\textsuperscript{5-7} Unlike intermittent pneumatic leg compression, for low dose heparin prophylaxis there is direct evidence that this pharmacologic approach significantly reduces fatal pulmonary embolism.\textsuperscript{5} Few studies, however, have used objectively diagnosed pulmonary embolism as the primary outcome event. The use of intermittent pneumatic leg compression perioperatively and postoperatively to reduce the frequencies of thromboembolic complications is based on a sound physiologic rationale. The prevention of venous thrombosis is likely associated with the observation that the achievement of high flow pulsatility empties the deep veins periodically, thus overcoming venous stasis.\textsuperscript{9,10} Furthermore, there is evidence that physiologic effects are achieved, such as enhanced fibrinolysis.\textsuperscript{11} Thus, intermittent pneumatic compression affects Virchow’s triad in two of the three domains, \textit{ie}, decreased stasis and altered coagulation.\textsuperscript{9,11}

Intermittent pneumatic compression has been studied in a broad spectrum of patients and has been shown to be both effective and safe.\textsuperscript{12-25} The patient populations studied had experienced a variety of surgical procedures—general surgery,\textsuperscript{12-14} gynecology,\textsuperscript{15} neurosurgery,\textsuperscript{16,17} orthopedics,\textsuperscript{18-24} and urology.\textsuperscript{25} Compared with no prophylaxis, intermittent compression clearly is effective in reducing distal deep vein thrombosis. Where bilateral venography is used to define the end point, intermittent pneumatic compression also reduces the incidence of proximal deep vein thrombosis. Intermittent pneumatic compression is especially useful in patients at high risk of bleeding complications, such as in neurosurgery and pelvic cancer surgery, or in situations where pharmacologic agents are contraindicated, as in multiple trauma.

On the other hand, intermittent pneumatic compression devices are somewhat cumbersome and inconvenient, potentially leading to less than optimal compliance rates by patients and nursing staff. The cumbersome nature of these devices has been overcome by the more modern versions. There are certain