capacity may be the most sensitive guide to the severity of diffuse lung disease. A flow volume loop may help in the assessment of upper airway obstruction, but an inspiratory tracing on the spirogram is usually just as revealing. It would be better if the physician decided what specific measurements were important and requested them rather than seeking a panoply of tests with a long printout of results.

In summary, if the clinic ward and office were equipped with spirometer, oximeter, and a pressure gauge for measuring respiratory muscle strength, most referrals to the pulmonary function laboratory could be avoided, relevant information would be provided more rapidly and in a more meaningful fashion, and the repeated measurements that are often necessary for the proper follow up and treatment of patients could be obtained. Physicians would also have a better understanding of their patients and of their lungs.

M. Henry Williams, Jr., M.D., F.C.C.P.
Bronx, New York

Improving the Cost-efficiency of Oxygen Therapy

Hypoxemia is an important and common complication in patients with chronic obstructive pulmonary disease (COPD). It may contribute to reduced survival due to pulmonary hypertension and right heart failure. Hypoxemia may be present at rest and may also develop or worsen during physical activity or sleep.1,4,5

Chronic oxygen therapy for selected patients with COPD has become well established and widely used in recent years. Two large multicenter studies demonstrated improved survival accompanying oxygen therapy in COPD patients with resting hypoxemia.6,7 The Nocturnal Oxygen Therapy Trial (NOTT) study in the United States showed increased survival with “continuous” compared to nocturnal oxygen (12 hours).8 The study by the British Medical Research Council demonstrated improved survival comparing intermittent oxygen (15 hours) with no oxygen.4 Based on these studies, continuous oxygen therapy has been recommended for patients whose resting PaO2 is less than 55 mm Hg. In addition, intermittent oxygen has been advocated and used increasingly during exercise and sleep to alleviate hypoxemia occurring at those times.

The availability of several types of systems for outpatient home oxygen therapy, including ambulatory therapy, has made long-term, continuous oxygen use practical and safe.6 However, the economic costs of widespread use of such systems are significant (more than $300 per month for continuous delivery of 2 L/min). Given the importance of allocating limited medical resources wisely, appropriate guidelines for cost-effective therapy are essential. The medical profession, patients, medical equipment suppliers, third party payers, and government agencies all must realize that such guidelines are in the best interests of everyone.

One approach to improve the cost-effectiveness of oxygen therapy is the development of more efficient techniques for oxygen delivery. Typically, low flow oxygen is provided at a constant flow rate through a nasal cannula. This results in a significant waste of oxygen since the gas continues to flow throughout the respiratory cycle, although most of the benefit occurs from oxygen available during early inspiration. One method to conserve oxygen is the use of a small reservoir which stores oxygen during expiration and supplies it on demand during inspiration.

The article in this issue by Carter and coworkers (see page 806) provides an important clinical demonstration of the use of a pendant oxygen-conserving cannula during exercise in COPD patients. Compared to continuous flow oxygen, the pendant resulted in a two thirds reduction in the amount of oxygen required to achieve an equivalent SaO2 at similar workloads. These results are similar to those described using this device at rest in another group of patients.6 Use of the pendant may be an advantage over the previously described bulky nasal reservoir in achieving patient acceptance.7 Conserving oxygen for these patients not only reduces the cost of therapy, but also importantly extends the time that portable systems can be used between refills. This is a significant advantage for exercise training programs and for improving ambulatory therapy.

Carter et al also emphasize the importance of providing patients with an appropriate oxygen prescription both at rest and during exercise. The occurrence of exercise-induced hypoxemia is unpredictable in COPD patients.8 One cannot just assume that the oxygen dose will be the same at rest and with exercise; patients may need more (or less) with physical activity.

The cost of long-term oxygen therapy certainly justifies attempts to develop more efficient techniques for oxygen delivery and more clinical studies to define the optimal methods and appropriate, cost-effective guidelines for its use. The study by Carter and coworkers is a step in the right direction.

Andrew L. Ries, M.D., F.C.C.P.
San Diego

Assistant Professor of Medicine, Division of Pulmonary and Critical Care Medicine, University of California Medical Center.
Reprint requests: Dr. Ries, UCSD Medical Center, H772, 235 Dickinson Street, San Diego 92103
REFERENCES


Pulmonary Arteriovenous Malformations, Aneurysms and Reflections

Almost 100 years have elapsed since Churton described the anatomic findings in a 12-year-old boy with multiple pulmonary arteriovenous aneurysms (PAVA). Since then, about 500 cases have been reported in the literature. Notwithstanding this experience, basic questions concerning terminology, etiology, diagnosis, optimal management and natural history still deserve consideration.

Nomenclature is confused by the plethora of descriptive terms (including aneurysm, fistula, malformation, angioma, hamartoma and hemangioma) which are often used imprecisely. In addition, studies which demonstrate the passage of particles many times larger than pulmonary capillaries through the normal pulmonary vascular bed support the concept that functional arteriovenous connections exist in the normal lung, despite the failure to demonstrate such vessels morphologically. It has been suggested that such passages may serve as safety valves to protect the capillary bed from pathologic increases in pressure or flow.

While recognizing that present understanding is incomplete, it seems reasonable to suggest that the term "pulmonary arteriovenous malformation" (PAVM) be used to include both arteriovenous connections visible on angiographic examination (PAVA) and those rare microscopic arteriovenous communications associated with abnormal intrapulmonary shunting which are too small to be visualized radiographically. This terminology, pragmatic rather than scientific, does not exclude the possibility (suggested by physiologic principles and clinical experience) that initially microscopic arteriovenous connections may enlarge with time, eventually reaching macroscopic proportions. Indeed, such a sequence may explain the delayed clinical presentation of many patients with this congenital disease. In two recent series, mean age at diagnosis was 39 and 41 years.

The reciprocal relationship between PAVA and Osler-Weber-Rendu disease (OWRD) is well-documented; in one large series, 36 percent of patients with single PAVA and 57 percent of those with multiple lesions had OWRD. Conversely, 15 percent of 91 members of a family with OWRD had PAVA. Patients with coexistent OWRD have an increased incidence of multiple PAVA and a higher rate of complications. Acquired PAVA are rare, but have been reported in association with cirrhosis, carcinoma, trauma, chest surgery, actinomycosis and schistosomiasis.

The role of noninvasive procedures in the diagnosis of right-to-left shunting deserves emphasis. Both contrast echocardiography and perfusion lung scintigraphy are useful screening procedures since a negative result excludes the presence of right-to-left shunting and a positive result confirms the diagnosis without risk to the patient. Scintigraphic examination has the advantage of providing a quantitative estimation of the magnitude of the shunt. One of these procedures should be performed prior to angiographic study in all cases and may be an important diagnostic clue in those rare patients with microscopic arteriovenous connections. Nevertheless, pulmonary angiography still remains the diagnostic gold standard for PAVA. In surgical candidates, angiographic examination is mandatory not only to establish the diagnosis, but also to exclude the presence of additional lesions and provide details of arterial supply and venous drainage. In patients unsuitable for or unwilling to undergo definitive treatment, scintigraphic or echocardiographic study should be conducted to confirm the clinical suspicion of PAVM.

Management options for PAVA include occlusion by embolotherapy, surgical excision, or deferral of treatment pending the onset of complications such as hypoxemia, dyspnea, hemoptysis, hemothorax or brain abscess. As is often the case in clinical medicine, decision-making is hampered by the paucity of relevant data; i.e., long-term outcome in untreated patients vs those subjected to occlusion or excision procedures. The sine qua non for informed decision-making, a clinical trial, seems unlikely to be carried out given the rarity of the condition, the duration of follow-up necessary and current perceived priorities. However, a